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BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

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BITS Pilani

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Bulletin
2019-20









55 Completing Years
in the service of the nation

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INSTITUTE EMBLEM

The Emblem of the Institute represents a synthesis of Science, Humanities and Engineering with Lotus representing Humanities & Social Sciences, the Structure of Molecule representing Science, and the Figure of Rocket representing Engineering & Technology.

The Motto is –

'Knowledge is power supreme'

BITS VISION

“What do we propose to do here? We want to teach real science whether it is engineering, chemistry, humanities, physics or any other branch. We want to develop a scientific approach in Pilani, which means there would be no dogma. There will be a search for truth. What we propose to do here is to cultivate a scientific mind.”

— The Late Shri G.D. Birla
Founder Chairman, BITS, Pilani

“ … to prepare young men and women to act as leaders for the promotion of the economic and industrial development of the country and to play a creative role in service to humanity.”

— The Late Dr. K.K. Birla
Former Chancellor, BITS, Pilani

“What is it that can empower our nation? The most obvious answer is education. Education that enhances livelihoods but also education that is value-based. Education that gives roots and gives wings as well”.

—Dr. Kumar Mangalam Birla
Chancellor, BITS, Pilani

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HIGHLIGHTS

- Multi-campus University with campuses at Dubai, Goa and Hyderabad
- *Admission in both semesters*
- *Admission only on merit through a unique computer based on-line admission test, BITSAT*
- *20 – 30 Board toppers join every year*
- *Scholarship to 30% of students*
- *Academic flexibilities – Dual Degree – a unique combination of Science and Engineering education*
- *Modular and flexible academic structure*
- *Vertical transfer options from First Degree to Higher Degree/ Ph.D.*
- *Continuous, internal, transparent evaluation system*
- *Practice School – strong linkages with industries*
- *Work-Integrated Learning Programmes for employed professionals*
- *State-of-the-art institutional library with over 2 lac books*
- *State-of-the-art Campus-wide computer network*
- *Large number of Alumni in top positions in India and abroad*
- *Very strong Alumni network*
- *Collaboration with foreign universities of repute*
- *Entrepreneurial Leadership Development*
- *Many societal development projects – Rain Water Harvesting, Desert Development Technologies, Women Empowerment, Healthcare*
- *Major cultural, academic and sports events – OASIS, APOGEE and BOSM - organized by students*
- *Privately funded with an affordable fee structure*

PART I

GENERAL INFORMATION











HISTORY AND PURPOSE

The Birla Institute of Technology and Science (BITS), Pilani is an all-India Institution declared as deemed to be university established under Section 3 of the UGC act. It is privately supported, fully residential and admits both male and female students. The primary objectives of the Institute are "to provide for and otherwise promote education and research in the fields of Technology, Science, Humanities, Industry, Business, Public Administration and to collate and disseminate in such fields effective ideas, methods, techniques and information as are likely to promote the material and industrial welfare of India" and to "train young men and women able and eager to create and put into action such ideas, methods, techniques and information".

The Institute was initially registered as a Society under the Rajasthan Societies Registration Act of 1958 on the 13th May, 1964. Subsequently, by notification published in the Gazette of India dated the 27th June, 1964, the Ministry of Education, Government of India, declared that the Institute being an institution for higher education shall be "deemed to be a University". The Institute started functioning with effect from 1st July, 1964 with late Shri G.D. Birla as its Founder Chairman.

The Institute started as a small "Pathshala" in Pilani way back in the year 1901 by Seth Shiv Narainji Birla with one teacher for educating his grandsons, late Shri G.D. Birla and late Shri R.D. Birla. Pilani was then a small isolated desert village in Rajasthan. The Pathshala evolved slowly and steadily into a High School in 1925 and became an Intermediate College in 1929. The Birla Education Trust was founded in the same year. The Intermediate College developed into a Degree College in 1943. In 1947, this college was raised to postgraduate level. In 1950, Pharmacy courses were started in this college, and in 1952, it was bifurcated into College of Arts and the College of Science, Commerce and Pharmacy.

During World War II, the Government of India established a Technical Training Centre at Pilani for the supply of technicians for Defence Services and industry. In 1946, late Shri G.D. Birla decided to convert it into an engineering college with degree programmes in Electrical and Mechanical Engineering. Master's programme in Electronics was started in 1955. B.E. programmes in Civil Engineering and Chemical Engineering were started later. In 1964 with the inception of the Birla Institute of Technology and Science, the colleges, viz., Birla College of Science, Commerce and Pharmacy, Birla College of Arts and Birla College of Engineering situated at Pilani, as also all properties, movable and immovable, together with educational facilities, hostels, staff quarters, playgrounds, etc., became part of the Institute and all these properties were vested in it. During the early years of its inception, i.e., 1964 to 1970, the Institute with the support of Ford Foundation Grant had the advantage of having collaboration with Massachusetts Institute of Technology (MIT), USA. It adopted the semester system, modular structure of courses, continuous and internal evaluation, letter grading, etc. It also created institutionalized linkages with the industries. Over a period of time, the Institute also introduced several flexibilities in its educational programmes.

Dr. K.K. Birla who took over as the Chairman of BITS in 1983 was deeply involved and closely associated with his visionary father in running both the earlier Birla Colleges and the current institute BITS, since its inception. With his spirited involvement in all the activities of the Institute, he was able to see the vision of his father Late Shri G.D. Birla unfolding. Taking over the responsibility of running the institute, Dr. K.K Birla who became the Chancellor in 2003 realized the need for greater number of promising graduates in the field of science and technology in shaping up the nation’s development. Hence he initiated an increase in the number of students at Pilani campus during 1999 which gradually carried the total strength from 2500 to 4000. Under his patronage, BITS started expanding by establishing three campuses, first in Dubai in the year 2000,second in Goa in the year 2004 and third in Hyderabad in the year 2008.

Consequent upon the sad demise of Dr. K.K. Birla on 30 August 2008, Dr. Kumar Mangalam

Birla was elected as the Chancellor and Smt. Shobhana Bhartia was appointed as the Pro-Chancellor of the Institute. Under the leadership of young and dynamic Chancellor, BITS is taking steps to scale greater heights.

BITS Pilani – Accreditations and Ranks.

BITS Pilani strives hard to attain greater heights in education, research and outreach. BITS Pilani participates in as many ranking and accreditation process as possible.

International: BITS Pilani is now ranked in the Global University ranking of both THE (Times Higher Education) and QS (Quacquarelli Symonds) (Which are the most internationally eminent Rankings published. The ranking in 2018 are as follows: THE Global ranking range 801-1000; THE Asia ranking range 201-250. The QS Global ranking range 801-1000; The QS Asia ranking 187; The QS BRICS ranking 109.

NAAC: In the year 2000, BITS was accredited in its first cycle, by NAAC with the highest possible rank in University accreditation. In 2008-2009, the NAAC peer team visited BITS campuses at Pilani, Goa and Dubai and BITS Pilani, has been reaccredited in its second cycle with CGPA 3.71 on four point scale at the highest 'A' grade. Again in 2016, the NAAC peer team visited BITS campuses at Pilani, Goa and Hyderabad and BITS Pilani has been reaccredited in its third cycle with a CGPA 3.45 with 'A' grade.

NIRF: National Institutional Ranking Framework (NIRF) has ranked BITS Pilani at 9, 13, 17, 23 in years 2016, 2017, 2018 and 2019 respectively, in University Category based on the data of all four campuses. Specifically in 2019 our ranking in overall category is 39, in engineering 25 and in pharmacy 5.

University Categorization: In order to grant autonomy to better performing institutions, UGC has notified UGC [Categorization of Universities (only) for Grant of Graded Autonomy] Regulations 2018 on 12th February 2018, in the Gazette of India. Based on our proposal the UGC in its 532nd meeting held on 24.5.2018, decided to grade BITS Pilani, as Category II Deemed to be University.

Institution of Eminence: BITS Pilani has been identified as one of the six institutes (three publicly funded and three privately funded) of eminence by MHRD on July 10, 2018.

Others: Among all the technical institutions of India, in 2018 BITS Pilani is ranked 1st among the private engineering colleges by India Today, 1st among the private and deemed technical universities by The Week and 5th by the Outlook magazines in their recent surveys, and it is good to note that BITS Pilani, is the highest ranked non-government institute consistently in some of these surveys.

BITS Pilani – Strategic Improvement Journey

In the last 10 years, BITS has taken giant strides to cement its legacy of being an excellent teaching institution, with focus on research. Besides, the institution has substantially expanded its capacity to provide education to more meritorious students from India and abroad. This has been realized through a well thought out transformation program that not only ushered major improvements in academics and research, but also in the infrastructure space with modernization and new construction of several academic blocks, faculty and student housing and other facilities at Pilani, Goa and Hyderabad campuses. An elaborate growth plan, with student and faculty intake over the next 10 years, formed the core of this transformation.

The beginning of this strategic transformation was with the launch of Vision 2020 in the year 2009, with an aim to improve BITS Pilani's ranking amongst science & technology institutions in India and Asia. The improvement in the rankings was planned through 3-year programs, known as "Mission" programs, with a clear objective of bringing significant transformation in chosen focus areas, known as thrust areas. First such program was called Mission 2012, that saw over 100 faculty member working with BITS leadership in 6 thrust areas. The major achievements of the Mission 2012 program were - a renewed focus on research with schemes such as Seed Grant, Research Initiation Grant etc., improved

administration through automation by implementing an ERP, introduction of new people policies in recruitment and performance management, bringing a distinct brand identity guidelines and the most significant of all – Project "Parivartan".

In November 2011, Chancellor Dr. Kumar Mangalam Birla formally announced the Project "Parivartan" to modernize and expand physical infrastructure in Pilani, which was subsequently extended to Goa and Hyderabad campuses as well. Through this project a number of new facilities have been created and the existing academic blocks, hostels and faculty & staff housing have been renovated and augmented. The project will take a few more years to complete.

After Mission 2012, a follow-up program called Mission 2015 was initiated with focus on 7 new thrust areas. Mission 2015 brought further transformation such as international student admission (on the basis of SAT scores), 3 inter-disciplinary centres-of-excellence for research and application, institution-wide innovation and incubation centres and policies, Teaching Learning Centres for research on new age teaching and pedagogy amongst other vital policies and programs. After two major transformation Missions, the leadership decided to consolidate and review the progress made thus far in the journey towards Vision 2020 and introduced periodic campus and institution reviews. These reviews are now completely institutionalized and are an excellent platform for departments and divisions across BITS to showcase their achievements, and an opportunity to align their objectives and activities with that of the institution. Equipped with several successes and deep learning of implementation of 2 strategic programs, followed by periodic institutional reviews, BITS began deliberations for an extended vision, that would prepare the institution well beyond 2020.

In 2017, BITS engaged a leading global strategy consultant for formulating an overall roadmap that would propel it to further heights and help attain leadership position in the coming years. This strategic exercise, christened as Project "Lakshya" is now in implementation phase, with focus on 5 thrust areas: Research, Faculty, Programs & Pedagogy, WILP & Industry Connect, and Alumni Relations. The thrust areas, each led by senior leader, have set themselves goals that would strengthen and enhance BITS' position amongst global science and technology institutions.

BITS Pilani has always been a leader in providing excellent education – the eminent alumni and stellar faculty who have been part of this institution for the last 55 years are a testimony to this fact. In 2018, Ministry of Human Resources and Development, Government of India, conferred "Institute of Eminence" status on BITS Pilani, concurring and endorsing the faith our student, faculty and alumni have reposed since its inception. BITS Pilani now admits 3344 first degree students, 769 higher degree students and 324 PhD scholars. With a strength of 775 faculty members and over 1100 staff across its 4 campuses, BITS is committed to achieve faculty-to-student ratio that meet global standards. BITS is also proud to have a network of over 55000 alumni spread across the world. "BITSians" are leaders in whichever field they have made their careers: Industry, Entrepreneurship, Academia, Research, Social Sector, Armed Forces, Entertainment, and the Government to name a few.

In the constant quest to scale newer heights and set new standards, BITS expects an active role and participation from all its key stakeholders – student, faculty, staff, and alumni.

CAMPUSES OF BITS

BITS Pilani - Pilani Campus

BITS Pilani, Pilani Campus is located in the Vidya Vihar campus adjacent to Pilani town in Jhunjhunu district, in Rajasthan. Pilani is the home town of the Birla family and has a population of about 50,000. It is about 200 km west of Delhi and about 220 km north of Jaipur. The temperatures during the year go to extremes like 45°C in summer and 0°C in winter. The climate is generally dry and healthy. Annual rainfall is about 30 cms.

The Institute buildings, hostels and residential quarters for staff with neatly laid out roads, lawns and gardens constitute the BITS Campus of about 240 acres.

Pilani can be reached either by rail or by road. The nearest railway stations are Chirawa on W.R. (16 km) and Loharu on N.R. (24 km). There are connecting buses to Pilani from Loharu and Chirawa railway stations. There are regular bus services between Delhi-Pilani and Jaipur-Pilani. The buses leave Delhi from Inter-State Bus Terminal, Kashmere Gate and Jaipur from Rajasthan State Roadways bus stand, Sindhi Camp. The Pilani campus is very close to the Pilani bus stand.

BITS Pilani, Dubai Campus

BITS Pilani, Pilani Campus is located in the Vidya Vihar campus adjacent to Pilani town in Jhunjhunu district, in Rajasthan. Pilani is the home town of the Birla family and has a population of about 50,000. It is about 200 km west of Delhi and about 220 km north of Jaipur. The temperatures during the year go to extremes like 45°C in summer and 0°C in winter. The climate is generally dry and healthy. Annual rainfall is about 30 cms.

The Institute buildings, hostels and residential quarters for staff with neatly laid out roads, lawns and gardens constitute the BITS Campus of about 240 acres.

Pilani can be reached either by rail or by road. The nearest railway stations are Chirawa on W.R. (16 km) and Loharu on N.R. (24 km). There are connecting buses to Pilani from Loharu and Chirawa railway stations. There are regular bus services between Delhi-Pilani and Jaipur-Pilani. The buses leave Delhi from Inter-State Bus Terminal, Kashmere Gate and Jaipur from Rajasthan State Roadways bus stand, Sindhi Camp. The Pilani campus is very close to the Pilani bus stand.

BITS Pilani - K.K. Birla Goa Campus

BITS Pilani - K.K. Birla Goa Campus started functioning in August 2004 and was formally inaugurated by Hon'ble Prime Minister of India, Dr. Manmohan Singh on May 5, 2006.

The Campus is spread over an area of 180 acres and the location on campus is unique with respect to scenic beauty and panoramic view of the picturesque surroundings with Zuari river, hillocks, waterways and forest. The Campus is about 25 km south of Panaji (capital of Goa), 10 km west of Vasco-Da-Gama and 22 km north of Madgaon. It is 5.5 km east of Goa Airport, along National Highway – 17B, bypass road.

BITS Pilani - Hyderabad Campus

BITS Pilani has established its fourth Campus in the city of Hyderabad in 200 acres area in Jawahar Nagar, Kapra Mandal in 2008. For the academic session 2018-19, the campus had admitted 1075 students in its ninth batch of First Degree programmes, 225 students in Higher Degree programmes and 108 students in Ph.D. programmes.

International Student Admission in Integrated First Degree Programmes

In order to introduce trans-national diversity and to embark upon making BITS Pilani a global university, the Senate has approved an alternate merit based mode for admitting international students to the integrated first degree programmes. Any student who is a not a citizen of India is eligible to apply through this scheme for which the admission will be based on performance in Scholastic Assessment Test (SAT) conducted by the College Board (USA) in Mathematics, Physics, and Chemistry. In the academic year 2017-'18, 26 international students have been admitted to the Hyderabad campus.

The campus is located on the Karimnagar highway and is about 25 kms from Secunderabad railway station; 40 kms from Hyderabad (Nampally) railway station; and 70 kms from Hyderabad Rajiv Gandhi International Airport.

The Institute has a Student Activities Centre housed in a separate building where students have their union office and rooms for various activities. This building also has badminton courts, a squash court, a Table tennis room, a Health Club, an open air amphi theatre and a cafeteria.

INTERNATIONAL STUDENTS ASSOCIATION

The International Students Association at BITS established to bring together the greatly diverse international community. The ISA works to bring elements from our distinct and richly diverse cultural backgrounds to share them with the BITS community at a cultural, academic, and social level. It is a Student advisory board of foreign students studying at BITS with a faculty member as an Advisor. The association organizes cultural activities and extends all possible help to foreign students whenever required.

FACILITIES AT CAMPUSES

Pilani Campus and Its Adjoining Facilities

Shiv Ganga and Saraswati Temple

Shiv Ganga is a central beauty spot of the Vidya Vihar Campus with 400 meters circular canal and the Sharda Peeth, a beautiful white marble temple dedicated to Goddess Saraswati.

Guest Accommodation

Limited facilities are available for board and lodging on payment at the VFAST Hostel (Visiting Faculty and Students Hostel) which is near the entrance of the Campus. Other accommodation facilities are also available at (i) Alumni Home (Requests should be addressed to Public Relations Officer, Birla Education Trust, Pilani), (ii) CEERI Guest House (Requests should be addressed to Administrative Officer, CEERI, Pilani) and (iii) Some guest houses and dharamshalas in the city operated by private agencies.

Schools/Colleges

There are several Middle and Primary Schools in Pilani. The Secondary schools are affiliated to Central Board of Secondary Education; prominent being Birla Public School, Birla Senior Secondary School, Birla Balika Vidyapeeth (for Girls upto 10+2) and Birla Shishu Vihar, a Co-educational Secondary School, located in Vidya Vihar Campus. Adjoining the Vidya Vihar Campus, there is Engineering and Technology Institute, Commerce & Arts College and a Polytechnic Institute. These schools and colleges are run by Birla Education Trust and other Educational Societies.

Blossom Kids-zone

The Blossom Kids-zone (BKz) is run voluntarily by faculty wives and it takes care of the pre-school training and education of the children in the age group of 3-5years. The center primarily caters to the needs of children belonging to staff of BITS and its sister organizations. BKz has a dedicated team of teachers and support staff who provide a very fertile and comfortable atmosphere for children to learn and grow.

Bank and P&T Service

Within the Vidya Vihar Campus there is a branch of UCO Bank with ATM facility. In the adjoining CEERI Campus there is a branch of the State Bank of Bikaner and Jaipur, with ATM facility. Vidya Vihar Campus also have ATM facility of Axis & ICICI Bank. Pilani also have ICICI, Axis, SBI, PNB Banks. The Pilani Post office is located within the Campus, while a Telegraph office is situated in the CEERI Campus.

Shopping Centers

AKSHAY, a Supermarket, located in the heart of the campus in an area of 7500 sq.ft. with an elegant modern building is a part of BITS Consumers' Cooperative Stores Ltd. (BITS Coop). Student volunteers of the Institute have worked with management of the BITS Coop in the establishment of the Supermarket. It has various sections for consumable items where the customers can choose and pick-up the items of their choice and pay on the cash counter. General provision, sanitary goods, cosmetics, snacks and other food items, Bakery and Dairy products, books & stationery, fruits & vegetables are made available to the students and staff at reasonable rates.

Birla Museum

The Birla Museum is located adjacent to the Institute Building. It is the first science and technology museum established in the country. Most of the exhibits and models incorporate stimulating animations and visual effects.

Central Electronics Engineering Research Institute (CEERI)

Adjoining the Campus, there is the Central Electronics Engineering Research Institute. It is one of the National Laboratories under the Council of Scientific & Industrial Research (CSIR).

STUDENT LIFE

Student Housing

The Institute is fully residential and hostel accommodation is provided to all students. Permission to become day-scholar may be granted only under exceptional circumstances where student's parents or close relatives are residents of Pilani

There is a central kitchen from where food is served to all messes for every set of two boys' hostels. Each unit of the mess serves vegetarian and non-vegetarian food and the unit operates under the management of students' mess committee. The girls' hostel has a separate mess of its own, situated within the boundary of the hostel. Students staying in the hostel have to necessarily take their food in the hostel messes. Every inmate of the hostel is provided with necessary furniture and fixtures in the room. Each hostel is equipped with solar water heating systems. Common room facilities like TT table, carrom etc. are available in each hostel. Internet connectivity has been provided in all hostel rooms.

There are 13 hostels for boys and one hostel complex for girls, the details of which are given below:

Name of the Hostel	***No. of single seated rooms***	***No. of double seated rooms***
Boys' Hostel:		
Ashok Bhawan	152	-
Bhagirath Bhawan	152	-
Budh Bhawan	174	100
CV Ramanunjam Bhawan	203	-
Gandhi Bhawan	176	112
Krishna Bhawan	176	108
Malaviya Bhawan – A	140	-
Malaviya Bhawan – B	140	-
Malaviya Bhawan – C	182	-
Malaviya Studio Apartment	-	60
Ram Bhawan	180	110
Rana Pratap Bhawan	152	-
Vishwakarma Bhawan	192	38
Shankar Bhawan	180	110
Srinivas Ramanujam Bhawan	-	209
Girls' Hostel:		
Meera Bhawan	452	222

Student Activities Centre

The Institute has a Student Activities Centre housed in a separate building where students have their union office and rooms for various activities. This building also has badminton courts, a squash court, a Table tennis room, a Health Club, an open air amphi theatre and three food outlets.

Cultural and Recreational Activities

The Institute has following clubs and societies: Music, Dance, Hindi Drama, English Drama, Hindi Press, English Press, Creative Activities, and Mime clubs; English Language Activity and Hindi Activity societies. These are entirely managed by the students and have been nurturing the creative and cultural talents of the students. In addition, the Institute runs Recreational Activity Forum, Photography Club, Swimming Club, and Health Club whose membership is open to students and staff. The Institute also organizes Theatre and Dance workshops. A classical music group called 'Ragamalika' aims at encouraging budding talent among the students in music and dance. It also arranges performances by leading artists in the field of classical music and dance. In addition, there is also a BITS Pilani Chapter of SPIC-MACAY which organizes programmes to promote Indian classical music and culture amongst youth.

Recreational Activity Forum (RAF) regularly organizes film shows for the BITS community. BITS being an all-India Institute, students have also established regional associations representing almost all Indian States conducting several special programmes on festive occasions.

Physical Education

Physical Education of the Institute aims at providing a safe atmosphere to enable students and staff members to exercise to their potential whilst achieving their goals. It offers a variety of fitness, wellness, and recreation opportunities, and Fitness Programmes including Yoga and Martial Arts. The Physical Education has major facilities that include Health Club, Swimming Club and Sports Club. Health Club is equipped with single and multi-stationed machines and weight training facilities to provide students with an opportunity of doing exercise for physical fitness. Swimming Club has a swimming pool of 25 m length while Sports Club has various indoor and outdoor facilities for students to take part in sports and games. The indoor facilities are Badminton, Table Tennis and Squash with synthetic flooring while outdoor facilities are Basketball, Football, Hockey, Volleyball, Cricket, Tennis, Track & Field (400 m) etc. Sports and fitness activities are supervised by the qualified and experienced staff members of the Institute.

Festivals on Campus

Traditionally students organize three festivals during an academic year. BOSM (BITS Open Sports Meet) in September, a sports festival; OASIS, a cultural festival in October and APOGEE (A Professions-Oriented Gathering Over Educational Experience), an Academic Festival in February thus bringing about a beautiful blend of sports, cultural and academic milieu of the campus. All the three festivals are entirely managed by students in which a large number of students from all over India actively participate.

Students' Participation in Institute Activities

Students actively participate in various continuing and developmental activities of the Institute as follows:

There are four students as members of the Senate – one representing each campus, two students in the Senate-appointed Academic Counselling Board and two students in the Senate-appointed Standing Committee for Students' Discipline in each campus. In addition, senior students act as mentors to junior students in the registration process. Some students are also associated with the course development activities. Students participate as associate members in the activities of various Divisions of the Institute. Their contribution in projects and research activities of the Institute has always proved to be very useful

STUDENT SERVICES

Orientation and Counselling

At the time of admission, the Institute organises an orientation programme in order to familiarise the new students with the Academic Programmes at BITS and to give them an idea about their campus-life and co-curricular activities. The Vice Chancellor, Director, Pilani Campus and senior faculty members meet the parents of Freshmen and Freshwomen at an interaction session organized at the time of admission.

Faculty members act as Advisors and Mentors for groups of students to guide them in the registration process, and encourage them to discuss any matter –academic and non-academic with them during their stay at BITS campus. Students can also approach their wardens for any help or guidance related to academic or personal matters. Hostels have Resident and Non-resident Wardens drawn from the faculty. In addition, there are Hostel Superintendents to assist the Wardens in matters related to the upkeep of the hostels and attending to the needs of the students.

DISCIPLINE ASSOCIATIONS

Associations formed by students of various academic disciplines organize extension lectures, paper reading seminars, etc. They also arrange symposia in which professionals from industries and other universities participate. These associations organize

exhibitions of working models during APOGEE, the academic festival.

NATIONAL SERVICE SCHEME

The Institute has a National Service Scheme (NSS) chapter which enrolls about 220 students every year. NSS aims at developing amongst students a sense of participation in nation building through social work. From past few years, the NSS volunteers of the Institute work in the surrounding villages and involve the villagers in activities like awareness camps, health camps, tree plantation drives, etc. Other activities like Blood Donation Camps, Junoon, Swacch Bharat Campaign and seminars on Right to Education are organized for the local people as well as the students. The Blood Donation Camp conducted in Feb, 2019 had a total collection of 748 units of blood. NSS has a school in campus where tutorials and personality development classes are conducted for local students of Pilani with great zeal and enthusiasm. Counseling sessions are also conducted at regular intervals. Volunteers put emphasis on overall development of the students. The students also work in the surrounding villages to impart computer literacy to children studying in government schools. A lot of technical solutions of grass-root level problems have also been implemented over the last few years by the students.

For further details, you may visit our website: http://nssbitspilani.org/

NIRMAAN

Nirmaan Organization is a constructive citizen movement for an empowered India. This social Organization founded on 12th February, 2005 by a group of BITS-Pilani students, is now spread over all the BITS campuses Pilani, Hyderabad and Goa and also with full time chapters in Bengaluru and Hyderabad. Nirmaan has been phenomenal in creating greater impact in areas of educational initiatives, livelihood opportunities and socio-technological sectors. Currently the Nirmaan workforce stands at 1200 across India and corporate chapters at US, UK and Singapore.

With more than 150 active volunteers, Nirmaan Pilani chapter is impacting the lives of more than 1500 beneficiaries with its activities like Eye checkup camp, Public toilet construction, Menstrual Health awareness camp, Cleanliness drives, Kadam, Tree plantation drive etc. More than 200 kids are being benefitted by the evening tuition program of Nirmaan. 3 vocational training centers under Nirmaan Pilani are empowering more than 80 women of Pilani to earn their livelihood. With the help of Utkarsh scholarship program, 52 meritorious students are continuing their study. This student run voluntary organization is constantly working towards its vision of “rising of a great nation” by providing cost effective and easily implementable solutions to the problems of the rural population.

Medical Facilities

Medical centre is providing quality healthcare services through its team of dedicated specialist doctors.

Three doctors, Dr. Rajiv Gupta Physician, Chief Medical Officer, Dr. Sanjana R Bhat, Gynecologist Deputy CMO and Dr. R.P. Pareek Physician Medical Consultant are fulltime doctors available at the centre while other specialists visit on different weekdays. ENT specialist Dr. H.S. Sankhla visits the centre on every Monday and Thursday evenings, the Pediatrician Dr. Karan Singh Beniwal on all Wednesday evenings, the Dentist Dr. Sanjay Katewa on all Saturday evenings and the Homeopathic doctor Dr. Diwakar Pathak is available on all Tuesday evenings & Dr. Ramesh P Jajoo Ayurvedic on every Sunday Morning. Besides these specialist doctors, a General Duty Medical Officer from Birla Sarvajanik Hospital visits MEDC for evening OPD’s.

There is a computerized system for registration, investigations and procurement of medicines from BITS Cooperative pharmacy thereby making all records available in a digital format and making all transactions cashless. Medicines from the pharmacy are available on prescription only.

Medical centre has an excellent well-equipped clinical laboratory. Besides having fully automated biochemistry and haematology analysers, latest machines for performing

glycosylated-haemoglobin test for diabetes, serum electrolytes and urine comprehensive examination tests are available. Computerized ECG machine, a spirometer, a digital dental X-Ray unit and a new multi-parametric automated immunoassay analyser for carrying out Thyroid function tests and other hormonal tests are also available. Rapid card tests for diagnosis of Malaria, Chickengunia, Dengue, Typhoid fever and Troponin I for Acute MI are also available.

MEDC has a dressing room and a fully equipped 3 bed emergency observation room. For patients requiring indoor care, referral is done to Birla Sarvajanik Hospital (not under BITS-Pilani) situated at a distance of 3Km from the campus- a multi-speciality 225 bed hospital with 24*7 emergency services and blood bank facility too. A special ward is reserved there for students of BITS-Pilani campus. MOU's have been signed with hospital's in Delhi (Fortis Group), Gurugram (Medanta-the Medicity) ,Jaipur (Fortis and SDMH),Sikar (S B Mittal Memorial Heart & Critical Care Hospital),Rewari (Pushpanjali Hospital).Serious patients are referred to these hospitals in an ambulance with an escort-this service is available 24*7 for such patients. The Mahadeo Singhi eye hospital at Pilani provides ophthalmic and dental care services.

Besides curative services, the doctors at MEDC provide preventive services by conducting awareness lectures on various topics of public health importance. The topics covered range from adolescent health, anaemia, nutrition and health, obesity, osteoporosis, diabetes, hypertension, cancers, cardio-vascular diseases etc. Health camps related to BMD – bone mineral density-estimation and sponsored by various pharma companies, to create awareness about osteoporosis are held in MEDC from time to time.

Medical Centre has been chosen as a primary care centre for BITS employees covered under ESIC scheme. This scheme was rolled out successfully on 14 September 2017. Besides the routine outdoor services provided to these patients, special medical camps are being organized for these patients from time to time. The entire process is computerized, the details of which are provided to ESIC on a monthly basis.

INTERNATIONAL STUDENTS ASSOCIATION

The International Students Association is a body of foreign students studying at BITS with a faculty member as the International Students Advisor. The association organises cultural activities and extends all possible help to foreign students whenever required.

PLACEMENT AND CAMPUS INTERVIEWS

A separate unit deals with this important activity. Around 194 companies have visited the institute this year to interview students who are about to graduate. The number of such interviews has actually grown considerably over the years. As the student population in the final year is divided into two batches, one going to practice school in the first semester and the other in the second semester, only one half of the final year students will be available for campus interviews during a particular semester. Hence many organizations find it worthwhile to conduct the campus interviews in both semesters so that they can interview both the batches on campus itself. The institute also tries to arrange interviews for practice school students in and around their own practice school centers. The impressions given by the representatives of industries about students are continuously fed back to the concerned divisions and departments. Organizations that have visited campus for interviews, are shown in the following table.

Organizations conducting Campus Interviews

1. Abinbev
2. ABST
3. Accenture
4. Accolite
5. Aditya Birla Capital
6. Adobe
7. Aeques
8. Amadeus Labs
9. Amazon
10. Amdocs
11. Amity Software Pvt Lim
12. Angara Inc
13. AppDynamics

14. Apple
15. Arcesium
16. ATCS
17. Axis Bank
18. Axtria
19. Axxela Advisory Services
20. Bajaj Auto
21. Baldor Tech
22. Bain Capability Centre
23. Boston Consulting Group
24. Beehyv
25. BNY Mellon
26. Byju's
27. Cairn India
28. Capgemini
29. CGI
30. Cipher Research Group
31. Cisco
32. Citi Bank
33. Cognizant
34. Cohesity
35. Credit Suisse
36. Cyient
37. Cypress Semiconductors
38. Dalberg
39. Dar Group
40. Deutsche Bank of India
41. DE Shaw
42. Delhivery
43. Dell
44. Deloitte
45. DirectI
46. Dr Reddy's Lab
47. Evalueserve
48. EXL
49. Exponentia Datalabs
50. Exxon Mobil
51. Ernst Young
52. Facebook
53. Fidelity
54. Fiorano
55. Flipkart
56. Fractal Analytics
57. Futures First
58. Gas Authority Of India Lim
59. GDRC
60. GE India
61. Genpact
62. GEP
63. GGK Tech
64. Goldman Sachs
65. Goodera
66. Grey Orange
67. HCL
68. HDFC Life
69. Hindalco
70. HSBC
71. Hyperdart Technologies
72. IBM
73. ICICI Bank
74. Indiamart
75. Indus Insights
76. Indus Valley Partners
77. Infor
78. Inmobi
79. Intel
80. Indian Oil Corporation Lim
81. IQVIA
82. ISGEC
83. Jarvis Tech
84. JDA Software Sol
85. Reliance Jio
86. John Deere
87. JP Morgan & Chase
88. JSW
89. KBR
90. KPIT
91. KPMG
92. Kubric Inc
93. L&T ECC
94. L&T Limited
95. Lavelle Networks
96. Lowes India
97. MakeMyTrip
98. Matercard
99. Mathworks
100. Maybank
101. Media IQ
102. Mediatek
103. Merilytics
104. Michilin
105. Microland
106. Microsoft GSMO
107. Microsoft IDC

108. Myntra
109. Nagarro
110. National Instruments
111. Nestle
112. Net App
113. Netcore
114. Newgen Software
115. Novartis
116. Nutanix
117. Nvidia
118. Ola Cabs
119. Oracle
120. Orbees Medical
121. PayPal
122. Petasense
123. Pfizer
124. Pharma Ace Analytics
125. Philips
126. Piramal
127. Postman
128. Praj Industries
129. PWC India
130. Q3 Technologies
131. Qualcomm
132. Quantiphi
133. Quantum Phinance
134. Qubole
135. Ramboll
136. Rao IIT
137. Reflexis
138. Reliance Jio
139. Rivigo
140. ROHM Semiconductors
141. Rubrik
142. Salesforce
143. Samsung Blore
144. Samsung Delhi
145. Samsung Noida
146. Samsung Semiconductor
147. SAP Labs
148. Sapient
149. Schneider Electric
150. Searce
151. SlingMedia
152. Smart Analyst
153. Society Generale
154. ST Microelectronics
155. Sterling Engineering
156. Suven Life Sciences
157. Suzlon
158. Swiggy
159. Synopsys
160. Tata Advanced Systems Lim
161. Tata Steel
162. Tata Technologies
163. Tata Teleservices
164. Tata Trust
165. TCG
166. TCS
167. Tesco
168. Texas Instruments
169. The Smart Cube
170. Thermo Fisher
171. Thornton Tomasetti
172. Times Internet
173. Toshiba
174. Tower Research Capital
175. Trident
176. Uber India
177. Uber US
178. UBS
179. Udaan
180. Unacademy
181. UST
182. Vakil Mehta Seth
183. Viacom
184. VM Ware
185. Vidya Mandir Classes
186. Western Digital
187. Whirlpool
188. Wipro
189. WNS
190. ZenDrive
191. Zilingo
192. Zinnov
193. Zomato
194. ZS Associates

Alumni Relations Cell

The BITS Alumni Association (BITSAA) has been functioning since 1989 as a nodal agency for maintaining liaison with Alumni all over the world and to involve them with the development of the institute. Since 1989, the institute has grown manifold. An overseas campus at Dubai

is functioning since 2000, and the K K Birla Goa and Hyderabad campuses are in operation since 2004 and 2008 respectively.

A new division, Alumni Affairs (BITSAA) Division, was created in 2010 to give distinct thrust to the activities related to Alumni and to connect and engage students, alumni, friends and well-wishers for a long-term relationship with BITS Pilani. It focused on development of alumni support to the continuing development of the Institute's academic, research, and off-campus programs, expansion and renewal of its facilities, and providing scholarships and financial aid to students through annual fundraising campaigns.

In 2017, to give a distinct thrust to Alumni Relations activities an Alumni Relations office was formed with distinct emphasis to connect with Alumni across the globe.

Alumni Relations Cell manages various events – Silver Jubilee Meet, Golden Jubilee Meet, fare well to passing out students etc. and brings the news about Alumni. It coordinates its efforts with BITSAA International and BITSAA chapters in various cities in India and abroad.

The role of Alumni Relations Cell includes the following:

- Constantly connect with alumni, and conceptualize, develop and organize various alumni led initiatives related to campus development, student life and academic processes.
- Plan, implement and promote alumni programs that support the BITS Pilani strategic initiatives.
- Establish and build relationships with a wide range of alumni as well as local, regional, national and international alumni chapters.
- Serve as the single point of contact for alumni & Institute for all matters related to alumni relations, and maintain regular communication with alumni.
- Educate graduating students about alumni benefits and engage them in various programs.
- Partner with various offices of the institute to spearhead the introduction of alumni involvement in the growth and continued leadership of the University.
- Collaborate closely with BITSAA Chapters throughout the world and enable increased support from alumni, and provide platforms and programs for such support.
- Raise funds for select special projects and events.

Seek alumni involvement for placements of graduating students and for promotion of entrepreneurship amongst students.

Alumni Lifetime Membership Fee

All passing out students automatically become Alumni Member and a Lifetime membership fee of Rs 1000 is charged across three campuses namely Pilani, Goa and Hyderabad at the time of passing out.

CENTRAL FACILITIES

Central Library

The BITS Pilani library is housed in a state-of-the-art building, covering about 65000 sq.ft area and is located close to all academic blocks of the Institute. The library indeed is an architectural marvel with an attractive palatial interiors, high ceiling, adequate natural lighting and ventilation with several series of courtyards, with each used for different activities. Inside the library, there is a layout of natural green plants that are soothing for the eyes. The library has a seating capacity for 850 students in one go. This year the library created new spaces like Brainstorm Room, Group Discussion Room and Research Zone, E-Zones, AC Reading Rooms with necessary IT infrastructure to serve the needs of the modern tech savvy users.

The library aims to support the teaching, learning and research activities of the institute with specially designed information services to meet the needs of its users. The library is fully automated with RFID technology integrated with KOHA library management software that provides quick and efficient circulation operations, enhanced security for Library print

collection, seamless inventory management and provides latest technology experience to its patrons. The Online Public Access Catalogue with efficient searching facility can be accessed from anywhere within the campus through Wifi and LAN. The library includes well-lit reading halls, stacks, display areas, e-library zones, audio-visual cum brainstorm facility and study carrels.

The collection consists of over 2,47, 000, books including rare books and bound volumes of journals since 1920s. Besides core subjects, the stock also covers a good blend of reference material in the form of Dictionaries, Encyclopedias, Handbooks, Yearbooks, Theses, Standards etc. The library also provides access to millions of E- Books.

The library has made a special efforts to preserve rare books by establishing a state of the art air conditioned **G.D Birla Rare Books Section** - in Hall No. 3. This newly set-up section has a remarkable stock of scholarly rare books, manuscripts, paintings and photographs which are timeless and invaluable. Many of these rare books are published almost about 150 and 200 years ago. The library staff has been trained to preserve rare books. by using German Tissue paper. So far more than 150 valuable and scholarly rare books have been preserved using this technique and the work is in progress.

Library subscribes to over 186 print National and International journals. It has access to over 39,000 full-text e-journals through 36 online databases such as ACM, IEEE, ASCE, ASME, Bentham Science, Springer, Science Direct, Wiley, IOP, Project Muse, ACS, PROQUEST, SciFinder, Scopus, Emerald, EBSCO,JSTOR, OUP, CUP, Indiastat, ProwessIQ etc.. covering all branches of Science, Technology, Engineering, Economics and Management, Humanities and Social Sciences. These can also be accessed from hostel rooms as well as from faculty residences. In addition to books and periodicals, the library has a good collection of non-book material namely Audio CDs, Videos, DVDs, CD ROMs, etc to cater to the educational/academic and research needs of students as well as faculty. These electronic resources are made available through an interactive and dynamic library portal called **infoBITS**. The portal provides an integrated search engine called **One Search** which is an online discovery tool that "pulls together" BITS Pilani Library resources so that users can be explored using a single search box. In other words, instead of searching individually the different resources such as WebOPAC, databases, E-books, Institutional Repository etc, users can use One Search and get the most relevant results using advanced scholarly filtering techniques.

There are 45 public access terminals in the library. The library provides Internet connectivity even for the readers' laptops.. The renovated Text Book section in Hall 5 provides all latest text and reference books for study in the library. Photocopying facility on First Floor is also available in the library premises.

The Library has implemented two institutional repositories namely **E-Print** and **D-Space** which provide access to Institute's research and academic output. Currently repositories contain over 2600 faculty publications , digitized books and institutions events in audio visual forms.

BITS Pilani Heritage Gallery (BHG) is going to be established soon in the Library. BHG will be a modern, state of the art gallery which will showcase the historical, cultural, educational and rich legacy established by this great institute and how it has evolved from Patashala to the current status of Institute of Eminence in the country. It will have a display of framed photographs and many other important documents and literature in a chronological order. It will also have a separate digital display of audio-visual content which can be retrieved through a search engine developed by the BITS Pilani library in collaboration with students.

Library Rules

i) The Central library is meant for the use by faculty, staff, research scholars and students of the Institute. Only those students who are registered for the academic programmes of the Institute are entitled to the library facilities and services.

ii) The entitlements for members and the duration of the loan are as follows:

Category	No. Of Books	Duration
Faculty	30	135 Days
Research Scholars	15	30 Days
Students(UG/PG)	10	15 Days
Non-Teaching	5	30 Days

The books can be re-issued provided they are not reserved by other members.

iii) **Self Check in and Check out Procedure to use SmartServe Kiosk**

To use this kiosk for the first time, please contact the Library Staff at Issue/Return Counter. a) Your PSRN No / ID No is your User ID

b) Re-set your password when you meet the library staff at the Main Counter.

Follow the steps below to Borrow the Books:

a) Please keep maximum 8 books at a time on the glass surface.

b) Click on 'Borrow' option, provide your user name and password,

c) On the screen, you will see the list of book kept on the glass surface.

d) If any book title is missing on the screen, please report the same to the staff at Issue/Return counter to resolve the problem.

e) Click on 'Finish' and choose 'Yes with slip"

f) Collect your Book/s and slip for completed transaction.

g) Get the Due Date stamp put on the book/s at the Issue/Return Desk.

h) If RFID gate blinks 'red light' while you are passing through it with books, please contact the library staff at the Issue/ Return counter along with the books.

Follow the steps below to Return Books:

a) Please keep maximum 8 books at a time on the glass surface.

b) Click on 'Return' option.

c) On the screen, you will see the list of book kept on the glass surface. Click on 'Finish'

d) If any book title is missing on the screen, please report the same to the staff at Issue/Return counter to resolve the problem.

f) Click on 'Yes with slip'

g) After returning, please keep the books on the trolley next to the Kiosk

iv) Books which are on loan may be renewed for a further period of 15 days or one month as the case may be, provided no other reader has requisitioned the book in the meantime. For renewal, either the book needs to be brought to the library to get the new due date stamped at the issue counter or simply send an e-mail request at helpdesk.library@pilani.bits-pilani.ac.in

v) The members will receive a system generated reminders for overdue books. When such reminders are received, the students are expected to return the books immediately or get them re-issued at the issue counter or simply by sending an e-mail at helpdesk.library@pilani.bits-pilani.ac.in

vi) A book can also be returned through another member,

vii) The Librarian has the right to recall any book at any time.

viii) A book which is on loan can be reserved online using Online Catalogue (KOHA) on the library portal http://library.bits-pilani.ac.in

ix) The following categories of books/journals are generally not issued:
a) Rare books b) Current issues and bound volumes of periodicals c) PhD theses d) other materials as specified by the Librarian.

x) The books can be borrowed by producing the Institute ID card issued by the SWD. The ID card is not transferable. The ID card needs to be kept in safe custody and the member is responsible for any books issued against the ID card. In case the card is lost, the matter has to be reported immediately both at the SWD and library so that misuse of the card can be prevented.

xi) The student should access his/her "check out" records either at the Issue/Return counter or on the library online catalogue from time to time and bring the discrepancies, if any, to the notice of library **Help desk** immediately.

xii) Before borrowing, the book should be checked by the student for missing pages and any damage may be brought to the notice of the staff at the Help Desk.

xiii) Students will be responsible for any loss or damage to the library material, while under their use, and shall be required to replace or pay the current cost of such materials as decided by the Librarian, plus a processing fee of Rs 20/- per each lost/damaged item being replaced.

xiv) The Librarian reserves the right to withdraw facilities from any student, who violates the rules and regulations of the library.

xv) Students should cooperate with Help Desk at the entrance..

xvi) The RFID gates at the entrance of the library will detect the unissued books and make a sound/signal. When such incidents happen, students are required to report immediately to the person at the Help Desk.

xvii) The library system automatically sends e-mails regarding the issued or returned items to the patrons when such transactions happen.

xviii) Students may take care of their personal belongings. Library will not take any responsibility for the loss of personal belongings of students.

xix) **Reference and Text Books**

Students may borrow Reference and Textbooks from the Textbook Counter (Hall No.5) for overnight half an hour before closing the library and are expected to return the same the next day morning before 9.15 am.

xviii) **Lost and Found items**

The lost and found items by the library staff are kept separately in the library. These items are included in the "Lost and Found" page of the Library Portal and can be claimed by the procedure laid down on the library portal.

xix) **Photocopy and Stationery facilities**

- This facility is available on the first floor
- Photocopying of complete book is a violation of copyright law and therefore it is forbidden. Only 10% of a book is allowed to be photocopied.
- For, photocopy work of more than 20 pages (i.e. continuous pages from one book/journal/thesis), a Photocopy Request Form has to be submitted. The request form is available with the photocopy operator.
- Reference and Text books should not be left for photocopying at the photocopier to be collected later. This inconveniences other readers who need the same book. In case there is a rush, please come again during lull period and submit the same book for photocopying.
- During peak hours, photocopies of less than 10 pages will be given priority

xx) **Research Zone**

To support the research activities in the campus a Research Zone has been established in the **Hall No. 4** where all the latest books acquired using project funded books on research, last 5 years Ph.D theses, Research@BITS Publications and research tools are kept. Faculty Publications are also displayed in this room. The Research Zone has one LED screen with Internet connection where research

scholars can book this room to make presentations and to conduct meetings, workshops, seminars etc.

xxi) **Entry and Exit Rules**

The students are expected to enter their ID Nos in the computers at the main gate every time they enter or exit the library.

The library remains open throughout the year (except on three national holidays) from 9 am to 12:00 p.m. on all working days. The opening hours of the library are extended 24X7 during Mid-Semester and Comprehensive examinations.

A list of New Arrivals is sent to all students and faculty members through root mail every week and also these books are displayed for one week in New Arrivals section in the Library Lobby Area.

xxii) **Online Portal infoBITS**

Through the interactive library portal **infoBITS,** all library services such as Daily News, Monthly infoBITS Bulletins, Book Finder, Periodical Finder, Books@MyDesk, Lost and Found Items, Suggestions/Complaints, Book Reviews, Feedback, book of the week are made available. All library resources are also made available through the library portal

The library organises many events throughout the year to inculcate reading habits among the students. Basant Book Festival, World Book and Copyright Day, Summer & Winter Reading Challenges are just a few to name.

Central Workshop

The central workshop of the Institute imparts training to the students as well as caters to the maintenance & fabrication needs of the Institute. Student's training consists of training all integrated first degree students through the course "Workshop Practice" by imparting skills in various production processes like machining, fitting, carpentry, smithy, sheet metal, electroplating, welding, etc. In addition, students are imparted training for other discipline specific courses like 'Production Techniques', 'Metal Forming and Machining' and 'Casting and Welding'. Apart from routine maintenance, fabrication and training, the workshop also accepts jobs on precision fabrication of project work of students, staff and research scholars. Workshop store caters to the needs of regular and urgent purchasing of materials for departments, units and divisions of the Institute.

The workshop housed in 3519 sqm built up area comprises of the following sections: machining, welding, electroplating, fitting, smithy & sheet metal, carpentry, foundry & patterns, tool room, metrology, painting, metal processing & metallurgy, electrical, CNC training centre and stores. The workshop is shifting in the new building. CNC machining centre with DMG Mori NL2000 and small training CNC centres; Joint Indo-German Experience Lab; Sustainable Manufacturing and Life Cycle Engineering Lab; Casting Lab; and Welding Lab are fully functional.

The major equipments include five CNC trainers (three turning centers and two vertical machining centers); industrial robot (pick and place); five universal milling machine tools; universal cylindrical, centreless, surface (hydraulic), and tool & cutter grinders; gear hobbing machine tool; NC machine tool (retrofitted at workshop); twenty eight lathes (centre, turret, precision and dc supply heavy duty); seven shapers; planner; slotter; twelve drilling machines; ten wood working lathes; two wood working planers; band, circular and universal wood saws; TIG, MIG, gas and arc welding equipments; power press, pneumatic hammer, etc.

Instrumentation Centre

The centre provides and maintains public address system, lights, video recording equipment, LCD projectors. Instrumentation Centre is involved in the installation, testing, service and maintenance of instruments/ equipment across the Institute. Centre also conducts programs to train the technical staff in computer hardware, software installation and operation & maintenance of instruments.

Reprography Services

The Reprography section provides services such as word processing, off-set printing and

binding. All Institute publications and forms, etc. are printed in this section. The equipments include off-set printing machines, photocopiers and machines for finishing, cutting, stitching, laminating, etc. This section takes care of the centralised postal dispatch service for the Institute and also houses a color laboratory for photography.

Computing Facilities

The central computing facility of BITS Pilani referred to as the IPC (Information Processing Centre) hosts and manages the computing/ networking infrastructure for the campus. The infrastructure includes local and external connectivity including email as well as computer services. IPC operates early morning to midnight on 360 days a year. Some specialized labs/centers offer round the clock computing facility.

The campus hosts about 1000 latest desktops/workstations (including 350 in a central location), about a dozen compute-servers (Intel-based SMP Systems, IBM Blade Center with several blades), multi-Tera-byte storage (including a SAN) a variety of peripherals (printers/scanners/ plotters). These systems support heterogeneous operating environments (Linux and Windows), compilers, development tools/packages for students and staff. The computing infrastructure issues are resolved through online portal.

Campus-wide Computer Network

The campus hosts a state-of-the-art, completely switched, voice-enabled local area network. The network has more than 5000 wired data ports and provides connectivity to Instructional/ Administrative buildings, Hostels, Guest House, Library and Staff residences. More than 800 access points have been deployed across campus to support wi-fi based connectivity. The campus backbone is a 1Gbps fiber optic cable on a dual ring configuration. The external (Internet) connectivity is supported through 3 Gbps of leased line. The network support team maintains the network facility and resolves the issues through online portal.

CENTRES OF RESEARCH AND DEVELOPMENT

The Institute has established the following centres under Software Development and Educational Technology Unit (SDET Unit) at BITS-Pilani :

Centre for Software Development (CSD) The Centre for Software Development *(CSD)* is responsible for the development and maintenance of University website, multimedia based content creation, maintenance of immersive Telepresence systems across all campuses, development of web based applications for providing various services to the user community (i.e. room booking, complaint management etc.) and maintenance of Open-source Moodle based learning management system. A team of students work on various research and development projects using latest technologies in the centre.

Centre for Education Technology (CET) The Centre for Education Technology (CET) is responsible for identifying and deploying the new and upcoming technology to support instruction delivery. It is involved in the Open-source Moodle LMS based *deployment for requirements of the Institute* in form of the *Nalanda portal* on a regular basis. The centre also manages class room lecture recording system, deployed in Lecture Theater Complex (LTC) rooms. It is involved in the research, development and deployment specific to the next-generation Education Technology solutions.

Human Resource Section

The inception of the Human Resource Section was from September 12, 2018. The Human Resource Section shortly known as the HR-Section is a facility that maintains the employee personal records, executes the payroll (through ERP), recruits' employees, appraises the employees through the PMS process, organizes training and development programmes for the non-teaching staff, handles the day to day general administration activities for the campus. Some of its key activities are mentioned below:

Activities like appointments, employee on-boarding during recruitment, Performance

Management System (PMS)- looks after Promotions, Regularization of the non-teaching staff. Employee Welfare & Statutory Activities like the PF (maintained for all the Indian Campuses), ESIC, Family Pension, Loans (for e.g. Furniture loans, Computer loans & Housing loans), School Education Fee Reimbursements, Medical Bills Reimbursements, Reimbursement of Relocation Expenses, LTC, issuance of employee ID cards, renewal of existing empaneled hospitals and other kind of welfare activities that are required for the employees are catered by this office. Issuing Certificates, letters to the staff based on the need, constant updation of employee information, disciplinary actions are some of the major activities handled by this office.

Central Analytical Laboratory

Central Analytical Laboratory (CAL) at BITS Pilani, Pilani campus houses many sophisticated instruments, catering to the needs of the various research Departments like Pharmacy, Biological Sciences, Chemistry, Physics and Chemical Engineering etc. The facility is used for training of the student's as well doctoral research. CAL has a spacious area of 2600 sq.ft and an equipment with latest instruments which include-Stability Cabinets (For stability testing of drugs and organic molecules), UV-Visible Spectrophotometers, UV-Visible-NIR Scanning Spectrophotometer, IR Spectrophotometer, FTIR Spectrophotometer, Scanning Spectroflourimeter, High Voltage Electrophoresis, Digital Polarimeter, Ultra and Refrigerated Centrifuges, Gas Liquid Chromatography and High Performance Liquid Chromatography (with auto-sampler and various detectors), High Performance Thin Liquid Chromatography, Spectroflorimeter T Anisotrophy, Thermogravimetric analyser, Cytoflex, Flash Chromatography, Elemental Analyser. Currently it is capable of carrying out research work at all levels including the industrial projects. The laboratory has also been upgraded with equipment's such 400 MHz NMR spectrophotometer (Bruker AVANCE III) equipped with BBFO probe and auto-sampler. Latest addition of equipment's to the laboratory are Field Emission Scanning Electron Microscope (FESEM), Surface enhanced Raman spectrometer with Atomic Force Microscope (SERS- AFM], Gas Chromatography-Mass Spectroscopy (GC-MS/MS).

Central Animal Facility

Central Animal Facility at BITS Pilani, Pilani campus is a CPCSEA approved facility with total floor area of 5330 sq. ft. Recently, the facility have received the approval for breeding. The facility maintains the animal species like Rats, Mice, Guinea Pigs, Rabbits and Hamsters. The facility was build up in accordance with guidelines issued by CPCSEA and other regulatory bodies. It is also equipped with Incinerator (electrically operated) facility for disposal of the biological and other biomedical waste. The air conditioned facility is maintained by well trained personnel, with a full time veterinarian to take care of the various requirements of the animals. Central Animal Facility caters to the needs of the various research departments like Pharmacy, Biological Sciences and Chemistry, etc. The facility also incorporates pharmacokinetics and pharmacology research laboratory for carrying out advanced research in the areas of pre-clinical pharma-cokinetics, bioavailability studies, pharmacological screening of various synthetic/natural origin drugs. The laboratory has sophisticated instruments such as two chamber automated organ bath, laser doppler, non-invasive blood pressure recorder, RT-PCR, electroconvulsiometer, actophotometer, analgesiometer, light dark apparatus, rotarod etc. Equipments such as surgical anesthesia machine, electrical cautery, and spare air-conditioners are also utilized. The laboratory is upgraded with video documentation system for various animal behavioral studies. Facility is geared to take up various industrial or governmental funded projects in various pre-clinical areas.

BITS Astronomical Observatory

BITS Pilani houses an astronomical observatory that is equipped with two telescopes, a 6" refracting telescope, and an 11" Celestron's Schmidt-Cassegrain telescope which is completely computerized. The observatory has

recently procured a CCD camera which can be used with the 11" telescope to obtain long-exposure, high quality images, of nebulae and star-clusters. The observatory is maintained by the Physics Department of the institute. A group of 20 students, known as, Astro Club, makes a regular use of the telescopes to observe celestial objects on a fortnightly basis. In addition, the club conducts regular astronomical observation sessions as well as workshops for general public, i.e. entire BITS community of students and staff, several times during a semester. Moreover, students registered in the elective course on Introduction to Astronomy and Astrophysics, offered by the physics department faculty, also make use of the observatory on a regular basis to augment their understanding of celestial objects.

Pilani Meteorological Observatory

The Institute runs and maintains Pilani Meteorological Observatory on behalf of the Meteorological Department of the Government of India. Daily meteorological data regarding the weather at Pilani are recorded and transmitted by the observer, under the supervision of a professor in-charge, appointed by the Institute. The observatory has an automated weather station.

CENTRES OF RESEARCH AND DEVELOPMENT

The Institute has established the following centres of Research and Development:

Technology Innovation Centre

Engineers/Scientists from industry bring their research and developmental projects for investigation in the campus. Such investigations are carried out in collaboration with Institute faculty associated with students registered in assigned research or project courses. Several industries have been participating in this programme. While in the campus, these engineers and scientists from industry are given a de-facto status of faculty members, so that they are encouraged to extend their professional interest much beyond the original scope of operation. Students also undertake identified projects by the industry wherein professional guidance is extended by professionals from industry virtually.

Centre for Innovation, Incubation & Entrepreneurship (CIIE)

Centre for Innovation, Incubation and Entrepreneurship (CIIE) at BITS Pilani across its 4 campuses continuously work in an integrated manner to strengthen the on-campus ecosystem to promote innovation, entrepreneurship and incubation taking care of all related academic and non-academic activities. The mandate of the CIIE includes facilitating technology transfer & commercialization, executing filing of patents, custodian of intellectual property of BITS, supporting entrepreneurial activities, interfacing with Technology business incubators of all campuses and fostering collaboration with alumni and industry for several entrepreneurial activities.

Pilani Innovation and Entrepreneurship Development Society

Pilani Innovation and Entrepreneurship Development Society (PIEDS) at BITS Pilani – Pilani Campus established in 2013 gives a distinct emphasis on creation of technology/innovation based new enterprises. The society takes up various activities to promote and encourage technology based innovation, incubation & entrepreneurship development. The main objectives of the society are to aid and help startup teams in the creation of technologies/innovations addressing market/societal needs; to foster the entrepreneurial spirit among students, faculty and community; and to provide mentoring, consulting, networking & funding services to aspiring innovators and entrepreneurs.

Teaching Learning Centre (TLC)

The fourth “Teaching Learning Centre” committee for Pilani Campus was formed in September of 2018 with Dr. Kaushar Vaidya as the head (more on TLC: https://www.bits-pilani.ac.in/tlc/Pilani/index.html). With 10 members from 10 various departments, three senior faculty members as mentors, a research consultant from IIT Kharagpur and a few student volunteers, the new committee started

working towards strengthening the work of the previous committees as well introducing new ideas/concepts to facilitate a greater learning environment through stakeholders' participation in Pilani campus. The following report gives a brief overview of all the activities that the TLC had undertaken from September 2018 till May 2019.

Invited Speaker: The TLC had its first guest speaker in Mr. Scott Hartley, a Venture Capitalist and author of the book "The Fuzzy and The Techie". He delivered a lecture to BITS students on "Human Skills in our Technical World" on September 10, 2018.

Intensive Teaching Workshop: The TLC conducted an Intensive Teaching Workshop (ITW) for 16 newly recruited faculty members. The entire exercise was divided into two major segments: ITW 1 and ITW 2. The ITW 1 saw ten modules presented by various domain experts. The inducted faculty members enjoyed the background information provided in these sessions and enthusiastically interacted with the resource faculty. The ITW 2 saw two presentations by the participating faculty members, one only based on blackboard, and, the second a mixed presentation involving board work and slides. The 16 members were divided into three groups with 6 resource faculty on each group, for interacting and giving feedback. The inducted faculty members were also given options of sitting in "open" classes to have hands-on experience on pedagogical practices that they could emulate from their colleagues. Few faculty members from various departments "opened" up their classes for the same. The participating faculty members liked this experiment very much.

Panel Discussion: On 17/11/2018, the TLC, along with the Humanities and the Social Sciences Department, Pilani Campus, hosted Prof. Saikat Majumdar, a noted writer and a faculty member at Ashoka University. A panel discussion titled "Undergraduate Education in India" was organized based on Prof. Majumdar's book, "College: Pathways of Possibility", where Prof. Ashoke K. Sarkar, Prof. Chandra Shekhar and Prof. Sanjiv K. Choudhary participated along with Prof. Majumdar. Dr. Manoj Kannan moderated the panel discussion.

SEER: The SEER (Sharing Experience and Educational Research) series is envisioned during Fall to be a once in a month TLC forum activity to discuss research articles in teaching-learning and to share unique pedagogical practices by the BITS faculty members. It was planned that a SEER session would typically have two sessions of thirty minutes each where a faculty member would present his/her research on pedagogy and its best practices in the first half, while another faculty member would share his/her teaching experience with the BITS community. The aim is to generate discussion and debate and to learn from each other. The **first session** of SEER was held on 31/01/2019 where Dr. Pankaj Kumar Sharma from the Department of Biological Sciences discussed a paper titled "*Can Undergraduate (Biology) Students Learn to Ask Higher Level Questions?"* by G. Marback-Ad and P.G. Sokolove. Prof. Ashoke Sarkar, our Director for Pilani campus, shared his valuable experience regarding teaching in BITS Pilani in the second half of the session. The **second session** of SEER took place on 28/02/2019 where Dr. Kaushar Vaidya from the Department of Physics discussed a paper titled *"Peer Instruction: Ten years of experience and results"* by Catherine Crouch and Eric Mazur. Prof. P. Srinivasan from the Department of Mechanical Engineering shared his insightful experience of classroom teaching in BITS Pilani.

Essay Writing Event: On 14/02/2019 TLC organized a 700-1000 words essay writing event for the students. Keeping in mind to engage our biggest stakeholder in the teaching-learning process, the students were asked to muse upon a topic titled "If I were a Professor". A total of 26 students including 6 research scholars participated in the essay writing. Based on the evaluations of a six-member committee comprising of BITS faculty, eight essays are chosen in the top five ranking (with a tie in the 1st, 2nd, and the 5th position). The winners are invited to share their key ideas with the BITS community in an hour-long function on 05/04/2019. The session was well attended by

both students and faculty and the winners enthusiastically participated in a Q&A session after their presentations. The winners were felicitated by our Director, Prof. Ashoke Sarkar, and all participants received a certificate of participation.

Invited Lecture: Prof. Usha Subramanian from the Myanmar Institute of Information Technology gave a guest lecture on Saturday, 23rd February 2019 from 3 pm for an hour followed by a discussion. Prof. Subramanian, a BITS alumnus, and a former faculty at the Department of Computer Science in Pilani Campus, in her talk titled "Teaching and Assessment - Experiences from BITS and MIIT", discussed how teaching and assessment should be learning- and learner- oriented.

Workshop: The Teaching Learning Centre of BITS Pilani, Pilani Campus had organized a two-day workshop on Team Based Learning on 8th and 9th of March, 2019. The resource person, Dr. Preman Rajalingam, is an Assistant Dean, Educational Development and a Senior Lecturer, Medical Education in Nanyang Technological University, Singapore. He introduced the concept of "Team based Learning" (TBL) and "Problem based Learning" (PBL) to the participants and offered hands-on exercises and discussion on student-centred approaches to learning in three consecutive sessions. The workshop is well-attended by BITS Pilani faculty members, totaling 41, with 04 from Goa campus and 01 from Hyderabad campus.

Delegation and Visits:

Dr. Pankaj Kumar Sharma and Dr. Manoj Kannan attended a workshop conducted by Dr. Eric Miller, Director, World Storytelling Institute, in Chennai, during 22nd - 25th December, 2018. The theme was based on how storytelling can be used to teach science subjects, dwelling upon potential questions that can be asked to invite discussion in class through elements of storytelling and case studies.

Dr. Tamali Bhattacharyya presented a paper titled "*Improving the Quality of Technical Education using Pedagogical Instructional System Design*" in the Future of Learning Conference, Learning 4.0: Connecting the Dots; Reaching the Unreached, during January 4 to January 5, 2019 in IIM Bangalore. Dr. Jayashree Mahesh had also attended the conference.

Dr. Kaushar Vaidya and Dr. Manoj Kannan presented a paper titled "*Intensive Teaching Workshop – An Institutionalized Program for Educator Training at BITS Pilani*" in the National Teachers' Congress at MIT World Peace University in Pune during January 4 to January 6, 2019.

- Dr. Kaushar Vaidya represented BITS Pilani in the launching of Asian Society of Engineering Education (AsiaSEE) on 8th May 2019 in Hong Kong. As a founding member of AsiaSEE, BITS Pilani, along with several other engineering institutes, commits itself to contribute towards the advancement and enhancement in engineering education via research and practice for the future generation.

Centre for Robotics and Intelligent Systems

The objective of the Centre for Robotics and Intelligent Systems (CRIS) is to develop prototypes that provide greater intelligence and higher versatility for robotic tasks under ever-changing constraints of the environment. This objective is set forth to make Indian industry competitive by developing indigenous technical skills, manpower and innovative spirit. Each prototype is developed in four different stages viz. (i) Conceptualization, (ii) Algorithmic development and verification in simulated environment, (iii) Real-time testing and (iv) Integration of automated system.

The Centre is well equipped with excellent computational facilities; advanced software packages for circuit design, image processing and mechanical design; micro controller and DSP based driver card for real-time experimentation; experimental bed, Pendubot (inverted pendulum), CRS-Plus robot manipulator, 4-DOF SCARA manipulator, 5-DOF articulated manipulator, ABB Industrial Robot, Hydra mobile base, Lab mate, mobile base, Allen Bradley PLC Micro Logix 1500,PLC based Hydraulic and Pneumatic Trainers and many other facilities.

The center is geared to provide research facilities in areas such as intelligent robotics and system design, intelligent control, neural and fuzzy neural based system modeling and control, evolutionary computation, robotic vision and virtual reality. Earlier BITSUMO, which is an autonomous assistant robot, was developed to work in restaurant/ and library. In addition to these, an autonomous glider, an autonomous hovercraft, a 14-DOF robotic arm, an intelligent mechatronics ball, a micro-mouse platform and a micro-mouse testing base were developed at CRIS.

The center is engaged with the development of humanoid robots. The first breakthrough is in terms of Acyut-I and Acyut-II (humanoid). Acyut-I is a dancing robot and which has won several laurels even at international competitive events (Rob games 2008 held at San Francisco, USA and INDEEN Expo, Germany etc.), Acyut-II has far better control and using remote command by way of hand movements etc, it can be moved synchronously. These models were demonstrated for their capabilities at Korea, USA, Germany and Japan. The student team is currently working on further developments related to Acyut-II to VI robot with added features Acyut-III had participated in FIRA-2010, Bangalore and created a world record in weight lifting (2.4Kg.) in year 2010. In 2010 a mobile Robot (named SHAURYA) participated in Annual student contest organized by DRDO, India and received recognition for best design.

Team Acyut has showcased their technologies at in the Tech fest of BITS Pilani Dubai campus and IIT Kanpur, Robotics symposium of RDE Pune (DRDO) and Tech test of NIT Calicut. For their effort the team has been appreciated by scientists of BARC Mumbai and DIT New Delhi. During the year under review, the students working at CRIS has developed a number of models and working robots. Namely, humanoid Acyut-IV had been invited to participate in ROBOCUP-2013. AcYut was redesigned completely and a novel system of parallel links is introduced. It stood 2nd in Robocup Iran Open 2013 and stood 4th in Robocup Netherlands 2013. Based on the progress in the area of humanoid robotics, Department of Information Technology (2012-2016) has sponsored a project worth 45 Lacs to develop a humanoid which is capable of stable walking and navigate in a structured environment. The team has continually improved the software for the robot to incorporate artificial intelligence and computer vision. Acyut can now play autonomous soccer against another robot and score goals. In February 2015 team AcYut demonstrated humanoid walking and image processing technology in HiSens Workshop at IIT Delhi. In July 2015 the team participated in RoboCup China in Teen Size humanoid league. One of our student team become zonal fast (west) in All India level DRDO contest, to develop an AGV which will behave like a buddy for the soldier and the vehicle had various features to help the soldier in exploration.

Continuing with the good work from previous years, this year saw development in software modules with better algorithms for cognition. Other improvements include up gradation of the camera sensor to new Fish Eye lenses and implementation of feedback system for more stable gait. The CRIS research incorporates with all aspects of creating and controlling robots such as mechanical design, dynamics, perception, control and decision making. Current faculty researches includes projects in the following areas: Humanoid robot, Autonomous Driving with the help of Artificial Intelligence/Machine learning tools, computer vision, motion planning and control, Machine learning for robotics, Development of Robots which understands gestures.

Embedded Controller Application Centre

This Centre was set up in Collaboration with Motorola India Ltd. This also include the Texas Instruments Kits sponsored by TI. The objective of the Centre is to impart detailed understanding of important features of embedded controller architectures and familiarization of advanced concepts in the field of embedded controllers through students projects/Industrial projects, Imparting training to the industry professionals and running short term courses in the field of Embedded System design, developing course modules. The infrastructure of the centre includes Pentium machines, Microcontroller Modular Evaluation

Systems, Microcontroller Development Systems, Emulators, Assemblers and Cross compilers for various microcontroller families (ARM, ATMEL, Microchip, Cypress, ST Microelectronics, etc.) DSP processors, logic analyser and other bench equipments.

Centre for Renewable Energy and Environment Development (CREED)

CREED is an interdisciplinary Centre that co-ordinates educational and research activities in the active areas of renewable energy and environment. The objectives of the Centre are (i) to conceive, develop and implement renewable energy applications and environment protection projects, (ii) to develop courses and organize awareness programmes, and (iii) to collaborate with external organizations in the areas of renewable energy education, training and technology development. Some of the existing facilities at CREED include an experimental set up for solar water heating, solar air-heating system, solar stills, and solar photovoltaic power pack with storage battery bank, SPV lighting systems, fluidized bed combustor with gasifier and various instruments related to energy audit and solar resource assessment.

Currently, active research areas of CREED include concentrated solar power and photovoltaic power based policy analysis, emissions and environmental impact of thermal power plants, planning and economics of renewable energy systems, real time operation and control of renewable systems, industrial cogeneration, integrated renewable systems, demand side management, clean development management integrated resource planning, CO_2 based refrigeration, biomass based fluidized bed combustion, biomass pyrolysis etc. The faculty members and research scholars of the center have also visited University of South Florida, USA and TU Braunschweig, Germany for the research purpose under institute's schemes.

The Renewable Energy Club is an exclusively a student managed body that operates under CREED. The Club has undertaken active work in organizing competitions, quizzes, carbon footprint analysis and carbon credits. Commercial organizations in these areas have evolved out of this club, and are currently owned and operated by BITS alumni.

Centre for Biotechnology

The Centre has in-house facilities of Genetic Engineering and Recombinant-DNA Technology. The objectives of the Centre are to take up research and development projects from various sponsoring organizations, establishments of University-Industry linkage through various R&D contract projects and conduct periodic Workshops and hands on training for faculty members, industry personnel and students in the area of advanced molecular biology/biotechnology and bioinformatics. The facilities available are Gel Documentation System, PCR Machines, Hybridization oven, Gel electrophoresis equipments, UV-Cross linker, FPLC, Nanodrop, Vacuum concentrator, Temperature Controlled Water Bath Shaker, Refrigerated Centrifuge, Ultracentrifuge, Cell counter, Plant growth chamber, Fluorescent microscopes, Gene Gun, ICP-OES, Fluorescent microscope, Cold Room, Tissue Culture Room, Plant Biotechnology facility, Semi-automated Green House, Radioisotope handling facilities, Liquid Nitrogen Plant Victor-3 Multichannel counter, Inverted microscope with camera attachment, –80°C Deep Freezer, etc. We developed Insectory to facilitate research on mosquito borne diseases.

Centre for Materials Science and Technology

The objective of the Centre for Materials Science and Technology is to develop and implement projects related to modern materials such as smart materials, biomaterials, fibre-reinforced plastic composites and also related to conventional materials such as metals, ceramics and polymers. The Centre undertakes mechanical and non-destructive testing of various engineering materials and products for evaluating their mechanical properties and for evaluating defects such as cracks, voids, delamination, inclusions etc. Other activities include providing consultancy related to materials aspects and testing/development and analysis in the field of materials science and technology in general. The testing facilities

available at the Centre include a conventional Universal Testing Machine of 50 Tons capacity, as well as, a fully computerized microprocessor based Electronic Universal Testing Machine of 100 kN capacity, Heating Chamber for UTM for High Temperature Testing, Hounsfield Tensometer, various hardness testing machines such as Brinell, Rockwell, and Vickers Hardness Testers, Rotating Bending Fatigue Testing Machine, Combined Bending and Torsion Fatigue Testing Machine, Strain-gauge testing facility, Izod Impact Testing Machines, Digital impact testing machine, Double disk polisher, Inverted Metallurgy Microscope, Erichsen cupping tester, Single Screw Extruder with Calendering and Pelletization Facilities, Ultrasonic Flaw Detectors, Liquid Penetrant Test kit, Magnetic Crack Detector, Eddy Current Tester, Acoustic Emission Testing equipment, Acousto-ultrasonic pocket hand-held AU scanner etc. Wet-lab facility and fume hood for polymer fabrication section. Basic Mechanical fault simulator, Data acquisition system for vibration measurement.

Centre for Desert Development Technologies (C-DDT)

Established with the financial support from BITS Alumni, C-DDT functions with the primary objective of developing world-class desert development technologies for making the desert bloom. It has joined hands with the Jacob Blustein Institute for Desert Research (BIDR) of Ben Gurion University, Negev, Israel to work in the area of desert development. The activities of the centre revolve around developing affordable and technically less esoteric technologies and integrating them with the existing practices of the desert areas of Rajasthan for economic upliftment, employment generation and poverty alleviation of the people of Rajasthan. Last four years research has been focused on the energy efficient houses. For the purpose four rooms were constructed with different architectural elements. Last two years three International papers are published in International reputed journals and two reputed International conferences and one Ph.D. scholar has completed her doctorate along with some first-degree projects at centre this year. Last year the solar house was integrated with rain water harvesting scheme and tank was covered, extended roof is fabricated to harness more rainwater and some roof tops were connected. This year ground is cleaned and leveled to apply contour irrigation system. Downward slope is made to flow the water in one direction.

SPECIALISED LABORATORIES

Apart from the Centers described above, the following specialized laboratories have been established with a view to strengthen research and development in the respective areas:

Process Dynamics and Control Laboratory

Infrastructure includes Universal Process Control Trainer, Multiprocessor Trainer and Computer Control of process variables such as temperature, pressure, level, flow and pH in Chemical Engineering Processes.

Environmental Engineering Laboratory

Infrastructure of this laboratory includes BOD Incubator Shaker, several gas and water pollutant sampling and analysis equipment such as air and water analysis kits, underground water sampling kit, Ph meter , conductivity meter, total dissolved solid, salinity, dissolved oxygen meter, BOD incubator, Digital BOD analyzer, digital COD apparatus, Temperature controlled shaker bath, Laminar hood chamber, orsat appratus, refractometer, Auto Clave Vertical, Fermenter, Distilled water setup, Peristaltic pump, Compressor, Muffle Furnace, Calony Counter, Balance, Ion Meter, Fluoride Electrode, Hot Plate, Vertex Mixture, Deep Freezer, Oven, Hot air oven, Vacuum oven, Remi centrifuge, High speed centrifuge, Refrigerator. Data logging Thermometer, 4-channel Thermometer, etc.

Petroleum Engineering Laboratory

Infrastructure of this laboratory includes setups for ASTM Distillation, Flash point and fire point, Cloud point and pour point, Reid vapor pressure, Saybolt viscometer, Copper-strip corrosion, Conradson carbon residue, Redwood viscometer-1 & 2, Engler viscometer, Penetrometer, Bomb calorimeter, Drop point of grease, Melting point apparatus, Smoke point

apparatus, Gum content testing apparatus, Oxidation stability tester, Sulfur analyzer etc.

Research (Setup) Laboratory

Continuous Adsorption Set-up, Biofiltration Column Set-up, Downdraft Biomass Gasifier, Pyrolysis Unit, Reactive Distillation Set-up, Air-Lift Bioreactor, CSTR Unit, Fluidized Bed Reactor, Fixed Bed catalytic Reactor, Re-circulating fluidized bed bench-scale riser, Loop reactor, Particle imaging velocimetry Flow Sense camera, isokinetic tar sampling setup, digital steam rotameter, ventury scrubber, sand bed filter, glass fiber candle filter, fixed bed Pyrolysis Unit, Fluidized bed Pyrolysis unit, biomass coke stove, etc.

Analytical Laboratory

UV-VIS Spectrophotometer, pH/Ion Meter, Thermal Gravimetric analyser (TGA), High Performance Liquid Chromatograph (HPLC), Digital Scanning Calorimeter (DSC), Automatic Potentiometric Titrator with KF Attachment, Atomic Absorption Spectrophotometer (AAS), Gas Chromatograph (GC), Fourier Transform Infrared Spectrometer (FTIR), Flue Gas Analyser, Surface Area Analyser, Dynamic Foam analyser, Multi Syringe Pump,Volumetric analyser (VA), Cooling Micro Centrifuge, Rota Vapour, Digital Viscometer, Ultrasonic cleaner, Auto vacuum desiccators, Ultrasonic liquid processor, HPLC Pump, Freeze Dryer (lifolizer), Nan-contact Infrared Thermometer, Spin coating machine, DTG, Contact angle meter,continuous gas chromatograph, weighing balance,CO_2 analyser.

Optical Communication Laboratory

The infrastructure in the laboratory includes facilities for study and characterization of optical waveguides, fibers, Optoelectronic sources and detectors. Facilities are available for fabrication and calibration of fiber optic sensors. Training kits to study, design and simulate fiber optic communication & network systems with additional computational facilities to characterize them.

Flexible Manufacturing Systems Laboratory

The Flexible Manufacturing Systems (FMS) Laboratory conducts hands on training to first degree & higher degree students and cutting edge research in manufacturing science. This laboratory is a center for carrying out practical experiments for various on campus courses such as Flexible Manufacturing Systems (EA C412/BITS F431), Computer Aided Manufacturing (ME F432), Production Techniques-II (ME F313), Metal Forming and Machining (MF 313), etc. This laboratory has been designed and configured to assist the Indian industry to become globally competitive in CNC manufacturing, CAD/CAM and machine tool sectors. The aim of the laboratory is to conduct fundamental as well as integrated research in order to achieve appropriate skill in CNC machining, in-depth knowledge in metal cutting, designing of manufacturing systems, developing manufacturing management techniques/strategies/practices for revitalization of Indian industries. The FMS lab aims to be foremost research center in CNC manufacturing, design of manufacturing systems and manufacturing excellence practices.

The following facilities are available in the FMS Lab.

- **Hardware:**
  - KODI-40 KLIEN Vertical Machining Center (Industrial)
  - Renishaw Probing System attached to KODI 40 VMC
  - Taylor Hobson Talysurf
  - FLIR Thermal Image System T250
  - MTAB STARRTURN CNC Lathe and Milling Trainer
  - MTAB FMS Cell
  - ROBOT
  - Rapid Prototyping Machines
    - ✓ Dimension Elite 3D Printer
    - ✓ FMD 200mc
  - IBM Intelli Workstations and High Computing Facility
- **Software Tools**
  - Umberto Life Cycle Assessment Tool
  - CATIA-PLM Tool
  - QUEST-3D Simulation Tool

- ARENA-2D Simulation Tool
- SIMUFACT Software
- MINITAB-Quality Control Tool
- DFMA-Product Design Tool
- LINDO/LINGO-Optimization Tool
- Multi-Attribute Decision Models

Oysters Lab. (VLSI DESIGN Laboratory): This laboratory has been established to support the Micro-electronics program and to carry out projects in the field of VLSI design. The facilities in the Lab, with a seating capacity of forty students, include the centralized IBM x3650 M4 servers, Sun Fire X2200, Ultra 20 with RHEL operating system and DELL Optiplex desktops as clients. The servers operate on High Availability platform with parallel computing and cluster configuration. The lab is equipped with the complete set of front-end and back-end EDA (Electronic Design Automation) tools from the top vendors including Cadence, Synopsys and Mentor Graphics for ASIC design, Symica custom IC design Tool kit, Altera for FPGA design, and Silvaco for device & process simulation.

The lab has collaboration with Europractice to obtain design kits for ASIC design including UMC 90 nm, 130nm, and 180nm, TSMC 180nm and 250nm and the Altera FPGA kits include 40 UP3 kits, 10 DSP development kits and 10 NIOS-II development kits. The lab also has a Mixed Signal Oscilloscope and a Function generator, from Tektronix, to test the fabricated chips.

Instrumentation Technology and Virtual Instrumentation Laboratory: The facility in the laboratory includes general purpose and specialized bench equipments, transducers and signal conditioning kits, PC based data acquisition and control cards, Virtual Instrumentation softwares (LabView) and data acquisition & signal conditioning modules, ELVIS boards, Green Engineering, bioengineering kits, wireless sensor network kits, Programmable Logic Controllers with I/O modules and interfaces.

Structural Engineering Lab: This lab has well-equipped testing facilities for structures and materials. The lab supports various equipment such as Loading frame with Servo-Hydraulic Actuator of 400 kN capacity, 100 kN Dynamic Universal Testing Machine, 1000 kN Static Universal Testing Machine, 2000 kN Automatic Compression Testing Machine, 1000 N Shake Table, Beam Torsion Testing Machine, Concrete cube permeability apparatus, Cement autoclave, Automatic Blaine apparatus, Rebound hammer, concrete cube cutter apparatus, etc.

Highway/Transportation Engineering Laboratory: The highway / transportation engineering laboratory is equipped with state-of-the-art devices that are used for the testing of pavement materials, conducting traffic engineering studies and to design safe flexible and rigid pavements. The equipment housed in the laboratory includes, among others, Los Angeles Abrasion Testing Machine, Light Weight Deflectometer (LWD), Dynamic Cone Penetrometer (DCP), MERLIN, Bump Integrator, Portable Skid Resistance Tester, Centrifuge Extractor, Viscosity Bath Test Apparatus, Digital Ductility Testing Machine, Speed Radar Gun, Auto Exhaust Multi- gas Analyzer, Global Positioning System (GPS) units, Digital California Bearing Ratio Test Machine, and Marshall Stability Test Apparatus. In addition, the laboratory also hosts several software packages that include VISSIM, ArcGIS, AutoCAD, MX Road, etc. These facilities are available to students, academicians, and researchers for their class and project work, and to outside agencies for consulting work.

Language Laboratory: A language laboratory with 45 booths is functioning to conduct practice sessions pertaining to the various courses offered by the department and to provide adequate practice to the students in different communication skills in English. The computer assisted lab facilitates the teacher to instruct and take responses from students through a computer network. Students and faculty across the institute also use these labs for the self-practice and self-assessment of their language and communication skills. The lab has a good collection of audio visual teaching materials in the form of Audio/Video CDs, Audio cassettes and Learning software which are used to

enhance the linguistic competence and interpersonal skills of the students. The Department has procured an advanced language lab software system named Orell Digital Language Lab (ODLL) which offers cutting edge software solutions and delivers language teaching – learning solutions integrating two – way communication and incognito individual student monitoring. The Lab also houses a 2D Classical Animation Desk for students to practice and do assignment for the course Mass Media Content and Design.

Creative Media Lab: The Department is equipped with a studio-cum-lab for meeting the requirements of asset of courses in the area of Media and Communication. Primarily designed to support the course Short Film and Video Production, the lab is now catering to the recording of institute events, lecture recordings, interviewing of visiting dignitaries and several in-house productions. The lab is equipped with DSLR and video cameras, colour video monitor, Microphones, basic lighting equipment and other accessories. For editing films, the lab has acquired a Mac –Pro 2.4 GHz Quad –core Intel XEON.

Music Lab: The finest of the fine arts, 'MUSIC' is not only for the sake of physical entertainment, but it also gives us mental pleasure as well as the spiritual bliss. HSS department has a unique set-up of music lab to enhance the Indian culture and music. The Music lab is used for offering the various courses, theoretical as well as practical, i.e.- Appreciation of Indian Music, Musicology-An-Introduction, Indian Classical Music-(Instrumentai-1) and Indian Classical Music (Instrumental-2), with different course plans of Indian and worldwide music, along with the musical practices and rehearsals for different institutional events taking place throughout the academic year. It houses various instruments like Tanpura, Tabla, Harmonium, Sitar, Guitar, Synthesizer, Violin, etc. for the class room practices for the practical courses and performances.

DUBAI CAMPUS AND ITS FACILITIES

BITS Pilani, Dubai Campus

BITS Pilani, Dubai Campus (BPDC) was established with the approvals of the Ministry of HRD (Vide Letter No. F.1-8/2000(CM) dated 4th August 2000) and the University Grants Commission (UGC) (Vide Letter No. F.34-18/2000-U.3 dated 6th November 2000) in the year 2000 in response to the growing need for quality engineering education among the residents of the Middle East. The beautiful campus is spread over an area of 14.7 acres in Dubai International Academic City in Dubai, with a built up area of approximately 5,36,436 sq.ft. It is about 16 kms from Dubai International Airport. All the programmes offered at the campus are also approved by Knowledge and Human Development Authority (KHDA), Government of Dubai, UAE. BITS Pilani is the first Indian Higher Educational Institution to set up its campus abroad.

Dubai Campus houses the academic building (main, library and mechanical blocks), hostels for boys and girls, library, sports facilities (playgrounds, indoor play areas, gyms), ATM facility, grocery and canteen. All classrooms, laboratories, offices, hostels and other indoor areas are centrally air-conditioned. Cisco Telepresence classroom and Cisco meeting rooms, campus-wide Wifi infrastructure are the latest addition to our facilities.

STUDENT LIFE

Student Housing

The Campus has segregated, conveniently located, singly occupied, and air-conditioned hostel accommodation for more than 900 boys and girls, furnished to suit the student's requirement. Wifi Internet connectivity and provisions for maintaining a small fridge are also provided. The hostels provide a safe and secure learning environment to students. Hostels have televisions, microwave ovens, gymnasium, laundromat, first aid kits and recreation rooms with indoor games, magazines and newspapers.

STUDENT ACTIVITIES

Cultural and Sports activities

The Campus provides facilities and services that encourage the personality development of every student in the social, cultural and interpersonal domains to produce self-reliant young professionals. Students organize various academic activities, social activities, and cultural and sports festivals. A variety of extracurricular activities such as drama, public speaking, debate, poetry and story writing, painting, sketching, singing, dancing, quizzing, gaming, digital art, face painting, rangoli, henna, photography, fashion show etc. have become a regular feature of the Campus calendar. Students also participate and win several laurels in various inter university events organized by other universities.

Student Clubs

Student clubs formed around academics and themes add to the rich mosaics of student life. The list of clubs includes Dance Club, Music Club, Art Club, Photography Club, Drama Club, Public speaking and Literary Club, Design Club, Fashion Club, Social and Environment Club, Astronomy Club, Quiz and Sports Club. These clubs enrich the social and cultural life on the campus by organizing number of inter and intra campus events. The Sports Club is committed to health and well being of student community and encourages students and faculty to be involved in recreational sports through intramural, extramural competitions and tournaments.

Social Activities

The Social and Environment club organizes events with the sole aim of sensitizing students about their responsibility towards environment and community**.** Some of the activities taken up by the club includes awareness programme, blood donation camp, clean up drive, English classes for the support staff, recycling of paper, cans and tetra packs, fund raising events for charity, program for special needs children etc.

Students are involved in making paper bags to replace the plastic bags used in the campus.

Student Professional Bodies

Dubai Campus has student branches of leading professional bodies such as the IEEE Inc., ASME, ASHRAE, WIE affinity group, SAE, ACM, Linux Group, Dot Net Club. Students actively engage themselves in the activities of these professional bodies and avail the opportunities provided by the professional bodies and their UAE chapters/sections, in addition to Department Technical Associations, namely, EEE Association, AIChE (American Institute of Chemical Engineers), CHIMERA (Biotechnology).

IEEE

The IEEE Student Branch of Dubai Campus has been one of the largest IEEE student branches in UAE Section. It organizes competitions, invited lectures from eminent scholars and successful entrepreneurs for the benefit of students of all disciplines. IEEE Power Engineering Society has also been formed on the campus and is active. Students from the Campus also participate in IEEE Xtreme which is a 24 hour online International Programming Competition held every year.

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AIChE

AIChE (American Institute of Chemical Engineers)-The Chemical Engineering Department of BITS Pilani, Dubai Campus was one of the first AIChE Student Chapters set up in the region in 2013. The Student chapter comprises of a sub chapter active in the intracollege front by organizing industrial field trips as well as interactive sessions and workshops which will equip our chemical engineering graduates with a hands on experience to excel in their careers. Technical events like Formulate This and the Big Split are organized for college fest every year. The second component of AIChE student chapter is involved with utilizing several other benefits like networking & mentoring opportunities, essential educational and career services. Over the last three years, we have been interacting with students from our sister chapter at the University of Utah and Brigham Young University. The sole goal of the Sister Chapter Program is networking is to connect future chemical engineers from around the globe.

Communications with our sister chapter has led to the development of a Pen Pal system where chemical engineering students of both universities via email and various social media platforms interact to promote Sister Chapter diversity.

Recently, our Sister Chapter students initiated the 1st Inter College Chemical Debate Tournament (ICDT) at the institute along with an active participation from students of our neighboring Sister Chapter - Manipal University, Dubai.

Interactions with International Regional Liaison of AIChE at AUB(American University of Beirut) opened avenues of gaining an insight of activities- social/cultural performed in AUB to enhance participation of students.

ASHRAE

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) student branch fosters students interested in pursuing a career in the field of heating, ventilating, air conditioning, and refrigeration. Student Branch offers the opportunity to interact and "network" with members of the ASHRAE Chapter, to participate in technical tours, invite guest speakers, and to interact with other students with the same career interests.

ASME

Students participate in several District level and Global level competitions and brought laurels to the institute. The ASME Chapter of the Campus in association with the Pinnacle Knowledge Group held its first ever and the biggest Student Professional Development Conference (SPDC). SPDC is an initiative of ASME to enhance and

develop the technical and leadership skills amongst the engineers worldwide. This Student section also organizes various student competitions every year in which many local universities participate.

SAE

SAE Student chapter is very active in participating in various competitions like FSAE BAJA SAE etc in USA / ITALY / INDIA. The students form into teams and register for these competitions and they design, fabricate and build the cars in college workshops and team Gear shifters also won many laurels in various competitions.

ACM

With many enthusiastic student members, the student chapter of the Association for Computing Machinery (ACM) was inaugurated at BITS Pilani, Dubai Campus on 1 March 2011. ACM regularly conducts technical events like "Prototype" and organizes several technical talks for the benefit of students of the Campus.

CIIE

The Center for Innovation, Incubation and Entrepreneurial (CIIE) [formally Centre for Entrepreneurial Leadership (CEL)] was established in 2012, to foster entrepreneurship among students and provide support to translate ideas into successful ventures. CIIE strives to create events and initiatives to bring together the young minds to "Ideate, Innovate and Implement". CIIE is an initiative of Birla Institute of Technology and Science, Pilani established in all four campuses (Pilani, Hyderabad, Goa and Dubai) in alignment with BITS Pilani's VISION 2020. The CEL was inaugurated on 8 September 2012 by Dr. Kumar Mangalam Birla, Chancellor in the presence of several dignitaries including Prof. B.N. Jain, the Vice Chancellor. Currently there are about 100 students enrolled as members with 12 students on its Executive Board. TiE Dubai is the Middle East chapter of TiE and was established in Dubai in 2003. The Dubai Campus and TiE Dubai have entered into a Memorandum of Understanding on 23 March 2013 to start TiE student chapter, in association with Dubai International Academic City (DIAC).

Microsoft Tech Club

Microsoft Tech Club is the tech club at BITS Pilani, Dubai Campus, associated with Microsoft Gulf, DIC. Is run by Microsoft Student Partners, and students of the Microsoft Student Community. Every year our club carries out training programs for our students beginning from 1st year onwards in emerging technologies using the software tools supplied by Microsoft. Evangelists from Microsoft used to visit and conduct workshop on cutting edge technologies delivered by Microsoft. The training offered by our club prepares the students to undergo PS-II program effectively where Microsoft software tools are widely used.

The Microsoft Student Partners Program is for students who realize the best tech careers come to those who chase their dreams. MSPS are involved in building apps, training others and social media. They are social, friendly students who enjoy creating global connections. Attend seminars, workshops and developer camps at the Microsoft Dubai office. The club was established in the year 2009.

FESTIVALS ON CAMPUS

Cultural and Sports Festivals

B-quizzed

B-quizzed, conducted at the Campus is the largest quizzing competition held in UAE where many universities and schools take part every year.

JASHN

JASHN is an annual intercollegiate cultural festival where universities from all over UAE participate in drama, dance, music, fashion, quizzing, art, literary, photography and many other competitions. Its mission is to mark the beginning of a new generation of cultural uprising in UAE, and give a platform to all those untapped sources of talent in the ocean of cultural ripples.

ARTEX

ARTEX is an annual intra college art, craft and photography event, held every year at the Campus. Competitions in different categories like acrylic painting, oil painting, pencil shading,

pen art, classroom art, best out of waste and photography etc., are held. Many on the spot events like Blind Art, Face Painting, Rangoli, Graffiti, Mad Art, Henna, AD Banner Making, Pick a Poem, Phycedelic, Clay Modeling, Rainbow Veins, Illusion-de-optica, Art Marathon, Big Picture, Artex Doodle and Poster Making etc. are also conducted.

Sparks

Sparks is an annual cultural intra college event organized every year at BPDC. Various competitions in dance, drama and music are held. Competitions in Duet and Group Dancing are conducted in both Eastern and Western categories. For Music, Solo and Duet singing is conducted in both Eastern and Western categories along with Battle of Bands. Drama events like Histrionics, Ad making etc are popular events. A large number of students participate in Sparks.

BSF

BITS Sports Festival (BSF) is the annual event in which the three Indian Campuses of BITS Pilani and more than 31 universities and colleges participate from all over UAE in the tournaments that include basketball, throw ball, football, cricket, table tennis, chess, volleyball, swimming and badminton. BITS Pilani, Dubai Campus has been the first institution to introduce badminton as an inter university sport event in UAE for both boys and girls.

BITS Sports Festivals were graced with the presence of sports stars like Diego Maradona,Virendra Sehwag, Pullella Gopichand, Sania Mirza, Sushil Kumar, Sania Nehwal, Madan Lal, Koneru Humpy, Vijender Singh and Piyush Chawla. The sports event witnesses crowds of around 4000 student, it is considered as the largest inter- University /college sports festival in the United Arab Emirates.

Technical Festivals

Technofest

Technofest is an annual intra-university technical festival. There are many interesting and innovative events organized by various clubs and associations under Technofest. The various events include: Mechathlon, Float, Capture the Flag, Puzzled, Frynapse, Tech Fiesta, Debate, What is the good word, Business Quiz, Code Blitz, MindSpark, Big Split, Consumer Product, Pass the Buck, Rings of Fire, RC Football, Play2Code, TrashPanic and Hackathon. There are separate sessions for Paper Presentations and Exhibits for Working and Non-Working Models. The events help our university students to exhibit their skills and generate a lot of interest and enthusiasm among them.

ENGINuity

ENGINuity, the annual inter-university techno-managerial and innovation festival held at BITS Pilani, Dubai Campus, is one of the most prestigious platforms to showcase one's technical affinity. The word ENGINuity is a word play on the phrase "An Engineer's Ingenuity" and the event caters to this philosophy by encouraging innovation and creativity amongst its participants. Since its inception, ENGINuity has metamorphosed into an ideal melting pot of the country's synergic talent resonating with unmatched frequencies of fierce competition. It aims at forming a conglomerate of students who share a mutual passion for science, technology and management in a synthesis of enthusiasm and jubilation. The broad categories of events include: Technical, Business, and Literary. The various events under them are BQuizzed, Treasure Hunt, Code Blitz, Hackathon, Art Carnival, Gaming, Model Designing, Azure Workshop, Infographic, Talk on Sustainability and so on.

Students Participation in Institutional Activities

The campus has a Student Council, the office bearers of which are President, Vice President, General Secretary and an Ex-Officio. Other members of the Student Council include a hostel and day scholar representative from each year. Students are also part of many committees like senate, discipline, event management, corroboration and review, library, academic counseling board, etc.

STUDENT SERVICES

Orientation and Counselling

The Institute organises an orientation programme at the time of admission of freshmen, to familiarize them with various aspects of BITS, Pilani education system and academic system, infrastructural facilities, hostel facilities and various other policies and procedures at BITS Pilani, Dubai Campus. The Director and the Institute Officers of other units such as Academic Registration, Instruction, Practice School and Placement, Student Welfare, Library, Information Technology, etc., meet the parents of freshmen at an interactive session at the time of admission. Students also receive important information about the Student Services, Learning Resources, Financial Aid, Student Activities, Career Counselling, Academic Advising, and Industry Internship, etc.

Academic Advising

Academic Advising is carried out through the faculty members as academic advisors to students. The academic advisors interact with their advisees on a regular basis and discuss their performance and progress. Students are advised to contact the academic advisors periodically. The goal is to help the students reduce their programme-related stress and maximize opportunities for academic performance improvements leading to a high quality professional life.

Student Counseling

A professional Counselor visits the campus every fortnight to foster well being on campus and to help students actualize both personal and career goals. The sessions are individual and confidential. The counselor interacts with students discussing all issues which affect their academic performance and help students in resolving their psychological issues, if any. Students are advised to contact the counselor directly. The goal is to help students reduce their stress, maximize academic and personal success, enhance personal development and quality of life. Students are also free to meet the faculty for counseling services and many students approach the faculty for the same.

Grievance Cell

The Students Grievances Cell (SGC) addresses the students' grievances, if any, and works to maintain the well-being of the student community in general. The SGC addresses the issues, investigates and recommends feasible solutions for resolving issues for the mutual benefit of the students and the Institution.

Earn-while-you-learn

Students can earn while learning under the earn-while-you-learn scheme. Students are given the opportunity to work as Professional Assistants in laboratories and/or assist the faculty and departments in other academic and professional tasks. They are paid an honorarium based on the work done and a certificate of appreciation is also provided.

Placement and Campus Interviews

The Campus offers a Placement Programme to all its graduating students. Reputed companies from UAE, Middle East Countries, India and multinationals participate in placement. Some of the recent organizations that conducted campus placement are given in Table 1. Many graduating students prefer to go for higher education. The Campus also facilitates admissions to reputed Universities. A sample list of Universities where students have got admissions for Masters or Ph. D. is given in Table 2.

Table 1: Organizations participated in Campus Placement/conducted Campus Interviews	
PayPal, India	Google, India
Schindler, Dubai, UAE	Ebay, India
DirectI, India	Amazon, India
MuSigma, India	Xiaomi, India
PwC, Dubai, UAE	Publicis Sapient, India
Texas Instrument, India	TetraPAK, Dubai, UAE
Redington, Dubai, UAE	Uber, Dubai, UAE
Al Shirawi Group, Dubai, UAE	Dubbizle, Dubai, UAE
Praxis, Dubai, UAE	Protivit, Dubai, UAE
Zomato, Dubai, UAE	Teknoware, Dubai, UAE
Petrofac, Dubai, UAE	IBM, Dubai, UAE
Accenture, Dubai, UAE	Delloitte, Dubai, UAE
ESAB, Dubai, UAE	IFFCO, Dubai, UAE
Reckitt Benckiser, Dubai, UAE	Sika Corporation, Dubai, UAE
UAE Exchange, Dubai, UAE	Emirates NBD, Dubai, UAE
Schneider Electric, Dubai, UAE	Dabur International, Dubai, UAE

Table 2: List of Universities where students secured admissions for Masters or Ph. D	
Michigan State University, USA	Bradford University, UK
Gatech	CMU, USA
Imperial College London, UK	University of Calgary, Canada
Columbia, USA	ETHZ
North Western State University	University of Southern California, USA
Perdue University, USA	Delft university, Netherland
Colarado State University, USA	UIUC, USA
UCSD, USA	NYU Steinhardt, USA
Hong Kong University of Science and Technology	University of Illinois, USA
University of Ottawa, USA	National University of Singapore
Kings College, London, UK	IIM, India
University of California-Los Angeles, USA	University of Calgary, USA
Syracuse University, USA	University of Minnesota, USA
Arizona State University, USA	Northeastern University-Graduate School, USA
UNSW, Waterloo, Australia	NCSU, USA
University of Illinois at Urbana-Champaign, USA.	University of Texas at Austin, USA.
Ohio State University, USA	University of Pennsylvania, USA
Johns Hopkins University, USA	University of Toronto, Canada
North Carolina State University, USA	Lund University, Sweden
Cornell University, USA	University of California, USA
University of Sydney, Australia	NTU, Singapore
University of Edinburgh, UK	University of Melbourne, Australia
Trinity College Dublin, Ireland	university of Glasgow, UK
UPenn, USA	McGill University, USA

Alumni Relations

The BITS Pilani, Dubai Campus Alumni Cell fosters long term relationships among alumni through various programs. Its mission is to enable the alumni, students, faculty and friends to maintain their connectivity with the Institute and each other for shared benefit. The website is periodically updated to enable the alumni to have an access to the information. The Alumni Relations at the campus uses various platform to connect with the alumni such as emails, Instagram, Facebook and Almaconnect. The Alumni Relations team consisting of faculty and students actively engaged in maintaining the up-to-date information of the passed out students as it provides a great strength to institution building and, engages with alumni for various events such as workshops and informative talks and social get-togethers.

The students team comprises of:

Post	Name/ ID no	Email
President	AHAMAD ABAAN ALTHAF (2016A3PS0181U)	f20160181@dubai.bits-pilani.ac.in
Vice President	ARUSHI KANSAL (2017A7PS0293U) and S KARTHIKA (2017A3PS0096U)	f20170293@dubai.bits-pilani.ac.in / f20170096@dubai.bits-pilani.ac.in
Campus Relations	MISHIKA (2016A7PS0261U)	f20160261@dubai.bits-pilani.ac.in
General Secretary	RITIK PANDA (2018A7PS0102U) and PRANSHU GOYANKA (2018A4PS0164U)	f20180102@dubai.bits-pilani.ac.in / f20180164@dubai.bits-pilani.ac.in

CENTRAL FACILITIES

Auditorium

The Campus has a large auditorium with a seating capacity of 1100. It has movable partitions to bifurcate the hall as per the requirements, acoustic paneling and carpeted floor and is equipped with five projectors with remote controlled screens, Bose speakers, a professional grade audio mixer and a carpeted wooden stage with stage focus lights.

Food Outlets

A canteen and a grocery shop are there for the students, staff and faculty. Vending machines are also available in the Campus and Hostels.

Sporting Facility

Campus has huge indoor and outdoor sports fields for games of Badminton, Carom, Table Tennis, Cricket, Volley ball, Basket Ball and Tennis. Also a new athletic track has been added in the student sports facility.

SECURITY

The complete campus and hostel is monitored through a CCTV system. Also round a clock security is available in the premises for the safety and the security of the students and property. Automated barrier system is introduced in the main gate to restrict the access of the outside vehicles to enter the premises.

HOSTEL FACILITIES

Mess

Hostels have independent mess facility with separate dining facility for boys and girls. Vegetarian and non-vegetarian food is being served in the hostel mess.

Laundry & Gym

For the ease of students, hostels have separate laundry and gym facility for boys and girls.

Library

BITS Pilani, Dubai Campus Library, a gateway to knowledge resources, is located in a separate building with two floors and total area of about 29,680 sq. ft.

The mission of the Library is to collect, organize, preserve and provide access to the information necessary for the institute, to achieve its educational, research and service goals and to improve and enhance access to information in all forms, using innovative technology thereby having a broad based collection, to assist in meeting the needs of students, faculty and staff.

Library has a contemporary design with reading halls, reference section, stacking area, faculty reading room and digital library with 25 computers, internet browsing centre with 25 computers, 60 individual study carrels, and exclusive 8 (ground and first floors) systems to browse Library resources online catalogue. Library has a seating capacity of more than 325 members. The RFID security system has been implemented. Self Service Kiosk for issue and return of books has been installed. CCTV cameras are installed. LED display panel for displaying information about library and its resources and services has been installed.

The Library operations are completely automated using the AUTOLIB Library Management Software and all the resources are bar-coded and RFID tagged for quick and easy service to the user community. The Online Public Access Catalogue (OPAC) is web enabled which can be accessed from anywhere at any time. Users can search the resources and check their account. The Library renders standard services such as circulation, reference, referral services and reprographic services such as networked printing, photocopying, scanning and binding facilities.

At present, the library has a collection of around 22,650 books. The collection of the library is growing continuously on a regular basis. Around 1,050 new volumes of books are added to the existing collection in major disciplines of Engineering, Management and Sciences. The Library has separate collection of Text Books under Book Bank Scheme for students to borrow. The Library procures good number of General Aptitude books such as TOEFL, GRE, SAT, IELTS, GATE etc. Fictions and books on Islam and Arabic are also added every year. Library procures latest editions of Reference Books and Handbooks on core disciplines of Engineering, Technology, General Sciences, Management and General Knowledge.

The Library caters the users' needs with the collection of 6660 e-journals from the following e-databases: IEL Online IEEE Xplore Digital Library, American Society of Mechanical Engineers (ASME) digital collection, Association of Computing Machinery(ACM) Digital Library, EBSCO Engineering source, EBSCO Humanities International Complete and JSTOR (Mathematics & Statistics, Life Sciences, Sustainability, Business & Economics, Arts & Sciences and Engineering). The e-databases have full text of e-journals with back issues, conference proceedings, e-books and reports. The Library has procured 722 e-books from IEEE/MIT Press.

A e-Library facility has been implemented which enables the users to access from anywhere at any time and to do Single Point Search for Online databases (e-journals) and OPAC. Digital library software DSpace has been installed for building Institutional digital repository which contains faculty research publications, thesis and project reports.

The latest question papers have been digitized and made available through the library Web OPAC. Library subscribes to print version of 46 international journals, 57 magazines and 5 newspapers (4 local print papers and 2 e-papers). The Library has around 712 back volumes of print journals subscribed during the previous years. Library has more than 1555 CD-ROMs on engineering courses. Library has available for reference more than 3238 practice school reports and project reports and 474 thesis submitted by students.

The Library provides conference alert service, competition for students alert service, higher education scholarship alert service and latest arrival service to the patrons and users. The Library also offers Inter Library Loan (ILL) facilities to the users. Library has Wi-Fi facility which enables the users to use their laptops for internet browsing / project / thesis work. The Library also provides the necessary training and information literacy secessions to users. The Library has an MOU with the Al Ain University of Science and Technology in UAE for the mutual benefit of both the institutions to facilitate the users to avail Inter Library Loan (ILL) of resources.

Library celebrated World Book and Copyright Day by organising Book Exhibition, Talk by Author and Free distribution of books. The event was organized to promote reading habits among the Institute's students, faculty and staff.

The Library remains open from 7.30 AM to 10.00 PM on all working days and 1.30 PM to 8.30 PM on Saturdays. The Library service is extended till Midnight during test and comprehensive examinations. The Library is open on Fridays for 2 hours and closed on national holidays.

ICT Facilities

The Campus and the hostels are covered with the latest Cisco network Infrastructure of both wired and wireless hotspot environment which provides the internal and external connectivity to fulfill the computing needs of the students.

We have Cisco sponsored networking research lab equipped with the required network components such as routers, switches, firewall, wireless controllers and access points to build the network from the base level to high level of networking. The Cisco lab has all the paper and soft copy material to help the students to learn and start the practical training on Cisco. This Cisco lab will lead the students to achieve the Cisco certifications and software defined Network projects.

Our data centre equipped with the following servers and Network components.

Servers

HP DL 380 series new generation

HP Storage serve (SAN)

QNAP NAS for Backup

Dell Blade Centre

Dell Rackmount RX740xD GPU Server

Network Components

Cisco Core switches Nexus series

Cisco Edge switches

Cisco Firewall

Cisco Prime system

Cisco Wireless controller

Cisco Network admission control and access control system

Cisco IP Telephony system

Panasonic IP camera setup

Ucopia Internet Hotspot Appliance

Sonicwall Unified Threat Management System

Most of our key critical applications are configured in Virtualized environment with load balancing and cluster mode. We have Business continuity and disaster recovery plan in place and we have a disaster recovery site is configured in different location to continue our operation in case of any unforeseen scenario. Periodic backup is scheduled by disk to disk method to backup the data as snapshots.

CISCO Telepresence Systems

Cisco Telepresense system (under BITS Connect 2.0 project) is implemented in the campus which is interconnected to all BITS' campuses in India. The Cisco Telepresense classroom, capacity of 160 seating will help the students to participate in the online classroom sessions.

CISCO Telepresence Meeting Room: The Telepresence Systems (Model: IX5200 – CISCO) is the 1st device of its kind in the entire CCG installed by CISCO in BITS Pilani, Dubai Campus. This model incorporates an elegant triple 4K Ultra High Definition camera cluster, three high-definition 70 inch LCD screens and theater quality audio to bring people together as if they were just across the table. Other meeting rooms are equipped with Model No.: EX-90 & SX-10 used for a smaller group members or individual can have one to one interaction across all the campuses. These technologies make it possible for users to communicate as naturally as they would in person.

CISCO Telepresence Classroom: Is equipped with C90 system with 160 seating capacity used for inter campus meetings and lectures. The benefits of this technology will be easy to connect with management across all three campuses, offering more specialized electives to students, knowledge exchange between students from the other three campuses, helping students to attend guest lecture sessions from a remote locations, expediting the recruitment process.

E-Campus Solution: As an initiative and creative vision from the Director of BITS Pilani, Dubai Campus to make the Institute a smart campus, E-campus solution is adopted to achieve the Smart University environment. E-campus involves cashless transactions using a single card solution for all institute facilities. The faculty members, staff and students can access all the services and facilities in the University campus by using E-Campus smart card. It reduces the administrative overheads, automates the workflow efficiently for a complete university lifecycle of students.

Medical Facilities

A Prime Medical Center with one doctor and nurse is there on the campus. The nurse is available on the campus round the clock to provide first aid and emergency care. Vehicles are available for taking students to the hospital in case of emergency. Institute ensures that all students are vaccinated for chicken pox, flu or any other such contagious diseases. From time to time free medical camps are organized for faculty and staff.

Sports Facilities

The Campus has sports facilities for boys and girls. The indoor Sports Complex consists of badminton courts, TT tables, boxing training room. In addition, the outdoor games facilities consist of ground for football, cricket, basketball, volleyball, throw ball and handball courts. Separate gyms of international standards are there for girls and boys in the institute and in hostels. Four Cricket practicing nets of sizes 20m x 5m are also there. Athletic track was made to facilitate marathons, relays and races. Grass football ground with flood lights was installed.

Central Workshop

The central workshop imparts training to the students in workshop practice course and caters to the needs of maintenance work of the campus. It also caters to the fabrication needs of students working on experimental setups and various projects. The workshop comprises of Machine shop, Welding, Smithy, Carpentry, Foundry, Tool room, Metrology, Sheet metal forming, CNC, tool crib and stores.

The major equipments include all geared lathes and shapers, surface grinding machine, universal milling machine, radial drilling machine, wood turning lathe, and smithy hearth furnace, AC & DC welding machines and Universal testing machine. In addition to these facilities, there is provision for sheet cutting & bending, wood planning, sawing, casting and heat treatment. The workshop has sophisticated machines like CNC Vertical Milling Machine, CNC Lathe, Plastic Injection moulding machine, Optical microscope with Image analysis software, Microhardness tester, Potentiostat,for corrosion testing, Servo hydraulic Fatigue testing machine, Ultrasonic Testing, Vacuum Hot press, TIG Welding, Tool dynamometer, Acoustic Emission tester and Surface roughness tester.

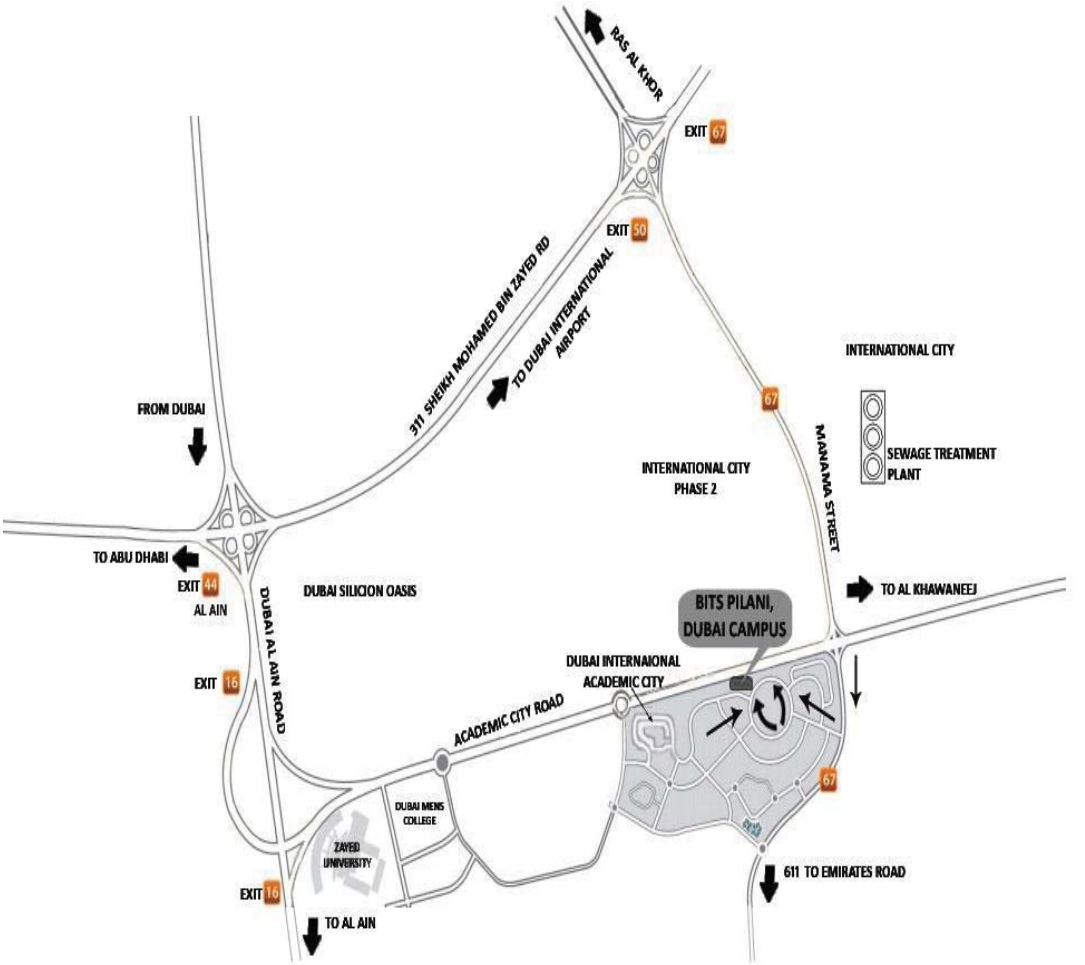
Laboratories

The Campus has well equipped engineering and sciences laboratories with latest instruments and software tools for students, faculty and research scholars. Viz., Biology Lab, Chemistry Lab, Physics Lab, Advanced Molecular Biology Lab, Bioprocess Engineering Lab, Genetic Engineering Lab, Instrumental Methods of Analysis Lab, Microbiology Lab, Computer Aided Design Lab, Engineering Graphics Lab, Heat Transfer Lab, Mechanical Engineering Lab, Prime Movers & Fluid Machinery Lab, Production Techniques Lab Workshop Practice Lab, Analog Electronics Lab, Communication Systems Lab, Digital Design Lab, Electrical Machines Lab, Instrumentation Lab, Power Electronics Lab, Signal Processing & Simulation Lab, Microprocessor Programming & Interfacing Lab, Computer Programming Lab, Software Systems Lab, Chemical Engineering Labs – I & II, Petroleum Lab and Creative Lab.

For more details, please visit:

http://universe.bits-pilani.ac.in/Dubai

ROUTE MAP BITS PILANI, DUBAI CAMPUS



K.K. BIRLA GOA CAMPUS AND ITS FACILITIES

The facilities available at BITS Pilani - K.K. Birla Goa campus include:

Student Housing

The institute is fully residential. There are separate hostels for boys and girls. First year they will be provided double-seated shared accommodation. Separate private room will be provided from second year onwards. There is a 'hostel attendant' stationed in each hostel.

Each room of the hostel is provided with modern furniture and Internet connectivity. Hostel common rooms are equipped with recreational facilities like Table Tennis, Carom & Chess along with LED TV with Dish connection, newspaper and telephones. Badminton court illuminated with solar lights inside the hostel lawn. Hostels are provided with Aqua guard purified drinking water facility with water coolers, and solar/electric geyser hot water for bathing. Each hostel is fitted with a CC tv camera and a security guard is posted for the security of students & hostel. The external housekeeping agency maintains the cleanliness of common areas of hostel & its surroundings daily.

There are three student dining to cater the food for the students which are run by outsourced mess contractors. There are three large sized Dining Halls with a seating capacity of 1200 students at a time. Each dining hall is well equipped with modern equipment and furniture.

Guest Accommodation

Excellent facilities are available for boarding and lodging on payment at Visitor's Guest House built in the southern corner of the campus. The guest house facilities include 11 AC rooms with modern amenities, a AC lounge, a AC dining hall and a level grass lawn.

Central Library

Spread over 3512 sq mts. area, the central library has a seating capacity of 550+ and includes several reading halls, a digital library with internet access terminals, and a large area for book storage. It has a good collection of over 39,301 books on a wide range of subjects. The library subscribes to 75 print journals. Subscription to important digital libraries and databases like IEEE Xplore online, Science Direct, ASME, ProQuest and ACM DL etc. provide full access to thousands of online journals to faculty, students and researchers.

Educational CDs, audio/video cassettes and question bank are also available. The textbook section keeps copies of all prescribed text books and reference books. A digital repository of resources curated from these as well as from the publications and dissertations of the Campus' faculty members and students is being built up.

A new initiative for making the Library a "Happening Place", taking a cue from the NAAC recommendations, is evolving through the leadership of the Library Committee. New comfortable and aesthetically pleasing furniture has been procured; spaces like lounge area and exhibition area and peripheral utility infrastructure have been developed to make the 'reading space library' experience more comfortable and enjoyable for the users.

The library has been provided with a wireless network whereby users can access the internet using laptops. The library transactions and search are managed using the (FLOSS) KOHA Library Management Software to automate its entire housekeeping activities. In this, the Campus is among leading campuses in the country. The bibliographic and holdings databases of books and e-journals can be accessed from anywhere in the campus through a Local Area Network. Indigenous projects are afoot to harness the same to a mobile phone-based social network.

Computer Centre

Computer Centre (CC) has a central computing lab having 300 workstations (DELL & Lenovo) connected through LAN. These workstations operate under LINUX and Windows environments and support a variety of software tools such as C, C++, Java, Python, Microsoft

visual studio, MySQL, Xilinx, ModelSim, Adobe Photoshop, OpenCV, Pro-Engineer, ANSYS, COMSOL, Matlab, AutoDesk etc. CC supports all Departments for their software, hardware and storage requirements. CC provides computing and storage facilities for students, staffs and faculties of the Institute. Presently, with the existing facilities, the centre provides support for conducting online examinations in several courses including Computer Programming, Data Structure and Algorithms, Operating Systems, Computer Networks, Creative Multimedia, Computer Architecture, Database Systems, Engineering Graphics, Control Systems, etc. BITSAT, Admissions, students' elections and other online events are also conducted in the central computing lab. Apart from the computing facilities, CC supports a LAN of 4000 nodes with intranet and internet facilities in the academic block, hostel rooms, staff quarters, guest house and other places. There are two internet lines: 300 Mbps from GWave for hostel rooms, 250 Mbps from Vodafone for academic block and staff quarters. 50Mbps dedicated internet bandwidth is provided for WILP classes. 45Mbps MPLS line is provided for video conferencing applications in Telepresence rooms. Secured Wireless connectivity is provided in the Institute building, student hostels, student activity centre, visitor's guest house and medical centre. The centralized e-mail solution is supported by Google. This solution is an integrated solution covering e-mail with 30 GB space, file storage with 5 GB space, collaboration tool, file sharing, personal web pages, calendaring system, etc.

Voice Communication

All faculty members have been provided with a laptop and IP phone facility in their chambers. The IP phone facilitates receiving of incoming calls directly on the individual's telephone.

Video Communication

Multi-point video conferencing facility is made available using POLYCOM HDX machine. This facility is utilized for online meetings of research groups in India as well as across the world apart from the administrative meetings.

Virtual Class Room (BITS Connect 2.0)

Virtual classroom is set up at K K BIRLA Goa campus. This facility will enable faculty to deliver lectures to all four BITS campuses simultaneously; alumni and experts to remotely deliver lectures and conduct workshops or panel discussions to multiple BITS campuses simultaneously, with recording and streaming of lectures.

Telepresence Conferencing Room (BITS Connect 2.0)

An 18+16 seat CISCO Telepresence conference room allows impressive multipoint teleconferencing facility among all the BITS campuses.180 seat Telepresence classroom is provided for delivering and receiving interactive lectures between all the BITS campuses. These facilities are used for cross campus courses, guest lectures, administrative meetings and online meetings of research groups in India as well as across the world. Telepresence at K K BIRLA Goa campus facilitate virtual meetings for academic and administrative decisions at University level. Licenses for WebEx (web conferencing software) have been provided to all the faculty to facilitate discussions related to course work and research. This facility will also open up avenues of multimedia collaboration with anybody outside the campus

Bring your own device (BYOD)

As a part of an effort to make Computer Centre Lab enhancement, collaborative learning with students own personal digital devices on campus, bring your own device (BYOD) area has been designed in the Computer Centre Lab. It is created with the purpose of encouraging students to use technology to support their academic learning and research. Students are permitted to bring devices that can connect to campus Wired/Wi-Fi network for any accessible digital content.

Workshop

The workshop is spread over 24,800 sq.ft. area and is well equipped with metal cutting machine tools like lathes, milling machines, shapers, pedestal grinders, tool and cutter grinders, cylindrical grinder, drilling machines, etc. It also has machines like pipe bending machine, plastics processing using rotational moulding

machine, Compression Moulding Press, Iron Worker, Muffle Furnace, Multi-Component Piezo Electric Cutting force Dynamometer etc.

There is a separate CNC machining section with production machines like CNC lathe, CNC Milling, Co-ordinate Measuring Machine and CNC Engraving Machine. These machines are based on FANUC controller. To introduce the concepts of layered manufacturing in product development, a 3-D printer or a Rapid Prototyping machine is also available.

An Electric Discharge Machine is used to introduce the students for un-conventional machining.

The carpentry section has the facilities of wood working lathes, planning machines and band saw machine.

A welding shop with the welding machines to facilitate arc, gas, TIG and MIG welding exists separately in the workshop.

The casting section includes an Aluminum melting furnace and casting testing laboratory to test the sand properties like strength, moisture, etc. A separate Metrology laboratory is also well equipped with measuring instruments like sine bar, dial gauge indicators, gauges, etc.

There exists an electroplating section where Ni and Zn plating is carried out on the workpieces produced.

Apart from the above facilities Central Workshop houses a well-equipped polymer and composite lab with equipment's like screw extruder, Density and Melt flow index tester, Dynamic Mechanical Analyzer (DMA), HDT& VSP tester, Universal testing machines for Polymeric materials (low capacity) as well as for metals and other materials (high capacity), Hydraulic Press for compression moulding, Izod Charpy impact tester, etc. An Injection Moulding Machine is being installed.

To test the formability of the sheets for metal forming an Ericcson's Cup testing equipment is housed.

The Non-destructive testing (NDT) equipment's like Ultrasonic Flaw Detector, Magnetic Particle Testing device is housed to introduce the concepts of NDT.

The KD2 Pro, a fully portable field and lab thermal properties analyzer is available. It uses the transient line heat source method to measure thermal conductivity, resistivity, diffusivity, and specific heat.

Pneumatic section with pneumatics and electro pneumatics set ups (Make Festo Controls) and a pick & place pneumatic manipulator is used to teach the concepts of Low Cost Automation using Pneumatics.

Acoustic Emission System

Cryogenic Treatment Equipment

Low Force Test System (UTM) (2KN)

Refrigerator/Heating Circulator

Tensile – Creep testing of Polymer & Rubber

Laboratories

The Institute provides labs equipped with sophisticated instruments and apparatus for students, faculty and research scholars. Some of these include: Nonlinear Optics Lab, Solid State Physics Lab; Physics Teaching Labs (Mechanics, Optics and Electricity and Magnetism, Modern Physics and Advanced Physics Lab), IMA Central Lab, Advanced Computing Lab, Materials Testing Lab, Measurement Techniques (Biology) Lab, Biotechnology Lab, Genetic Engineering Lab, Animal Cell & Tissue Culture Lab, Microbiology Lab, Applied & Environmental Biotechnology Lab, Advance Bio Lab, Cognitive Neuroscience Lab, Proteomics Lab, MT1 Chemistry Lab, Chemistry Project Lab [Also known as Nano Material Lab], Chemistry Special Project Lab [Also known as Biosensor Lab], Chemistry lab - Research & Teaching Lab, Chemistry Lab II - Teaching Lab, Analog and Digital Lab, Embedded Systems Lab , Digital Signal Processing Lab, Electric Machines Lab, Digital Communications Lab, Instrumentation Lab, Microelectronics Lab, Power Electronics Lab, Reconfigurable Computing Lab, Renewable Energy Lab, Weather Observatory, Network Embedded Systems Lab, Remote Embedded Lab,Advanced Measurement Techniques Lab,

Robotics & Automation Lab, MEMS Design Center, Thermal Science Lab, Fluid Mechanics and Machines Lab, IC Engines Lab with Low Speed Wind Tunnel Facility, Dynamics& Vibration Lab,Polymer & Composite Lab,Material Science Lab, Material Testing Lab, Mechanical Engineering.Process Engineering Technology lab, Process Control lab, Phase Equilibrium lab, Computer Aided Design Lab, Separation Processes Lab, Selected Chemical Engineering Operation Lab, Gas Hydrate Lab, Material Synthesis Lab, Engineering Chemistry Lab, Scientific Computing Lab and Language Lab. In addition to computer centre facility the Computer Science department has an additional lab with following facilities, for higher degree and research work.

- The lab has the 50 state of art computers with the necessary software.
- Cloud computing facility.
- Monosek Network Analyzer.
- Pervasive devices for applications in wireless sensor device.
- FPGA Kits for Hardware reconfiguration.
- Multimedia Equipment
- Real Time Operating Systems like VxWorks, QnX.
- HiPC Server (For University-wide Computation Service) IBM x3650 (Intel Xeon 5, 2GHz, 32 GB, 2-Processor, 16-core, 4TB RAID 5) Head Node with RHEL6.2 and 5 IBM x3550 (Intel Xeon 5, 2GHz, 32 GB, 2-Processor, 16-core diskless) Compute Nodes; MPI on IB backbone and ethernet connectivity. 650 MFLOPS tested nominal 1TFLOPS.
- Labs of the Department of EEE are equipped with the following Major Facilities for higher education and research work:
- Anechoic Chamber
- Vector Network Analyzer - Keysight, USA
- Logic Analyzer - Tektronix, USA
- Arbitrary Waveform Generator – Tabor Electronics, Israel
- USRP (Universal Software Radio Peripheral) - National Instruments
- IRNSS + GPS Receiver
- Cadence EDA Tools
- Mentor Graphics (HEP) EDA Tools
- Synopsys EDA Tools & TCAD Tools
- Xilinx Vivado System Edition

Incubator

BITS BIRAC BioNEST incubation facility is set up with a vision to: 'Enabling innovation in health care and environment for a better tomorrow'.

The objectives of the incubator are:

- To create an ecosystem that will enable innovation and knowledge based entrepreneurship to improve quality of life.
- To promote sustainable development while taking the innovations from lab to land.
- To encourage the concept of techno-entrepreneurship, enable the creation and sustainability of viable Bio & Healthcare enterprises.

The incubator includes both wet lab facilities and office spaces. Spread over 3500 sq. ft. with 3000 sq. ft .of landscaped surroundings ,it has a capacity to support more than 10 startups

The incubator's state of the art infrastructure provides great resource support to the startups in the initial phase. Several industry collaborations and a mentor network of experienced scientists, entrepreneurs and investors, along with institute faculty create a strong ecosystem to nurture and grow ideas. The incubator supports the institute's efforts in taking innovations from 'lab to land'.

Students Activity Centre (SAC)

Sports play a pivotal role in shaping one's personality and maintaining good health. BITS Goa specially developed a sports environment that matches international standards and gives a truly global experience to all our students. BITS Goa has multiple sports facilities to its

members with the opportunity to experience sport either for leisure and recreation or to an elite competitive level using state of the art equipment and a wide-range of sports facilities.

Indoor Sports facilities

The Student Activity Centre of BITS Pilani Goa Campus is constructed in an area of 37,000 square feet with state of the art sports facilities. It is equipped with indoor sports facilities like wooden Badminton courts, Table Tennis hall, Billiards room, and wooden Squash court with viewing gallery, Carom room, and a Dance room. It also has a music room with both eastern and western musical instruments, and also a Prayer room. A modern air-conditioned gym, with all the latest gadgets has been set up, it provides a wide variety of fitness classes and fun activities throughout the year for the BITS community.

Outdoor sports facilities

The campus boasts of a BCCI approved well maintained cricket ground, cricket practice net arena, an IIFF approved football ground, volleyball courts, lawn tennis courts, and Concrate as well as synthethic basketball courts with LED flood lights and also a Futsal court. All our outdoor sports facilities are open to students, staff & faculty members their kids and the BITS alumni. The Institute has left no stone unturned in encouraging students to participate in sports and recreational activities

Auditorium

A centrally air-conditioned auditorium with a seating capacity of 2200 is available for cultural activities, seminars, annual functions and other such activities.

Shopping Complex & Bank

The Shopping complex is a hub for facilities like a supermarket, book store, stationery shop with printing and photocopying facility, vegetable and fruit shop, cafeteria, gent's saloon, beauty parlor, laundry and tailor. State Bank of India has a BITS Goa branch in the complex, along with ATM, for all banking requirements of the students and residents of the campus. HDFC Bank has also provided an ATM facility. All the shops have cashless transaction facility through credit/debit cards.

Medical Centre

The Medical Centre provides primary medical care as an outpatient and in-patient services. 24x7 Emergency care is provided for the in campus residents through dedicated medical team. Medical facilities with modern equipment like Multi-parameter monitors, Defibrillator, Syringe pumps, ECG, X-ray, Ultrasonic therapy, etc. are available on campus to provide modern medical care. Dental Unit is operational with a visiting dentist on the prior appointment basis. Specialists are available on routine and on-call basis for outpatient care are General Medicine / Surgery / Orthopedics/ Pediatrics / Gynecology. In house Pharmacy is available. The Institute is empaneled with corporate, private hospitals and Goa Medical College for higher care.

Child Care Centre

The Institute runs a Child Care Centre to provide a safe, nurturing and creative environment where the children of faculty and staff can spend quality time while their parents are at work. The Centre runs a play school for infants in the morning and a Day Care in the afternoon. It is equipped with all necessary facilities (toys, activities, outdoor play equipment, educational material and infrastructure).

Parks

A park in the center of the residential complex provides greenery and space for play for the children on campus. It is equipped with outdoor play stations, swings, merry-go-rounds and benches, as well as a newly-setup outdoor gym facility for adults. The park is lit by solar lighting. Another smaller park for little children is provided near the D-type quarters as well.

Campus Placements

"The Placement Unit organizes campus placements, providing students in the final year with career opportunities for their first jobs. A large number of companies offering a variety of profiles in different sectors are contacted and hosted on campus during the recruitment cycle in both the semesters. Inviting the companies

takes place for the University as a whole and is not Campus specific; however, the recruiting company chooses the campus they intend to visit. We also make use of the Cisco Tele-presence facility and the Ex 90 systems for inter-campus interviews i.e Any company visiting one of the Campuses can interview students from other Campuses using this facility" and thus students are given large number of opportunities.

The end to end placement processes is fully automated from sending invites to the companies till receiving feedback from the companies about the performance of the students. The feedback is shared to the respective departments on regular intervals.

Mentioned below is the list of companies that visited the Campus:

S.No.	Company Visited/Recruited
1	159 Solutions
2	Absentia
3	ABSTC
4	Accenture
5	ADM Agro
6	Aeques
7	Altisource Business Solutions
8	Amazon
9	American Express
10	Anarock
11	Apple India Private Limited
12	Arcesium
13	ARM
14	Bajaj Auto
15	Barclays
16	Belong tech
17	Binani - 3 B Fibre glass
18	Birla Century
19	Bitmapper
20	Blue Jeans Network India Pvt. Ltd. , Bangalore
21	BlueOptima
22	CA Tech
23	Capgemini
24	Capillary
25	Cetas Healthcare
26	CGI
27	Cisco
28	Cognizant
29	Credit Suisse
30	Cypress Semiconductors
31	DBOI
32	Deccan Fine Chemicals
33	Deloittee
34	Deshpande Foundation
35	Direct i
36	Dream Vu
37	Embibe
38	EMC , Bangalore
39	Ericsson Global India Pvt. Ltd.
40	EXL Services
41	Fiorano
42	Flipkart
43	FOYR
44	Future First
45	Genpact
46	GGK Tech
47	Golden Hill capital
48	Goldman Sachs
49	Goodera
50	Grey Orange
51	Halftick
52	Here Maps
53	Histogenetics
54	Honeywell
55	HSBC
56	IBM
57	IDEAS-AS
58	IFB
59	IMI Mobile
60	Infosys
61	Infoworks
62	InMobi
63	Intas Pharma
64	Intel
65	Intuit
66	IQVIA
67	IVP
68	Jivox
69	JP Morgan Services - Quant , Mumbai
70	JPMC
71	Knolscape

72	L&T Construction
73	Lithium Tech
74	Lowes
75	Magnitude Software
76	Mahindra & Mahindra
77	Mathworks
78	Mckinsey
79	Media IQ Digital
80	Mediatek
81	Mentor graphics
82	Michelin Tyres
83	Microsoft IDC
84	Morgan Stanley
85	Moringstar
86	Musigma
87	NestAway
88	Netapp
89	Next Education
90	Nomura
91	Novartis
92	NIT
93	Nucleus Software
94	Nutanix
95	Nvidia Graphics
96	OFSS
97	Oracle
98	Orbees
99	Oyo Rooms
100	Paypal
101	PayU
102	Petasense
103	Pirmal Group
104	Postman
105	Qualcomm
106	Quantiphi
107	Qubole
108	Rao IIT
109	RedSeer Management Consulting Pvt. Ltd.
110	Reflexis
111	Reliance Industries
112	Reliance Petrochemicals
113	Report garden
114	Rivigo
115	Samsung R&D
116	Sandisk
117	Servicenow
118	Siemens
119	Skoda
120	Slingmedia
121	Statestreet
122	swiggy
123	Symentec
124	Syngene
125	Target
126	Tata Autocomp
127	Tata Motors
128	Tata Trust
129	Tavisca
130	TCS Analytics
131	Tech Racers
132	Tejas Networks
133	Tesco
134	Tesco Analytics
135	Texas Instruments
136	The Math Company
137	Tonbo Imagining
138	Tredence
139	Truecaller
140	Uber
141	Upgrad
142	UST Global
143	Vega Conveyors and Automation Ltd.
144	Veritas
145	Vizury
146	Walmart
147	Webware
148	Wipro
149	Xilinx
150	Zendrive
151	Zeotap
152	ZS Associates

Practice School

The Practice School division coordinates the PS-I and PS-II activities for student of the campus. On campus faculty are deputed by PSD for various PS-I stations across the country to mentor students in PS-I activities. PSD also is involved in expansion of industry base that partner BITS in the practice school activities.

During SEM I and SEM II, 2018-19 611 first degree students and 53 higher degree students went for PS-II from Goa campus. During summer term 2018, total of 573 students went to 171 PS-1 stations from the Goa campus

Activities - Games and Sports

The Institute encourages students to participate in sports and recreation. The Gymnasium at SAC is well equipped with mechanized treadmill and other latest exercise equipment. The campus has well maintained football, volleyball and cricket grounds, and lawn tennis and basketball courts. SAC also organizes the All India Inter Collegiate Institute annual sports festival “Spree”

SPREE is the biggest Inter-Collegiate Sports and Entertainment festival of India, Organized with the sole aim of promoting sports and social interaction amongst colleges from India and abroad SAC also conducts inter Hostel; inter department sports all games for the students community and also for employers annually inter department cricket, badminton and table tennis tournaments and athletic meet. SAC also encourages the students to participate in Inter collegiate and open tournaments throughout India

Cultural and Recreational Activities

Various student clubs – photography, music, foreign languages, movie, painting, dance and drama – enrich the quality of campus life at Goa.

Students organize various inter-institute festivals: “Waves” is the Annual Cultural Festival and “Quark” the Annual Technical Festival. An inter-institutional sports festival “Spree” draws enthusiastic participation from young sportspersons.

Students also organize TEDx under which talented individuals from across the country and the globe are invited to present their innovative ideas.

Major Indian festivals such as Makar Sankranti, Lohri, Holi, Ganesh Chaturthi, Onam, Durga Puja, Diwali and Christmas are celebrated by the entire campus community.

Classical Music, Dance and performing arts have a strong presence supported by classes held on campus for students, staff and children. The student group “Srutilaya” organizes concerts and workshops by eminent artists.

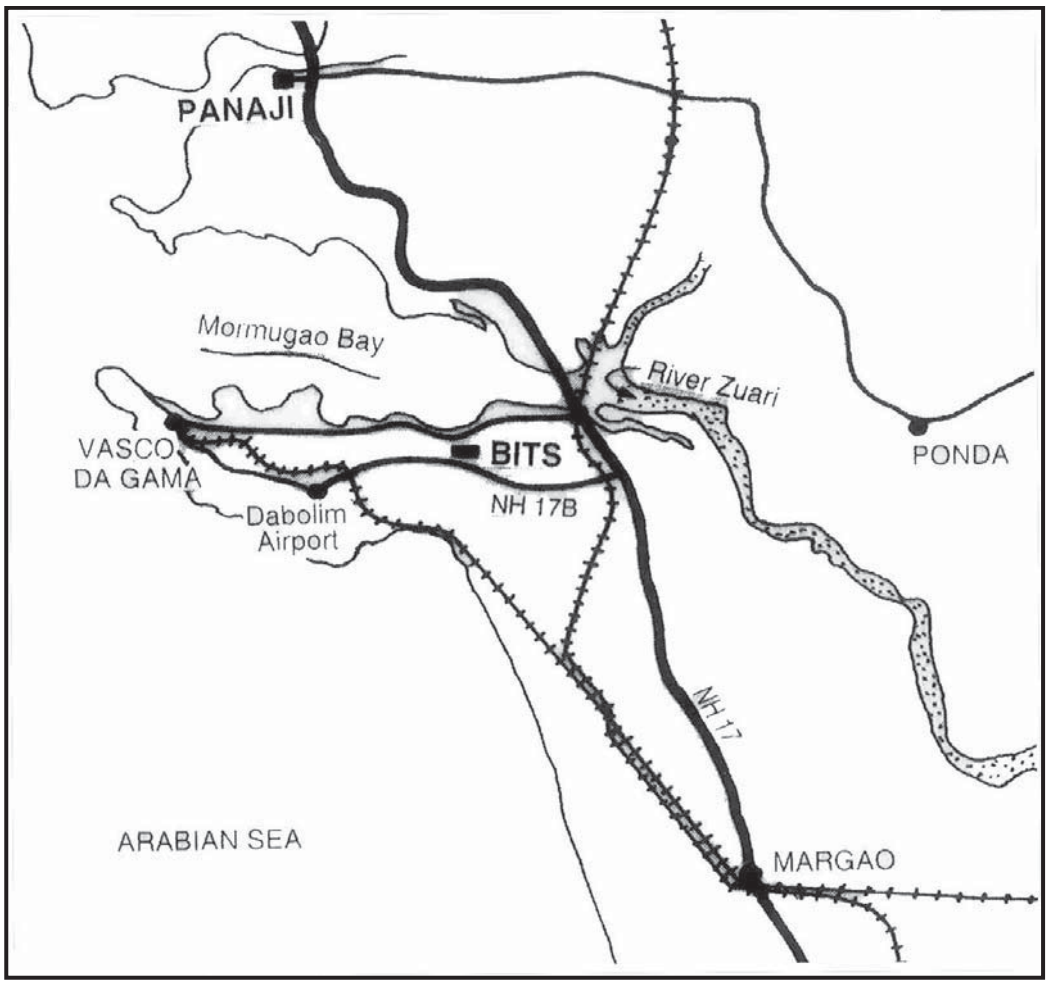
The Staff Cultural Association brings teaching and non-teaching staff members together in end-semester dinner get together, fetes, Holi and Diwali Milan and other activities.

The campus Film Club organizes screenings of latest release movies, as well as educational films with interactive sessions with the directors.

Environmental Awareness

The cleanliness and greenery in the campus is a matter of pride among residents. The *Plant a Tree* drive is an ongoing activity and has resulted in 3200 trees in the campus. In addition, there are campaigns to promote social awareness for cleanliness, waste management, energy conservation, utilization of renewable energy and environment protection.

ROUTE TO BITS PILANI – K.K. BIRLA GOA CAMPUS



Institutional Address:

BITS Pilani – K.K. Birla Goa Campus

NH17 B, By-Pass Road

Zuari Nagar – 403 726

GOA

Phone: 0832 – 2580101

Home page: http://www.bits-goa.ac.in

HYDERABAD CAMPUS AND ITS FACILITIES

The campus houses the main academic building, hostels for boys and girls, Student Activity Centre (SAC), library, residential quarters for faculty and staff, medical centre, playgrounds and a shopping complex. The main building comprises of centrally air conditioned classrooms, Central library, Auditorium, laboratories, lecture theatres, faculty chambers and administrative offices.

Student Housing

BITS Pilani, Hyderabad Campus is a fully residential campus outside the bustle of the city, yet not far from the attractions of the city during weekends. BITS Hyderabad boasts 10 boys & 2 girls' hostels accommodating both UG & PG students. The campus provides spacious well ventilated **double/single** room Non AC accommodation to each student. Each room is provided with modern furniture, internet connectivity and round the clock security. Floor wise common room facilitates with cable TV, magazines, newspapers, Table Tennis, Chess and carom boards. Other recreational facility like volley ball is also available in each hostel QTs. Potable drinking water is available in each floor and telephones are provided in all the hostel offices.

The central dining facility is available for all the students. There are two independent large dining halls with modern and well equipped kitchens with RO plant for drinking water. A variety of food and beverage joints spread across the campus.

Information Processing Centre

In the beginning of the academic year 2018-19, the erstwhile Information Processing Center (IPC) and CAD Labs were merged to form the new division – **Computer Centre (CC)**. The Computer Centre takes care of Campus-wide Network, WiFi services, Servers, Computational facilities (HW/SW) required to run FD/HD courses, and computers/telephones provided to the staff and offices of the Institution. The Computer Centre has three wings– (i) CCIT (ii) CC-Labs and (iii) Website maintenance.

The **CCIT** wing maintains the server room, which houses an IBM Blade server-H with 14 Blade Chassis out of which 7 blades are populated and a 3 TB DS 3400 IBM SAN box is available on the network supporting Pentium based PCs and Workstations of Lenovo/HP/Dell make equipped with Windows and/or Linux environments supporting a variety of software tools.

The CCIT manages and maintains the campus-wide network which is built using Cisco three-tier architecture with wired and WiFi access to users. The campus LAN is connected 1 Gbps dedicated fiber leased line (taken from three different ISPs) for the Internet connectivity to the entire campus community, and one 2 Mbps PRI line for tele phones at various offices within the campus.

These three ISP WAN links are load balanced through a Radware Linkproof load-balancer for better monitoring of WAN links, bandwidth management to different VLANs, and to provide application level QoS to users. One Cyberoam UTM device sits on the periphery of the network for authenticating users, performing web and spam filtering etc.

The CCIT is also responsible for creating and managing official e-mail IDs for all students, staff, departments and divisions, using Google's centralized e-mail solutions.

The CCIT also maintains the Voice over IP (VoIP) infrastructure and the Telepresence infrastructure in the campus. Using the Telepresence facility, BITS Hyderabad campus establishes connectivity with three other BITS campuses to conduct conferences, meetings and online live lecture sessions.

The **CC-Labs** wing of Computer Centre facilitates the computational requirements for teaching and research in Hyderabad campus. This wing manages eight computational laboratories for teaching and research. The CC-Labs facility with approximately 450 PCs is accommodating integrated teaching with computational/ numerical tools. In the academic

year 2018-19, CC-Labs facilitated 50 courses from all engineering and science departments, and this number may increase in the next academic year. A dedicated research lab equipped with 50 desktops is catering to the research needs of the faculty and students working on funded projects, dissertations as well as on design-oriented-projects. This wing also maintains 30 network based software/numerical tools which include the course specific software and the general application software. The course specific licenses include Design Tools- Auto CAD, FLEXSIM and PTC Creo, Numerical Computing Tools- MATLAB, MATHEMATICA and MATHCAD, Computational Fluid Dynamics (CFD) Tools- ANSYS CFD, Open Foam and COMSOL, Finite Element Method (FEM) analysis Tools- ABAQUS and ANSYS Mechanical, Civil Engineering Design Software- Bentley, and several other Statistical and Geographical Information System (GIS) tools. The CC-Labs is also involved in the procurement and maintenance of computer aided tools or software and the supporting hardware infrastructure for the academic use. The vision of the CC-Labs is to facilitate advanced computing facilities to faculty and students to enhance teaching and research endeavors of the Institute. With the increase in student intake, to achieve its aim, the CC-Labs wing is constantly conducting trainings to staff/students that impart knowledge on basics and advancements in software/numerical tools.

The **Website maintenance wing** of the Computer Centre manages the website specific to Hyderabad Campus.

Further, the Computer Centre supports the Admissions Division in conducting the BITSAT online entrance examination.

The CC also supports various departments and student associations in conducting workshops, Conferences, and seminars.

Workshop

The Central Workshop imparts training to students and caters to the maintenance & fabrication needs of the Institute. Students' training involves training all first degree students through the course "Workshop Practice" by imparting skills in various manufacturing processes like machining, fitting, carpentry, smithy, foundry, sheet metal, electroplating, welding, etc. and two computer oriented exercises, CNC Programming using Pro-E and Master CAM software's and Manufacturing Simulation using FlexSim software. For B.E. (Mechanical Engineering) and B.E. (Manufacturing Engineering) degree courses, students are also imparted in-depth training in various other courses such as "Production Techniques-I and II", "Manufacturing Processes", "Casting and welding" and "Computer Aided Manufacturing". Apart from routine maintenance and training, the workshop also accepts fabrication jobs concerning the project works of students and also technical support for TBI works.

The workshop comprises the following sections: Machine shop, Welding, Electroplating, Fitting, Smithy, Sheet Metal, Carpentry, Foundry and Metrology. Major equipment's include 1 Vertical Machining Center (Bridgeport VMC GX600), 1 EDM Wire cut (Model: SPRINT CUT), 1 CNC Lathe(Model PTC- 200), 1 Hydraulic press with computer control(40T), 9 Lathes, 2 Shapers, 1 Radial Drilling Machine, 1 Universal Milling Machine(Batlibai make) with indexing attachment, 1 Cylindrical Grinding Machine with internal grinding attachment, 1 Surface Grinding Machine, 1 Tool and Cutter Grinder, 1 Pedestal Grinder, 1 Slotting Machine, 1 Power Shearing Machine(Vivek Brand), 1 Portable Drilling Machine, 1 Injection Moulding Machine, 1 TIG Welding Machine, 1 MIG Welding Machine,1 Spot Welding Machine, 1 Universal Milling Machine (BFW make), 1 Shaper (Sagar make),1 Surface Roughness Tester (Mitutoyo make) and 1 Hydraulic Bulge Test Rig,1 ECM setup (Electro Chemical Machining), 1 Lathe Tool Dynamometer, and 1 Rotational Moulding Machine, 1 M TAB CNC Lathe Trainer, 1 3-D Coordinate Measuring Machine (CMM) "Spectra", 1 HMT-PRAGA Universal Tool & Cutter Grinding Machine, 1 FRITSCH Vibratory Sieve Shaker, Magnesium metal stir casting Furnace, 1 Milling tool dynamometer, 1 Drilling tool dynamometer, 1 Lathe tool dynamometer, 1 200TON capacity Compression testing machine, Mold Testing Equipment, 1 Open-hearth furnace for smithy, 1 Gas-fired furnace

for foundry, 5 Wood-working Lathes, 2 Arc-welding equipment, 1 Oxy-Acetylene gas welding equipment, 1 Gauge planner for wood works, Electroplating equipment (zinc coating), 1 Power Hacksaw, Sand Muller (Capacity-75kg), 2 Panther make lathe machines, Model: 1350/1, 1 HMT make High Speed Precision Machine, Model: NH26/1500, and two 3D Printers, 13 Lenovo make desktops and CIMCO CNC Simulation software (20 Licenses) and MASTER CAM (15 Licenses).

Medical Centre

A full-fledged medical center with three doctors and four nurses has been established with all necessary facilities including a 24x7 nurse and ambulance service. The institution has also tied up with reputed corporate hospitals in the city. A consulting Gynecologist and a Dentist visit the medical center regularly. A lab technician takes care of a diagnostics lab which has become fully operational in the medical center.

Shopping Complex & Bank

The Shopping complex (Connaught Place) comprises of Super Market, Restaurant, Gents Saloon, Beauty Parlours, Laundry, Medical Shop, Post Office, Book Shop, Stationery Shop with photocopying facilities, Bakery, Dairy Parlour, a Fruit and Vegetable Shop, and a Juice Parlour. An ice cream parlor is located close to the Shopping Complex. State Bank of Hyderabad, Jawaharnagar Branch and two ATMs are located in the shopping complex. In addition, more Food Kiosks are being added near Dining Hall – I & Dining Hall – II.

Laboratories

Advanced research laboratories for pharmacy, chemistry and biology have been setup. Research laboratories in Analytical, Organic, Inorganic and Physical Chemistry have been set up.

The department of biological sciences at BITS-Pilani Hyderabad Campus, despite being just nine year-old, has attained success in almost all spheres of academia, in line with the aims and objectives of BITS-Pilani University. We have established a strong research culture, replete with sponsored funding, publications and patents in the designated thrust areas. The faculty are constantly striving towards enhancing the departmental research programmes through individual and collaborative contributions. Since inception, the department has been successfully running M.Sc., M.E. and Ph.D. programmes, making the department a preferred destination for several graduate and undergraduate students across the country. The department has several national fellowship holders from agencies such as CSIR, UGC, DBT at both Junior and Senior Research Fellow levels. We have also established startup companies, strong industry linkages and are presently working towards strengthening these and establishing more. The department has nine faculty members of which all Ph.D holders. The research thrust areas of the department are Medical biotechnology, Agriculture biotechnology, Food and Nutrition, Environment and bioenergy, Bio resources, Structural Biology and Bioinformatics, Technology development, Biophysics, Microbiology, Biochemistry and Molecular biology, Health Sciences and Public/ Global Health.

The department has several Inter-institutional collaborative projects both at the national and the international level. The national institutes that the department collaborates with Apollo hospitals, Bangalore; All India Institute of Medical Sciences, New Delhi, National Institute of Ayurveda, Jaipur; Ranbaxy Research Labs, New Delhi, India; SP College of Medicine, Bikaner, Rajasthan; Indian Institute of Science, Bangalore; LV Prasad Eye Institute, Hyderabad; Shankar Netralaya, Chennai, Tamil Nadu; Elite School of Optometry, Chennai, Tamil Nadu and Grasim Industries, Nagda. The International collaborations are with Baylor College of Medicine, USA; University of Pittsburgh, USA; University of Chicago at Illinois, USA; Mälardalens Högskola, Swedish Council of Higher Education, Sustainable Innovations Inc, Virginia, USA; Equate Health, Silicon Valley, California, USA;

There are twelve laboratories, out of which four laboratories i.e biology laboratory, microbiology, biotechnology and genetic engineering are basic undergraduate facilities. Department also

has separate labs for Animal Cell Technology, Structural Biology and Bioinformatics, and which are laboratories for Higher Degree Students as well as Research Scholars. Department has also advanced research laboratories such as Genomics, Stem Cell and plat biotechnology, Environmental Biotechnology and Virology. There is also a research lab, which takes care of the general needs of research scholars.

The sophisticated and high-end equipment that caters to both research and teaching purposes include BSL-2a and -2b laminar flow hoods, refrigerated orbital shakers, CO2 incubators, FPLC, plant growth chambers, fluorescent microscope, inverted microscope, Nomarsky microscope, UV-vis spectrophotometers, multimode readers, advanced PCR machines, QRT-PCR machines, hybridization ovens, advanced table and floor top centrifuges, ELISA reader, cold room, gel documentation system, Nanodrop, flow cytometer, fermenter, servers for computational work etc. The department also has access to equipment in the central instrumentation facility provided by the institute which houses instruments such as, HPLC, GC, AAS, spectro-fluorimeter, LC-MS, FPLC, FTIR, confocal microscope, etc. A specialized laboratory has been set up with financial support from DST-FIST laboratory, funded by the Department of Science and Technology having equipment such as flow-cytometer, real-time PCR machine and phosphorimager.

The department publishes the research work in peer reviewed national and international journals of repute and high-impact factors, filed several patents and transferred a technology to a start-up company. Both departmental research committee and Synapsis, a student association conducts several invited lectures regularly. Some of the eminent speakers who visited the department in the last year are Hitesh Goswami, Co-Founder Bionivid Technology Pvt. Ltd, Bangalore; Dr. K.J. Mukherjee, Jawaharlal Nehru University, New Delhi; Dr. Abhijit Chakrabarty, Saha Institute of Nuclear Physics, Kolkata; Dr. Souvik Maity, Scientist and Shanti Swaroop Bhatnagar awardee- CSIR Institute of Genomics and Integrated Biology, New Delhi; Dr. Beena Pillai-Scientist-CSIR Institute of Genomics and Integrated Biology, New Delhi; Dr. Indumathi Mariappan, L.V. Prasad Eye Institute, Hyderabad.

The Central Analytical Labs (Central Analytical Lab 1 and new Central Analytical Lab 2) of BITS Pilani – Hyderabad Campus, popularly known as CALabs is equipped with modern state of the art instruments useful for advanced teaching and research. These equipment covers various modes of elemental analysis, spectroscopy, separation, thermal studies and material characterization and imaging. The following list of equipment are already established and functional for teaching and research. Important instruments list: Powder XRD, single crystal XRD, FE-SEM, Laser scanning confocal microscope, AAS-7000, Flame photometry, XRF, BET surface area analyser, GC, HPLC (detectors: diode array UV, RI, fluorescence), LC-MS-MS, DSC-60, TGA-DTA, spectrofluorometer FP-6300, UV-Vis-650, UV-Vis-NIR spectrophotometer, FTIR-4200 spectrometer, CD, Polarimeter, Karl-Fischer Titrator, Electrophoresis, Milli Q water facilities. 400 MHz Bruker NMR equipment will be installed soon. In this current year Impedance analyzer, spectrofluorometer for life time measurement and rheometer are already planned and budgeted for installations. In addition, we extend our service support to the external institutions and industries.

The Department of Chemistry offers M.Sc. and Ph. D. (Chemistry) courses where the students are systematically trained in well-equipped laboratories as a part of their practical courses. Individual students are given the scope to run the experiments on their own with the guidance of faculty members. The laboratory facilities include organic, inorganic, physical, spectroscopy, material science and computational chemistry laboratories. Apart from that, they also take the courses on an instrumental method of analysis where all the students individually run various equipment such as IR, AAS, Fluorescence, GC-MS, X-ray, Raman spectroscopy, microwave oven and high-end UV-Vis spectrometer. The department has recently added current source, plasma cleaner and solvent purification system to its

existing infrastructure. It is our pleasure to inform that SEM has been commissioned at our CAL (Central Analytical Laboratory) and NMR has reached to our campus. Both of this two equipment is the heart of the chemistry-based research and teaching. The faculty members for the department are involved in various projects such as organic synthesis, material science, and computational, physical, inorganic and analytical chemistry.

The faculty in physics research in Astrophysics, Theoretical Physics, Computational Physics; Materials Physics; Bio-sensing, Microfluidics, and Pedagogy. The current existing research facilities include Scanning Tunneling Microscope, Atomic force microscope, Fluorescence Microscope, AC Impedance Analyzer, Dynamic Mechanical Analyzer, Faraday rotation measurement unit, thin-film deposition unit, and four-probe resistivity measurement unit; Soft-lithography based micro fabrication unit, Dell server for computation, COMSOL with microfluidics module for simulations, Igor Pro and Microcal Origin software for data analysis. M.Sc students are also familiarized with some of the research equipment through the “Advanced Physics Lab” course. Apart from this, the undergraduate lab has been bolstered with apparatus to measure the Zeeman Effect, Velocity of light, Frank-Hertz equipment etc. A computer interfaced telescope is being procured to provide hands-on experience to students on acquisition and analysis of astronomical data.

The department of Pharmacy offers B. Pharm, M. Pharm and Ph.D. courses where the students are trained in well-equipped laboratories for their practical exposure. The laboratory facilities include analytical instruments, equipment for pharmaceutical dosage form preparations, computer aided drug design lab, medicinal chemistry lab, pharmacology, molecular biology, BSL-3 and animal facilities. The department has recently added clean room facility for making formulations to its existing infrastructure. The faculty for the department are involved in various projects including development new lead molecules for TB, cancer, neuropathic pain; formulation development, Nano-delivery systems, transdermal delivery systems, natural product chemistry and pharmacological systems.

The civil engineering department has established following state-of-art laboratories and facilities, which can provide opportunities at various levels to students, academicians, researchers and to outside agencies for consulting works:

Structural Engineering Laboratory: This lab has UTM of 1000 KN capacity, Torrent air permeability tester, Compression testing machine of 3000 KN capacity, Loading frame, Servo-hydraulic actuator (250 KN) for Dynamic Testing, Advanced dynamic testing shake table along with accelerometers, Advance ultrasonic test equipment, Accelerated curing tank, Impact hammer, Reaction mass assembly and required data acquisition system. The other major equipment available in the advanced structural lab include Wind tunnel, Plate load-testing equipment, weighing balance of 300 kg capacity and Hydraulic floor crane.

Concrete Laboratory: The major equipment/facilities available in the lab are Servo Hydraulic Compression Testing Machine (2000 KN), Vibrating table, Vibrating machine, Sieve shaker, Cement/Mortar/Concrete Permeability Apparatus, Auto clave, Torsion testing Machine, Air Permeability Apparatus, Flexural Testing, Machine, Rebound Hammer Test-NDT, Ultrasonic Pulse Velocity Tester, Dynamic Pull-Off Tester, Stereo Microscope and Strain Gauges of 120 ohms and 350 ohms capacity attached with Lab View Tester.

Highway Material Testing Laboratory: The lab has Hamburg Wheel Tracking Device, Humidity Chamber, Modified Marshall apparatus, Abrasion Testing Machine, Brookfield Rotational Viscometer, Advanced Bitumen Ductility Test set up, Aggregate Impact Test set up, Aggregate Crushing Value test set up, Asphalt density Meter, Closed cup Penskey Martin Apparatus Field CBR test set up, Fifth Wheel Bump Integrator , Rolling Thin Film Oven, Bump Integrator, Benkelman Beam, Universal Bitumen Penetrometer , Dynamic Cone Penetrometer, Soxhlet extractor and Saybolt Viscometer for Bitumen.

Geotechnical engineering laboratory: The lab has manual and Electronic Direct Shear apparatus, Large Shear Box apparatus, electronic Tri-axial set-up, Unconfined Compressive Strength test set up, electronic Consolidometer, Model Plate Load Test set-up, Rock Permeability Apparatus, Automatic Liquid limit Apparatus, Cone Penetrometer, Core drilling Machine, Soil Trimmer – CBR, Automatic Soil Compaction Machine and Relative density Apparatus. The lab also, has 2D Plaxis software for modelling soil.

Environmental Engineering Laboratory: The lab has facilities to test most of the water quality parameters. The facilities include, Spectrophotometers, Portable water testing kits, Digital PH meter, Fluoride meters, Double Distillation Unit, Turbidity meter, Portable DO meters, Fume Hood , Rain Gauge Equipment, BOD Incubator, BOD Analyzer , PM 2.5 and PM 10 dual dust sampler, Colony Counter and Auto clave.

Geodesy Laboratory: The Geodesy lab has majority of advanced instruments available for executing modern surveying techniques. The major instruments available are Total stations, DGPS, Handheld GPS, Auto level, Electronic Digital Theodolite and Planimeter along with conventional surveying instruments. The lab also has ArcGIS software for mapping and spatial analysis.

The Civil Engineering Department also, has **Center for Excellence in Water Resources Management** (CEWRM), which is initiated for innovation in sustainable research, education and training in water resources management and allied fields.

The Department of Chemical Engineering has six undergraduate labs namely Selected Chemical Engineering Operations, Transport Phenomena, Chemical Reaction Engineering, Environmental engineering, Petroleum Engineering lab and Process Control labs. The department also houses Multiphase Systems lab, Advanced Separation processes lab, Materials Science and Engineering lab for the Master's program. The department houses apparatus such as Supermasscolloider MKCA6-2J (Ultrafine friction grinding machine), Micro Gaschromatography (Agilent G3581A-490, Moisture Analyzer (50 to 200 OC, Shimadzu MOC63U), Karl Fisher Titrator (Moisture measurement in solids and liquids using chemical agents), Electrospinning Machine (Super-ES-2, nanoscale fibres and core-shell fibres), Fluidized bed Granulator, BET Surface area analyser (0.1-1500 m2 /g), Gas Liquid Chromatography (Agilent 7820 A, suitable for liquids having boiling points below 300 OC, FID detector), Muffle furnace (1000 OC), Fixed bed reactor (Chemito, up to 1200 OC), Brookfield Rheometer (coaxial cylinder 0.026 to 8830 Pas) Potentiostat & Galvanostat (Metroohm, used to measure the Electrochemcial energy conversion and storage), Temperature controller bath (PP07R-20 refrigerating/ heating, -20 to 200 OC), High pressure Autoclave (PARR reactor, 350 OC, 140 Kg/cm2), Reid Vapor Pressure Bath (Koehler Instrument Company, K11459), Rotary Microtome (Leica, sections of 500 nm using tungsten carbide and diamond knife, automated), Humidity Chamber (40 to 80% RH, 10 OC - 60 OC), Granulator, Tray Fermenter (Biomate India, BI-FERM-8D), Rotary Pulp Digester (160 OC, 10 Kg/cm2), UV-Visible double beam Spectrophotometer (Hitachi, U-2900, 190-1100nm), Optical Microscope (transmission mode, 10X, 40X including software to measure parameters), Injection moulding (200OC) , Compression moulding (250OC), Ultrasonic processor (VCX 130 Sonic Vibra cell.), Autoclave (Ambient to 140OC), Thermax Boiler (REVOMAX, 200 Kg/hr), Bubble cap distillation column, Filtration equipment, Software tools such as ANSYS-CFD, COMSOL, MATLAB, MATHCAD, ASPEN, etc are also available for computational work in the Central Computer Aided Design laboratory.

The CS&IS department has access to around 360 DELL/Lenovo machines (made available by IPC) as workstations and desktop PCs catering to the needs of Computer Science & Information Systems students for running their labs/programming assignments related to the lab oriented courses. In addition to these, the department has IBM e-Server Blade Center running Linux Redhat Enterprise Compute server, and FTP servers for use in the courses. The development tools and software available in these labs include Compilers (gcc /g++ &

JDK), Script Interpreters (Tcl/Tk, Perl 5.0, and gawk), GNU Assemblers, flex, flex++, X-development tools, NetSim, Oracle, etc. The department has recently setup a virtual Infrastructure which comprises Academic vCloud Suite 5 (4 CPU license), 2 Servers with Dual processor 6 cores (E2620) with Total 48 logical cores, 256 GB RAM, 6 GBPS HBA and Single Controller DAS with 8 TB.

The department has Atom processor kits, Gen1 Galileo Boards, Gen 2 Galileo Boards, and embedded software (sponsored by Intel) for developing embedded systems. The lab also includes Raspberry PI, Arduino Boards, NetFPGA, Hack-RF cards. The lab is used by the students of Software for embedded systems, IoT related projects.

The department has following 10 labs with necessary hardware and software facilities available for use by students to work on regular assignments and Computer Oriented projects. i.e. Computer Networks Lab, Operating Systems Lab, Database Systems Lab, Data Storage Lab, Software Engineering Lab, Intel Embedded Systems Lab, Distributed Systems and Information Security Lab, Compilers lab, Computer Org and Advanced Architecture Lab and Programming and Data Structures Lab.

Department of Humanities and Social Sciences has a computer based English language lab to strengthen communication skills of students. It has software that offers language teaching-learning solutions through interactive practice sessions.

The Mechanical Engineering Department has nine laboratories, catering to the undergraduate and postgraduate teaching and research activities of the department: Robotics and Mechatronics and Automation Laboratory, Materials Testing Laboratory, Product Design and Realization (PDR), Dynamics & Vibration Laboratory, Tribology Laboratory, Refrigeration Air-Conditioning & Energy (RACE) Laboratory, Heat Transfer Laboratory, Hydraulic Machines Laboratory and IC Engines Laboratory.

Robotics, Mechatronics and Automation laboratory is presently equipped with facilities such as 5-axis industrial robot, NI-Myrio Kit, Multiple sets of Docile X mobile robot, Omni wheel robot loaded with sonars, ABB Articulated arm Robot with finger and vacuum gripper, Smart camera evaluation kit, Mechatronic workbenches, Industrial AC servo motor kit, PLC, Hydraulic and Pneumatic training kit, etc.

Material testing laboratory has the following important facilities: Universal testing machine (Zwick / Roell) consist of tension, compression, bending test facility from cryogenic temperatures to elevated temperatures (-180^{0}C to 1200^{0}C) for metal, composite and polymers. Rotating fatigue testing machine for metallic specimens. Creep and rapture testing machine for constant load condition. Torsion testing machine for circular metallic specimens. Material characterization facility such as polishing machine, hot mounting machine, Digital density meter, stereo and inverted metallurgical microscopes (up to 500X magnification). Pultrusion machine. Hardness testing: Micro-Vickers and Brinell hardness testing. Impact testing: Charpy and Izod impact testing. Furnace: Muffle furnace (1200^{0}C).

PDR laboratory is equipped with Rank-Taylor-Hobson computerized profilometer, additive manufacturing machine (rapid prototyping), David SL2 & 3D scanner, milling dynamometer and etching machines along with the softwares like ABAQUS, DEFORM-3D, LS-DYNA, and Design-Expert.

Dynamics and Vibration laboratory has miniature shakers, uniaxial and triaxial accelerometers, universal vibration apparatus, whirling of shaft apparatus, gyroscopes, static and dynamic balancing machines, wireless strain remote monitoring WSDA link, gear box with spur gear arrangement to perform condition monitoring studies, planetary gear box for wind turbine fault diagnosis, NI DAQ system for data acquisition, sensors for lubricating oil monitoring and microphones for acquiring acoustic signals.

Tribology laboratory is equipped with number of sophisticated equipments to study friction and wear characteristics, such as pin on disc tribometer, four ball tester, tool maker's microscope, scratch tester with humidity controller and journal bearing equipment.

RACE laboratory is equipped with refrigeration and air conditioning test rigs, cool thermal energy storage test system, wind emulator, wind energy training system, indoor air quality testing instrument with air quality probe having digital multimeter, solar PV training & research systems, solar concentrator training system and solar thermal training systems.

Heat Transfer laboratory is equipped with heat transfer and heat exchanger modules, convection, conduction and radiation equipment setups, convection drier, thermal constant analyser, flame propagation unit, and computerized fluidized bed.

Hydraulic Machines laboratory has the following equipments: centrifugal pumps, submersible pumps, hydraulic turbines, Wind Tunnel Test Rig, steam power plant test rig, a nozzle performance test module, modular air flow bench, Laser flow visualization, hotwire anemometer and rheometer.

IC Engines laboratory is equipped with computerized SI and CI engine, AVL Ditest MDS 650 system with features such as smoke meter and gas analyzer, pressure sensor adapter & tooling device, computerized dual fuel VCR system, a test rig for evaluating alternate fuels, LPG & CNG sequential kits.

Also Mechanical Engineering Department is supported by a **Central Workshop** and a **Centralized CAD laboratory.** Central Workshop is an autonomous unit, equipped with numerous manual, semi-automatic and automatic machine tools and machines and providing services to all other departments and divisions. Centralized CAD laboratory has variety of computer aided design and engineering software like Pro/Engineer, ANSYS, COMSOL, MATLAB, etc. In addition, Mechanical Engineering Department has collaboration with Hemair Systems Ltd. Hyderabad, for establishing an **ISO-6 (Class-1000) Clean Room** in the institute for micro-electro-mechanical systems (MEMS) fabrication, which is part of the Institute's Technology Business Incubation (TBI) programme funded by the Department of Science and Technology (DST), Government of India.

The EEE department at Hyderabad campus, over the last 10 years, has established laboratories with equipment and Software worth more than Rs. 9 Crores. The labs include, Analog Electronics Lab, Communication Systems Lab, Microwave Engineering Lab, Microelectronic Circuits Lab, Digital Electronics Lab, Microprocessor Applications Lab, Digital Signal Processing Lab, Electrical Machines Lab, Control System lab, Power Electronics Lab, Power systems lab, Instrumentation and Transducers lab, MEMS Lab, Optical Communications Lab, Advanced Communication Lab, Embedded Systems lab, Signal & Image processing Lab, Advanced Digital Communication, FPGA design lab, Mobile and personal communication, Computer Architecture, VLSI CAD Lab, and High Voltage Lab to supplement the undergraduate programs in EEE, ECE & EEI and the higher degree programs. The High voltage lab has recently been set up and it consists of all state-of the art equipment such as 100 KV AC/DC Source and control panel, 3 stage 300 KV 3 KJ Impulse Generator, C and Tan-delta Test Kit (Schering Bridge), Vaccum and Pressure Vessel, Rod Gap Apparatus – Horizontal Sphere Gap Apparatus, Rain Making Equipment, Salt Fog Chamber, and Electrolytic Tank. On the other side, some sophisticated instruments also added up which include Solar simulator, Laser engraver, contact angle measurement, UV laser writer, and dry film photoresist. The EEE department has also been equipped with software's such as Cadence, COMSOL, Synopsys, Silvaco, Opnet, NetSim, DSA tools & PSCAD for power systems, PSIM, Ansys HFSS, Coventorware, Intellisuite NI Vision Tools, Rsoft Optsim V, LabView, Graphtech Studio, LT Spice, Xilinx Design Tools, FASM, CST Microwave Studio, AR Phased Array System Toolbox and OS RHEL.

The Central Computer-Aided-Design (CAD) Laboratory facilitates the computational requirements for teaching and research in Hyderabad campus. This facility manages three computational laboratories for teaching and research. The CAD Lab facility with 200 PCs is accommodating integrated teaching with computational/numerical tools. In the academic year 2017-18, CAD lab facilitated 40 courses

mainly from Chemical, Civil and Mechanical departments, and this number may increase in this academic year. A dedicated research lab equipped with 50 high-end desktops is facilitating the research needs of the faculty and students working in funded projects, dissertations as well as in design-oriented-projects. The facility maintains 26 network based software/numerical tools which include the course specific software and the general application software. The course specific licenses include Design Tools- Auto CAD, FLEXSIM and PTC Creo, Numerical Computing Tools- MATLAB, MATHEMATICA and MATHCAD, Computational Fluid Dynamics (CFD) Tools- ANSYS CFD, Open Foam and COMSOL, Finite Element Method (FEM) analysis Tools- ABAQUS and ANSYS Mechanical, Civil Engineering Design Software- Bentley, and several other Statistical and Geographical Information System (GIS) tools. The facility also involved in the procurement and maintenance of computer aided tools or software and the supporting hardware infrastructure for the institute. The facility is equipped with High Performance Computation (HPC) cluster based on the Domain Decomposition Method for parallelization with capacity of 2.4 Tflops.

The vision of the Central CAD Laboratory is to facilitate advanced computing facilities to faculty and students to enhance teaching and research endeavors of the institute. With the increase in student intake, CAD Laboratory establishing new computation laboratories starting from academic year 2018-19. To achieve its aim, CAD laboratory is constantly conducting trainings that provide basics and advancements in software/numerical tools. Pooling computation resources help faculty funding opportunities, and control expenses and reduce overheads as well as it benefits more faculty and students.

Sandboxx

Sandboxx is a multi-disciplinary platform to develop technologies in the domains of Internet of Things, Wearable Technologies and Consumer Electronics. The lab is envisioned as a platform that enables students in the creation of technologies that solve real world problems at the interface of engineering (Mech, EEE, CS, etc) sciences (biology, pharmacy, physics, etc) and design. This lab is for facilitating student ideas and implementation with easy access to equipment and tools such as sensors, microprocessors, power tools etc

Technology Business Incubator (TBI)

The role of technology business incubator is to proliferate overall entrepreneurial process and thus increasing the competiveness and bring about sustain development to an innovative idea till formation of a successful venture. A Technology Business Incubator (TBI) can ably support such an environment by nurturing technical bents of mind and innovations. TBIs are, a desirable link, in the present context between manifesting the potential of technical innovations and New Enterprise Creation & Growth. The essence of economic development lies in the pace of entrepreneurship development.

Against this backdrop BITS-Pilani, Hyderabad has promoted a Technology Business Incubator, The Incubator is supported by National Science and Technology Entrepreneurship Development Board, DST, Govt. of India.

The Technology Business Incubator at BITS-Pilani, Hyderabad aimed at fostering technology/knowledge based entrepreneurial start-ups by:

- Nurturing them at an early-stage and helping them overcome limitation trough low cost services
- Offer value added services viz. legal, financial, technical, IPR, mentoring, business networking (National and international) etc. to incubatee's
- Providing business environment for operation with well-equipped infrastructure support
- Commercialization of technologies and nurturing any such business collaboration for profitable business

- Strengthening business skills/knowledge startups and making them more enterprising
- Skill development in the region in terms of innovation and Entrepreneurship and creating job opportunities.
- Creating a sustainable ecosystem with multiple stakeholders for enterprise creation.

Sectors of Intervention:

TBI will offer services in diverse sectors. To begin with, TBI@BITS Hyderabad aims to provide a low cost and resource intensive sandbox for Health-Tech, Bio-Tech and Devices where entrepreneurs can develop their product, services or process ideas towards commercialization.

Current Infrastructural support and facility

Working Area

Office space and co-working

ICT lab

Space for design of smartphone/tablets for healthcare around 1200SFT is in use.

Bio-Tech Lab

Lab space for biotech/pharma around 2000SFT is available for startups

Health-Tech Lab

TBI will be setting up a HealthTech Lab in collaboration with two leading hospitals in Hyderabad

- Digital Health and Healthcare IT
- Medical Electronics & Devices
- Rapid Diagnostics

MEMS clean room (Micro-Electro-Mechanical Systems)

Clean room (Micro and Nano Fabrication Facility)

https://universe.bits-pilani.ac.in/hyderabad/cleanroom/cleanroom

BITS Pilani Hyderabad campus established state of the art facilities for Micro and Nano semiconductor device fabrication and characterization. The size of clean room is 581 sq. f and 80% of it is maintained as (ISO 6) class 1000 and the rest is class 100 (ISO 5). Complete class 100 area covered with yellow light and dedicated for Lithography process. This facility consists of the following equipment Wet chemical work station for semiconductor and other clean applications, Two-inch tubular furnace capabilities, Spin Coater System, Probe station with source measure unit, UV Exposure System, and Electron beam evaporator system. This financial year (2019-2020), a state-of-the art mask aligner has been budgeted and to be included in the clean room.

Makers space: 3D printer's, CNC machine, machining tools, Lathe etc.

Library facility

The Library at BITS Pilani – Hyderabad Campus is a gateway to knowledge resources. The Library is one of the central support services of BITS Pilani - Hyderabad Campus. It provides information services and access to textual and bibliographic digital and print resources to the BITS Community. Institute's state-of-the-art library with two floors spread over 45000sq.ft. Open 7 days a week till 9 pm and during the tests and examinations till 1 am (midnight). It has a collection of over 39000 books, 920 educational CD-ROMs and subscribes to over 74 Indian and foreign journals. The Library also subscribes to 9600+ e-journals like, American Society for Civil Engineers (ASCE), American Society of Mechanical Engineers (ASME), Association of Computing Machinery (ACM), JSTOR, SciFinder, SCOPUS, Royal Society of Chemistry, IOP, APS, Nature, IEEE, Science Direct etc. The Digital Library has a collection of over 7279 e-books on engineering and question papers of previous years' examinations. The library operations are fully computerised and students can have access to the Online Public Access Catalogue (OPAC) from their hostel rooms. Recently, RFID (Radio-Frequency Identification) technology and self-check-in and Check-out facility was introduced in the library. With the introduction to RFID has enabled

faculty and students to borrow and return materials whenever the library is open. No time restrictions for books issues and returns. Self-service facilities also allow for a much faster and more efficient way of borrowing and returning books. Discussion rooms are available in the library for the faculty and students to meet and discuss their project their project and other academic related work. The Library is equipped with the most modern furniture and is specially designed taking into consideration the future growth of the library collection and needs of the users in the coming years. The air conditioned Library has WI-FI facility as well.

Students Activity Centre (SAC)

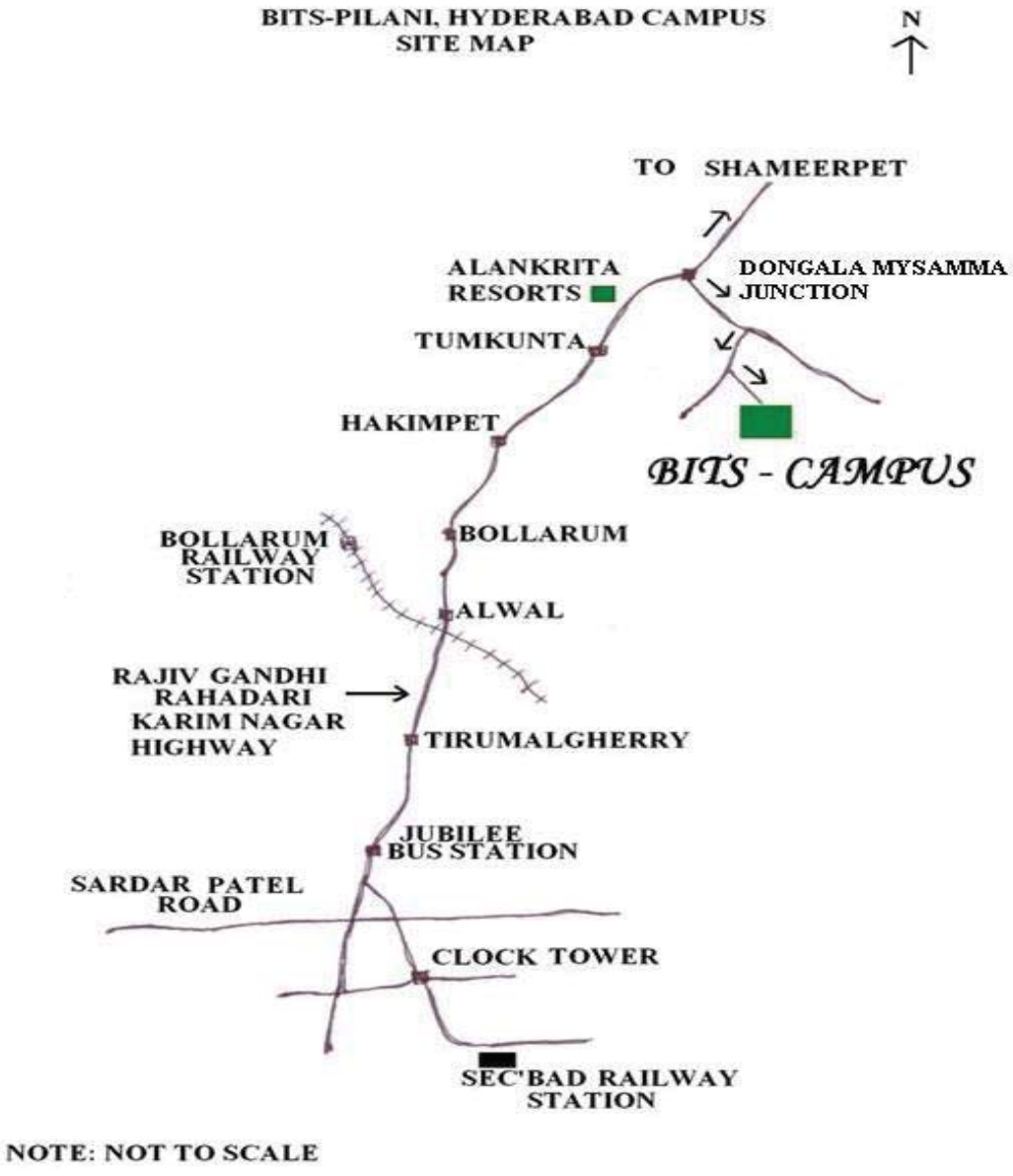
To ensure overall development of every student, the institute provides multiple avenues for relaxation, health and fitness through sports and recreation facilities. Student Activity Centre (SAC) offers facilities for various Indoor Games & Sports like Chess, Carroms, Table Tennis, Pool Table, Snooker, Billiards Badminton and Squash. A Gymnasium (With separate sections for strength and weight training) with state-of-the-art equipment is available here.

A separate hall with wooden flooring is being provided for Dance. The Students Union and various clubs like Music (Indian and Western), VFX, Photography, Dramatics, Shades (Fine Arts) and English Language Activities Society (ELAS) are provided with rooms inside SAC to pursue their activities. Many more clubs share space in SAC for their activities.

A variety of musical instruments like synthesizers, drums, guitars, etc., have been made available for students of the Music Club to encourage them to practice and perform.

Games and Sports

In addition to indoor facilities, modern facilities for outdoor sports like Tennis, Basketball and Throw ball are available in SAC premises. Two indoor Badminton courts with wooden flooring, two Tennis and Volley Ball courts with synthetic surface have been provided with flood lights. The cricket ground having two pitches with grass playfields along with a spectator gallery is located inside the institute premises. Three synthetic grass turf pitches are also provided besides the ground for practice. Football and hockey ground along with kabaddi courts are located centrally inside the institute. In addition to the common sports facilities, separate play areas for volley ball, table tennis, chess and carom are provided in each hostel.



Institutional address:

Jawahar Nagar, Kapra Mandal,

Medchal District, Hyderabad – 500078.

Telangana State. Phone: 040 – 66 303 999.

Home page: http://universe.bits-pilani.ac.in/ /Hyderabad

MEMBERSHIP OF DISTINGUISHED BODIES

The Institute is an institutional member of the following Associations and Bodies:

(i) Association of Commonwealth Universities, London.

(ii) Association of Indian Universities, New Delhi.

(iii) Current Science Association, Bangalore.

(iv) Federation of Indian Chambers of Commerce and Industry – Higher Education Network, New Delhi.

(v) India International Centre, New Delhi.

(vi) Indian Association of Social Science Institutions, New Delhi.

(vii) Indian Distance Education Association, Hyderabad.

(viii) Indian Institute of Foreign Trade, New Delhi.

(ix) Indian Society for Technical Education, New Delhi.

(x) Institution of Communication Engineers and Information Technologists, New Delhi.

(xi) International Association of Universities, Paris.

(xii) International Council for Open and Distance Education, Oslo, Norway.

(xiii) National Council of Applied Economic Research, New Delhi.

(xiv) Petrotech Society, New Delhi.

(xv) Pharmacy Council of India, New Delhi.

(xvi) The Institution of Engineers (India), Kolkata.

(xvii) World Association for Cooperative Education, Boston, USA.

(xviii) Council for Advancement and Support of Education, Washington.

(xix) Association for Institutional Research, Florida

COLLABORATION WITH FOREIGN EDUCATIONAL INSTITUTIONS

The Institute has collaborative arrangements in terms of exchange of students, faculty and information with the following institutions:

1. The University of Oklahoma, Norman, Oklahoma, U.S.A.
2. Tulane University Medical Centre, New Orleans, Louisiana, U.S.A.
3. Purdue University, West Lafayette, Indiana, U.S.A.
4. Uniformed Services University of the Health Sciences, Bethesda, Maryland, U.S.A.
5. Kathmandu University, Kathmandu, Nepal.
6. University of Otago, Dunedin, New Zealand.
7. Rivers State University of Science and Technology, Nigeria.
8. University of Colombo, Srilanka.
9. George Mason University, Fairfax, USA.
10. ETA Network of Education and Training, Dubai, UAE.
11. University of Windsor, Windsor, Canada.
12. The George Washington University, Washington, USA.
13. Massachusetts Institute of Technology, Cambridge, Massachusetts,USA.
14. Cornell University, Ithaca, USA.
15. Northeastern University, Boston, USA.
16. Waseda University, Tokyo, Japan.
17. Högskolan i Borås (University College of Borås), Sweden.
18. The University of New South Wales, Sydney, Australia.
19. Binghamton University (State University of New York), Binghamton, New York, USA.
20. Victoria University of Technology, “Victoria University”, Melbourne, Australia.

21. University of Southern California, California, USA.
22. Iowa State University of Science and Technology, Ames, Iowa, USA.
23. University of Maryland, College Park, USA.
24. Kansas State University (KSU), Manhattan, Kansas, USA.
25. Arizona State University IRA A. Fulton School of Engineering, USA.
26. The Tun Hussein Onn National Eye Hospital, Petaling Jaya, Malaysia and National Institute of Ophthalmology, Petaling Jaya, Sede Boquer Campus, Malaysia.
27. Universities of Ontario, Canada.
28. The Jacob Blaustein Institute for Desert Research (BIDR) of Ben Gurion University (BGU), Israel.
29. Utah State University, Logan, USA.
30. York University, Toronto, Ontario, Canada.
31. University at Buffalo, The State University of New York, USA.
32. University of Dundee, United Kingdom.
33. Lund University, Sweden
34. Helsinki University of Technology, Espoo, Finland.
35. Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA 15213, USA.
36. TELECOM Bretagne, Cedex 3, France.
37. The University of North Carolina at Greensboro, Greensboro, NC, USA.
38. The University of Toledo, College of Engineering Toledo, Ohio, USA.
39. Lunghwa University of Science and Technology, Taoyuan, Taiwan.
40. Ecole Nationale Supérieure D'Ingénieurs De Limoges (ENSIL), Université de Limoges, France.
41. Concordia University, Montereal, Quebec, Canada.
42. Technische Universität Braunchweig, Germany.
43. Faculty of Engineering and Graduate School of Science and Technology, Kumamoto University, Japan.
44. Carleton University, Ottawa, Canada.
45. University of Savoie, Chambéry Cédex, France.
46. Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA 15213, USA.
47. La Trobe University in Australia.
48. University of Rhode Island, Rhode Island, Kingston, USA.
49. USC Viterbi School of Engineering, USA.
50. RAK Medical & Health Sciences University, UAE.
51. New Mexico State University, USA.
52. "n+i" Network of Engineering Institutes, France.
53. Pace University, New York, USA.
54. Florida International University, Miami, Florida, USA.
55. Norwegian University of Life Sciences (NMBU), Norway.
56. University College Dublin, National University of Ireland, Dublin.
57. Macquaire University, Australia.
58. Michigan State University, College of Engineering, East Lansing, Michigan, USA.
59. The University of Wisconsin-Madison, USA.
60. University of Tartu, Estonia, EU.
61. University of Limoges, France.
62. CSIR National Institute of Oceanography(NIO), Goa.

63. The Universite De Perpignan Via Domitia, France.
64. Tunghai University, Taichung, Taiwan.
65. Carleton University, Ottawa, Canada.
66. University of Leeds, Leed, United Kingdom.
67. School of Mechanical Engineering, Kyungpook National University, Republic of Korea.
68. The Technische Universitat Braunschweig, Germany.
69. The Uiversity of South Florida, Florida, USA.
70. Tel Aviv University, Israel.
71. Cardiff University, Cardiff, U.K .
72. Maktoum Bin Hamdan Dental University College, Dubai.
73. Saint Petersburg Electrotechnical University, Russia.
74. The Graduate School of Engineering, Hiroshima University, Japan.
75. Memorial University of Newfoundland, Canada.
76. Al Ain University of Science and Technology, Al Ain, UAE.
77. The University of Nottingham, UK.
78. University College Dublin, Ireland.
79. University of Virginia, Charlottesville, Virginia, USA.
80. Hiroshima University, Hiroshima, Japan.
81. International Center for Biosaline Agriculture, Dubai, UAE.
82. Trinity College, University of Dublin, Dublin, Ireland.
83. The College of Engineering, National Cheng-Kung University, Tainan, Taiwan.
84. Ontario Universities International, Toranto, Canada.
85. The University of Queensland, St. Lucia, Australia.
86. College of Life Sciences, Kaohsiung Medical University, Taiwan.
87. Nanhua University, Taiwan.
88. The Norwegian University of Science and Technology (NTNU), Gloshaugen, Norway.
89. The University of Illinois, Champaign, USA.
90. International Water Association (IWA), London (United Kingdom)
91. University of Agder, Grimstad (Norway)
92. University of Central Florida, Orlando (U.S.A.)

PART II

EDUCATIONAL PROCESS & PROGRAMMES OF STUDIES











EDUCATIONAL PROCESS

The mission of BITS is to prepare young men and women to act as leaders for the promotion of the economic and industrial development of the country and to play a creative role in society. It has the reputation of a highly purposive and innovative university often setting the pace for workable reforms in higher education, suitable and relevant for the Indian cultural milieu.

BITS has been following semester system with continuous and internal evaluation since its inception. The educational programmes are modular and flexible. Through its Practice School programme, BITS has established purposeful linkages with industries. The Institute has evolved a direction for Research which makes research relevant to the national development and social needs. It has developed and adopted a unique academic administrative structure which makes all its innovations possible and workable.

The Institute operates educational programmes at three tiers of education, namely, the Integrated First Degree programmes, Higher Degree programmes and the Doctoral programmes. All programmes in the Institute are designed to allow as many components of science and applied science as are necessary for the graduates of the programmes to function effectively and efficiently in the technological society. All programmes contain certain structural commonality and the common courses are invariably operated together irrespective of the clientele who are required to take the courses. Similarly, irrespective of the ultimate degree for which a student qualifies, the large factor of this commonality between all students creates an educational basis which provides easy professional linkage, communication and group activity among students graduating in different degrees. This similarity among different students graduating with different degrees is further welded in a stronger professional bond when they work as internees in the Practice School stations or as members in a team working on mission-oriented time-bound research and development projects.

The various structural flexibilities provide not only scope for multiple point entries but also enable the system to accommodate many legitimate educational and operational needs of students. Some of these aspects are described in various sections that follow.

PROGRAMMES OF STUDIES

All programmes of studies are based on the principle that a series of courses make up the hierarchy of the structure where each course is self-contained but nevertheless acts as a bridge between what precedes and what comes after. A formal contact hour is such that a student is invariably required to spend several times of these hours towards self-study. Attempt here is to awaken curiosity in the mind of the student and train him to think rationally and scientifically and enable him to face the unfamiliar. Through the Practice School option, the flavour of the professional world is sought to be imbibed by the student as well as the teacher. Even many co-curricular activities are converted into a learning situation whereby the growth of a student becomes a continuing operation.

The Institute also conducts Off-campus Work-Integrated degree programmes as a means of continuing education for employed professionals as part of the human resource development programmes of specific organizations at the various off-campus centres. In all these programmes, emphasis is on self-learning and the pedagogy attempts to incorporate as many modern technologies as desirable. While each one of these programmes requires collaboration of an organization, some programmes have a highly structured collaboration with planned classroom activities and some programmes may have less structured planning. While a number of degrees are offered through structured collaboration with many collaborating organizations, there are also degrees, which are available in an open manner for a large number of organizations, each of which may sponsor

only few students. For all these programmes, faculty/resource persons are drawn from the Institute and the participating organizations as well as other Institutions.

The Three Tier Structure shown on page II-3 gives all the programmes offered by the Institute.

Integrated First Degree Programmes

The Integrated First Degree Programmes are offered at the first tier with nomenclatures like B.E., B.Pharm. and M.Sc.. These are all level wise equivalent degrees. These are called integrated degrees for two reasons: (i) there are several common courses amongst these degrees, and (ii) no intermediate degrees, like, B.Sc. etc. are awarded. These degrees are based on a modular structure and their academic requirements are spelt out in respect of the number of courses and units rather than the number of years. All these programmes are structured in such a way that normally a student will be able to finish a programme in eight semesters. Of course, the flexibility of the Institute allows a student to do his programme at a faster pace and finish it earlier than 8 semesters or at a slower pace to finish it later than 8 semesters.

(a) B.E.

These programmes in engineering are mathematics and hard science based and incorporate many up-to-date techniques of analysis and synthesis.

(b) B.Pharm.

This programme has been so structured that it not only meets the requirements of the Pharmacy Council of India but also has additional courses which give a shape and flavour of both engineering and fundamental sciences to the programme.

(c) M.Sc. (Programmes under Group B)

These are integrated degree programmes without any intermediate B.Sc. degree. While these programmes ensure the required science component in any comparable postgraduate science degrees of other universities, they also incorporate many courses which have been notionally considered to be the preserves of engineers. The integrated nature of the programmes and their analytical and engineering science contents give them a professional character and enable students to participate usefully in industrial jobs. While a good 10+2 input may be able to complete these programmes in four years, any person coming from 10+2+3 system with a B.Sc. degree admitted on advanced standing basis will require two to three years to finish the programme. Almost all students who are admitted for these degrees also aspire and work for a second degree from B.E. and B.Pharm. degrees under the dual degree scheme.

(d) M.Sc. (Programmes under Group C)

These programmes are basically multi-disciplinary and technological in character and are designed to meet the requirements of newly emerging professional activities. The areas which are currently incorporated in these degree programmes are Information Systems, Finance and General Studies.

The programme on Information Systems gives among other things a good exposure to the students on computer software and software engineering techniques, both at the conceptual and application levels. The Finance degree has been designed to meet the manpower needs arising due to the new thrust given to growth patterns in the economy. The courses planned for this programme are of such a nature that they fulfil the requirements of financial institutions as well as financial management needs of any industry. This programme is complementary to the M.Sc. Economics programme.

Details of Work Integrated Learning Programmes are given in Part V.
Birla Institute of Technology & Science, Pilani
Three Tier Structure of Education

<table>
<tr><th colspan="2">Ph. D. Degrees</th></tr>
<tr><th colspan="2">Higher Degrees</th></tr>
<tr><th>On-campus programmes</th><th>Work-Integrated Learning Programmes</th></tr>
<tr><td>M.E.

Biotechnology, Chemical, Civil with specialization in Structural Engineering, Civil with specialization in Infrastructure Engineering & Management, Civil with specialization in Transportation Engineering, Communication Engineering, Design Engineering, Embedded Systems, Manufacturing Systems Engineering, Mechanical, Mechanical with specialization in Thermal Engineering, Microelectronics, Software Systems, Sanitation Science, Technology and Management

**Chemical with specialization in Petroleum Engineering, Chemical with specialization in Nuclear Engineering,

Civil with specialization in Water Resources Engineering, Computer Science, Computer Science with specialization in Information Security, Electrical with specialization in Power Electronics & Drives,

M. Pharm.

M.Pharm., M.Pharm. with specialization in Pharmaceutics, M.Pharm. with specialization in Pharmaceutical Chemistry

M. Phil.

Biological Sciences, Chemistry, Economics, English, Management, Mathematics, Physics, Liberal Studies

Master of Business Administration (MBA)

Engineering & Technology Management, IT Enabled Services Management, Finance, Marketing</td><td>M.B.A.

Consultancy Management, Finance, Hospital and Health Systems Management, Manufacturing Management, Quality Management.

M. Tech.

Automotive Electronics, Automotive Engineering, Computing Systems and Infrastructure, Data Science and Engineering, Design Engineering, Digital Manufacturing, Embedded Systems, Environmental Engineering, Manufacturing Management, Microelectronics, Pharmaceutical Operations and Management, Quality Management, Software Engineering, Software Systems, Systems Engineering, Telecommunications and Software Engineering, Transportation Engineering</td></tr>
</table>

Integrated First Degrees			
On-campus programmes			**Work-Integrated Learning Programmes**
Group A **B.E.** Biotechnology, Chemical, Civil, Computer Science, Electrical & Electronics, Electronics & Communication, Electronics & Instrumentation, Manufacturing, Mechanical **B. Pharm.**	**Group B** **M.Sc.** Biological Sciences, Chemistry, Economics, Mathematics, Physics	**Group C** **M.Sc.** General Studies, ***Information Systems,* ***Finance*	**B.Sc.** Design & Computing, Pharmaceutical Sciences **M.Sc.** Business Analytics, Information Systems **B.Tech.** Engineering Design, Engineering Technology, Information Systems, Manufacturing Technology, Power Engineering, Process Engineering.

*****These programmes are not offered during academic year 2019-20***

Minor programs
Minor programs are being offered in certain areas as options for integrated first degree students with the intent of encouraging them to add focus to their supplemental learning (outside a major area) as well as recognizing and certifying the knowledge obtained in an area that is outside of their major area. A minor would allow a Department (or multiple Departments) to offer a package of courses in an area/sub-area to students for whom this area/sub-area would not be part of their (major) program (e.g. a minor in Finance for students who are not pursuing a program in Finance). A minor will be recognized by means of a separate certificate. The details of minor programs are described in Part IV of this Bulletin.

For Admission to on-campus programmes	
Integrated First Degree :	**Higher Degree :**
For admission to all the programmes: Candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm., the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B. Pharm. , candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects.	Normal input: Integrated First Degree of BITS or its equivalent. **Ph.D. Degree:** Normal Input: Higher Degree of BITS or its equivalent.

The General Studies programme aims at providing an opportunity to the students to acquire specific skills to meet varied career objectives through judicious use of electives and project oriented courses. Students are given opportunities to take two different streams, namely Communications and Media Studies or Developmental Studies by choosing courses of specific streams. Further, the requirements of mathematics, science and applied science, etc. are normally different from Group A and Group B Programmes. Candidates admitted to this programme have to take humanities courses as well as certain general science and technology courses.

All the Integrated First Degree programmes described above have a Practice School option which consists of two courses, Practice School I and Practice School II. A student goes to Practice School I of two months' duration during the summer following second year and to Practice School II of five and a half months' duration during the final year. The curriculum, through Practice School, finds a formal method of bringing the reality of professional environment into the educational process.

For the various programmes in all the three tiers of education, the admission policy and the educational process at BITS take care of multiple entry into the programmes and allow several other flexibilities. The on-campus integrated first degree programmes are divided into Groups A, B and C. The following table provides a tabular condensation of the information.

INTEGRATED FIRST DEGREE PROGRAMMES

Name of the Programme	Normal Input	Special features
Group A programmes: B.E. : Biotechnology : Chemical : Civil : Computer Science : Electrical & Electronics : Electronics & Instrumentation : Electronics & Communication : Manufacturing : Mechanical B.Pharm. **Group B Programmes:** M.Sc. : Biological Sciences : Chemistry : Economics : Mathematics : Physics **Group C Programmes:** M.Sc. : General Studies	**For admission to all the programmes:** Candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm., the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B. Pharm. , candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects. **Admission to all the programmes is subject to the conditions given below:** Admissions will be made purely on merit. The merit position of the candidate will be based on the score obtained by the candidate in a Computer based Online Test (BITSAT) conducted by BITS, Pilani. The candidate should have obtained a minimum of aggregate 75% marks in Physics, Chemistry and Mathematics subjects (if he/she has taken Mathematics in BITSAT) or a minimum of aggregate 75% marks in Physics, Chemistry and Biology subjects (if he/she has taken Biology in BITSAT) in 12th examination, with at least 60% marks in each of the Physics, Chemistry, and Mathematics / Biology subjects.	**Duration:** Planning has been made such that a student will be able to finish any of the integrated first degrees in 4 years (8 semesters). However, the flexibilities available and the modular structure of the system will allow individual student to have variation in the duration of his degrees. Some can finish earlier than 4 years and some may take more than 4 years. Students who take two degrees simultaneously under dual degree scheme will spend about 5 to 5½ years (10 to 11 semesters). **Practice School:** All the integrated first degree programmes have Practice School options. **Dual Degree:** Institute offers dual degree facility to number of students who are admitted. The features of dual degree scheme are described later in this part under the section 'Flexibilities'. **Electives:** A student is required to complete at least 12 elective courses under the categories of Humanities electives, Discipline electives and Open electives. By judicious choice of these courses a student can obtain depth in his/her discipline and/or expand his/her horizon to gain exposure to one or more other areas of study.
For Details of Admission policy to Work Integrated Learning Programmes Refer to Part V.		

HIGHER DEGREE PROGRAMMES

M.E./M.Pharm./M.Phil.

The requirements of these programmes are described in terms of the total number of units which a student is required to complete rather than the duration. However, a normal student may be able to complete such a programme in four semesters, wherein the last semester may be spent for either of the two available alternatives, namely, Dissertation and Practice School. The programmes are intended to give a penetrating professional experience and an opportunity to acquire further competence either in one's own discipline or in many other traditional areas of Engineering, Pharmacy as well as interdisciplinary areas, like, Embedded Systems, Microelectronics, Software Systems, Biotechnology, Manufacturing Systems, Design Engineering, Transportation Engineering, etc.

Following is the exhaustive list of all the higher degree programmes approved by the Senate.

Name of the programme	Input
M.E.	**Normal input**
: Chemical	
: Chemical with Specialization in • Petroleum Engineering • Nuclear Engineering	Integrated first degree of BITS in the same discipline or its equivalent.
: Civil with Specialization in • Infrastructure Engineering & Management • Structural Engineering • Transportation Engineering • Water Resources Engineering	
: Computer Science : Mechanical : Mechanical with specialization in Thermal Engineering	
: Communication Engineering : Electrical with specialization in Power Electronics and Drives	Integrated first degree of BITS in Electrical & Electronics or in Electronics & Instrumentation or its equivalent
: Embedded Systems	Integrated first degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.
: Design Engineering : Manufacturing Systems Engineering	Integrated first degree of BITS in Mechanical or its equivalent. Any other Integrated first degree of A & B groups or M. Sc. Engineering Technology of BITS or its equivalent with the requirement of taking certain additional courses.
: Microelectronics	Integrated first degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or Physics or its equivalent.
: Software Systems : Sanitation Science, Technology and Management	Any first degree of the Institute, provided the minimum component of MATH, TA, Science, ENGG, prescribed in each of the groups A, B and C through compulsory requirements or conventional options. **Other inputs:** (a) For those Integrated first degree programmes under Work Integrated Learning Programmes which have no counterpart in Groups A, B and C, the minimum requirement should be at least what

Name of the programme	Input
	is prescribed in Group C. (b) Any equivalent degree from other University with preparation indicated above.
: Biotechnology	Any Integrated first degree of BITS or its equivalent with adequate preparation in Bio-Chemistry and Microbiology.
M.Pharm.	Integrated first degree of BITS in Pharmacy or its equivalent.
: M.Pharm.	
: M.Pharm. with Specialisation in Pharmaceutics	
: M.Pharm. with Specialization in Pharmaceutical Chemistry	
M.Phil. Liberal Studies	Any Integrated first degree of BITS or its equivalent in respective discipline.

Special features of Admissions to any M.E. programme:

Students coming with integrated first degree of BITS in A & B groups may be considered for admission to any M.E. Programme with the requirement of taking additional courses. The duration in these cases may be more than the normal duration and will be determined on a case by case basis. Similar dispensation may also be possible for students coming with an engineering degree from IITs and other reputed institutions.

Note: While no direct admissions are planned for M.Phil. degree, students who are admitted to Ph.D. may be asked whenever necessary, to register for this degree.

Master of Business Administration

The Institute is running an MBA programme with input requirement as first degree of BITS or its equivalent. The programme endeavors to create manpower who have scientific and engineering approach to business administration. Students will also have a reasonable exposure to certain modern technologies. The programme is designed to have many flexibilities and a very strong component of industry project experience. The input for the programme may have multiple entry points. While principal input will be students already possessing an engineering degree, those who have other qualifications like B.Sc., B.A., B.Com. may also apply provided they have aptitude towards having training in science, mathematics and technology as well. The requirements of the programme will necessitate such students to spend additional time which may vary from 1 to 4 semesters depending upon their qualifications. For students not having an engineering degree, the course requirement will be worked out, looking at the earlier training on a case-by-case basis at the time of admission. However, for the current year, admissions are planned for an input with engineering degree only in which case the normal duration is 4 semester.

Master of Business Administration (MBA) in	Input
(i) Engineering & Technology Management (ii) IT enabled Services Management (iii) Finance (iv) Marketing	B.E./B.Tech in Engineering or a Masters degree in any discipline from any recognized university or any Integrated first degree of BITS.

DOCTORAL PROGRAMMES

The Institute's Ph.D. programme is structured on the basis of a preferred input of those who have completed one of the Institute's higher degrees. It requires each student to finally qualify for formal acceptance in the programme only after passing a qualifying examination.

The Institute also offers a unique opportunity for working professionals to work for Ph.D. in the settings of their own work environments through part-time, Off-campus Ph.D. scheme.

Ph.D.	**Normal input** Any Higher degree of BITS or its equivalent. **Other inputs** a) Integrated First Degree of BITS or its equivalent. b) Any preparation between the above described first degree and higher degree. c) High professional standing and proven competence even without a formal degree. Note: Each case of other inputs will be decided on a case by case basis regarding admission and with the requirement of doing higher degree courses before taking qualifying examination. In the case of inputs with qualification like B.E., M.Sc., etc. the selected candidates will be required to do course work.	**Structure:** Qualifying examination, Research Methodology, Teaching practice, Foreign language when required, Thesis and Seminar. Course work as specified for various input and prior preparation. **Locale:** Normally any of the BITS campuses and other off-campus locations with prior approval. **Ph.D. Aspirant:** To help in the development of professionals at large, provision exists for taking directly the qualifying examination as a `Ph.D. Aspirant' even before seeking admission to the Ph.D. Programme. The Aspirants can work in the settings of their own work environment with the approval of Research Board.

PROGRAMMES OFFERED AT BITS PILANI – PILANI CAMPUS

Integrated First Degree Programmes

B.E. Chemical
B.E. Civil
B.E. Computer Science
B.E. Electrical & Electronics
B.E. Electronics & Instrumentation
B.E. Manufacturing
B.E. Mechanical
B.Pharm.
M.Sc. Biological Sciences
M.Sc. Chemistry
M.Sc. Economics
M.Sc. Mathematics
M.Sc. Physics
M.Sc. General Studies

Higher Degree Programmes

M.E.:

Biotechnology
Chemical
Civil with specialization in Structural Engineering
Civil with specialization in Infrastructure Engineering & Management
Civil with specialization in Transportation Engineering
Communication Engineering
Computer Science
Design Engineering
Embedded Systems
Manufacturing Systems Engineering
Mechanical
Microelectronics
Software Systems

M.Pharm:

M.Pharm.
M.Pharm. with specialization in Pharmaceutics
M.Pharm. with specialization in Pharmaceutical Chemistry

Master of Business Administration (MBA)

Doctoral Programme

Doctor of Philosophy (Ph.D.)

PROGRAMMES OFFERED AT BITS PILANI – K.K. BIRLA GOA CAMPUS

Integrated First Degree Programmes

B.E. Chemical
B.E. Computer Science
B.E. Electrical & Electronics
B.E. Electronics & Communication
B.E. Electronics & Instrumentation
B.E. Mechanical
M.Sc. Biological Sciences
M.Sc. Chemistry
M.Sc. Economics
M.Sc. Mathematics
M.Sc. Physics

Higher Degree Programmes

M.E.:

Biotechnology
Chemical
Computer Science
Design Engineering
Embedded Systems
Mechanical
Microelectronics
Sanitation Science Technology and Management

M. Phil

Liberal Studies

Doctoral Programme

Doctor of Philosophy (Ph.D.)

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

PROGRAMMES OFFERED AT BITS PILANI – HYDERABAD CAMPUS

Integrated First Degree Programmes

B.E. Chemical
B.E. Civil
B.E. Computer Science
B.E. Electrical & Electronics
B.E. Electronics & Communication
B.E. Electronics & Instrumentation
B.E. Mechanical
B. Pharm.
M.Sc. Biological Sciences
M.Sc. Chemistry
M.Sc. Economics
M.Sc. Mathematics
M.Sc. Physics

Higher Degree Programmes

Biotechnology
Chemical Engineering
Civil with specialization in Structural Engineering
Civil with specialization in Transportation Engineering
Communication Engineering
Computer Science
Design Engineering
Embedded Systems
Mechanical
Mechanical with specialization in Thermal Engineering
Microelectronics

M.Pharm:

M.Pharm. with specialization in Pharmaceutics

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

Doctoral Programme

Doctor of Philosophy (Ph.D.)

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

PROGRAMMES OFFERED AT BITS PILANI – DUBAI CAMPUS

First Degree Programmes

- B.E. Chemical Engineering
- B.E. Civil Engineering
- B.E. Electrical & Electronics Engineering
- B.E. Mechanical Engineering

- B.E. Computer Science
- B.E. Biotechnology
- B.E. Electronics & Communication Engineering

Higher Degree Programmes

M.E.:

- M.E. Software Systems
- M.E. Microelectronics
- M.E. Electrical
- M.E. Design Engineering

M.B.A. (Master of Business Administration)

Doctoral Programme

Doctor of Philosophy (Ph.D.)

TEACHING-LEARNING PROCESS

The objective of class room education is to awaken the curiosity of the student, generate habits of rational thinking in him/her, gear his/her mind to face the unfamiliar and train him/her to be able to stand on his/her own. With its team of committed and dedicated faculty, BITS aims at maximizing the learning through teaching. Through their innovative teaching, the teachers enable the student search for knowledge on his/her own and motivate him/her to use the facilities like the library, laboratory and the environment to optimize his/her learning process. Self-study by the student is therefore an important factor in the planning of teaching and evaluation and in this environment the student exhibits interest and responds to this challenge. Teaching and evaluation form a unity of function and operate in a climate of mutual understanding and trust.

Every course whether single section or multi-section is conducted by a member of the faculty called instructor-in-charge, with the assistance, where necessary, of the required number of instructors – who will be partners with him in meeting the full academic perceptions and organizational needs of teaching the course and evaluating the students.

Within one week of the beginning of class work, the instructor-in-charge/ instructor announces to his class/section through a hand-out, the necessary information in respect of (i) the operations of the course (its pace, coverage and level of treatment, textbooks and other reading assignments, home tasks etc.); (ii) various components of evaluation, such as tutorials, laboratory exercises, home assignment, project, several quizzes/ tests/ examinations (announced or unannounced, open book or closed book), regularity of attendance, etc., (iii) the frequency, duration, tentative schedule, relative weightage etc. of these various components; (iv) the broad policy which governs decisions about make-up; (v) mid-semester grading; (vi) grading procedure (overall basis, review of border line cases, effect of class average, etc.) and (vii) other matters found desirable and relevant.

EVALUATION

All courses are conducted and evaluated in a continuous & internal manner by the faculty who teach these courses. The student registers for a certain number of courses each semester; the year being divided into two semesters, and a summer term, whenever offered. A faculty member, as registration advisor, helps a student to draw up his programme, suitable to his pace and needs, which is made possible by the coursewise time-table of the Institute. Every student gets, incidentally, a training in decision-making through (i) choice of load, i.e. number of courses per semester to suit his/her pace, (ii) selection of his/her own time-table to suit his/her convenience, and (iii) picking up courses as electives to meet his/her own aspirations. It is the responsibility of the student to attend classes regularly and to maintain a required level of scholastic standing.

The performance of a student in each course is assessed by the teacher by means of continuous evaluation throughout the semester in classwork, periodical quizzes (sometimes unannounced), tests (both open and closed book), tutorials, laboratory work, home work, seminars, group discussions, project, etc., and a comprehensive examination at the end of the semester. The student is thereby given a large number of opportunities to carryout various academic assignments and be evaluated. Besides encouraging and rewarding continuous and systematic study, the system provides a constant feedback to the student as to where he/she stands, thus enabling him/her to cultivate regular habits of studying and preparing himself/herself for the future.

The system discards the conventional emphasis on a single final examination and numerical marks as the only absolute indication of the quality of student's performance. Thus, at the end of the semester the teacher of the course awards letter grades **A, A⁻, B, B⁻, C, C⁻, D, E** to the student based on the total performance of the student and it is relative to the performance of others taking the same course. These letter grades stand for quality of performance: A (Excellent), A⁻ (Very Good), B (Good), B⁻ (Above Average), C (Average), C⁻ (Below Average), D (Poor) and E (Exposed). Further, these letter grades have points associated with them in a quantified hierarchy: a maximum of 10 (for an A) to a minimum of 2 (for an E). There are also courses in which the teacher awards non-letter grades which have only a qualitative hierarchy. The teacher may also pronounce the performance of a student in a course in terms of certain reports which should not be misconstrued as grades.

Although BITS does not stipulate a minimum percentage of attendance before a student is permitted to appear in any test/examination, the Institute, being a fully residential university with internal and continuous evaluation system, expects every student to be responsible for regularity of his/her attendance in classrooms and laboratories, to appear in scheduled tests and examinations and to fulfill all other tasks assigned to him/her in every course. The system has adequate resilience to accommodate unforeseen situations through withdrawal from a course, make-up test, feedback from examinations and interaction with teachers. In spite of all these facilities when a student fails to cooperate with the teacher in the discharge of his/her part of the contract to such an extent that the teacher is unable to award any grade, the teacher is authorized to give a "Not Cleared" (**NC**) report.

A student is deemed to have cleared a course if he/she obtains a grade in the course. However, the educational philosophy of the Institute interlinks and at the same time distinguishes between the performance of a student in a single course and his/her overall cumulative performance. The overall performance of a student is indicated by an index known as the "Cumulative Grade Point Average" (CGPA). It is the weighted average of the grade points of all the letter grades received by the student since his/her entry into the Institute and is expressed on a 10-point scale. In the case of Integrated First Degree programmes the final division for the degree is decided on the basis of CGPA and there are three classifications, namely Distinction, First Division and Second Division. However, in the case of Higher Degree and the Doctoral programmes no division is awarded.

During the student's stay in the Institute, the Institute expects him/her to show a certain minimum performance and progress. The minimum academic requirements regarding the performance and progress for the Integrated First Degrees and Higher Degrees are:

(i) A CGPA of at least 4.5 at the end of every semester for integrated first degree students and 5.5 for higher degree/Ph.D. students.

(ii) Not more than one E grade in a semester for integrated first degree programmes and no E grade in the higher degree programmes.

(iii) The pace of progress of a student should be such that at any stage of reckoning he/she should not have spent more than 50% extra time than what is prescribed for him/her upto that stage in his/her programme.

The Institute's Academic Regulations must be consulted regarding the minimum academic requirements for the pursuit of the Ph.D. programme and also for off-campus programmes.

Students who fail to meet the minimum academic requirements stipulated above are put under an appropriate committee which monitors their programmes and give guidance so that they are properly rehabilitated at the earliest. In case of Ph.D., this is done by the Departmental Research Committee (DRC) and Doctoral Counselling Committee and in the case of higher degrees and integrated first degrees this is done by Academic Counselling Board (ACB). These Committees are appointed by the Senate and are given authority to take appropriate action including discontinuance of the student or transfer to other programme.

FLEXIBILITIES

The admission policy and the educational process at BITS take care of multiple entry into the programmes and allow several other flexibilities.

Wherever a flexibility is possible according to the Academic Regulations of the Institute, the implementation of the decision invariably takes place along with registration at the beginning of a semester for the continuing students. As in the admission process, the decision is guided by the principle of merit, preferences and facilities available.

It is obvious that CGPA cannot serve as the only measure of merit when the total number of courses/units is different between two competing candidates. To normalise all competing candidates, generally the Institute uses a Progressive Branching Index (**PBI**).

Admissions in both the Semesters

The structural flexibilities available in the Institute make it possible to admit students in both the semesters. However, in the case of both first degree and higher degree programmes most of the admissions are made during the first semester itself. In the case of Ph.D. and off-campus degree programmes, admissions are planned in both the semesters. However, a separate advertisement is given for the second semester admissions and applications for the same are made available only after an advertisement is issued.

Admission with Marginal Deficiency

While the academic preparation required for the admission to each degree has been clearly spelt out there is a provision in the Institute Academic Regulations whereby brilliant students whose prior preparation has been marginally deficient in terms of stated courses/subjects may also be admitted with the condition that they are required to do additional courses over and above those prescribed for a student with normal preparation and the sequence is determined by the institute. This flexibility is invariably used in the case of higher degree programmes where students may come without sufficient exposure to courses like computer programming.

Admission with Advanced Standing

When a candidate for any programme in the three tiers of education of the Institute comes with a preparation beyond the minimum requirement for admission in that programme, the admission of such a candidate is handled under what is known as admission with advanced standing. While such admission is not available as a matter of right, at the time of admission the Institute would spell out in detail the advanced credit it proposes to give to the candidate and the matter would be handled within the framework of the Institute's operation for normal students. Essentially the guiding principle is two-fold : the courses the candidate has already done before entering the Institute cannot be repeated and also that the time spent elsewhere is not wasted. Such an open-ended situation is handled on a case by case basis. It is important that the candidate supplies all the pertinent data in respect of syllabus of courses taken by him/her, examinations passed, question papers of the examinations and the grades/marks obtained by him/her in different subjects. A candidate who is shortlisted for such admissions would be asked to come to Pilani and explore a workable programme that would be appropriate for him/her before admission is completed. If required, the candidate may have to take certain examinations in various subjects that he/she has completed before a prescribed programme is pronounced for him/her there onwards.

However, there are certain situations which cannot be treated as advanced standing. In view of the uncertainty of the level to which some of the courses of the First Degree programmes is treated as optional subjects in the 10+2 system, to be consistent with the past tradition, no student is allowed to register in a course if he/she is considered to be overprepared in relation to the content of the course. Some examples of such courses are: General Biology, Engineering Graphics and Workshop Practice. Such an overprepared student is required to take an appropriate higher level course, as determined by the Associate Dean, Academic, Undergraduate Studies.

Dual Degree Scheme

The Institute has created facility by which any student who is admitted to M.Sc. programmes (offered under Group B) is offered a second

degree in B.E programmes under dual degree scheme. This assignment is made on the basis of Progressive Branching Index (PBI) at BITS at the end of the first year, separately in Pilani, Goa and Hyderabad campuses.

Number of dual degree seats in any particular branch of engineering is decided by using following formula:

$$A = \frac{P \times Q}{R}$$

Where A is the number of dual degree seats in an engineering branch; P is the total number of students eligible for dual degree in science; Q is the number of engineering students admitted in an Engineering Branch in which number of dual degree seats need to be assigned; and R is the total number of students admitted in Engineering on the day of admission.

If any student is under the purview of ACB, his/her pursuit of the Dual Degree will be governed by the clause 7.02 of the Academic Regulations. He/She is required to maintain a minimum CGPA of 4.5 at the end of the fourth Semester failing which ACB may recommend withdrawal of the dual degree offer made to him/her.

Students in any other group seeking a second degree from amongst the programmes in the same group or another group will also be considered under 'other' priorities.

Transfer

(i) Within the same tier

It is possible for a student to seek transfer from one programme to another in the middle of a programme without starting from the beginning. This is possible because he/she is given credit for what he/she has done till then towards the requirements of the programme to which he/she seeks the transfer. Details have to be seen in the Academic Regulations. Transfer is possible from M.E. (all branches) and M.Pharm. to M.Phil. On the other hand, very restricted and tutored transfer would be possible from M.Phil. to M.E./ M.Pharm.

Since admission to a programme is done on assigned and competitive basis, there cannot be any scope of undoing the fact of an assigned admission through transfer. Thus only exceptionally meritorious students in a limited number of cases can expect to compete for transfer to a more sought-after programme. On the other hand, transfer to a less sought-after programme for a student who is unable to cope with the rigours of the programme in which he/she has been admitted would be readily used to rehabilitate him/her without much loss of time. In any event, transfer must be treated as an admission process.

(ii) From first degree to higher degree / Ph.D. degree:

In the case of bright and promising student of the Integrated First degree programmes a transfer to Higher Degree and/or Ph.D. degree may also be provided.

(iii) Between Ph.D. and higher degree programmes:

Under special situations a transfer between Ph.D. and higher degree programmes may be permitted. Movement in either direction is theoretically possible. The Institute's Academic Regulations must be consulted for details.

Audit

The facility of taking a course on audit is principally conceived to give an opportunity to a student to update his/her knowledge in selected courses. It is expected to meet primarily the needs of casual students (not enrolled for degree). No degree of the Institute can be acquired by merely taking courses on audit.

There are certain courses like Foreign Languages, Music, etc. which are neither part of a degree programme nor are available through electives. Any student who wishes to take such courses can take them only on audit basis and also on payment of additional fees.

Other Flexibilities

The structure of degree programmes and the Academic Regulations also provide certain other flexibilities like choice of electives, number of electives, repetition of courses, departure from normal pace, withdrawal from or substitution of course(s) etc.

Academic Regulations

The operations described above are not exhaustive. For precise rules, Academic Regulations of the Institute may be consulted.

UNIVERSITY-INDUSTRY LINKAGE

A recurring theme in the realm of educational reform and innovation has been that of linking university education with industry experience. Since its very inception in 1964, the Institute has been committed to University-Industry Collaboration. Beginning in 1973, the Institute has taken pioneering initiatives towards the development of institutionalized linkages with industry, through its (i) Practice School, (ii) Technology Innovation Center, and (iii) Off-campus work-integrated learning programmes. The details of Practice School are described here.

PRACTICE SCHOOL

All Integrated First Degree and Higher Degree Programmes of the Institute provide a Practice School option. A student who exercises this option receives, on successful completion of the requirements of the programme, a degree which carries the tag, “With Practice School”.

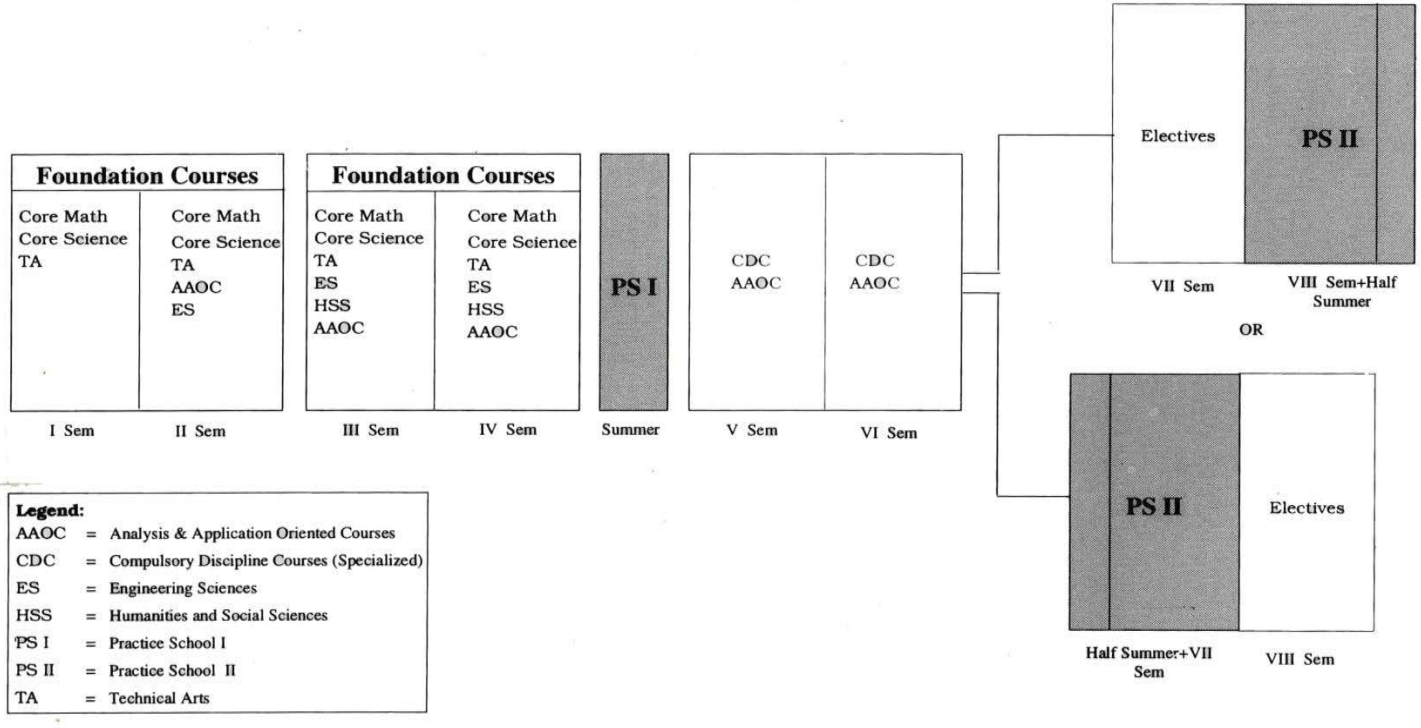
Theme

BITS is strongly committed to the view that university education must be oriented so as to (i) meet the rapidly changing needs and challenges of the environment, (ii) help people use their intelligence and become capable of facing unfamiliar, open-ended real-life situations, and (iii) bear an economic relevance to the society.

The Practice School (PS) method of education links the university with the professional world, by infusing the reality of the world of work into the educational process. The classroom is shifted for a period of 7½ months to a professional location where the students, under the supervision of the faculty, are involved in applying the knowledge acquired in the classroom to finding solutions to real life problems. The PS experiment began with a small group of 12 students in 1973 and has been extended to accommodate all students from all disciplines. The distinguishing features of the PS method of education - (i) the work of the students is supervised and evaluated by faculty, (ii) the credits earned by the student count towards the total credit requirement of the degree, and (iii) the PS option is available to students of all disciplines - make it a bold and radical educational reform with no parallel.

Operation of the PS Programme

The **PS** programme for the Integrated First Degree has two components, namely **PS-I** of two months duration implemented during the summer following the 2nd year and **PS-II** of five and a half months duration implemented during either of the semesters of the final year. (Refer to the chart on page II-12) Dual degree students can also opt for PS-II in both the semesters of the final year.



The Structure of Integrated First Degree Programme
(Practice School Option)

The **PS** Programme for Higher Degree has a single component, namely Practice School for Higher Degree operating in an identical fashion to PS-II, in the final semester of the Higher Degree Programme.

Practice School - I (PS-I)

This component is the first exposure to the world of work, necessary for the subsequent problem solving experience during PS-II. It is implemented at large industrial complexes, research and development centers, software development houses, pharmaceutical companies, etc. While the general aim of PS-I is to afford an opportunity for the student to learn how work is organized and carried out; by a process of observation and participation, the learning can be quite varied and exhaustive depending on the nature of the organization. It provides an opportunity for a detailed understanding of vast engineering operations and its various facets such as inventory, productivity, management, information systems, human resource development, etc. Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students are accompanied by a teacher, who is responsible for coordination with the organization and the day-to-day educational as well as evaluation details.

Some of the places where this component has been implemented are Indian Institute of Petroleum, Dehradun; Rourkela Steel Plant, Rourkela; National Aluminium Company Ltd., Damanjodi; Indian Institute of Remote Sensing, Dehradun; The Institute of Minerals & Materials Technology, Bhubaneshwar; Texmaco Ltd., Kolkata; Central Leather Research Institute , Chennai; Century Rayon, Kalyan; Orchid Bio Medical Systems, Goa; Carborundum Universal Ltd., Kochi; Bharat Forge Ltd , Pune.

Practice School - II (PS-II)/ PS for Higher Degree

PS-II is attended by the students of the Integrated First Degree Programmes in their final year of study. This is also faculty supervised, and for this purpose, teachers are located at various centers around the country where PS stations operate. In order to maintain continuity of operation, the students are divided into two batches, about half the students doing PS-II in the first semester and the other half in the second semester. In either case, the time duration is augmented by a part of the summer term (preceding or following the semester). The operation is therefore round the year with batches coming about every six months. PS for Higher Degree is however available only in the final semester of the programme, after completion of the campus-based courses. The PS-II/PS component is implemented at Production and Manufacturing units, Design, Development and Consulting Agencies, Research and Development Centers, Financial Institutions, Software Development organizations, etc. The student education here is in terms of the direct involvement of the student in problem solving efforts of specific interest to the host organization. The assignments are identified by the PS faculty well in advance in consultation with experts from the host organization. The problems are often multidisciplinary in nature, which are assigned to a group of students drawn from different disciplines. The professional expert in charge of a particular problem and the PS faculty play the roles of consultant and supervisor respectively. The students are encouraged to work independently and are required to defend the technical aspects of their work through periodic written and oral presentations. Emphasis is laid on realizing the importance of teamwork, development of leadership qualities, and the

need for effective time management.

Some of the typical assignments that the students have undertaken are: Development of Category Configuration Portal; System on Chip Design and Verification; Design and Development of Features in the Mtg-Automation; Risk and Control Tools in Operations; Integrating HP Performance and HP Nonstop Measure; Planning and Implementing Events at ECLUB and Work at Resource Bureau; Partial Metadata Get/Set Support in CDMI Server; Sabre Cruises Booking Analytics Tool; Mobile Engineering at Pocket Gems; Data Management and Organizaion of Datasets.

Typical PS Station – A Model

The PS station is the analogue, in the professional world, of the university classroom and laboratory. The Institute endeavours to ensure that each PS station has all the physical facilities necessary to carry out meaningful education. In fact, host organizations have always come forward with all possible assistance. At least one faculty member is attached with each PS station. Since a city may have more than one PS station, the term PS Centre is used to designate a location where one or more PS stations are present.

PS Assignments

The general nature of PS-I assignments is of study and orientation. However, the assignment plays a pivotal role in PS-II and is of direct and immediate relevance to the host organization. The educational challenge is therefore that of evolving the pedagogy for teaching, learning, and evaluation while the students are involved in their problem solving efforts. The tasks are generally multidisciplinary, mission oriented and therefore time bound and open ended. The development of solutions to such problems requires a scientific attitude, technical competence, discipline and adherence to procedure, decision making ability, and a spirit of curiosity and exploration. Often, the assignments form a part of long term research and development projects.

Student Allotment in PS

Allotment in PS-I is done keeping the student's preferences and academic performance in view, along with the availability of physical facilities, in particular, accommodation. Student allotment in PS-II is, however, a much more complex and multi-dimensional task. With the help of the PS faculty, information about the total set of skills and attributes required of the student for the task at hand is collected from the host organization. Simultaneously, a profile of each student is prepared, incorporating details such as CGPA, performance in various categories of courses including electives and projects, assignment worked on in PS-I, professional interests, and extra-curricular achievements. With this information base, a matching is carried out, keeping in view the student's preferences and constraints of physical facilities.

Computerization of the various activities related to PS, such as profile preparation, allotment, monitoring, and feedback has made the entire process expeditious and efficient.

Evaluation in PS courses

The PS method of education, as has been emphasized earlier, is a medium for integrating real-life situations with the learning process. In line with this objective, the student is given the responsibility of planning, scheduling, implementing, and defending the steps to the solution of the assigned problem. The students work under the supervision of the faculty, in consultation with the professional expert(s). As with all other courses, a process of continuous evaluation is followed. The PS method of education seeks out and focuses attention on many latent attributes which do not surface in the normal classroom situation. These include professional judgment and decision making capacity, inter-disciplinary approach, data-handling skills, ability in written and oral presentation, leadership qualities, ability for team work, sense of responsibility, ability to meet deadlines, etc. These attributes are judged by the faculty through various instruments of evaluation, namely quiz, viva, seminar, group discussion, project report, diary, and daily observation. At the end of each PS course, a student is awarded a letter grade based on his total performance. Supplementing the degree transcript issued by the Institute, the PS Division issues a 'Practice School Transcript' to those students who opt for the PS stream. This

transcript gives a complete record of the performance of the student in the PS programme. It also includes a rating sheet which describes qualitatively the student's personality traits mentioned earlier.

Since the PS programme interfaces with the world outside the campus, whenever the progress of a student in a PS course is found to be unsatisfactory and/or guilty of conduct unworthy of the professional world, the PS option may be withdrawn by the Institute, without any reason being assigned.

Role of Professional Experts in PS

The PS programme clearly places demands on the time and energy of various officers from the host organization. However, every effort is made to ensure that they are not burdened with the day-to-day details concerning the educational and administrative organization of the PS programme, these being the responsibility of the PS faculty.

In the case of PS-I, the preparation of the educational schedule is initiated at the Institute itself. On reaching the PS station, the faculty discusses the same with officers from the host organization, seeking their concurrence and their suggestions. The faculty engages the students on various assignments and periodically informs the experts of the progress made. The faculty may also arrange meetings of the students with the experts and also invite them to participate in seminars given by the students from time to time. At the end of the course, the faculty seeks the expert's critical comments on the report submitted by the student, to receive essential feedback on the quality of the work.

In respect of PS-II, the officers from the host organization first come into picture when the faculty is compiling the problem bank for the batch of students to come. At this stage, the experts provide the details of the various problems on which the students will work, as well as their requirements in terms of the type of student input for each assignment. After the arrival of the students at the PS station too, the faculty remains at the helm of affairs, forming student groups, assigning projects, conducting evaluation components, etc. The faculty also ensures that each student blends well with the group of fellow students and staff from the host organization, in which he/she is working. When seminars or group discussions are held, the faculty invites the officers to participate. During the course of the assignment, the students seek consultation with the expert, normally through the faculty, who ensures that the student is well-prepared for these meetings. At the end of the course, the student is required to present a seminar and defend the technical credibility of the work before as large a gathering of experts as possible. Detailed discussions ensue on various technical aspects of the problem, often resulting in the resolution of critical issues involved.

Some PS Statistics

Ever since its beginning in the year 1973 with just one station accommodating 12 students and 4 faculty members, the PS has grown immensely. In the academic year 1975-76 the programme was thrown open to all the students of the Institute. During an academic year arrangements have to be made for PS programme for a steady number of 4371 students, accompanied by nearly 128 faculty members. Specifically, it means accommodating a steady number of 2119 students and 103 faculty members at about 205 different organisations for PS-I in the summer term and arranging for about 2252 students accompanied by about 65 faculty members to attend PS-II operated round the year at about 397 different host organizations. So far about 73,135 students have been benefited by this programme. While all the host organisations pay the students out-of-pocket allowance, some organizations provide the students and the faculty with housing and other facilities as well.

The list of organisations where PS programmes are in operation is given below. There are also organizations outside India where the PS programme is being conducted for several years. (Refer to the following map showing PS Stations).

BITS PRACTICE SCHOOL STATIONS
2019 - 2020



LEGEND

● -- PS 1 CENTERS

▲ -- PS 2 CENTERS

EXAMPLE -- PRIVATE ORGANIZATIONS

EXAMPLE -- GOVERNMENT ORGANIZATIONS

LIST OF PS-I STATIONS

Ahmedabad

Adani Power (AP), PGS Energy Services Pvt. Ltd. (PGS-ESPL), Pharmalab India Pvt. Ltd. (PIPL), Rajnagar Textile Mills (National Textile Corporation Ltd) (RTM), Viitorcloud Technologies Pvt. Ltd.(VTPL)

Ajmer

National Highways Authority of India (NHAI)

Amreli

Ultratech Cement Limited (UCL)

Aurangabad

Aurangabad Electricals (AE)

Ballabgarh

NCCBM (NCCBM)

Bangalore

AlphaICs India Pvt. Ltd. (AIPL), COUTURE AI PVT LTD.,(CAPL), Edelweiss securities Ltd (ESL), Faregeo Technologies (FT), Fiabilite Network Solutions Pvt. Ltd. (FNSPL), GoScale Technologies (GST), Grindwell Norton Ltd (GNL), HAL ROTARY WING (HAL-RW), Happiest Minds (HM), Heraizen Technologies Pvt. Ltd. (HTPL), Indian Red Cross Society (IRCS), Innoviti Payment Solutions Pvt. Ltd. (IPSPL), Khyateh Consulting Pvt Ltd (KCPL), Letstransport (Diptab Ventures Pvt Ltd) (LT), Metarain Distributors Pvt Ltd (MDPL), Numancia Aerospace Private Limited (PIXXEL), PASFEX Technologies Pvt. Ltd.(PASFEX), Power Grid Corporation of India Limited (PGCIL), Race2Cloud Technologies Pvt. Ltd. (RCTPL), Sen Sei Technologies (SST), SenZopt Technologies Pvt Ltd. (AZTPL), Sun Mobility (SM), VoiceQube (VQ), Zinnov Management Consulting (ZMC)

Bapatla

Andhra Pradesh Human Resource Development institute (APHRDI

Bharuch

Birla Cellulosic (BC)

Bhopal

AIIMS (AIIMS), New Bhopal Textile Mills (National Textile Corporation Ltd) (NBTMILLS)

Bhubaneshwar

NALCO (NALCO), The Institute Of Minerals And Materials Technology (IMMT).

Bilaspur

South Eastern Coalfields Limited (SECL)

Chandigarh

Deepak Spinners Ltd (DSL), Gates India Pvt Ltd (GIPL), PGS Energy Services Pvt. Ltd. (PGS-ESPL)

Chandrapur

Awarpur Cement Works (ACW), Manikgarh CEMENT (MC)

Chennai

Belief Systems (BS), BSCPL Infrastructure Ltd. (BSCPL-IL), Carborundum Universal Ltd (CUL), Center for Medical Genetics (CMG), Central Electronics Engineering Research Institute(CEERI),Central Leather Research Institute (CLRI), Chennai Metro Rail Limited (CMRL), Daimler India Commercial Vehicles (DICV), Ebek Language Laboratories Pvt. Ltd. (ELLPL), HTIC (HTIC), Indian Red Cross Society (IRCS), Integral Coach Factory (ICF), National Metallurgical Laboratory (NML), Rane TRW Steering Systems Limited (RTSSL), Tamil Nadu eGovernance Agency (TNGA), Tamil Nadu Science and Technology Centre (TNSTC), Wheels India Ltd. (WIL)

Coimbatore

National Textile Corporation Ltd(Regional Office) (NTCL-RO), Southern Regional Office (NTCL), ZF Windpower (ZFW)

Dalla

Dalla Cement Works (DCW)

Damanjodi

National Aluminium Company Limited - Smelter Plant (NACL-SP)

Dehradun

Indian Institute Of Remote Sensing (IIRS)

Delhi

505 Army Base Workshop (ABW), AlmaConnect (AC), CEERI (CEERI), Centre for Railway Information Systems (CFRIS), Centre For Science and Environment (CFSE), CSIR-Institute of Genomics & Integrative Biology (IGIB), G.M.R. Varalakshmi Foundation (GMR), Indian Institute of Public Administration (IIPA), Indian Oil Corporation Limited (IOCL), Indian Railways Organization for Alternate Fuels (IROAF), Indian Red Cross Society Blood Bank(IRCSBB),Jaguar Overseas Ltd (JOL), Mapmy India (MI), National Textile Corporation Limited (NTCL), Oil and Natural Gas Corporation Ltd (ONGC), Solar Energy Corporation of India (SECI)

Dhanbad

Bharat Coking Coal Limited (BCCL), CSIR-Central Institute of Mining and Fuel Research (CSIR-CIMFR)

Dhule

District Collector Office (DCO)

Faridabad

Aaress Auto Pvt.Ltd (AAPL), Escorts (ESCORTS), Gates India Pvt. Ltd. (GIPL), JBM Auto Ltd. (JAL), L&T MHPS Boilers Pvt. Ltd (L&T-MHPS), Superseals India Ltd (SIL)

Gandhinagar

Bhaskaracharya Institute For Space Applications And Geoinformatic, (BISAG), Gujarat Environment Management Institute (GEMI), Infibeam Avenues Ltd. (IAL), Institute of Seismological Research DST (ISR-DST)

Gauhati

Gauhati Refinery (GR)

Ghaziabad

Tata Steel BSL Ltd.(TS-BSL)

Goa

CG PPI Adhensive Products Ltd (CGPPAPL), Department of Agriculture (DA), Funskool (india) Ltd(FUNS), Helix Tech (HELIX), Helpage India(HI), IFB Industries Limited (IFB-IL), Mormugao Port Trust (MPT), National Centre For Antartic And Ocean Research (NCAOR), National Institute of Oceanography (NIO), Orchid Bio Medical Systems (OBMS),Parinati Solutions Private Limited (PARINATI), Qualpro Diagnostics (QD), Smartlink Holdings Ltd. (SHL), Zephyr Biomedical (ZB).

Greater Noida

Bharat Petroleum Corporation Ltd. (BPCL).

Gurgaon

A. V. Engineers (AVE), Concept Infracon Pvt. Ltd (CIPL), Convergent Technologies (CT), Ecom Express Pvt. Ltd. (EEPL), Maruti Suzuki India Limited (MSIL), Power Grid Corporation of India (PGCI), TKW Fasteners Pvt. Ltd (TKW-FPL)

Halol

Aditya Birla Insulators (ABI), CEAT Ltd. (CEAT)

Haridwar

Renowed LifeSciences (RLS)

Harihar

Birla Polyfibers (BP)

Hosur

Harita Fehrer Ltd. (HFL)

Hubballi

Deshpande Foundation (DF)

Hyderabad

Analogics Tech India Ltd (ATIL), CtrlS Data Centre Pvt Ltd (CDCPL), Data M Intelligence (DMI), DRDO – CAS (DRDO – CAS), DRDO – RCI (DRDO - RCI), EgnifyÂ Technologies (ET), Eliptico IT Solutions Pvt. Ltd. (EISPL), Enixta Innovations Pvt. Ltd. (EIPL), Fountane Makerspace Pvt. Ltd (FMPL), G.M.R. Varalakshmi Foundation (GMR), H.B.L. Power Systems Ltd (HBL), Helpage India (HI), Hexagon Capability Center India Pvt. Ltd. (HCCIPL), Hyderabad Metro Rail Corporation (HMRC), Indian Red Cross Society (IRCS), L.V.Prasad Eye Institute (LV), Market Data Forecast (Business Development Associate) (MDF), National Institute of Rural Development & Panchayati Raj (NIRDP), NCCCM (NCCCM), Pass Consulting (PC), Power Grid Corporation of India Limited (PGCIL), Preto Tooling Systems (PTS), RA Chem Pharma (RACP), Telangana e-governance (TG), Vidcentum R & D Pvt. Ltd.(VRDPL)

Jafrabad

Ultratech Cement Limited (UCL)

Jaggayapet

The Ramco Cements Ltd (RCL)

Jaipur

BOSCH LIMITED (BOSCH), CEERI (CEERI), IT Department, Government of Rajasthan (ITDGR), Jaipur Development Authority (JDA), KEC International Ltd (KEC), NBC Bearings (NBC-B)

Jharsuguda

Sesa Sterlite Ltd. (Vedanta Aluminium & Power) (VAL)

Jodhpur

Birla White Cements (BWC), Regional Remote Sensing Centre (RRSC)

Kalpakkam

Atomic Energy Regulatory Board (AERB), Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI), Indira Gandhi Centre For Atomic Research (IGCAR)

Karnal

Gupta Agro Industries (GAI)

Kolkata

Allahabad Bank (AB), Delta Step Learning Pvt. Ltd (DSLPL), Department of Health & Family Welfare,

Govt. of West Bengal (DHFW), Department of Higher Education, Govt. of West Bengal (DHE), Department of Planning, Statistics and Program Implementation (DPSPI), Irrigation and Waste Water Department (IWWD), Self Help Group, Self-Employment Department, Government Of West Bengal (SHG-SED), Texmaco Ltd (TEXMACO), Transport Department, Govt. of West Bengal (TD), Variable Energy Cyclotron Centre (VECC), West Bengal Traffic Police (WBTP)

Kota

Kota Super Thermal Power Station (KSTPS)

Kotputli

Ultratech Cement Ltd (UCL)

Kutch

Sewagram Cement Works (SCW)

Lucknow

Board of revenue - UP Government (BRUPG), Council of Science & Technology (CST), Research Design & Standards Organisation (RDSO), UP -100 (Police Emergency Management System) (UP100_PEMSY)

Malkhed

Rajshree Cement (RC)

Manesar

Honda Motorcycle & Scooter India Pvt. Ltd (HONDA MOTORS)

Mathura

Indian Oil Corporation Ltd. (IOCL)

Mehsana

Knack Packaging Pvt. Ltd (KPPL)

Mohali

Edifecs Technologies Private Ltd. (ETPL), IDS Infotech Ltd (IDS), Semi- conductor labs (SCL)

Mumbai

ACC Ltd. (ACCL), Aditya Birla Science & Technology (ABST), Aditya Jyot Eye Hospital (AJEH), Atomic Energy Regulatory Board(AERB), Ben Line Agencies (India) Pvt. Ltd. (BLAIPL), Cateina Technologies Pvt. Ltd. (CTPL), Century Rayon(CR), Edelweiss Securities Ltd. (ESL), Henkel Loctite (HL) Hindustan Petroleum Corporation Limited (HPCL), Homi Bhabha Centre For Science Education (HBCSE), India United Mills (National Textile Corporation Ltd) (IUMILLS), Indian Oil Corporation Limited (IOCL), Indian Red Cross Society (IRCS), L & T (L&T), Lenest (LENEST), Maker Asylum (MA)Mumbai Rail Vikas Corporation Ltd(MRVC), Podar Mills Mumbai (National Textile Corporation Ltd) (PMILLS), Regional Office (NTCL), Samhita Social Ventures (SSV), Strides Chemicals Pvt. Ltd (SCPL), Tata Mills- Dadar Mumbai (National Textile Corporation Ltd) (TMILLS)

Nagda

Grasim Chemicals (GC), Grasim Industries (GI)

Nagpur

Geomitra Solutions LLP (GSL), Kizora Software Pvt. Ltd. (KSPL), Power Grid Corporation Ltd. (PGCL), Western Coalfields Ltd. (WCL)

Nandyal

Nandi Group of Companies (NGC)

Narsapura

Honda Motorcycle & Scooter India Pvt. Ltd. (HONDA MOTORS)

Nashik

Starlite Lighting Ltd. (SLL)

Neemuch

Vikram Cement Works (VCW)

Noida

IMARC Services Pvt. Ltd. (ISPL) Million Sparks Foundation (MSF), Noida Metro Rail Corporation (NMRC), Samvardhana Motherson Adsys Tech Ltd. (SMATL), TV Today Network Ltd. (TV-TODAY)

Pilani

Birla Museum (BM), Central Electronics Engineering Research Institute (CEERI)

Pune

AFour Technologies Pvt. Ltd. (ATPS), APS Lifetech (APSL), Bank of Maharashtra (BOM), Bharat Forge Ltd(BFL), Century Textiles (CT), Carraro India P Ltd. (CIPL), Divgi TorqTransfer Systems Pvt. Ltd, Shivare (DIVGI), Divgi TorqTransfer Systems Pvt. Ltd. - Bhosari (DIVGI), Indian meteorological department (IMD), Inter-university Centre For Astronomy and Astrophysics (IUCCA), Liveweaver India Pvt Ltd(LIPL), Maritime Research Centre (MRC), National Chemical Laboratory (NCL), Schindler India Pvt. Ltd. (SIPL), Smarti i Electronics Systems Pvt.Ltd (SESPL), Tata Auto Comp Composite Division (TAC-CD), Tata Motors Ltd. (TATA-MOTORS), Yazaki India Ltd (YIL)

Raipur

Rawan Cement Works (RCW)

Ranchi

Central Coalfields Limited (CCL), Central Mine Planning and Design Institute (CMPDI)

Reddipalayam

Reddipalayam Cement Works (RCW)

Renukoot

Birla Carbon India Pvt. Ltd. (BCIPL), Hindalco Industries Limited (HINDALCO)

Renusagar

Hindalco Industries Limited (HINDALCO)

Rishra

Aditya Birla Insulator (ABI)

Roorkee

Government Irrigation Workshop (GIW)

Rourkela

Rourkela Steel Plant (RSP)

Secunderabad

South Central Railway(SCR)

Shambupura

Aditya Cement Works (ACW)

Shimla

HelpAge India (HI)

Sidhi (MP)

Sidhi Cement Works (SCW)

Simga

Hirmi Cement Works (HCW)

Solan (HP)

Baga Cement Works (BCW)

Sriganganagar

Medanta (MEDANTA)

Srikalahasti

Andhra Pradesh Human Resource Development institute (APHRDI)

Surat

Essar Steel India Ltd. (ESIL), Finnacle Investment Academy (FIA), L & T Heavy Engineering (L&T-HE)

Tadpathri

Ultratech Cement Limited (UCL)

Tapukara

Honda Motorcycle & Scooter India Pvt. Ltd. (HONDA-MOTORS)

Thane

Eclipse Instrumentation Pvt. Ltd (EI), Teksons Pvt. Ltd. (TPL)

Tirora

Adani Power (APL)

Tirupati

VoiceQube (VQ)

Trivandrum

Centre for Development Of Imaging Technology (CDIT), ISRO Inertial Systems Unit (ISROISU), Law Pundits LLP (LPL), UST Global (USTG)

Udaipur

Pyrotech Electronics Pvt. Ltd.(PEPL)

Umiam

North Eastern Space Applications Centre (NESAC)

Vadodara

Cosmos Impex (India) Pvt.Ltd (CIIPL), Indian Oil Corporation Ltd.(IOCL)

Vijayawada

Andhra Pradesh Innovation Society (APIS), AP Govt. Mee Seva (APGMS), E Pragati (EP), Efftronics Systems Pvt. Ltd (ESPL), Million Sparks Foundation (MSF)

Vijaynagar

JSW Energy (JSW-E), JSW Steel(JSW)

Visakhapatnam

Andhra Pradesh Human Resource Development institute (APHRDI), Sarda Metals & Alloys (SMA), Vishakapatnam Steel Plant (VSP)

LIST OF PS-II STATIONS

Ahmedabad

Amazon Operations (Area Manager) (AMAZON), Pfizer Ltd. (PFIZER)

Aurangabad

Skoda Auto India Pvt. Ltd. (SKODA)

Ballabgarh

National Council for Cement and Building Materials (NCB)

Bangalore

Aditya Auto products & Engg (I) .P.Ltd. (ADITYA AUTO), Aditya Birla Fashion and Retail Ltd. (AB-FASHION RETAIL), Aditya Birla Group -Data and Analytics (ABG-DATA ANALYTICS), Adobe Systems (ADOBE), Altair Engineering India Pvt. Ltd (ALTAIR), Amazon Development Center (AMAZON), American Express (AE), Analog

Devices - Design and Simulation (ANALOG), ARM Embedded Technologies Private Limited (ARM), Avaamo (AVAAMO), belong.co (BELONG_CO), Blue Jeans Network India Pvt. Ltd. (BLUE-JEANS), Bosch Research and Technology center (BOSCH), Bundl Technologies Private Limited (Swiggy) (BTPL), Capillary Technologies - Testing Automation (CAPILLARY), CIREL Systems (CIREL), Cisco Systems (India) Pvt. Ltd (CISCO), Cloudcherry Analytics Pvt Ltd. (CLOUDCHERRY), Cohesity Storage Solutions India Pvt. Ltd. (CSSIPL), Couture AI(COUTURE-AI) Cypress Semiconductor India Pvt Ltd(CSTIPL), Decision Resources Group (DRG), Dell R&D (DELL), eGovernments Foundation (EGF), ENSCI - A Unit of Weir Minerals India Pvt. Ltd (ENSCI), Ericsson Global India Pvt. Ltd (ERICSSON), Ernst & Young Global Delivery Services (EYGDS), Fidelity Investments (FIDELITY), Flipkart Analytics (FLIPKART), Genpact(GENPACT), Goldman Sachs (GS), Goodera (NextGen PMS Pvt. Ltd) (GOODERA), HAPPAY (VA Tech Ventures Pvt Ltd.) (HAPPAY), HealthCubed (HC), Hindustan Unilever Research Centre(HURC), Holiday IQ-Tech (HIQT), HSBC Global Analytics Centers (HSBC), IBM Security – Fiberlink (IBM), IMS Health (IMSH), Infinera (INFINERA), Ingersoll Rand India Ltd (IRIL), InMobi (INMOBI), Intel - India (INTEL), JDA Software Solutions(JDA), J P Morgan Services (JPMS), John F Welch Technology Center (GE), JP Morgan Chase - Technology (JPMC), Juniper Networks (JUNIPER), KPMG (KPMG), Lavelle Networks (LN), Lenskart (LENSKART), Lightplane Technologies India Pvt. Ltd(LTIPL), MathWorks India Pvt. Ltd. (MATHWORKS), Maybank Labs Pvt. Ltd. (MBLPL), Media Iq Digital(MEDIA IQ), MediaTek Bangalore Pvt. Ltd. (MEDIATEK), Mercedes Benz(MERCEDES), Morgan Stanley Advantage Services (MSAS), National Aerospace Laboratories (NAL), National Centre for Biological Sciences (NCBS), National Instruments Systems (India) Pvt. Ltd. (NISPL), National Instruments India Sales (NIIS), NetApp (NetApp), Netcore Solutions (NETCORE), NetSkope Software India Pvt. Ltd.(NETSKOPE), Nreach Online Services Pvt. Ltd. (NOSPL), Nutanix Technologies India Pvt. Ltd (NUTANIX), Nvidia Graphics (NVIDIA), PAYPAL(PAYPAL), Petasense-Services & App Development (PETASENSE), Publicis Sapient (PS), PwC DIAC US Advisory (PWC), QUALCOMM INDIA PRIVATE LIMITED(QUALCOMM), Qubole (Qubole), Reliance Jio (RELIANCE), Robert Bosch Center for Cyber Physical Systems (RBCCPS),), Samsung R &D Institute(SAMSUNG_R&D), Sattva Media & Consulting Pvt Ltd (SATTVA), Searce (SEARCE), Shell Technology Center (SHELL), Siemens technology and Services Pvt ltd (SIEMENS), StateStreet Global Advisors (SGA), Sun Mobility(SM), TapChief (TAPCHIEF), Tejas Networks (TN), TESCO Hindustan Service Centre (TESCO) , Texas Instruments (I) Pvt. Ltd. (TEXAS), Thinkerbell Labs - Electronics (TLE), Thorogood (THOROGOOD), Udaan (UDAAN), Unnati (UNNATI), Vitor Healthsciences Pvt. Ltd. (VHPL), VMware Software India Pvt. Ltd. (VMWARE), Walmart Global Technology Services(WALMART), Wealth India Financial Services Pvt. Ltd (WIFSPL), Western Digital (SANDISK), William O Neil India Pvt Ltd (WONIPL), Zendrive India Pvt Ltd (ZIPL), Zeotap India Pvt. Ltd. (ZIPL), Zinnov Management Consulting Pvt. Ltd(ZMCPL)

Bilaspur (Gurgaon)

Amazon Operations (Area Manager) (AMAZON)

Chennai

Amazon Development Center (AMAZON), Central Leather Research Institute (CLRI), Dell R & D (DELL R&D), FreshWorks Inc (FWI), Healthcare Technology Innovation Centre (HTIC) Paypal (PAYPAL), Pfizer Ltd.(PFIZER), Wabco India Pvt. Ltd (WIPL)

Cochin

UST Global - Business Domain (USTG) UST Global (USTG)

Dahej

Tega Industries SEZ Ltd(TISL)

Delhi

Amazon Development Center (AMAZON), BLS International Services Limited (BISL), DMI Finance Private Limited (DFPL), Ecom Express Pvt. Ltd. (ECOM EXPRESS), GMR Infrastructure Ltd. (GMR), Goodera (Next Gen PMS) (Non IT) (GOODERA), LEA Associates (LEAA), National Council of Applied Economic Research (NCAER), National Institute of Science and Tech. Dev. Studies (NISTADS), PricewaterhouseCoopers (PWC)

Goa

GMR Infrastructure Ltd. (GMR), IFB Industries (IFB)

Gurgaon

Amazon Operations (Area Manager) (AMAZON), American Express (AE), Concept Infracon Pvt. Ltd. (CIPL), Decision Resources Group (DRG), Futures First- Financial Market & Research (Quant) (FFMRQ), IMS Health (IMSH), KPMG (KPMG), MM Aqua Technologies Ltd. (MM-AQUA), OfBusiness

(OF-BUSINESS), OYO Non Tech (OYO) OYO Tech (OYO), Pluss Advanced Technologies Pvt. Ltd. (PATPL), Ramboll India Pvt. Ltd. (RIPL), Rivigo Non Tech (RIVIGO) Rivigo Tech (RIVIGO), Skoda Auto India Pvt. Ltd. (SKODA), SRF Ltd (SRF), Zinnov Management Consulting Pvt. Ltd(ZMCPL)

Halol

Aditya Birla Insulators (ABI)

Hyderabad

Amazon Development Center (AMAZON), Amazon Operations - Area Manager (AMAZON), Analogics Tech India Ltd. (ATIL), Apple India Pvt Ltd. (AIPL), Arup India Pvt. Ltd. (ARUP-INDIA), DataM Intelligene 4Market Research (DMIMR), EA Games India Pvt. Ltd. (EGIPL), Egnify Technologies (EGNIFY), GGK Technologies - Software Development (GGKT), GMR Infrastructure Ltd (GMRIL), IMI Mobile R&D (IMI), IMI Digital R&D (IMI), Intel India Technology (INTEL), JDA Software Solutions (JDA), JPMC - Technology (JPMC-TECH), MAQ Software (MAQS), Market Data Forecast (Business Development Associate) (MDF), Market Data Forecast (Marketing Associate) (MDF), Market Data Forecast (Research Associate) (MDF), MathWorks India Pvt. Ltd. (MATHWORKS), Novartis (NOVARTIS), Nvidia Graphics – Hardware (NVIDIA), OYO Tech (OYO), PricewaterhouseCoopers (PWC), Qualcomm India Private Limited (QUALCOMM), Reliance Jio (RELIANCE JIO), ReportGarden Technologies Pvt. LTd. (RGTPL), Servicenow Software Development India (SSDI), Synergiz Global (SG), Synopsys India Pvt. Ltd.(SIPL), Taxilla Info Pvt. Ltd. (TIPL), UBER (UBER), UBS Business Solutions (India) Private Limited - Group Operations (UBS-BSIPL), WCB Robotics (WCBR), Xilinx India Technology Services Pvt. Ltd. (XITSPL)

Jaipur

Angara Ecommerce Pvt. Ltd. (AEPL), CEG Limited (CEG), NBC Bearings (NBCB),

Jamshedpur

Tata Motors (TATA-MOTORS)

Jodalli

Spicer India Ltd. (SPL)

Kalyani

Tega Industries Ltd. (TIL)

Kolkata

Futures First - Financial Market & Research (Quant) (FUTURES FIRST), Texmaco Rail & Engineering Ltd. (TEXMACO)

Mumbai

Aditya Birla Science & Technology Company Ltd (ABSTCL), Amazon Operations - Area Manager (AMAZON), Ascent Health and Wellness Solutions Private Limited (AHWSPL), Ashoka Buildcon Ltd (ABL), Baldor Technologies Pvt Ltd (BTPL), Century Rayon(CENTURY-REYON), Citec Engineering India Pvt. Ltd. (CEIPL), Credit Suisse - Credit Analytics (CREDIT SUISSE), Credit Suisse - Enterprise Operational Risk Management (CREDIT SUISSE), Credit Suisse - Global Market Risk Management (CREDIT SUISSE), Credit Suisse - Global Markets Controls COO (CREDIT SUISSE), Credit Suisse - GM Trading Risk (CREDIT SUISSE), Credit Suisse - International Wealth Management (CREDIT SUISSE), Credit Suisse - Prime Services (CREDIT SUISSE), Credit Suisse - Risk & Finance Data Analytics Reporting (CREDIT SUISSE), Credit Suisse- Investment Banking and Capital Markets (CREDIT SUISSE), DBOI - Credit Risk (DBOI), DBOI - MLRM Risk Methodology & NFRM (DBOI), DBOI-Trading Risk & PL (DBOI), Dorsch Consult (India) Pvt. Ltd. (DORSCH CONSULT), Girish Enterprises Pvt. Ltd. (GEPL), Goodera - (Next Gen) (Non IT) (GOODERA), Grasim Industries Pulp and Fibre Division (GRASIM), HDFC Life (HDFC), Here Maps - Distributed Data (HEREMAPS), Hindalco Innovation Centre - Semifab Taloja (HINDALCO), Hourglass Research(HOURGLASS), J P Morgan Services – GKN Markets (JPMS), J P Morgan Services - GKN-CCB Risk (JPMS), J P Morgan Services Ltd - Finance (JPMS), J P Morgan Services Ltd - GKN Quant (JPMS), J P Morgan Services Ltd - GKN Research - Corporate Risk Management (JPMS), J P Morgan Services Ltd - GMG & Quant (JPMS), J P Morgan Services Ltd - GRC- GKN Global Research (JPMS), JPMC - Technology (JPMC), Morgan Stanley Advantage Services (MSAS), Morningstar(MORNING-STAR), MSCI (IMR) (MSCI), MSCI (NPD - Index Research) (MSCI), MSCI Technology & Development (MSCI), My POS Technologies Pvt. Ltd.(MPTPL), Netcore Solutions (NS), Nomura – FinTech (NOMURA), Nomura - Wholesale Strategy (NOMURA), Nomura Global Finance (NOMURA), Nomura Global Markets (NOMURA), Nomura Global Risk (NOMURA), Oyo Rooms - Non tech(OYO ROOMS), (Piramal Group (PG), Pricewaterhouse Coopers (PWC), PwC DIAC US Advisory (PWC-DIAC), Quantiphi (QUANTIPHI), Reliance Jio (RELIANCE), Samhita Social Ventures (SAMHITA),

Skoda Auto India Pvt. Ltd. (SKODA), Thornton Tomasetti (TT), UBS - Group RISK (UBS), UBS Business Solutions (India) Private Limited - Ras Finance (UBS), UBS Business Solutions(India)PrivateLimited-Group Operations (UBS), UPGRAD(UPGRAD), Viacom18 Media Pvt. Ltd - Corporate Strategy (VIACOM18), Viacom18 Media Pvt. Ltd - Digital Ventures (VIACOM18), VMS (Vakil Mehta Seth) Consultants Private Limited (VMS), Worley Parsons India(WPI),

Nagda

Grasim Industries Ltd (GRASIM).

Nagpur

Techture Structures Pvt Ltd (TECHTURE)

Noida

Adobe Systems (ADOBE), Amity Software Systems Ltd. (ASSL), Cadence Design Systems (CDS), Indiamart Intermesh Ltd.(IIL), Nucleus Software Export Ltd (NSEL), Samsung R&D Institute (SAMSUNG), Society for Health Information Systems Programme (SHISP),

Pantnagar

Tata Motors (TATA-MOTORS)

Pilani

Central Electronics Engineering
Research Institute (CEERI).

Pune

AFour Technologies (AFT), B.G. Shirke Construction Technology Pvt. Ltd (B.G), Bajaj Auto (BAJAJ), Bharat Forge Ltd (BFL), Credit Suisse - Business Control (Credit Suisse), Credit Suisse - Group Finance - FMAR Transition Management (CREDIT SUISSE), Credit Suisse - Information Technology (CREDIT SUISSE), Credit Suisse - Risk & Finance Data Analytics Reporting (CREDIT SUISSE), Credit Suisse- Finance Change (CREDIT SUISSE), DAR Al-Handasah (DAR-Al), DBOI (DBOI), Divgi TorqTransfer Systems Pvt. Ltd. – Bhosari (DIVGI), Espressif Systems (ES), IBM Security - Fiberlink (IBM), IDeaS - SAS - Software Development (IDEAS), JW Consultants (JWC), Mahle Behr India Pvt. Ltd. (MBIPL), National Chemical Laboratory (NCL), Nvidia Graphics - Software Systems (NVIDIA), PharmaACE (PHARMAACE), Reflexis Systems India Pvt Ltd(REFLEXIS), Siemens PLM Software (SIEMENS), Symphony Fintech Solutions Pvt. Ltd. (SYMPHONY), Tata Autocomp Systems Ltd(TAS), Tata Chemical Innovation Center(TCIC), Tata Motors Ltd. (TATA-MOTORS), Tata Technologies (TATA-TECH), UBS Business Solutions (India) Private Limited - Finance Group (UBS), UBS Business Solutions (India) Private Limited - Group Operations (UBS), BS Business Solutions (India) Private Limited - Ras Finance (UBS), VMware Software India Pvt. Ltd. (VMWARE), Whirlpool (WHIRLPOOL), ZiMetrics Technologies Pvt. Ltd. (ZMTPL)

Sirsi

Divgi TorqTransfer Systems Pvt. Ltd. (DIVGI)

Sonipat

Amazon Operations (Area Manager) (AMAZON)

Thiruvananthapuram

Law Pundits (LP), UST Global Infinity Labs-Robotics (USTG), UST Global (USTG),

Vijayawada

Andhra Pradesh Capital Region Development Authority (APCRDA)

RESEARCH AT BITS

Research is an important academic activity at BITS Pilani. Large number of students at all levels of the educational programmes are involved in research that exploits the multidisciplinary educational base emerging out of the broad-based integrated education in engineering, science and humanities. Strong emphasis is laid on interdisciplinary, mission-oriented and relevant research. The Practice School, which is an important component of the integrated programmes of BITS, provides an opportunity to identify research problems relevant to industrial needs. The participation of students and the faculty members in research ensures a team effort towards problem solving activities. Such a total involvement of the faculty as well as the student population integrate research and teaching activities of the Institute in such a manner that they draw strength and support from each other.

Research Areas

Topics of Research can be chosen from any of the disciplines in which the Institute offers Higher Degree and First Degree programmes and also from the areas given in Table at the end of this Part. The Department HOD or faculty may be contacted for more details on research areas.

Research Linkages

The Institute has built up research linkages with a large number of R & D organizations in the country and abroad and provisions exist for candidates to work for a part or whole of the research work at these organizations in their thrust areas. Some of the organizations are: Tata

Institute of Fundamental Research, National Institute of Oceanography, Sankara Nethralaya and Elite School of Optometry, Chennai; LV Prasad Eye Institute, Hyderabad, University of Leeds – UK, NIH USA, University of Hiroshima Japan etc.

Research Components in the Educational Programme

Research is emphasized in all the educational programmes of the Institute. At the first degree level, Thesis and at the higher degree level Dissertation are optional alternatives to the Practice School. Thesis is an integral component of the Ph.D programme.

While some salient features are described below, for further details, please refer to Academic Regulations.

(A) First Degree

(i) In the First tier, a single degree student must take either Thesis or PS and a dual degree student has to normally do Thesis for one degree and PS for the other degree. Such a student can also opt for PS/Thesis for both the degrees.

(ii) Students will be assigned a topic of research and a supervisor after giving due consideration to the student's preference, the research goals of the Institute and the equalization of the work-load of the supervisors.

(iii) A First degree student opting for a Thesis has two options: (i) register for a 16-units Thesis, in which case the student cannot be simultaneously registered in any other course; or (ii) register for a 9-units Thesis, in which case it may be necessary for the student to take additional elective courses to meet graduation requirements and He/she may be permitted to register in courses simultaneously with the Thesis

(iv) Thesis is graded in terms of same letter grades.

(v) Thesis can also be done at collaborating organization, industries under joint supervision.

(B) Higher Degree

For students who opt out for Practice School, Dissertation of 15-25 units is a required component. Student may be registered for one full semester after completing all courses or may be registered concurrently for varied units along with other courses. This is a course in which the student takes up a research topic under the supervision of a faculty. Pursuit of research through this course in any semester must end up in a written report at the end of the semester. The performance is graded in terms of same letter grades. Dissertation can also be done at collaborating organizations, industries under joint supervision.

(C) Ph.D. Degree

Thesis is an integral component in the Ph.D. degree programme. It requires a minimum of 40 units to be distributed normally in four semesters. A Ph.D. student can register for the Thesis course only after passing the Qualifying Examination and after approval of his topic of research and supervisor(s) by the Dean, Academic, Graduate Studies and Research.

The pursuit of the thesis can be done on campus or at Practice School Centres and in certain circumstances at other specific centres with prior permission.

Other Components and Features of the Ph.D. Programme

(i) Types of Input

While the preferred input is a Higher Degree of BITS or its equivalent, the Institute's Academic Regulations permit an input which is at least a First degree of BITS or its equivalent or any input between these two extremes. Further, in a rare case of a person of high professional standing and proven competence who is deemed to have acquired mastery over all or substantial part of the course-work of a higher degree of the Institute through long professional experience exhibited through published papers, technical reports, etc. would also be an acceptable input.

(ii) Qualifying Examination

Every student admitted to Ph.D. must pass the qualifying examination which is based on two areas chosen by the candidate depending on his intended area of research and courses done. The qualifying examination tests the student's knowledge, grasp of fundamentals and his ability

to use them in unknown situations.

The admission to On-campus Ph.D. programme is provisional in the first instance and gets confirmed only after passing the Qualifying examination within the prescribed time. Whenever a candidate is unable to pass the qualifying examination within the prescribed time, he will automatically be discontinued from the programme.

(iii) Seminar / Independent Study

Normally a Ph.D. student will have to register every semester in the Seminar course or in the Independent Study course.

(iv) Course work

The various categories of courses including Research Methodology, for the whole possible range of input of Ph.D. students are described in the Academic Regulations. In most cases, the course work consists of courses which are required for obtaining the knowledge in the area of research. Further, the qualifying examination is conducted on the basis of chosen two sub-areas approved by the Senate

(v) Research Methodology and Teaching Practice

These are two courses required to be done by every Ph.D. student. These courses attempt to train the student in the art, methodology and skill of teaching and research. Alternatively, Dean, AGSRD may permit a student to register in Practice Lecture Series courses *in leu* of Teaching Practice.

(vi) Language Requirement

The foreign language is prescribed as an eligibility requirement for the Ph.D. only when the supervisor(s) and/or the Dean, AGSRD approve the same. Otherwise English or an Indian language, as the case may be, would suffice.

A Ph.D. student for whom foreign language is prescribed is expected to demonstrate an ability to translate a piece from current periodicals in the area of major interest of the student in one of the modern European languages into English with the help of a dictionary.

(vii) Fellowships and Scholarships

Students admitted to Ph.D. Programme normally get fellowship from some funding agencies like UGC, CSIR, DBT, DST, ICMR, MNES or Industries, etc. However, the Institute also offers fellowships from its own resources intended to take care of needs of Ph D students.

Ph.D. programme for working professionals

The Institute also offers an unique opportunity for employed professionals working in industries and R&D Organizations and having experience to work towards Ph.D. degree of the Institute. Such students can be admitted either under 'Part-Time' PhD or under 'PhD aspirants' scheme. While the 'Part-Time' Ph D students will work on the thrust area identified by the Institute, a “PhD aspirant will work in the settings of their respective work environments. Normally candidates working in an organization collaborating with BITS are considered under aspirant scheme. Industries/organizations interested in the scheme for the development of their manpower at the doctoral level are invited to seek collaboration with BITS and sponsor their suitable candidates.

A PhD candidate has to choose a BITS faculty as supervisor. However, co-supervisor may be chosen from other organization.

Admission

The admission modalities given in the next part also apply to Ph.D. wherever applicable.

Eligibility

* A candidate with a formal higher degree which is the minimum qualification for the Ph.D. programme; namely M.E./ M.E. (Coll.)/ M.Phil./ M.Phil. (Applied)/ M.Pharm./M.S. of BITS or an equivalent degree of another university of standing.
* A person of a long and high professional standing and proven competence not possessing a higher degree but whose experience, in terms of professional documents, can measure upto a higher degree.
* A student coming after clearing the courses prescribed by Departmental Research Committee of the Institute or its equivalent without completing the degree.

There may be occasions where the admissions of Ph.D. Aspirants end up in protracted correspondence. If the admissions are finalized

before the starting of the semester, the students will be registered in that semester. Otherwise the admission will be deferred to a subsequent semester.

All 'Ph.D. Aspirants' after passing the qualifying examination shall seek formal admission to the Ph.D. programme at the earliest opportunity available to them and register in the Ph.D. Courses.

Components of Ph.D. Programmes

The components are (a) Course work, (b) Qualifying Examination; (c) Foreign Language, when required; (d)Research Methodology (e) Teaching Practice/Practice Lecture Series; (f) Seminar/Independent Study; and (g) Ph.D. Thesis.

Operational Features

a) Place of work: On-Campus: Any of the BITS Campuses. Off-campus Centre: Any location, where Practice School, Work-Integrated Learning programmes are conducted and organizations having collaborations and research linkages with BITS.

Outside Centre: In worthy circumstances, an outside centre not covered by the above may be approved.

b) Topic of Thesis: From areas of focus of the Institute or from problems of intimate concern to the in-house R & D needs of the host organization and matching with focus of the Institute.

c) Supervisor: Subject to final approval by the Dean, AGSRD, any regular assistant professor and above of BITS Pilani with standing, authority or competence can become the supervisor for the Ph.D. thesis. A supervisor at any point of time is any senior faculty member of the Institute or a person with equivalent responsibility in the campus or in an off-campus centre. However, as per requirement, one or more persons may be approved as co-supervisor for a PhD student. A person from other organization with adequate research credentials can become co-supervisor.

d) Places and Dates of Qualifying Examination: Normally arranged and announced twice in each year at all campuses of BITS.

Areas of Research*

1. **Biological Sciences:** Environmental Biotechnology, Bioinformatics, Microbial Biotechnology, Molecular Biology, Molecular Parasitology & Vector Biology, Molecular Diagnostics, Genomics, Plant Biotechnology.

2. **Bioengineering**: Biomaterials, Biomechanics, Bioinstrumentation, Bio-transport Process.

3. **Civil Engineering**: Structures, Water Resources, Geotechnical, Transportation, Environmental Engineering, Image Processing and G.I.S., Disaster Management, Earthquake Engineering, Solar Architecture, Finite Element Method, Non-traditional optimization algorithms, Artificial Neural Networks, Fuzzy Logic and Multi-criterion Decision Making and their applications.

4. **Chemical Engineering:** Biochemical Engineering, Biomass Gasification, Computation Fluid Dynamics, Energy Engineering, Environmental Engineering, Evolutionary Computation, Modeling and Simulation, Multi-Objective Optimization, Multiphase Reactors, Process Dynamics and Control, Process Integration and Process Intensification, Reaction Engineering, Polymer Science and Engineering, Process Synthesis and Design, Separation Processes and Petroleum Refining and Petrochemicals.

5. **Chemistry:** Organic including Natural products, Bioorganic, Inorganic, Bioinorganic, Physical, Biophysical, Medicinal, Analytical, Green, Theoretical and Computational Chemistry; Nanomaterials; X-Ray Crystallography.

6. **Computer Science & Information Systems:** Computer Networks, Distributed Systems, Database Systems, Software Engineering, Operating Systems, Multimedia, Computer Control Systems, Computer Architecture, Compilers, Formal Methods, Information Retrieval.

7. **Economics and Finance**: Macroeconomic Models and Policy, Microeconomic Analysis, Money and Financial Markets, Financial Engineering, Econometric Studies, Financial Modeling, Mathematical Economics, Environmental Economics, Resource Management Systems, Growth Economics, Banking, Micro Finance, Capital Markets, Macroeconomic Modeling, Applied Finance, Environment and Resource Economics International Trade and Finance, Strategy, Financial Management, Corporate Planning, Entrepreneurship, Project Management.

8. **Electrical and Electronics Engineering:** Communication Systems, Wireless and Mobile Ad-hoc Networks, Optical Communication and Networks, Microelectronics and VLSI Design, Signal Processing and Embedded Systems, Power Electronics and Drives, Power Systems, Telecommunication, Robotics and Intelligent Systems, Fiber Optic Sensors, Artificial intelligence techniques in robotics, Instrumentation & Control, Wearable computing, Energy and Power Systems.

Areas of Research*

9. **Humanities and Languages:** Film Studies, Music, Theatre, History and Politics, Language, Communication and Soft Skills, Literature and Cultural Studies, Comparative Indian Literature, ELT, Media Studies and Advertisement, Ethics and Indian Philosophy, Psychology, Public Policy, Public Administration and Development Studies, Urban and Landscape Studies, Digital Humanities, Journalism, Tourism and Travel, Sociology, Philosophy, Ethics, Higher Education, Spiritual Intelligence, Development Studies, Computer-Mediated Communication, Technology Enabled Learning / Education.

10. **Mathematics:** Coding Theory, Cryptology, Algebraic Geometry, Parallel Computing, Fuzzy Logic and its applications, Water pollution, Mathematical Modelling, Nonlinear functional analysis, Computational fluid dynamics, Optimization, Operations Research, Mathematical Biology, Differential equations, Fractional Calculus, Dynamical System, Epidemiology.

11. **Mechanical Engineering:** Product Design and Development, Manufacturing Engineering, Manufacturing Excellence Practices, Design Engineering, Materials Engineering, Fracture Studies, Non-destructive Testing, Robotics and Intelligent Systems, Nano Technology, Thermal Engineering, Energy Systems Engineering and Energy Management.

12. **Management**: Indian Management Practices, Management Practices in MNC, Cross Cultural Management, Performance Appraisal, Strategic Marketing, Retail, Brand Management, Clustering Methodology, Strategy, Sustainable Development, Evolving Capitalism& Regulations, Project Management, Production Management, Facility Layout Planning, Application of TOC in Operations Management, Supply Chain Management, R&D Management, R&D Performance Measurement, Technology Management, ERP, MIS, E-business, Image Processing, Risk Management, Capital Markets, Quantitative Methods, Business Modeling, Stochastic Modeling of Production Systems, Reliability Analysis & Modeling, Organizational Behavior, Positive Health Psychology, I/O Psychology, Indian Psychology, Innovation and Creativity, Negotiation Skills, Managerial Skills, Entrepreneurship and Health Care Management.

13. **Pharmacy**: Drug Design, Synthesis and Screening of New Bioactive Molecules, Drug Delivery Systems, Phytochemistry and Natural Drugs.

14. **Physics**: Materials Physics; Condensed Matter Physics; Nuclear, Particle and High Energy Physics; Optics & Spectroscopy.

15. **Interdisciplinary Research:** Nanotechnology and nanoscience, Nano-robotics, Micro-electro-mechanical systems (MEMS), Nanomaterials, Mechatronics, Waste, Water and Energy management

16. **Educational Innovation and Institutional Development**

***Respective Department HOD's may be contactedfor further information**



PART III

ADMISSION MODALITY









ADMISSION MODALITY

Admissions are made on an all India basis. English is the medium of instruction for all the programmes in the Institute. Selection is based entirely on candidate's merit, his/her preference, facilities available and availability of seats. Some details of admission modality for all the three tiers of education are described in the following paragraphs.

INTEGRATED FIRST DEGREE PROGRAMMES

Admissions will be made purely on merit. The merit position of the candidate will be based on the score obtained by the candidate in a Computer based Online Test (BITSAT) conducted by BITS, Pilani.

Eligibility for admission:

For admission to all the integrated first degree programmes candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm. the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B. Pharm., candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects.

The candidate should have obtained a minimum of aggregate 75% marks in Physics, Chemistry and Mathematics subjects (if he/she has taken Mathematics in BITSAT) or a minimum of aggregate 75% marks in Physics, Chemistry and Biology subjects (if he/she has taken Biology in BITSAT) in 12th grade examination, with at least 60% marks in each of the Physics, Chemistry, and Mathematics / Biology subjects.

For **BITSAT–2019,** candidates who fulfill the following conditions are eligible to appear:

- Students appearing for 12th grade examination in 2019.
- Students who have passed the 12th grade examination in 2018 provided they explain the reasons for the gap. The admissions committee will examine all such cases before taking a final decision on their eligibility.
- Students should have taken Physics, Chemistry, and either Mathematics or Biology (PCM/PCB) subjects in 12th class.

Note:

1. Students should have appeared in/ passed the 12th examination of the 10+2 system from a recognized Central/ State board.
2. Students who are presently studying in BITS at any of its campuses are NOT eligible to appear in BITSAT.
3. The Institute considers only the latest performance through a public examination for admission. If the results of the latest examination are not available within the due date for submission of application, the candidate will not be considered even if there are some earlier performances of 12th class or its equivalent or any higher examination available with him/her. If a candidate has taken more than one attempt in 12th class or its equivalent, only his latest performance is considered, provided this attempt has been for the full component of subjects/courses prescribed.

The mechanism of admission procedure through BITSAT:

(i) Applying for admission:

All candidates who have appeared in BITSAT-2019 and are interested in admission will be required to submit application forms with 12th class marks and programme preferences on or **before 18thJune 2019, 5:00 PM.**

(ii) Preparation of Merit List for Admission:

The merit position of all eligible candidates (i.e., those who have appeared in BITSAT-2019 and have submitted application form for admission in the prescribed format with 12th marks, preferences and the required fees) will be prepared on the basis of their total scores in BITSAT-2019.

When the BITSAT score of two candidates are the same:

- First their scores obtained in Mathematics/Biology in BITSAT will be considered for separating them.
- If the tie still exists, then their scores in

Physics in BITSAT will be considered for separating them.

- Further tie is eliminated using their scores in Chemistry in BITSAT.
- Finally, their PCM total marks in 12th examination will be considered for their separation.

The candidates have to fill only a single application form for seeking admission to all the degree programmes offered at Pilani, Goa and Hyderabad campuses. The candidate's order of preference for different programmes offered at Pilani, Goa, and Hyderabad campuses of the Institute is processed through a computer software and the offers are made accordingly. This may take a few iterations and at each stage, the status is made available to the candidates at the Institute's website www.bitsadmission.com through Internet.

For a candidate to remain in the race, it is mandatory that the following conditions are fulfilled and strictly adhered to by the candidate:

(i) The Data provided by the candidate in the application form with respect to the candidate's background, academic performance, and order of preference for various degree programmes etc. is final.

(ii) The required fees as mentioned in the communication from the Institute are paid in advance and the candidate does not raise any new arguments in this connection.

(iii) A candidate, when offered provisional admission/ placed on waiting list, can choose to remain in the competition or withdraw from the competition within the stipulated deadline, details of which will be made available on the website in June 2019.

Any candidate who seeks to alter the above conditions in the middle of this process is liable to disqualify himself/herself and forfeit fee as per Institute rules. See the section on 'Advance Fees, Refund and Forfeiture of Fees' later in this part.

(iii) The Actual Mechanism of Admission:

The facilities of the Institute are pronounced invariably in terms of the ratio of seats allotted between the different programmes rather than in terms of a fixed number of seats. The total number of admissions made may vary from year to year. The change in the total number of seats takes place primarily to adjust to the requirements of a highly flexible system which accommodates dual degree, transfer, etc.

In order to reduce the number of iterations, based on earlier experience and on a statistical projection of the responses received, the Institute might make admission offers to a larger number of candidates than the number of seats earmarked.

The computer is programmed to assign the seats starting from the first candidate on the merit list and going down the same until all seats are filled up. At any time when the computer considers a candidate, it first tries to accommodate the first preference of the candidate and goes to his/her second preference if his/her first preference could not be accommodated and so on. Assignments for all programmes are thus completed and immediate admission offers are made.

Based on our past experience, a certain number of candidates would be placed on waiting list. Whenever vacancies arise, the procedure of assignment would be exactly the same as described above. During each iteration, a *de novo* assignment starting from the first candidate in the merit list will be made. Of course, in this operation, candidates who have declined the offer and/or who have not paid fees would be removed from the merit list. It is now clear that in this process not only some of the candidates who are on the waiting list will get an assignment but also certain students who have already got an assignment may now get a new assignment to one of their higher preference if seats are now available. The waiting list of the Institute has the following characteristics namely:

(i) The cut-off point for the waiting list is arrived at by our past experience in terms of the responses from the candidates, the number and the quality of candidates who have applied in the current year with a view

to complete the admissions and start the classes in time.

(ii) Those who are admitted to a programme will continue to be on the waiting list for their higher preferences.

(iii) The waiting list is for admission to the Institute and not for a particular programme, Hence, it will not be possible to assign a waiting list number for a student for a particular programme.

(iv) A student who has a higher BITSAT score may be on the waiting list while a student who has a lesser BITSAT score may have got admission because the former crossed out a programme which the later had opted for and seats were available in that particular programme.

(v) Those who cross out a programme not only cease to be candidates for admission to the programme but also for consideration on the waiting list of the programme.

(vi) Those who get offers to be on the waiting list must pay their fees in advance to remain in the waiting list.

Some tips on showing preferences and crossing out: The candidates are strongly advised to exercise their preferences after careful consideration. ***No candidate at any time of the operation can change his/her preferences or refuse to slide up in his/her order of preference from the closing of application process till the entire admission process is completed.*** If a candidate wishes to join BITS irrespective of the programme so that he/she can float up until the admission process is complete or he/she can avail of certain unusual flexibilities like dual degree etc. it would not be in his/her interest to cross out any programme. The other extreme is where a candidate is absolutely sure of his/her inclination and such candidates would be advised to show preferences to those limited programmes only and cross out the rest.

Normally a candidate cannot change the preferences once submitted. However, if for any reason a candidate discovers a mistake in his preferences already submitted, he can edit his preferences during the editing window, details of which will be communicated through the website. Please see BITS Admissions website for details.

Admissions at Pilani campus, K. K. Birla Goa Campus and Hyderabad Campus:

As already announced, admissions to BITS, Pilani- Pilani campus, BITS, Pilani – KK Birla, Goa campus and BITS, Pilani – Hyderabad Campus will be made through a single admission process. In the different admission iterations mentioned in the earlier paragraphs, it is possible that a student who has got an admission offer for a programme in one campus gets slid up for a programme at the other campus in the next iteration. Once a student reports for admission at a particular campus, he/she remains in the waiting list for the programmes of his higher preferences at the other campuses, till all admissions are finalized. To minimize inconvenience to students, once the student has reported for admission at any one of the campuses, he/she will be given a chance to opt out of the race for the programmes offered at the other campuses and he/she will be considered only for programmes of his/her higher preferences at the campus where he/she has joined. The student has to make the decision on this option on the day of reporting for admission. Further instructions in this regard will be sent to those who have been offered admission.

In all the above matters, the Vice-chancellor's decision shall be final.

Dual degree for students of M.Sc. (Biology, Chemistry, Economics, Mathematics and Physics) programmes: The Institute has created facilities by which any student who is admitted to M.Sc. programmes is accommodated in a dual degree scheme for a second degree in B.E. programmes. This assignment is made by competition on their performance at BITS at the end of first year, separately in Pilani, Goa and Hyderabad campuses on the basis of Progressive Branching Index (PBI). Requirements of both the degrees are structured to be completed normally in five years. If a student is admitted to a second degree programme under dual degree

scheme, he/she has to pay admission fees of the second programme at the time of such admission is made.

Note: There will be restriction on the availability of flexibility such as transfer and dual degree allotment for students admitted to B. Pharm. programme with PCB input. Since all the first degree programmes other than B. Pharm. programme requires PCM input, no transfer/dual degree allotment is possible with PCB input.

Direct Admission to Board Toppers:

In the past, admission process of the Institute always ensured guaranteed admission to all the students who obtained first ranks in their respective board examinations. This has given a very vital input of highly meritorious students from all over India. Continuing this tradition, the Institute will give direct admission to first rank students of all the central and state boards to the programme of their choice, irrespective of their BITSAT-2019 score.

While the first rank student in PCM stream will be considered for admission to any of the first degree programmes of his/her choice, the first rank holder of PCB stream will be considered for admission to B. Pharm. programme only.

Moreover, they should have obtained the minimum marks in PCM/PCB subjects in 12th examination, as described above. For more details, see the later sections in this part and also the BITS website.

Eligibility criteria for admission under 'Direct admission to Board toppers' scheme:

To be eligible for admission under the 'Direct admission to Board toppers' scheme, the candidate should be the topper from the science stream having taken Physics, Chemistry, Mathematics subjects in 12th standard. To identify the topper the following criteria will be adopted (see below for PCB students).

The topper is the student who fulfills the following criteria:

a) has taken Physics, Chemistry, and Mathematics subjects in 12th class and
b) has obtained the highest aggregate percentage of marks in 12th class among all the students who have taken Physics, Chemistry, and Mathematics subjects in 2019 from the Board. For the purpose of calculating the aggregate percentage, the aggregate marks should include the marks of Physics, Chemistry, and Mathematics subjects in addition to other subjects which are required to pass the 12th examination from the Board under consideration. Further, the Physics, Chemistry, Mathematics subject marks should be included in the aggregate, irrespective of whether the Physics, Chemistry, and Mathematics subjects are identified as main/optional/elective in his marksheet(s).

In the case of first rank candidate of Physics, Chemistry, Biology stream, the criteria is same as above, replacing the word 'Mathematics' with 'Biology' in the above paragraph. However, the first rank holder of PCB stream will be considered for admission to B. Pharm. programme only.

Applicants under the scheme should attach documentary proof in support of their claim, along with the 12th mark sheet and a letter from the Board declaring the candidate as the topper in the specified stream. The Institute will also make efforts to get these data from the different boards on its own. In all cases, the Institute will be guided by the data provided by the concerned Board. In cases where for a particular board, the data available before the deadline is insufficient or inconclusive, the admission committee may decide not to make any offer under the scheme for that specified Board. In all such cases, the decision of the Vice chancellor will be final and binding on the applicants.

The applications are to be made online. The filled forms are to be printed and should be posted along with the enclosures to reach the Institute before the deadline, which is **18thJune 2019**. See the BITS website for more details.

International students through 'International Student Admission (ISA) Scheme':

Candidates holding foreign passport and having valid Scholastic Assessment Test (SAT) and SAT Subject Tests scores are eligible to apply for admission under "International students scheme" at BITS Pilani-Pilani Campus, BITS Pilani-Hyderabad Campus and BITS Pilani-Goa Campus for Academic Year 2019-20. This is another mode of admission for integrated first degree programmes which does not require BITSAT-2019 score. Candidates who have taken SAT and SAT Subject Tests conducted by College Board (USA) can apply for admission to different first degree programmes at Pilani, Hyderabad and Goa Campuses of BITS Pilani for Academic Year 2019-20. Such international candidates should meet the following eligibility criteria.

- Candidates holding passport issued by a country other than India only are eligible under this scheme.
- The candidate should have passed the qualifying examination (grade 12) with Physics, Chemistry, Mathematics and English conducted by the country's or province's Board of Higher/Senior Secondary Education, including those in India, or its equivalent examination recognized by Association of Indian Universities such as the "A" levels (conducted by Cambridge International) or the International Baccalaureate, etc.
- Candidates should be proficient in English.
- The candidate should have obtained a minimum of 75% aggregate marks (or average grade of 7.5 on 10-point scale), in Physics, Chemistry and Mathematics in the above examination (grade 12). Additionally, he/she should have scored at least 60% marks (or grade of 6.0 on 10-point scale) in each Physics, Chemistry and Mathematics in grade 12.
- The candidate should have a minimum aggregate score of 1160(out of maximum of 1600) in SAT (New format), as also a minimum aggregate score of 1600 (out of maximum of 2400) in SAT Subject Tests in Physics, Chemistry and Mathematics Level 2.
- The candidate should have written the SAT and SAT subject tests not earlier than February 1, 2017.

Admissions will be made on merit determined by score obtained by the candidate in SAT Subject Tests in Physics, Chemistry and Mathematics Level 2, subject to candidate meeting above eligibility criteria. For more details on SAT & SAT Subject Tests visit website: www.collegeboard.com. SAT and SAT subject test scores have to be sent to BITS Pilani directly through College Board using the Designated Institution (DI) code: 7759 - BITS Pilani.

Candidates who have passed the qualifying examination in 2018 or 2019 are eligible to apply under this scheme. Students who are appearing in the examination in 2019 are also eligible to apply. For more details, please visit http://www.bitsadmission.com/ois.

Preparation of Merit List for Admission (ISA):

The merit position of all eligible candidates (i.e., those who have applied under ISA scheme and have submitted application form for admission in the prescribed format with 12th marks, preferences and the required fees) will be prepared on the basis of their aggregate scores in SAT subject tests (SAT 2) in Physics, Maths, and Chemistry. To resolve tied scores so as to draw up the merit list the following methodology shall be applied in given order: SAT Mathematics Level 2 score, SAT Physics score, SAT Chemistry score, number of years of education in a foreign country, and exceptional talent.

Advance fees, Refund and Forfeiture of fees:

For the International students the rules concerning payment of fees and refund thereof are as follows:

- Candidates offered admission (or provisional admission) to any programme have to pay the required fee within the deadline mentioned in the offer letter. This

includes the admission fee and first semester fees.

- If a candidate, who is offered admission, accepts the offer by remitting the above fees but fails to report at the respective Campus of the Institute on the reporting date then he or she will forfeit 10% of the aggregate fee and his/her admission will stand cancelled.
- If a candidate reports on the specified date and submits original documents and completes all other admission formalities, but subsequently withdraws within 15 days from the reporting date, he/she will forfeit 20% of the aggregate fees paid at the time of confirming his/her admission (viz. admission and facilitation fees and first semester tuition fees).
- If a candidate reports on the specified date and submits originals, but subsequently withdraws within 16th to 30th day from the date of reporting, he/she will forfeit 50% of the aggregate fees (admission fee, facilitation fee and one semester fee after deducting fee waiver) paid by him/her.
- If a candidate reports on the specified date and submits originals, but subsequently withdraws after 30 days from the date of reporting, he/she will forfeit the entire amount and no refund will be made to him or her.
- Candidates placed on the waiting list will have to pay the admission fee of USD 1150/- (its equivalent in INR Rs. 80500/-) and subsequently if admission is offered they are required to pay first semester fees as mentioned in the offer letter within the stipulated time. If admission is not offered to a wait-listed candidate, the entire admission fee will be refunded within 30 days from the admissions closing date (i.e. 8th August 2019).
- If a candidate in wait list, is offered admission, but does not accept the offer by remitting the balance fees (i.e. facilitation fee and one semester fee after deducting fee waiver) he/she will forfeit INR 1,000/- and his/her admission offer will automatically stand cancelled. Remaining amount will be refunded within 30 days from the admissions closing date (i.e. 8th August 2019).
- If a candidate in waiting list withdraws before completion of admission process, then Rs. 1000/- will be deducted towards processing charges and remaining will be refunded within 30 days from the admissions closing date (i.e. 8th August 2019).
- While paying fees a candidate cannot stipulate any conditions such as changing order of preferences, addition or deletion of preferences etc. If any such condition is mentioned by the candidate while paying fees, the fee will not be accepted.

Scholarship policy for International students admitted through ISA Scheme:

All International students admitted under the scheme will be provided merit scholarships in the form of tuition fee waiver as follows:

Tuition fee waiver is based on merit: Top 4% students will get 80% waiver, next 10% will get 50%, next 20% will get 30% waiver, and remaining will get 15% Tuition fee waiver. All fee waiver decisions will be announced after admissions are completed. The number of scholarships will depend on the total number of seats for the particular Academic Year in a campus.

Scholarships will be for one semester at a time. Scholarships for the first semester will be decided based on the position in the merit list within foreign students (admitted under International Students Admission scheme). Scholarships will be reviewed in each subsequent semester and will be awarded based on the academic performance of the student at BITS. For further scholarship eligibility during subsequent semesters while studying in BITS, a student has to score a Minimum CGPA of 8.0 to claim 80% tuition fee waiver, and a minimum of 6.0 CGPA for claiming any other scholarship level (50, 30, or 15%) while remaining in top 4, 10, 20, and 66% percentage respectively. These students will not be eligible for any other scholarship/aid offered

by BITS Pilani but may avail other scholarships. The student must maintain the absolute minimum academic performance to be eligible to receive any form of tuition fee waiver in the subsequent semesters, viz.

The student should not have obtained more than one 'E grade' or one 'NC report' in the registered courses in the previous semester.

Further, scholarships will be provided only for the normal duration of the programme.

Higher Degree (PG) Programmes

To all the higher degree programs, admissions will be made, on the basis of merit, as per the modalities explained below:

I. Admissions based on GATE (for M.E.)/ GPAT (for M. Pharm.) score and

II. Admissions based on the marks obtained in the online HD test conducted by BITS and/or written test, group discussions and interviews conducted by BITS at its campuses/any other places. Further details are available at the BITS website, http://www.bitsadmission.com.

Ph.D. Programme

For admission to the on-campus Ph.D. programme of the Institute, the marks/grades of the candidate in the latest examination as well as his/her performance in a specially designed admission test and/or interview would be considered.

Off-Campus Ph.D. Under Ph.D. Aspirant Scheme

The Institute offers a unique opportunity for employed professionals working in Industries and R&D organizations and having long experience and proven competence in various fields to work towards Ph.D. degree of the Institute in the settings of their respective work environments. Candidate holding any of the BITS degree or working in an organization collaborating with BITS will normally be considered under this scheme. Industries interested for the development of their manpower at the doctoral level are invited to seek collaboration with BITS and sponsor their suitable candidates along with their applications in the prescribed format.

Foreign Students or Indian Students Having Qualifications from Foreign Countries

The Institute welcomes foreign students but the admission is strictly made on the basis of merit. There is no separate provision for admission of such candidates and they have to compete with all other candidates, as per the procedure already described above for various degree programmes.

In order to verify the eligibility for admissions, the candidates should enclose, with their application, documents explaining grading/marking system and calculation of cumulative grade point average/ aggregate percentage of marks along with their transcript/ mark sheet. Further the candidates must send a copy of syllabus of courses and rules and regulations for the examinations they have passed well in advance.

Students should request their examining authorities to send the transcript/ mark sheet with relevant documents directly to Dean Academic and Undergraduate Studies, BITS, Pilani - 333031, Rajasthan-India so as to reach him before the deadline.

A specially appointed committee examines all applicants with foreign qualifications regarding their eligibility for admissions.

Graduates of BITS

Candidates who come with a degree where the structure and the features of the programme are similar to that of BITS are naturally ready to fit more effectively into the BITS educational system. This experience prompts the Institute often to describe the prior preparation for another degree in the same tier or a degree in a higher tier in terms of not only a minimum qualification but also specific courses which they should have done.

Admission with marginal deficiency

For details refer to the section on flexibilities in the previous part.

Casual Students

Persons, other than regular students of BITS

who desire to register for some courses to update their knowledge are designated as casual students. Casual students can register for courses on audit only and cannot enroll for a degree. The facility of taking a course on audit is principally conceived to give an opportunity to a person to update his knowledge and he cannot claim acceptance of such a course for the fulfillment of requirements of any programme, current or future.

This scheme has been devised to take care of professionals from various industries and organizations who express a desire to update their knowledge, although they, ipso-facto, have no desire to work for a degree.

Persons desiring to register as casual students should apply on the prescribed form within the last date.

Whenever such a student is admitted he may be allowed to continue as a student for a maximum period of eight registered semesters. However, he should request at the end of every semester for permission to continue him as a casual student in the succeeding semester.

The Institute may offer direct admission to a limited number of children of the staff of BITS and BET and also to some meritorious students from the schools of BET in Pilani to non-professional programmes with a proviso that the students admitted to these programmes will not be eligible for any of the flexibilities like transfer to and dual degree in any of the professional programmes.

INFORMATION FOR CANDIDATES

(To be read in conjunction with the instructions given in the application form and any other communications sent from the Institute).

APPLICATION PROCEDURE

Application for admission should be made on the prescribed form. Separate application forms are prescribed for (i) Integrated First Degree Programmes (ii) Higher Degree Programmes (iii) MBA Programmes (iv) Doctoral Programmes.

(i) Integrated First degree Programmes:

In order to apply for admission to the Integrated First Degree programmes, the candidate should have appeared in the online computer-based test (BITSAT) as per the announcement made by the Institute through separate advertisement and brochures. The last date for registering for BITSAT-2019 was 31st March 2019 and BITSAT-2019 tests are scheduled between 16th May and 26th May 2019.

In addition to the application made earlier for registering for BITSAT test, they should apply for admission by submitting the prescribed form, complete in all respect, so as to reach the Institute before the deadline, i.e., 5:00 PM on 18thJune 2019.

The application forms are available at the BITS admission website (i.e. www.bitsadmission.com) and are to be filled online along with the prescribed fee to be paid online.

Last Date for Submission of Completed application for Integrated First degree Programmes:

18th June 2019 (5.00 P.M.)

(ii) Higher Degree, MBA and Ph.D. programmes:

Interested and eligible candidates should apply through the prescribed application form available online at :

http://www.bitsadmission.com/.

Further details are also available on this site.

Last Date for Submission of Completed applications:

MBA:

First Semester: 5.00 P.M. 15th February 2019**

Higher Degree:

First Semester: 5.00 P.M. on 30th April 2019**

Ph.D.:

First Semester: 5.00 P.M. on 16th May 2019**

Second Semester: 5.00 P.M. on 2nd December 2019**

** subject to change

(Refer to section on Flexibilities in the previous part).

Some Important Instructions

1. The application process, announcement of results after each iteration, detailed instructions etc. are all announced at BITS website during the various stages of the admission process. It is the responsibility of the candidate to follow these announcements and instructions.
2. The number on your application form is unique. Quote this application number in all subsequent correspondence with the Institute.
3. If you are accepting the offer of admission/accepting to be placed on the waiting list you will be required to pay fees in advance, as per the instructions mentioned along with the offer.
4. Whenever admissions are made in the second semester a separate notification to this effect will be issued. Applications for second semester admission should be submitted only after such a notification.
5. If you desire to be considered for the award of Institute merit-cum-need scholarships, you will be required to submit an income certificate showing gross income of your Parents/Guardian, duly signed by the 1st Class Magistrate/Notary Public. Persons in service should submit a certificate from employer showing separately basic salary and other allowances.

Enclosures with Application

Applications for admission to integrated first degree programmes should be accompanied by the following documents:

1. An attested photocopy of the X pass/ Matriculation/Secondary School certificate issued by the Board. (to be uploaded online)
2. An attested photocopy of the mark sheet of the qualifying and any other higher University/Board examinations passed. (to be uploaded online)

The BITSAT score for each of the candidate will be taken from the Institute records.

SELECTION FOR ADMISSION

Candidates are finally admitted to the Institute subject to the following conditions:

1. They have paid the requisite fees asked for in their admission/waiting list letters.
2. They are declared medically fit by a registered medical practitioner.
3. They have submitted all required original mark sheets & certificates, with photocopies, and the statements made in their application forms are verified against their originals.
4. They fulfill the eligibility requirements.

For Integrated first degree programmes, on the reporting day at Pilani/Goa/Hyderabad, a Dean/Senior faculty member of the Institute will interact with the candidates. If any candidate fails to be personally present on that day, his admission will stand automatically cancelled.

Every admitted student is required to undergo a registration process on the day announced for the purpose. One of the objectives of the registration process is to name the courses to be pursued during a given semester, after allowing for the student's options within the prescribed rules and regulations. By this process, each student makes his own Time Table at his own responsibility, to be followed in that semester. No student will be permitted to attend classes or use any of the Institute facilities without completing the registration process.

Advance fees, Refund and Forfeiture of fees:

In the Integrated First Degree programmes, a candidate selected for admission/placed on the waiting list through BITSAT will be required to pay fees in advance subject to the following conditions:

1. If a candidate is offered admission to any programme of his/her preference as specified in the application form, he/she has to pay admission fee of Rs. 39,800/- and requisite one semester tuition fee of Rs. 1,78,000/- within the stipulated deadline. However, if a candidate is placed on the waiting list, he/she has to pay only admission fee of Rs. 39,800/- in advance and subsequently, if he/she is offered admission he/she has to remit the semester tuition fee of Rs.1,78,000/- as announced in the wait list offer.

- If a candidate, who is offered admission, accepts the offer by remitting the above fees but withdraws his or her application by 16th July 2019 (through an online withdrawal process only), he or she will forfeit INR 1000/- and his/her admission will stand cancelled. The remaining amount will be refunded in due course of time as mentioned under item no. 2 (f).

2. a) If a candidate, who is offered admission, accepts the offer by remitting the above fees but fails to report at the Institute on the date specified above, he/she will forfeit the 10% of the total fee towards processing charges (Admission fee Plus the one semester tuition fee plus hostel fee) and his/her admission will stand cancelled. The remaining amount will be refunded in due course of time as mentioned under item no. (f).

   b) If a candidate accepts the admission offer but withdraws within 15 days of reporting to the assigned campus on the specified date, he/she will forfeit the 20% of the total fee (Admission fee Plus the one semester tuition fee plus hostel fee) plus actual expenses incurred towards mess and electricity usage. The remaining amount will be refunded in due course of time as mentioned under item no. (f).

   c) If a candidate accepts the admission offer but withdraws between 15 to 30 days of reporting to the assigned campus on the specified date, he/she will forfeit the 50% of the total fee (Admission fee Plus the one semester tuition fee plus hostel fee) plus actual expenses incurred towards mess and electricity usage. The remaining amount will be refunded in due course of time as mentioned under item no. (f).

   d) If a candidate accepts the admission offer but withdraws after 30 days of reporting to the assigned campus on the specified date, he/she will forfeit the 100% of the total fee (Admission fee Plus the one semester tuition fee plus hostel fee) plus actual expenses incurred towards mess and electricity usage.

   e) If a candidate in waiting list withdraws before completion of the admission process then he/she will forfeit Rs. 1000/- towards processing charges and remaining amount will be refunded in due course of time as mentioned under item no. (f).

   f) All applicable refunds will be completed within 30 days from the admissions closing date (i.e. 8th August 2019).

- Whenever a candidate is admitted to a programme, he/she is kept on a waiting list for programmes of your higher preferences. Until all admissions for First Semester 2019-2020 are completed, any vacancy in any programme caused by non-acceptance of the offers will be filled by offering the vacant seat to the next candidate in the order of merit. This process is called 'Sliding-Up'. According to the Institute rules, your acceptance of the admission offer implies that you will be automatically considered for sliding up to programme of higher preference as indicated in your application form, under the above circumstances.

3. If the Institute is not able to offer admission to a wait-listed candidate in any of programmes of his/her preferences as specified in his/her application form, the total amount of fee paid will be refunded to him/her in due course of time.

4. A candidate who accepts an offer of admission or who accepts to be placed on waiting list by paying the requisite fees (as above) can choose to remain in the competition or withdraw from the race within the stipulated deadline, details of which will be made available on the website in June 2019.

5. While remitting fees, no candidate can stipulate any conditions such as changing order of preferences, addition/deletion of preferences etc. Even if any such conditions are mentioned while remitting fees, these will be ignored.

For higher degrees, conditions stipulated in the Instructions sheet sent to the shortlisted candidates, will be applicable.

The Institute reserves the right to refuse admission to any candidate without assigning any reason. The decision of the Vice-chancellor in the matter of admission and allotment of programmes of study shall be final.

Instructions for Payment

1. The schedule of fees given below is for a normal situation. Wherever a student's programme gets modified or his progress is delayed beyond the maximum permissible time, such a student is advised to consult the appropriate authority before registration.
2. The below mentioned schedule of fees is applicable for all the students admitted in July 2019. All students admitted earlier than July, 2019 will continue to be governed by the schedule of fees as shown in the bulletin corresponding to their year of admission. However, it should be clear that they will have to pay along with the new students the same amount of fees for students' union fee, students' aid fund, hostel fee and mess & electricity advance.
3. The fees and other charges are payable in advance in each semester/term on the notified dates before registration. No withdrawal from a course or courses will entitle a student for refund of fees.
4. Students who go for Practice School II will be charged semester fees and the summer term fees because the practice school is longer than a semester and extends in to summer.
5. Casual students will pay fees prescribed for regular students.
6. Institute caution deposit is refundable only at the time of graduation or withdrawal from the Institute.
7. If there are dues outstanding from a student, his grades will be withheld.
8. Mess dues are to be cleared by each student every month. Students who accumulate mess arrears would be required to pay a prescribed additional advance at the time of next registration.

SCHEDULE OF FEES

A. The following is the details of the fees in INR payable by all students admitted in the academic year 2019-2020 at **BITS-Pilani, Pilani Campus.**

Fees	Integrated First Degrees	Higher Degrees	Ph.D. Programme	
			Full Time	Part Time
Admission Fees	39800/-	39,800/-	39,800/-	39,800/-
Semester/Term Fees				
First Semester	1,78,000/-	1,78,000/-	17,800/-	35,600/-
Second Semester	1,78,000/-	1,78,000/-	17,800/-	35,600/-
Summer term	62,300/-	62,300/-	6,230/-	12,460/-
Students' Union fee	450/- pa	450/- pa	—	
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	12900/-	12900/-	12900/-	
Second Semester	12900/-	12900/-	12900/-	
Summer term	6450/-	6450/-	6450/-	
Ph.D. thesis examination fees	-	-	31,500/-	31,500/-
Mess & Electricity advance				
First Semester	10000/-	10000/-	10000/-	
Second Semester	10000/-	10000/-	10000/-	
Summer term	5000/-	5000/-	5000/-	
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Other Advances				
First Semester	12000/-	12000/-		
Second Semester	12000/-	12000/-		
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Institute Caution Deposit	3000/-	3000/-	3000/-	3000/-
Fee for Eligibility Test(s)/Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

Also, Please refer to Notes at the bottom of table C for further information.

B. The following is the details of the fees payable by all students to be admitted in the academic year 2019-2020 at **BITS-Pilani, K. K. Birla Goa Campus.**

Fees	Integrated First Degrees	Higher Degrees	Ph.D. Programme	
			Full Time	**Part Time**
Admission Fees	39800/-	39,800/-	39,800/-	39,800/-
Semester/Term Fees				
First Semester	1,78,000/-	1,78,000/-	17,800/-	35,600/-
Second Semester	1,78,000/-	1,78,000/-	17,800/-	35,600/-
Summer term	62,300/-	62,300/-	6,230/-	12,460/-
Students' Union fee	450/- pa	450/- pa	—	
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	17300/-	17300/-	17300/-	
Second Semester	17300/-	17300/-	17300/-	
Summer term	8650/-	8650/-	8650/-	
Ph.D. thesis examination fees	-	-	31,500/-	31,500/-
Mess & Electricity advance				
First Semester	10000/-	10000/-	10000/-	
Second Semester	10000/-	10000/-	10000/-	
Summer term	5000/-	5000/-	5000/-	
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Other Advances				
First Semester	12000/-	12000/-		
Second Semester	12000/-	12000/-		
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Institute Caution Deposit	3000/-	3000/-	3000/-	3000/-
Fee for Eligibility Test(s) / Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

Also, please refer to Notes at the bottom of table C for further information.

C. The following is the details of the fees payable by all students to be admitted in the academic year 2019-2020 at **BITS-Pilani, Hyderabad Campus.**

Fees	Integrated First Degree	Higher Degree	Ph.D. Programme	
			Full Time	**Part Time**
Admission Fees	39800/-	39,800/-	39,800/-	39,800/-
Semester/Term Fees				
First Semester	1,78,000/-	1,78,000/-	17,800/-	35,600/-
Second Semester	1,78,000/-	1,78,000/-	17,800/-	35,600/-
Summer term	62,300/-	62,300/-	6,230/-	12,460/-
Students' Union fee	450/- pa	450/- pa	—	
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	17300/-	17300/-	17300/-	
Second Semester	17300/-	17300/-	17300/-	
Summer term	8650/-	8650/-	8650/-	
Ph.D. thesis examination fees	-	-	31,500/-	31,500/-
Mess & Electricity advance				
First Semester	10,000/-	10,000/-		
Second Semester	10,000/-	10,000/-		
Summer term	5,000/-	5,000/-		
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Other Advances				
First Semester	12000/-	12000/-		
Second Semester	12000/-	12000/-		
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Institute Caution Deposit	3,000/-	3,000/-	3000/-	3000/-
Fee for Eligibility Test(s) / Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

Notes: (Applicable to Pilani, Goa and Hyderabad Campus candidates):

1. The above prescribed semester fees is for the Integrated First Degree, Higher Degree, PhD students admitted in the academic year 2019-20. For these students, the semester, term and admission fees will be revised upward every year. The details of semester tuition fee and summer term fee is given below (unless the government announces any new levy/tax, which will be passed on to all existing students irrespective of their year of entry).

Tuition fees per semester & summer term fee (if it is required to register in summer) for the students admitted in academic year 2019-20 [for Domestic students] (Amount in INR)					
Academic Year of admission	**AY 2019-20**	**AY 2020-21**	**AY 2021-22**	**AY 2022-23**	**AY 2023-24**
Semester Tuition Fee#	1,78,000	1,94,000	2,11,500	2,30,500	2,51,000
Summer Term Fee*, #	62,300	67,900	74,000	80,700	87,900

* Summer Term Tuition Fee will be about 35% of Semester Tuition Fee in Corresponding Academic Year. All three Indian campuses will have the same summer term fee in an academic year. It is to be noted that every summer term is not part of the academic calendar except where specifically stated in the Semester-wise pattern of a given programme. Though the prescribed summer term fee for domestic students is mentioned above, depending on the requirement of registration of a student in a given summer term, he/she will be required to pay summer term fee for that particular academic year only.

The tuition fees per semester for full time and part time PhD students will be 10% and 20% of the amount mentioned in the above table respectively.

3. If a student is admitted to a second degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time such admission is made.

4. If a single degree student registers for PS II in a Semester, he/she has to pay the semester fees of the batch for that semester plus additional fees of summer term of previous academic year (i.e. about 35% of the Semester fees of the previous Academic Year). For example: If a single degree FD student registers in Practice School II (PS II) in his/her fourth year, the PS II fees will be Semester Fees of the batch for his/her corresponding Academic Year in which he/she registering for PS II plus summer term fees of the previous year (i.e. summer term fees of his/her third year). Similarly, if a dual degree FD student registers in PS II in his/her fifth year, the PS II fees will be Semester Fees of the batch for his respective Academic Year in which he/she registering for PS II plus summer term fees for that batch as per their third year of study.

5. Course-wise Fees (Per Course): Rs. 3250/- (Applicable to only certain limited courses outside academic requirement after paying full semester fees. No semester fee is computable on the basis of course wise fees).

6. If any continuing student is also admitted to a minor programme, he/she has to pay a fee of Rs. 20000/- for AY 2019-20 in addition to fees for the semesters / summer terms enrolled in. The fee is payable in two installments – Rs.10000/- at the time of admission and Rs. 10000/- on completion of requirements. Admission fees for minor programme will be revised in subsequent years as per Institute norms.

5. All fees are to be paid in advance. Only caution deposit and mess advance are refundable after adjustment of dues at the time of graduation or withdrawal from the Institute. This applies to prospective candidates who are seeking admission as well as ongoing students of the Institute.

6. For some specific programs requiring special treatment, fees and mode of their payment will be determined by the Vice-Chancellor in consultation with the Chancellor**.**

International Student Admission Scheme, BITS, Pilani

Pilani, Goa and Hyderabad campuses

For Academic Year 2019-2020

Fees required to be paid at the time of Admission (in INR)

	(**All figures in INR)**
Admission fees	80500
Facilitation fee (covering charges for local travel, room and board during "orientation" in 1st month)	16130
Institute Caution Deposit (Refundable on graduation or leaving the Institute, after adjusting all dues).	32000
Students' Union, Student Aid Fund for AY 2019-20	4160
First Semester Tuition Fees	458500
First Semester Hostel Fees and Internet Charges	36610
First Semester Mess and Electricity Advance (this is adjusted against mess and electricity bills at the end of semester).	10000
Other Advances (Per Semester)	12000
Total payment required at the time of Admission	649900

Note: Students are expected to pay their Fees in INR. The USD payment is to be made if any, using the conversion rate on the day of payment.

The above prescribed semester fees are for the FD students admitted through ISA scheme in the academic year 2019-20. For the students, the semester, term and admission fees will be revised upward every year. The details of semester tuition fee and summer term fee is given below (unless the government announces any new levy/tax, which will be passed on to all existing students irrespective of their year of entry).

Tuition fees per semester & summer term fee (if it is required to register in summer) for the students admitted in academic year 2019-20 [for International students] (Amount in INR)					
Academic Year of admission	**AY 2019-20**	**AY 2020-21**	**AY 2021-22**	**AY 2022-23**	**AY 2023-24**
Semester Tuition Fee	4,58,500	5,00,000	5,45,000	5,94,000	6,47,500
Summer Term Fee*	1,60,500	1,75,000	1,90,800	2,07,900	2,26,600

*Summer Term Tuition Fee will be about 35% of Semester Tuition Fee in Corresponding Academic Year. All three Indian campuses will have the same summer term fee in an academic year. It is to be noted that every summer term is not part of the academic calendar except where specifically stated. Though the prescribed summer term fee for International students is mentioned above, depending on the requirement of registration of a student in a given summer term, he/she will be required to pay summer term fee for that academic year only.

1. If a student is admitted to a second-degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time of such admission is made.

2. International Students admitted in AY 2019-20 will pay tuition fee of 4.585L per Semester in AY 2019-20. In subsequent years (AY 2020-21, 2021-22, 2022-23, 2023-24 etc.) tuition fee will increase @9% every year in INR for 2019-20 batch students as shown in above table.

3. If a single degree student registers for PS II in a Semester, he/she has to pay the semester fees of the batch for that semester plus additional fees of summer term of previous academic year (i.e. about 35% of the Semester fees of the previous Academic Year). For example: If a single degree FD student registers in Practice School II (PS II) in his/her fourth year, the PS II fees will be Semester Fees of the batch for his/her corresponding Academic Year in which he/she registering for PS II plus summer term fees of the previous year (i.e. summer term fees of his/her third year). Similarly, if a dual degree FD student registers in PS II in his/her fifth year, the PS II fees will be Semester Fees of the batch for his respective Academic Year in which he/she registering for PS II plus summer term fees for that batch as per their third year of study.

4. If any continuing international student is also admitted to a minor programme, then he/she has to pay the minor fee and in two instalments. The first instalment of the fee will be paid at the start of the minor program and it will be 3% of semester tuition fee in the corresponding academic year. The second instalment will be paid at the completion of minor program and it will be 3% of tuition fee in the semester when he /she complete minor program. This fee will be in addition to the semester/term fees. Admission fees for minor programme will be revised in subsequent years as per Institute norms.

5. All fees are to be paid in advance. Only caution deposit and mess advance are refundable after adjustment of dues at the time of graduation or withdrawal from the Institute. This applies to prospective candidates who are seeking admission as well as ongoing students of the Institute.

6. For some specific programs requiring special treatment, fees and mode of their payment will be determined by the Vice-Chancellor in consultation with the Chancellor.

SCHOLARSHIPS

A large number of scholarships, fellowships and other financial assistance are available to the students of the Institute. Past experience shows that about 30% of the students receive some form of financial assistance or other. For continuance of scholarships, scholarship holders are required to maintain good scholastic standing and good conduct.

Some of the scholarships/financial assistance normally available are listed below:

1. Institute's own merit or merit-cum-need awards for students:

a) For FD students: Every year about 30% of students admitted to First Degree Programs get semester tuition fee waivers in the range between 15% to 100% in the form of either merit or merit-cum need scholarships as tabulated below:

Under Institute's own merit award scheme	**Amount of scholarship**
Top 1% Students	100% of total tuition fee
Top 2% Students	40% of total tuition fee
Under Institute's own merit-cum-need awards scheme	**Amount of scholarship**
3% Students	80% of total tuition fee
6% Students	40% of total tuition fee
12% Students	25% of total tuition fee
6% Students	15% of total tuition fee

Note: There will be no waiver of admission fee.

b) All awards are made for one semester only and their continuance in the subsequent semesters(s) will depend on the candidate's performance in the Institute and his/her needs.

c) Approximately 50% of full time Ph.D. students without any other aid will also get a monthly stipend of up to Rs. 31,000/- which will be in the form of assistantship for which they will be required to devote up to 8 - 10 hours per week for assisting in teaching/research or in administration.

The Institute's decision on these awards/ stipends is entirely worked out by the Institute's own pre-declared procedure and is not dependent on the nationally conducted tests such as GATE, GPAT etc.

2. Students admitted to Higher degrees and Ph.D. will also be recommended for award of scholarships /Fellowships from various sources like UGC, CSIR, DST, DBT, ICMR, etc. These Scholarships are operated as per rules & regulations stipulated by the awarding authorities. Students admitted to higher degree programmes and who are qualified in GATE may apply to the UGC for the GATE scholarship and the Institute will forward such applications to the UGC. It should be noted that the decision regarding award of the GATE / GPAT scholarship to admitted students is made by UGC as per its existing norms and the Institute cannot guarantee such awards.
3. Scholarships under National Talent Search/ National Science Talent Search Schemes.
4. Government of India National Scholarships.
5. Merit Scholarships, Merit-cum-need Scholarships and Need-cum-Merit Scholarships awarded by State Governments.
6. Government of India Scholarships for Scheduled Caste and Scheduled Tribe students.
7. National Scholarships to the children of Primary and Secondary School teachers.
8. Scholarships from various charitable trusts.
9. Financial assistance from Students Aid Fund.
10. The Ministry of Non-Conventional Energy Sources (MNES), Govt. of India has sanctioned two research fellowships to the Institute for advanced study in the area of Renewable Energy.
11. Students can also participate in the nationwide competitions for prestigious scholarships such as Aditya Birla Scholarship, Lucent Global Science Scholars Program and GE Fund India Scholarship.

12. Financial Assistance from BITS Alumni. BITS and BITSAA International Travel Fellowship is co-sponsored by the Institute and BITSAA International. Meritorious students are supported with 75% of travel cost for traveling abroad for presenting selective papers at international conferences.

Student Record

The students' records are computerized and a grade sheet for each semester is issued to the student normally within one week after the comprehensive examination.

The grade sheet will be withheld when a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.

The Institute issues a transcript (an up-to-date performance of a candidate from the date of his entry to the date of his leaving the Institute) to all the passing out candidates at the end of each semester/summer term normally within four weeks of the last examination. The provisional certificate is issued and refund of the positive balance and caution money by RTGS is made at the same time. This estimate is based on an assumption that each candidate has ensured by prior initiative that there is nothing pending against him on academic, financial and disciplinary matters.

Since all student records are computerized, each student is assigned a unique identification number (ID No.) which is constructed by building in the number certain information to assist in data storage and data retrieval. No two ID numbers are ever identical.

Degree programmes are assigned codes as below and the ID No. carries the degree programme code(s) along with other information such as year of admission, whether in Practice School (PS) or Thesis (TS) stream and the last character indicates the campus which a student belongs to For example, 2019A1PS350P refers to a student admitted in 2019-20 to B.E. Chemical Engineering (with Practice School) programme at Pilani Campus. The Higher Degree students are assigned ID No. indicating whether the candidate is in PS stream (K1) or in the Dissertation (H1) stream. For example, 2019K103350P refers to a student admitted in 2019-20 to M.E. Computer Science (with Practice School) programme at Pilani Campus.

Programme Codes

First Degree Programmes	
B.E. Chemical	A1
B.E. Civil	A2
B.E. Electrical & Electronics	A3
B.E. Mechanical	A4
B. Pharm.	A5
B.E. Computer Science	A7
B.E. Electronics and Instrumentation	A8
B.E. Biotechnology	A9
B.E. Electronics & Communication	AA
B.E. Manufacturing Engineering	AB
M.Sc. Biological Sciences	B1
M.Sc. Chemistry	B2
M.Sc. Economics	B3
M.Sc. Mathematics	B4
M.Sc. Physics	B5
M.Sc. General Studies	C2
M.Sc. Engineering Technology	C5
M.Sc. Information Systems	C6
M.Sc. Finance	C7
Higher Degree Programmes	
M.E. Biotechnology	29
M.E. Chemical	01
M.E. Chemical with specialization in Petroleum Engineering	32
M.E. Civil with specialization in Structural Engineering	43
M.E. Civil with specialization in Transportation Engineering	30
M.E. Civil with specialization in Infrastructure Engineering & Management	44
M.E. Civil with specialization in Water Resources	11
M.E. Communication Engineering	24
M.E. Computer Science	03

M.E. Design Engineering	41
M.E. Electrical with specialization in Power Electronics & Drives	31
M.E. Embedded Systems	40
M.E. Manufacturing Systems Engineering	42
M.E. Mechanical	06
M.E. Mechanical with specialization in Thermal Engineering	48
M.E. Microelectronics	23
M.E. Sanitation Science, Technology and Management	51
M. Phil.in Liberal Studies	52
M.E. Software Systems	12
M.Pharm.	08
M.Pharm. with specialization in Pharmaceutics	46
M.Pharm. with specialization in Pharmaceutical Chemistry	47
M.B.A.	49
MPH	37

RULES AND REGULATIONS

All students admitted to the Institute will be governed by the Rules and Regulations that are prescribed from time to time.

Anti-Ragging

The Institute has formulated strict anti-ragging guidelines and all students are required to sign an undertaking to abide by these guidelines. Students, if found violating these guidelines are liable to disciplinary action including expulsion from the Institute and also possible legal action as per the directive from the Honourable Supreme Court of India.

The Institute has formed a committee and anti-raging squads at hostel and institute level to combat raging. The students can also communicate directly with the Dean, Students Welfare, through the Institute website.

Information for Candidates for all Work Integrated Learning Programme

Prospective candidates must consult the separate section in the Institute Bulletin. They should note that a separate application form is provided for admission to Work Integrated Learning programmes. It is further to be noted that all rules, regulations will automatically apply in the Work Integrated Learning programmes. Information about these can also be obtained at:

http://www.bits-pilani.ac.in/university/wilp/wilpoverview

INFORMATION FOR CANDIDATES APPLYING FOR BITS PILANI, DUBAI CAMPUS

Admissions to Dubai Campus are made on merit in qualifying examinations. All equivalent international qualifications are considered. A specially appointed committee examines all applicants with foreign qualifications regarding their eligibility for admissions.

For educational process and programmes of studies, refer section II. For candidates admitted from countries other than UAE, student residence visa is facilitated.

APPLICATION PROCEDURE

Application for admission to Dubai Campus should be made in the prescribed form available at: www.bits-pilani.ac.in/dubai. Separate application forms are prescribed for (i) First Degree Programmes (ii) Higher Degree Programmes (iii) Doctoral Programme.

INTEGRATED FIRST DEGREE PROGRAMMES

Admissions are made purely on overall aggregate in the qualifying examination (12th Grade or its equivalent examination), secured by the candidate. Admission is offered based on merit, seats in the preferred discipline and facilities available.

Eligibility for admission

For admission to all integrated first degree programmes, the eligibility requirement is a minimum of 60% overall aggregate* marks in

the qualifying examination and a minimum aggregate of 60% in the Physics, Chemistry and Mathematics subjects with at least 50% marks in each subject in the Senior School Certificate Examination of the Central Board of Secondary Education (CBSE-12th grade), New Delhi, India, or its equivalent from any recognized International, National, or State examination with adequate proficiency in English. However, for admission to B.E Biotechnology, candidates with Physics, Chemistry and Biology will also be accepted with a minimum aggregate of 60% in Physics, Chemistry & Biology subjects with at least 50% marks in each subject.

** Aggregate: Aggregate is the total marks of all subjects in the Qualifying Examination, considered essential by the Board/University for passing the examination. The Aggregate must compulsorily contain the required subjects, namely, Physics, Chemistry and Mathematics.*

The mechanism of admission for Dubai Campus:

Applying for admission:

(i) In order to apply for admission to the Integrated First Degree programmes, the candidate should submit the application in prescribed form. The application form is available at the website: www.bits-dubai.ac.ae/admissionand can be filled online. The printout of the filled form should be sent along with an Admission Application fee of AED 220/- only, complete in all respects, so as to reach Dubai Campus by the due date: 20 June 2019 for First Semester 2019-20 and 10 December 2019 for Second Semester 2019-20:

(ii) The candidate must fill only a single application form for seeking admission to all the degree programmes offered at Dubai Campus.

Preparation of Merit List and Admission process:

(i) The merit list will be prepared on the basis of overall aggregate percentage of marks obtained by the candidates in the Qualifying Examination (12th grade or equivalent), for all eligible candidates, whose application, complete in all respects with 12th marks, preferences and required fees, is received till last date.

(ii) If a candidate with a higher merit position is not able to get any of his/her programme preference due to non-availability of seats in the indicated preferences, such a candidate is kept in Waiting List. For a candidate to secure the seat or remain in the race, it is mandatory to pay the required fees in advance as mentioned in the Admission/Wait list letter.

(iii) Normally a candidate cannot change the preferences once submitted. Candidates are strongly advised to exercise their preferences after careful consideration and give preference for all programmes to better the chances of admission.

(iv) Admission Offer letter is sent to candidates above the cut-off of merit. To accept the offer of admission, candidate must comply with all the requirements specified in the Admission Offer letter including submission of various documents and payment of fee on or before the date mentioned in the Admission Offer letter. If the requirements are not met by the specified due date, the admission offer will be deemed to be cancelled and the seat will be allotted to Wait Listed candidates.

HIGHER DEGREE PROGRAMMES

The Higher Degree Programmes offered at Dubai Campus are uniquely designed and structured to meet the learning aspirations of Engineers, who are employed Executives, Entrepreneurs and Professionals. The admission is based on the performance of the

candidate in the qualifying degree and Admission test.

Admissions to Higher Degree Programmes are done in both the semesters. Candidates interested in applying can fill the application form online or collect the application form from the Admissions Office of Dubai Campus. Deadline for submission of Application form is 10 June 2019 for First Semester 2019-20 and 10 December 2019 for the Second Semester 2019-20.

DOCTORAL PROGRAMME (Ph.D.)

The Doctoral programme is offered in Engineering and allied interdisciplinary areas. A candidate with a higher degree: namely M.E./M.S./M.B.A./ M.Phil. of BITS Pilani or its equivalent from any other recognized university can apply for the doctoral programme.

For admission to the Ph.D. programme, the marks/grades of the candidate in the latest examination as well as the performance in a specially designed admission test and/or interview would be considered.

Admissions to Doctoral Programme are done in both the semesters. Candidates interested in applying for Doctoral Programmes can collect the application form from the Admissions Office or apply online at the website: www.bits-dubai.ac.ae/admission. Deadline for submission of Application form is 30 May 2019 for First Semester 2019-20 and 10 December 2019 for the Second Semester 2019-20.

FLEXIBILITIES FOR FIRST DEGREE PROGRAMMES AT DUBAI CAMPUS

The educational process permits multiple entry points into the programmes and allows several other flexibilities. As in the admission process, the decision for use of flexibilities is guided by the principle of merit, preferences and facilities available.

Practice School, Dual Degree and Transfer

For details, refer to the section on flexibilities in the previous part.

Admission with Advanced Standing

For details, refer to the section on flexibilities in the previous part and the website: www.bits-pilani.ac.in/admission.

Second Semester Admission

The structural flexibilities available in the Institute make it possible to admit students in both the semesters. However, most of the admissions are made during the first semester itself. The second semester admissions provide opportunity to candidates who could not apply in time for the first semester admissions.

The second semester admission students are merged with the students admitted in the first semester. They may be doing courses with the students admitted in the same academic year or in the next academic year. The total normal duration of programme will be eight semesters.

A separate admission notification for second semester admissions will be issued in October 2019.

Other Flexibilities

For details, refer to the section on flexibilities in the previous part

Some Important Instructions

1. The application process, announcement of admission, detailed instructions, etc., will be available at Dubai Campus website. It is the responsibility of the candidate to follow these announcements and instructions.
2. Application forms sent by Fax or Email will not be accepted.
3. The application number allotted to you on submission of application form is unique. Quote this application number in all subsequent correspondence.
4. To accept the offer of admission/accepting to be placed on the waiting list, you are

required to pay fees in advance, as per the instructions mentioned along with the offer.

SELECTION FOR ADMISSION

Candidates are finally admitted to the Dubai Campus of BITS Pilani subject to the following conditions:

1. They have paid the requisite fees as specified in their admission/waiting list letters.
2. They are declared medically fit by a registered medical practitioner and local medical examination, if required.
3. They have submitted all required original marksheets & certificates, with photocopies, and the statements made in their application forms are verified against their originals.
4. They fulfil the eligibility requirements.
5. They have a valid UAE Residence Visa or shall get a UAE residence visa facilitated by the Institute. Any student not having a valid residence visa, at any time during the study, will not be permitted to register.
6. For Integrated first-degree programmes, on the reporting day at Dubai, a Dean/Senior faculty member of the Institute will interact with the candidates.
7. Every admitted student is required to undergo a registration process every semester, on the day announced for the purpose. One of the objectives of the registration process is to name the courses to be pursued during a given semester, after allowing for the student's options within the prescribed rules and regulations. By this process, students make their own Timetable at their own responsibility, to be followed in that semester. No student will be permitted to attend classes or use any of the Dubai Campus facilities without completing the registration process.

Advance fees, Refund and Forfeiture of fees

1. A candidate offered admission/placed on the waiting list will be required to pay all requisite fees in advance.
2. If a candidate is offered admission either directly or from the waiting list but does not join the Institute, then the refund will be based on the following:
   i. If a candidate completes the admission formalities but withdraws before the date of registration, the admission will automatically stand cancelled and 80% of first instalment of first semester tuition fees is refundable.
   ii. If a student withdraws within one week of the date of registration irrespective of whether the student registers or not, 50% of the first instalment of first semester tuition fee will be refundable.
   iii. If a student withdraws after one week of the date of registration irrespective of whether the student registers or not, the entire first instalment of first semester tuition fees paid is non-refundable.
   iv. If the Institute is not able to offer admission to a Waitlisted candidate to any programme of preferences as shown in his application form, the total amount of advance fees will be refunded.
   v. While remitting advance fees no candidate can stipulate any conditions such as changing order of preferences, addition/ deletion of preferences etc. Even if any such conditions are mentioned while remitting fees, they will be ignored.
   vi. Application Fee, Admission Fee and all Visa related fees are non-refundable.

For refund of hostel, transport and other fees, conditions stipulated in the Admission Bulletin will be applicable

SCHEDULE OF FEES

D. The following are the details of the fees payable by all students to be admitted in the academic year 2019-20 at **BITS Pilani, Dubai Campus** (all figures are in AED).

One - Time Fee (Payable at the time of Admission)			
	Integrated First Degree	**Higher Degree**	**Ph.D. Programme**
Application Fee**	220	220	220
Admission Fee*	1,800	1,800	1,800
Activity Fee*	1,200	1,200	1,200
Caution Deposit$	5,000	2,000	2,000
Tuition Fee*			
First Semester (Payable in 2 installments)	22,500	15,500	2,400# (On-Campus)
Second Semester (Payable in 2 installments)	22,500	15,500	3,600 (Part-Time & Off-Campus per semester)
Summer Term (Payable for PS 1 after second year)	5,500	-	
Hostel fee (For Students Availing Hostel)			
First Semester***	15,000		
Second Semester***	15,000		
Summer Term***	5,200		
Hostel Caution Deposit$	2,000		
Facility Fee*	750 per annum		
Laundry charges and services charge for using refrigerator in room are additional			
Visa and Insurance Fee (For Students availing Visa/Insurance)			
Fresh Visa Fee**	2,900		
Visa Renewal Fee**	2,150		
Medical Insurance Fees*	1,800		
Current prevailing Visa and Insurance Fee, subject to change)			
Transport Fees(For day scholars availing Institute Transport)**			
For Dubai	2,000		
For Sharjah & Ajman	2,300		

*VAT of 5% is applicable on this fee
**VAT of 5% is included on this fee
***VAT of 5% will be charged on the food cost of the hostel fee
$ Refundable after adjustment of all dues on graduation or on leaving the institute, after due adjustment for damages, breakages caused by the student, if any.
Fee after providing a fee waiver of 80% of tuition fee for On-Campus scholars and 70% of tuition fee for Part-Time and Off-Campus scholars.

Notes:

1. A fee of AED 3,750+vat per course is applicable for casual students registering for any course on audit only during any semester apart from a one-time admission fee.
2. Visa fee payable annually and is subject to change by Government of U.A.E.
3. If a student is admitted to a second-degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time such admission is made.
4. The fees and other charges are payable in advance in each semester/term on the notified dates before registration. Non-payment of fees and dues may result in semester registration cancellation. No withdrawal from a course or courses will entitle a student for refund of fees.
5. If there are dues outstanding grades will be withheld.
6. Refunds, if any, will be made through Bank Transfers/ Bank drafts.

SCHOLARSHIPS AT DUBAI CAMPUS

A large number of scholarships, fellowships and other financial assistance are available to the students admitted to Dubai Campus. Normally more than 25% of the students receive some form of financial assistance. For continuance of scholarships, scholarship holders are required to maintain good scholastic standing and good conduct.

Some of the scholarships/financial assistance normally available are listed below:

Merit Scholarships for First Degree Students

(a) New Admission students

1. **Board Toppers:** Candidates who have secured the top position in 12th standard in their respective boards (General Secondary Education Certificate Examination of Ministry of Education, UAE or CBSE-India or any other State, National or International Board) are given merit scholarship of 50% of the first year tuition fee. The minimum overall aggregate of the candidate must be a minimum of 90% or equivalent in the qualifying exam to avail the scholarship.

2. **Merit in Qualifying Examination:**

   i) Students who have obtained 95% or above in the aggregate of the Qualifying Examination are given a merit scholarship of 40% of first semester tuition fee.

   ii) Students who have obtained 90% or above but less than 95% in the aggregate of the Qualifying Examination are given a merit scholarship of 25% of first semester tuition fee.

   iii) Students who have obtained 80% or above but less than 90% in the aggregate of the Qualifying Examination are given a merit scholarship of 15% of first semester tuition fee.

3. **Merit in BITSAT:** Students with **BITSAT 2019 (or BITSAT 2018)** score of 200 or above are given merit scholarship of 25% to 75% of tuition fees based on the BITSAT score for one semester in the first year.

4. **Hostel Fee Concession**: Admitted students with 90% or above in the qualifying examination (Grade 12 or equivalent) or BITSAT 2019/2018 score of 150 or above will be offered a 25% concession in the Hostel fee for the normal duration of the programme (four years).

(b) Merit Scholarship for continuing students

All Students with a CGPA of 9.00 or above on a 10.00 point scale at the end of a previous semester are given a merit scholarship of 20% of tuition fee for the current semester.

(c) Other Special Concessions (First Degree Programmes)

1. **Arab Nationals:** Meritorious GCC/Arab Nationals will be offered a scholarship of upto 75% on the tuition fee for the normal duration of the programme based on their performance in the qualifying exam (Grade 12) and continuity of certain minimum performance during the programme. This will be restricted to specific number of students under each of the above mentioned scholarship category.
2. **For Sudden bereavement of earning member of the family:** Such students are helped by waiving off up to 100% tuition fee for that semester followed by up to 75% in the subsequent semesters on a case to case basis.
3. **For Physically Challenged Students:** All physically challenged students satisfying the conditions laid out in the Bulletin are given 15% concession on the tuition fee throughout the programme subject to satisfactory academic performance in each semester.
4. **For Sibling:** For families that have more than one child enrolled concurrently, a concession of 25% on the tuition fee is offered to the second child until the first child graduates.

Scholarships for Higher Degree Programmes

1. **Merit in Qualifying Examination:** Students who have obtained aggregate marks of 75% or above in the Qualifying Examination (B.E./B.Tech.) are given a merit scholarship of 20% of first semester tuition fee.
2. Students who are UAE Nationals will be offered 50% tuition fee scholarship for the normal duration of the programme based on their performance in the qualifying exam and continuity of certain minimum performance during the programme.
3. BITS Alumni, Employees of Collaborative Organizations and Siblings/Parents of continuing students will be offered a 10% concession on the tuition fee, during the normal duration of the programme.
4. **Merit Scholarship for continuing students:** All Students with a CGPA of 9.00 or above on a 10.00 point scale at the end of a previous semester are given a merit scholarship of 20% of tuition fee for the current semester
5. **Hostel Fee Concession:** Higher degree students who have obtained aggregate marks of 80% or above in the Qualifying Examination (B.E./B.Tech) are given a concession of 25% on the hostel fee for the normal duration of the programme.

Scholarships for Ph.D. Programmes

Full-time, on-campus Ph.D. Scholars will be considered for 80% tuition fee waiver and part-time Ph.D. Scholars will be considered for 70% tuition fee waiver for the normal duration of the programme subject to terms and conditions.



PART IV

DETAILS OF PROGRAMMES









Legend

BIO	Biological Sciences
BIOT	Biotechnology
CDP	Courses on Development Process
CE	Civil Engineering
CHE	Chemical
CHEM	Chemistry
CHI	Chinese
CS/Comp/Comp Sc	Computer Science
ECON	Economics
ECE	Electronics and Communication Engineering
EEE	Electrical & Electronics Engineering
EI	Electronics & Instrumentation
ES	Engineering Science
ET	Engineering Technology
Engg	Engineering: Chemical, Civil, Computer Science, Electrical & Electronics, Electronics & Instrumentation, Electronics and Communication, Manufacturing, Mechanical
ENGL	English
Exptl Sc	Experimental Science: Biological Sciences, Chemistry, Physics
FIN	Finance
FRE	French
GER	German
HSS	Humanities and Social Sciences
IS	Information Systems
ITEB	Internet Technology and e-Business
JAP	Japanese
L	Lecture hours per week
MATH	Mathematics
MBA	Master of Business Administration
MECH	Mechanical
MF	Manufacturing Engineering
Min/Max	Indicates minimum/maximum number of units specified in a course or semester programme
MGTS	Management
MGSYS	Management Systems
MM	Manufacturing Management
MPH	Master in Public Health
MST	Material Science and Technology
P	Practical, Seminar & Project, etc. hours per week
PHIL	Philosophy
PHARM	Pharmacy
PHY	Physics
RUS	Russian
SAN	Sanitation Science, Technology and Management
SS	Software Systems
Sc.	Biological Sciences, Chemistry, Economics, Mathematics, Physics
T	Suffixed to a course number indicates that a non-letter grade will be awarded in such a course
TA	Technical Arts
TOC	Technique Oriented Courses
U	Number of units associated to a course

Course descriptions are available at: www.bits -pilani.ac.in/courses/fs_coursedescriptions.html

INTEGRATED FIRST DEGREE PROGRAMMES

(I) Structure of the Integrated First Degree Programmes

The structure and the requirements of the first degree programs, namely, B.E., B. Pharm., and M.Sc., are provided in the following sections.

The structure and the requirements of the first degree programs, namely, B.E. (Hons), B. Pharm (Hons), M.Sc. (Hons), and M.Sc.(Tech) are the same as provided in the following sections although the nomenclature of these programs is indicated without the Hons. / Tech. tag in the rest of the section.

The category-wise structure of each program:

Category	Number of Units Required	Number of Courses Required
(I) General Institutional Requirement		
Humanities Electives	8	3
Science Foundation	12	6
Mathematics Foundation	12	4
Engineering Foundation	6	2
Technical Arts	10	4
General Awareness / Professional Courses	3 to 6	1 to 3
Sub-Total	**51 to 54**	**20 to 22**
(II) Discipline Requirement		
Core	33 to 48	10 to 16
Elective	12 to 27	4 to 9
Sub-Total	57 to 60	15 to 20
(III) Open Electives	15 to 27	5 to 9
Course-work Sub-Total	**129 (min)**	**41 (min)**
(IV) PS-I and II **OR** **Thesis**	25 OR 9 to 16	2 OR 1
Total	**144 (min)**	**42 (min)**

A student should complete the minimum number of courses and units required in each category as well as meet the minimum requirements of courses (42) and units (144) in total.

1. The following courses are needed to meet the General Institutional Requirement:

a) General Biology, Biology Laboratory, General Chemistry, Chemistry Laboratory, Mechanics, Oscillations and Waves, and Physics Laboratory under the head of Science Foundation. For specific programs, General Physics may replace Mechanics, Oscillations and Waves.

b) Electrical Sciences, Thermodynamics and Process Engineering under the head of Engineering Foundation.

c) Computer Programming, Workshop Practice, Engineering Graphics, and Technical Report Writing under the head of Technical Arts.

d) Principles of Economics, or Principles of Management and Environmental Studies* under the head of General Awareness / Professional courses. *[Students completing this course will be awarded a non-letter grade (GOOD or POOR)]

2. The courses under the following heads are designed to meet the General Institutional Requirement under the head of Humanities Electives:
    - Languages and Literature
    - History and Philosophy
    - Political and Social Sciences
    - Fine Arts and Professional Arts
3. A thesis is for 16 units and for a full semester duration. But a student has the option of pursuing a Thesis of 9 units concurrently with coursework over a full semester, in which case the additional coursework would be at least 2 courses of total 6 units to meet the minimum unit requirements.

The nominal semester-wise chart for first degree programs are given in the Pages IV-3-20.

Dual Degree Programs:

Based on the above, the structure of a dual degree program has been derived using the following principles.

- General Institute Requirements will remain the same for both the degrees of the composite dual-degree program and therefore need not be repeated.
- While the Discipline Requirements of each of the two degrees in a dual degree program have to be met separately, any course that meets the discipline requirements of both the degree programs need not be repeated.
- In addition the Discipline Elective courses of either of the two degrees in a dual degree program may be used to fulfill the open elective requirement of the other degree.
- A PS-II or Thesis must be done to meet the requirements of each degree. Therefore to complete the dual degree program a student must complete one of the following:
    - 2 Practice School-II courses
    - 2 Thesis courses
    - 1 Practice School-II course and 1 Thesis course.

A thesis for 9 units with concurrent course work for at most 9 units over a full semester duration is also possible as an option.

Based on these principles, the semester-wise patterns for a composite dual degree program as options for the student are shown in pages IV-21-23. However the charts mentioned on pages IV-24-63 are designed to enable the students to complete the composite dual degrees in their respective programmes in 10 semesters.

Semester-wise Pattern for Students Admitted to B.E. Biotechnology Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Open/Humanities Electives	3(min)			or	or
	BIOT	F211	Biological Chemistry	3	MGTS	F211	Principles of Management	3
	BIOT	F212	Microbiology	4			Open/Humanities Electives	3(min)
	BIOT	F215	Biophysics	3	BIOT	F241	Genetic Engineering Techniques	4
	BIOT	F213	Cell Biology	3	BIOT	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIOT	F245	Introduction to Environmental Biotechnology	3
					BIOT	F244	Instrumental Methods of Analysis	4
				22				**20**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	BIOT	F311	Recombinant DNA Technology	3	BIOT	F342	Immunology	3
					BIOT	F343	Experiments in Biotechnology	3
	BIOT	F314	Industrial Microbiology & Bioprocess Engineering	4	BIOT	F344	Downstream Processing	3
			Discipline Electives	8			Discipline Electives	6
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core - 43 Units (13 Courses)

Discipline Electives - 17 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Chemical Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CHE	F211	Chemical Process Calculations	3	MGTS	F211	Principles of Management	3
							Humanities Electives	3(min)
	CHE	F214	Engineering Chemistry	3	CHE	F241	Heat Transfer	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science & Engineering	3
	BITS	F225	Environmental Studies	3				
					CHE	F244	Separation Processes I	3
				21 (min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	3 to 6
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F313	Separation Processes II	3	CHE	F342	Process Dynamics &	3
	CHE	F311	Kinetics & Reactor Design	3			Control	
	CHE	F314	Process Design Principles I	3	CHE	F343	Process Design	
			Discipline Electives	3			Principles II	3
							Discipline Electives	6
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				11/17				**15/20**

Discipline Core - 45 Units (15 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Civil Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3 (min)			or	or
	CE	F211	Mechanics of Solids	3	MGTS	F211	Principles of Management	3
	CE	F231	Fluid Mechanics	3			Humanities Electives	3 (min)
	CE	F213	Surveying	4	CE	F241	Analysis of Structures	3
	CE	F230	Civil Engineering Materials	4	CE	F242	Construction Planning & Technology	3
					CE	F243	Soil Mechanics	4
					CE	F244	Highway Engineering	4
					BITS	F225	Environmental Studies	3
				20 (min)				**20(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	1 to 4			Open/Humanities	2 to 5
	CE	F320	Design of Reinforced Concrete Structures	3			Electives	
	CE	F312	Hydraulic Engineering	4	CE	F342	Water & Waste Water	4
	CE	F313	Foundation Engineering	3			Treatment	
			Discipline Electives	6	CE	F321	Engineering Hydrology	3
					CE	F343	Design of Steel Structures	3
							Discipline Electives	6
				17/20				**18/21**
IV			Open Electives	8to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				8/14				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. E. Computer Science Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CS	F214	Logic in Computer Science	3	MGTS	F211	Principles of Management	3
	CS	F222	Discrete Structures for Computer Science	3			Humanities Electives	3(min)
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
					CS	F212	Database Systems	4
					BITS	F225	Environmental Studies	3
				20(min)				**21(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	2to5
	CS	F351	Theory of Computation	3				
	CS	F372	Operating Systems	3	CS	F363	Compiler Construction	3
	CS	F301	Principles of Programming Languages	2	CS	F364	Design & Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
			Discipline Electives	3(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	6to12	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				9/15				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electrical & Electronics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	EEE	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	EEE	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacin	4
	EEE	F214	Electronic Devices	3	EEE	F242	Control Systems	3
					EEE	F243	Signals & Systems	3
					EEE	F244	Microelectronic Circuits	3
					BITS	F225	Environmental Studies	3
				20(min)				**22(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	4to6			Open/Humanities Electives	3to6
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or		EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2			Discipline Electives	4(min)
	EEE	F313	Analog & Digital VLSI Design	3				
			Discipline Electives	5(min)				
				18/21				**18/21**
IV			Open Electives	5to11	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15to18
				8/14				**15/20**

Discipline Core - 47 or 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electronics & Communication Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	ECE	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	ECE	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors and	
	ECE	F214	Electronic Devices	3			Interfacing	4
					ECE	F242	Control Systems	3
					ECE	F243	Signals & Systems	3
					ECE	F244	Microelectronic Circuits	3
					BITS	F225	Environmental Studies	3
				20(min)				**22(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F314	Electromagnetic Fields &		ECE	F343	Communication Networks	3
			Microwave Engineering	3	ECE	F344	Information Theory &	
	ECE	F434	Digital Signal Processing	4			Coding	3
			Discipline Electives	4(min)			Discipline Electives	5(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electronics and Instrumentation Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	INSTR	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	INSTR	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F214	Electronic Devices	3	INSTR	F242	Control Systems	3
					INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
					BITS	F225	Environmental Studies	3
				20(min)				**22(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	3to6
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
					INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers & Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			Discipline Electives	4(min)
			Discipline Electives	5(min)				
				18/21				**18/21**
IV			Open Electives	5to11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				8/14				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Mechanical Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	ME	F213	Materials Science & Engineering	2	MGTS	F211	Principles of Management	3
							Humanities Electives	3(min)
	ME	F212	Fluid Mechanics	3	ME	F241	Machine Design & Drawing	4
	ME	F211	Mechanics of Solids	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F243	Production Techniques I	3
	ME	F215	Mechanical Engineering Laboratory	2	ME	F244	Kinematics & Dynamics of Machinery	3
					BITS	F225	Environmental Studies	3
				19(min)				**21(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	1 to 4			Open/Humanities Electives	3 to 6
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers & Fluid	
	ME	F312	Advanced Mechanics of Solids	3			Machines	3
					ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques II	4	ME	F342	Computer Aided Design	4
			Discipline Electives	6(min)	ME	F344	Engineering Optimization	2
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	7to13	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				10/16				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Manufacturing Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			/Humanities Electives	3(min)			or	or
	MF	F213	Materials Science & Engineering	2	MGTS	F211	Principles of Management	3
							Humanities Electives	3(min)
	MF	F212	Fluid Mechanics	3	MF	F241	Machine Design & Drawing	4
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F214	Applied Thermodynamics	3	MF	F243	Manufacturing Processes	3
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinematics & Dynamics of Machinery	3
					BITS	F225	Environmental Studies	3
				19(min)				**21(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	2 to 5
	MF	F311	Mechatronics & Automation	3	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F313	Metal Forming & Machining	4	MF	F342	Computer Aided Design	4
			Discipline Electives	6(min)	MF	F344	Engineering Optimization	2
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	7 to 13	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to18
				10/16				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. Pharm. Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	PHA	F211	Pharmaceutical Analysis	3	MGTS	F211	Principles of Management	3
	PHA	F214	Anatomy, Physiology & Hygiene	3			Humanities Electives	3(min)
					PHA	F241	Pharmaceutical Chemistry	3
	PHA	F212	Dispensing Pharmacy	3	PHA	F242	Biological Chemistry	3
	PHA	F213	Microbiology	3	PHA	F243	Industrial Pharmacy	3
	BITS	F225	Environmental Studies	3	PHA	F244	Physical Pharmacy	3
				21(min)				**18(min)**
Summer			**BITS F221 Practice School – I**		**(for PS Option Only)**			
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	4 to 6
	PHA	F311	Pharmacology I	3	PHA	F341	Pharmacology II	3
	PHA	F312	Medicinal Chemistry I	3	PHA	F342	Medicinal Chemistry II	3
	PHA	F313	Instrumental Methods of Analysis	4	PHA	F343	Forensic Pharmacy	2
	PHA	F314	Pharmaceutical Formulations & Biopharmaceutics	3	PHA	F344	Natural Drugs	3
			Discipline Electives	3(min)			Discipline Electives	3(min)
				18/21				**18/20**
IV			Open Electives	6 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				12/17				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted during 2011-2013 as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. Pharm. Programme						
Year	**First Semester**		**U**	**Second Semester**		**U**
I	BIO F110	Biology Laboratory	1	BITS F114	General Mathematics II*	3
	BIO F111	General Biology	3	OR		
	CHEM F110	Chemistry Laboratory	1	MATH F112	Mathematics II	
	CHEM F111	General Chemistry	3	ME F110	Workshop Practice	2
	BITS F113	General Mathematics I*	3	CS F111	Computer Programming	4
	OR			PHA F214	Anatomy, Physiology, & Hygiene	3
	MATH F111	Mathematics I				
	PHY F110	Physics Laboratory	1	PHA F212	Dispensing Pharmacy	3
	PHY F112	General Physics	3	BITS F112	Technical Report Writing	2
	OR			MGTS F211	Principles of Management	
	PHY F111	Mechanics, Oscillations and Waves		OR		3
				ECON F211	Principles of Economics	
	BITS F110	Engineering Graphics	2			
			17			**20**
II	Humanities Electives		3	Humanities Electives		3
	BITS F218	General Mathematics III*	3	BITS F111	Thermodynamics	3
	OR			PHA F241	Pharmaceutical Chemistry	3
	MATH F211	Mathematics III		MATH F113	Probability and Statistics	3
	PHA F211	Pharmaceutical Analysis	3	PHA F215	Introduction to Molecular Biology and Immunology	3
	BITS F219	Process Engineering	3			
	PHA F242	Biological Chemistry	3	PHA F244	Physical Pharmacy	3
	PHA F213	Microbiology	3			
	BITS F225	Environmental Studies	3			
			21			**18**
Summer	**BITS F221 Practice School I (5 Units) Only for PS Option**					
III	Open/Humanities Electives		2 to 5	Open/Humanities electives		4 to 6
	PHA F311	Pharmacology I	3	PHA F341	Pharmacology II	3
	PHA F312	Medicinal Chemistry I	3	PHA F342	Medicinal Chemistry II	3
	PHA F313	Instrumental Methods of Analysis	4	PHA F343	Forensic Pharmacy	2
				PHA F344	Natural Drugs	3
	PHA F314	Pharm. Formulations & Biopharmaceutics	3	Discipline Electives		3(min)
	Discipline Electives		3 (min)			
			18 /21			**18 /20**
IV	Open electives		6 to 11	BITS F412 Practice School II		20
	Discipline Electives		6 (min)	OR		
				BITS F421T Thesis (16) or Thesis (9) and Electives (6 to 9)		16 or 15 to 18
			12/17			**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

* A student must pursue all three courses in one sequence only (i.e. either Mathematics I, Mathematics II, and Mathematics III, or General Mathematics, General Mathematics II, and General Mathematics III).

Note: This is operative pattern for the students who are admitted from August 2014 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Biological Sciences Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	BIO	F211	Biological Chemistry	3	MGTS	F211	Principles of Management	3
	BIO	F213	Cell Biology	3			Humanities Electives	3(min)
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental	
	BIO	F214	Integrated Biology	3			Science	3
	BITS	F225	Environmental Studies	3	BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
				22(min)				**19(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	0 to 3
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
					BIO	F342	Immunology	3
	BIO	F312	Plant Physiology	3	BIO	F215	Biophysics	3
	BIO	F313	Animal Physiology	3			Discipline Electives	9(min)
			Discipline Electives	6(min)				
				18/21				**18/21**
IV			Open Electives	8 to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				8/14				**15/20**

*****Discipline Core - 44 Units (14 Courses)

*Discipline Electives - 15 Units (min)-(4 Courses (min))

Note: *This is operative pattern for the students who are admitted from August 2013 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Chemistry Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CHEM	F211	Physical Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F212	Organic Chemistry I	3			Humanities Electives	3(min)
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	
	PHY	F212	Electromagnetic Theory I	3	CHEM	F242	Chemical Experimentation I	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F243	Organic Chemistry II	3
					CHEM	F244	Physical Chemistry III	3
					BITS	F225	Environmental Studies	3
				21(min)				**21(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	2 to 5
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
			Discipline Electives	6(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	7 to13	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				7/13				**15/20**

Discipline Core - 47 Units (15 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Sc. Economics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
			Humanities Electives	3(min)			Humanities Electives	3(min)
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
	BITS	F225	Environmental Studies	3				
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
			Discipline Electives	6(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				11/17				**15/20**

Discipline Core - 42 Units (14 Courses)

Discipline Electives - 18 Units (6 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Mathematics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	MATH	F212	Optimization	3	MGTS	F211	Principles of Management	3
	MATH	F213	Discrete Mathematics	3			Humanities Electives	3(min)
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
	BITS	F225	Environmental Studies	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
				21(min)				**18(min)**
Summer			**BITS F221 Practice School – I (for PS Option Only)**					
III			Open/Humanities Electives	3 to 6			Open/Humanities	
	MATH	F311	Introduction to Topology	3			Electives	0 to 3
	MATH	F312	Ordinary Differential		MATH	F341	Introduction to Functional	
			Equations	3			Analysis	3
	MATH	F313	Numerical Analysis	3	MATH	F342	Differential Geometry	3
			Discipline Electives	6	MATH	F343	Partial Differential Equations	3
							Discipline Electives	9
				18/21				**18/21**
IV			Open Electives	8 to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to18
				8/14				**15/20**

Discipline Core - 42 Units (14 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Sc. Physics Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	PHY	F211	Classical Mechanics	4	MGTS	F211	Principles of Management	3
	PHY	F212	Electromagnetic Theory I	3			Humanities Electives	3(min)
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
					PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
			Discipline Electives	6(min)	PHY	F344	Advanced Physics Laboratory	3
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				11/17				**15/20**

*****Discipline Core - 45 Units (15 Courses)

*Discipline Electives - 15 Units (min)-4 Courses (min)

Note: *This is operative pattern for the students who are admitted from August 2014 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. General Studies – Communication & Media Studies Stream								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	GS	F221	Business Communication	3	MGTS	F211	Principles of Management	3
	GS	F222	Language Lab Practice	3			Humanities Electives	3(min)
	GS	F223	Introduction to Mass Communication	3	GS	F244	Reporting & Writing for Media	3
	GS	F224	Print & Audio Visual Advertising	3	GS	F241	Creative Writing	3
					GS	F245	Effective Public Speaking	3
	BITS	F225	Environmental Studies	3	GS	F243	Current Affairs	3
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	GS	F321	Mass Media Content & Design	3	GS	F342	Computer Mediated Communication	3
	GS	F322	Critical Analysis of Literature & Cinema	3	GS	F343	Short Film & Video Production	3
			Discipline Electives	9(min)			Discipline Electives	9(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				8/14				**15/20**

Discipline Core - 36 Units (12 Courses)

Discipline Electives - 21 Units (7 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. General Studies – Developmental Studies Stream								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
			Humanities Electives	3(min)			Humanities Electives	3(min)
	GS	F211	Modern Political Concepts	3	GS	F231	Dynamics of Social	
	GS	F212	Environment, Development				Change	3
			& Climate Change	3	GS	F232	Introductory Psychology	3
	GS	F213	Development Theories	3	GS	F233	Public Policy	3
	ECON	F211	Principles of Economics	3	GS	F234	Development Economics	3
	BITS	F225	Environmental Studies	3				
				21(min)				18(min)
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities	
	GS	F311	Introduction to Conflict				Electives	0 to 3
			Management	3	GS	F331	Techniques in Social	
	GS	F312	Applied Philosophy	3			Research	3
			Discipline Electives	9(min)	GS	F332	Contemporary India	3
					GS	F333	Public Administration	3
					GS	F334	Global Business Technology & Knowledge Sharing	3
							Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	8 to 14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core - 42 Units (14 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 1 Semester-wise Pattern for Composite Dual Degree Programmes (Option A: Duration 10 Sem.)							
Year	**First Semester**			**U**	**Second Semester**		**U**
I	BIO F110		Biology laboratory	1	MATH F112	Mathematics II	3
	BIO F111		General Biology	3	ME F110	Workshop Practice	2
	CHEM F110		Chemistry Laboratory	1	CS F111	Computer Programming	4
	CHEM F111		General Chemistry	3	EEE F111	Electrical Sciences	3
	MATH F111		Mathematics I	3	BITS F112	Technical Report Writing	2
	PHY F110		Physics Laboratory	1	MATH F113	Probability and Statistics	3
	PHY F111		Mechanics, Oscillations		BITS F111	Thermodynamics	3
	BITS F110		and Waves	3			
			Engineering Graphics	2			
				17			**20**
II	MATH F211		Mathematics III	3	ECON F211	Principles of Economics	3
			First Discipline Core			or	
			Courses	13 to 17	MGTS F211	Principles of Management	
			Electives	3 to 6		First Discipline Core	
						Courses	13 to 17
						Electives	3 to 6
				23/24			**23/24**
Summer	**BITS F221 Practice School – I (for PS Option Only)**						
III			Second Discipline Core			Second Discipline Core	
			courses	12 to 16		Courses	12 to 16
			First Discipline Courses-Core/Elective	7 to 11		First Discipline Courses – Core / Elective	7 to 11
				23/24			**23/24**
IV			First Discipline Elective Courses	3 to 10		First Discipline Elective Courses	3to10
			Second Discipline Courses – Core + Elective	14 to 18		Second Discipline Courses - Core + Elective	14 to 18
						Electives (0 to 6)	0 to 6
				23/24			**23/24**
V			Electives	5 to 9	BITS F412	Practice School-II	20
	BITS F423T		Thesis	9		or	or
					BITS F421T	Thesis	16

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 2			**Semester-wise Pattern for Composite Dual Degree Programmes (Option B: Duration 10 Sem. and a Summer Term)**						
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	4
	BITS	F110	Engineering Graphics(2)	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	
							or	
			First Discipline Core Courses	13 to 17	MGTS	F211	Principles of Management	3
			Electives	3 to 6			First Discipline Core Courses	13 to 17
							Electives	3 to 6
				23/24				**23/24**
Summer			**BITS F221 Practice School – I (for PS Option Only)**						
III			Second Discipline Core Courses	12 to 16			Second Discipline Core Courses	12 to 16
			First Discipline Courses - Core / Elective	7 to 11			First Discipline Courses - Core / Elective	7 to 11
				23/24				**23/24**
IV			First Discipline Elective Courses	3/10			First Discipline Elective Courses	3 to 10
			Second Discipline Courses – Core + Elective	14 to 18			Second Discipline Courses - Core + Elective	14 to 18
			Electives	0 to 6			Electives	0 to 6
				23/24				**23/24**
Summer			Electives	5/9				
V	BITS	F412	Practice School - II	20	BITS	F413	Practice School - II	20
			or	or			or	or
	BITS	F421 T	Thesis	16	BITS	F422	Thesis	16

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 3	Semesterwise Pattern for Dual Degree (Duration 11 Sem.)					
Year	**First Semester**		**U**	**Second Semester**		**U**
I	BIO F110	Biology laboratory	1	MATH F112	Mathematics II	3
	BIO F111	General Biology	3	ME F110	Workshop Practice	2
	CHEM F110	Chemistry Laboratory	1	CS F111	Computer Programming	4
	CHEM F111	General Chemistry	3	EEE F111	Electrical Sciences	3
	MATH F111	Mathematics I	3	BITS F112	Technical Report Writing	2
	PHY F110	Physics Laboratory	1	MATH F113	Probability and Statistics	3
	PHY F111	Mechanics, Oscillations and Waves	3	BITS F111	Thermodynamics	3
	BITS F110	Engineering Graphics	2			
			17			**20**
II	MATH F211	Mathematics III	3	ECON F211	Principles of Economics	13
		First Discipline Core Courses	13 to 17		or	
				MGTS F211	Principles of Management	
		Electives	3 to 6		First Discipline Core Courses	13 to 17
					Electives	3 to 6
			21/22			**21/22**
Summer	**BITS F221 Practice School – I (for PS Option Only)**					
III		Second Discipline Core courses	12 to 16		Second Discipline Core	
		First Discipline Courses -			Courses	12 to 16
		Core/Elective	7 to 10		First Discipline Courses – Core / Elective	7to11
			21/22			**21/22**
IV		First Discipline Elective Courses	3 to 10		First Discipline Elective Courses	3 to10
		Second Discipline Courses – Core+Elective	14 to 18		Second Discipline Courses - Core + Elective	14 to 18
		Electives	0 to 6		Electives	0 to 6
			21/22			**21/22**
V		Electives	17 to 23	BITS F412	Practice School-II	20
					or	or
				BITS F421T	Thesis	16
VI	BITS F413	Practice School-II	20			
		or	or			
	BITS F422T	Thesis	16			

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Biological Sciences with B.E. Chemical)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics/	3
	BIO	F211	Biological Chemistry	3			Principles of Management	
	BIO	F213	Cell Biology	3	BIO	F241	Ecology & Environmental	
	BIO	F212	Microbiology	4			Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to	
			Humanities Elective	3			Bioinformatics	3
	BITS	F225	Environmental Studies	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of	
							Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
	First Semester			**U**	**Second Semester**			**U**
III	BIO	F311	Recombinant DNA	3	BIO	F341	Developmental Biology	3
			Technology		BIO	F342	Immunology	3
	BIO	F312	Plant Physiology	3	BIO	F215	Biophysics	3
	BIO	F313	Animal Physiology	3	CHE	F241	Heat Transfer	3
	CHE	F211	Chemical Process Calculations	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science &	
	CHE	F214	Engineering Chemistry	3			Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				21				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering		CHE	F342	Process Dynamics & Control	3
			Laboratory I	3	CHE	F343	Process Design Principles II	3
	CHE	F313	Separation Processes II	3			First Discipline Electives	9
	CHE	F314	Process Design Principles I	3			Second Discipline Electives	6
			First Discipline Electives	6				
			Second Discipline Electives	3				
				21				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412		Practice School - Ii	20
	BITS F423T		Thesis	9				
				15				**20**

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Civil)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F231	Fluid Mechanics	3	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials	4	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				23				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	F320	Design of Reinforced Concrete Structures	3	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F321	Engineering Hydrology	**3**
	CE	F313	Foundation Engineering	3	CE	F343	Design of Steel Structures	3
			First Discipline Electives	6			First Discipline Electives	9
			Second Discipline Electives	6			Second Discipline Electives	3
				22				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Biological Sciences with B.E. Computer Science)

Year	First Semester	U	Second Semester	U
I	Same as First degree Programme		Same as First degree Programme	
II	**First Semester**	**U**	**Second Semester**	**U**
	MATH F211 Mathematics III	3	ECON F211 Principles of Economics	
	BIO F211 Biological Chemistry	3	or	
	BIO F213 Cell Biology	3	MGTS F211 Principles of Management	3
	BIO F212 Microbiology	4	BIO F241 Ecology & Environmental Science	3
	BIO F214 Integrated Biology	3	BIO F242 Introduction to Bioinformatics	3
			BIO F243 Genetics	3
	Humanities Elective	3	BIO F244 Instrumental Methods of Analysis	4
	BITS F225 Environmental Studies	3	Humanities Electives	5
		22		**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**			
III	**First Semester**	**U**	**Second Semester**	**U**
	BIO F311 Recombinant DNA Technology	3	BIO F341 Developmental Biology	3
	BIO F312 Plant Physiology	3	BIO F342 Immunology	3
	BIO F313 Animal Physiology	3	BIO F215 Biophysics	3
	CS F215 Digital Design	4	CS F241 Microprocessors & Interfacing	4
	CS F214 Logic in Computer Science	3	CS F212 Database Systems	4
	CS F222 Discrete Structures for Computer Science	3	CS F211 Data Structures & Algorithms	4
	CS F213 Object Oriented Programming	4		
		23		**21**
IV	**First Semester**	**U**	**Second Semester**	**U**
	CS F351 Theory of Computation	3	CS F363 Compiler Construction	3
	CS F372 Operating Systems	3	CS F364 Design and Analysis of Algorithms	3
	CS F342 Computer Architecture	4	CS F303 Computer Networks	4
	CS F301 Principles of Programming Languages	2	First Discipline Elective	9
	First Discipline Electives	6	Second Discipline Electives	3
	Second Discipline Electives	3		
		21		**22**
V	**First Semester**	**U**	**Second Semester**	**U**
	Second Discipline Electives	6	BITS F412 Practice School - II	20
	BITS F423T Thesis	9		

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electrical & Electronics)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	`5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	EEE	F212	Electromagnetic Theory	3	EEE	F243	Signals and Systems	3
	EEE	F211	Electrical Machines	4	EEE	F244	Microelectronic Circuits	3
	EEE	F214	Electronic Devices	3	EEE	F241	Microprocessors & Interfacing	4
	EE	F215	Digital Design	4	EEE	F242	Control Systems	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or	or	EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2			First Discipline Electives	6
	EEE	F313	Analog & Digital VLSI Design	3			Second Discipline Elective	4
			First Discipline Electives	3				
			Second Discipline Electives	8				
				20/21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electronics & Communication)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
			Humanities Elective	3	BIO	F244	Instrumentation of Analysis	4
	BITS	F225	Environmental Studies	3			Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	3			First Discipline Elective	6
			Second Discipline Electives	7			Second Discipline Electives	5
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments &		INSTR	F341	Analog Electronics	4
			Instrumentation Technology	4	INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	9			Second Discipline Electives	4
			Second Discipline Electives	3				
				22				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			5	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	MF	F212	Fluid Mechanics	3	MF	F243	Manufacturing Processes	3
	MF	F214	Applied Thermodynamics	3	MF	F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinetics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2				
				22				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF	F342	Computer Aided Design	4
			First Discipline Electives	9	MF	F344	Engineering Optimization	2
			Second Discipline Elective	3			First Discipline Electives	6
							Second Discipline Elective	3
				22				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Biological Sciences with B.E. Mechanical)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
	BITS	F225	Environmental Studies	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				22				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				22				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques- II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	9	ME	F344	Engineering Optimization	2
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	3
				23				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Chemical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
					CHEM	F342	Organic Chemistry IV	3
	CHEM	F311	Organic Chemistry III	3	CHEM	F343	Inorganic Chemistry III	3
	CHEM	F312	Physical Chemistry IV	3	CHE	F241	Heat Transfer	3
	CHE	F211	Chemical Process Calculations	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				19				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3				
	CHE	F313	Separation Processes II	3	CHE	F342	Process Dynamics & Control	3
	CHE	F314	Process Design Principles I	3	CHE	F343	Process Design Principles II	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	3			Second Discipline Electives	6
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS	F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Civil)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	**F231**	**Fluid Mechanics**	**3**	CE	F242	Construction Planning & Technology	3
	CE	**F230**	**Civil Engineering Materials**	**4**	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				24				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	**F320**	**Design of Reinforced Concrete Structures**	**3**	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	**CE**	**F321**	**Engineering Hydrology**	**3**
	CE	F313	Foundation Engineering	3				
			First Discipline Electives	6	CE	F343	Design of Steel Structures	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	6
				19				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Chemistry with B.E. Computer Science)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
III	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures For Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				24				**22**
	First Semester			**U**	**Second Semester**			**U**
	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of	
	CS	F342	Computer Architecture	4			Algorithms	3
IV	CS	F301	Principles of		CS	F303	Computer Networks	4
			Programming Languages	2			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**19**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Electrical & Electronics)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3		F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
					CHEM		Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
III	EEE	F211	Electrical Machines	4	EEE	F243	Signals and Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
					EEE	F242	Control Systems	3
				21				**23**
	First Semester			**U**	**Second Semester**			**U**
	EEE	F311	Communication	4	EEE	F341	Analog Electronics	4
			Systems		EEE	F342	Power Electronics	4
	MATH	F212	Optimization	3	EEE	F312	Power Systems	3
			or				First Discipline Elective	6
IV	ME	F344	Engineering Optimization	2			Second Discipline Elective	4
	EEE	F313	Analog & Digital VLSI Design	3				
			First Discipline Electives	6				
			Second Discipline Electives	5				
				20/21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
M.Sc. Chemistry with B.E. Electronics & Communication

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors &	
	ECE	F211	Electrical Machines	4			Interfacing	4
	ECE	F214	Electronic Devices	3	ECE	F242	Control Systems	3
					ECE	F243	Signals and Systems	3
					ECE	F244	Microelectronic Circuits	3
				21				**23**
	First Semester			**U**	**Second Semester**			**U**
IV	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	4			Second Discipline Electives	5
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Electronics & Instrumentation)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3	MGTS	F211	or	
	CHEM	F212	Organic Chemistry I	3			Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F211	Electrical Machines	4	INSTR	F242	Control Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
				21				**23**
	First Semester			**U**	**Second Semester**			**U**
IV	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
					INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	4
			Second Discipline Electives	5				
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Manufacturing)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
II	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	MF	F212	Fluid Mechanics	3	MF	F243	Manufacturing Processes	3
III	MF	F214	Applied Thermodynamics	3	MF	F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinematics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2				
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
					MF	F343	Casting & Welding	4
IV	MF	F312	Tool & Fixture Design	3	MF	F342	Computer Aided Design	4
	MF	F311	Mechatronics & Automation	3	MF	F344	Engineering Optimization	2
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Elective	6			Second Discipline Elective	3
				22				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Chemistry with B.E. Mechanical)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid	
	ME	F312	Advanced Mechanics of Solids	3			Machines	3
	ME	F313	Production Techniques-II	4	ME	F343	Mechanical Vibrations	3
			First Discipline Electives	6	ME	F342	Computer Aided Design	4
			Second Discipline Electives	3	ME	F344	Engineering Optimization	2
							First Discipline Electives	6
							Second Discipline Electives	3
				20				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Economics with B.E. Chemical)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
			First Discipline Elective	3			First Discipline Elective	3
	CHE	F211	Chemical Process Calculations	3	CHE	F241	Heat Transfer	3
	CHE	F212	Fluid Mechanics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F214	Engineering Chemistry	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				24				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Civil)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
					BITS	F225	Environmental Studies	3
				21				**23**
Summer				**BITS F221 Practice School -1(for PS Option Only)**				
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F231	Fluid Mechanics	**3**	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials	**4**	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				24				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	CE	F320	Design of Reinforced Concrete Structures	**3**	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F321	Engineering Hydrology	**3**
	CE	F313	Foundation Engineering	3				
			First Discipline Electives	6	CE	F343	Design of Steel Structures	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	6
				19				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Computer Science)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures for Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				23				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	6				
				24				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Electrical & Electronics)							
Year	**First Semester**			**U**	**Second Semester**		**U**
I	**Same as First degree Programme**				**Same as First degree Programme**		
	First Semester			**U**	**Second Semester**		**U**
II	MATH F211		Mathematics III	3	MGTS F211	Principles of Management	3
	ECON F211		Principles of Economics	3	ECON F241	Econometric Methods	3
	ECON F212		Fundamentals of Finance & Accounts	3	ECON F242	Microeconomics	3
	ECON F213		Mathematical & Statistical Methods	3	ECON F243	Macroeconomics	3
	ECON F214		Economic Environment of Business	3	ECON F244	Economics of Growth & Development	3
			Humanities Electives	3		Humanities Electives	5
	BITS F225		Environmental Studies	3			
				21			**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**						
	First Semester			**U**	**Second Semester**		**U**
III	ECON F311		International Economics	3	ECON F341	Public Finance Theory & Policy	3
	ECON F312		Money Banking & Financial Markets	3	ECON F342	Applied Econometrics	3
	ECON F313		Issues in Economic Development	3	ECON F343	Economic Analysis of Public Policy	3
	EEE F212		Electromagnetic Theory	3	EEE F243	Signals and Systems	3
	EEE F211		Electrical Machines	4	EEE F244	Microelectronic Circuits	3
	EEE F214		Electronic Devices	3	EEE F241	Microprocessors & Interfacing	4
	EEE F215		Digital Design	4	EEE F242	Control Systems	3
				23			**22**
	First Semester			**U**	**Second Semester**		**U**
IV	EEE F311		Communication Systems	4	EEE F341	Analog Electronics	4
	MATH F212		Optimization	3	EEE F342	Power Electronics	4
			or		EEE F312	Power Systems	3
	ME F344		Engineering Optimization	2		First Discipline Electives	6
	EEE F313		Analog & Digital VLSI Design	3		Second Discipline Elective	4
			First Discipline Electives	6			
			Second Discipline Electives	8			
				23/24			**21**
	First Semester			**U**	**Second Semester**		**U**
V	First Discipline Electives			6	BITS F412 Practice School - II		20
	BTS F423T		Thesis	9			

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Electronics & Communication)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	7			Second Discipline Electives	5
				24				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	8			Second Discipline Electives	4
				24				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	MF	F212	Fluid Mechanics	3	MF	F243	Manufacturing Processes	3
	MF	F214	Applied Thermodynamics	3	MF	F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinetics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2			First Discipline Elective	3
				22				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF	F342	Computer Aided Design	4
			First Discipline Electives	6	MF	F344	Engineering Optimization	2
			Second Discipline Electives	6			First Discipline Elective	3
							Second Discipline Electives	6
				22				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Mechanical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
					ECON	F243	Macroeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F244	Economics of Growth & Development	3
	ECON	F214	Economic Environment of Business	3			Humanities Electives	5
			Humanities Electives	3				
	BITS	F225	Environmental Studies	3				
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				22				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques- II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	6	ME	F344	Engineering Optimization	2
			Second Discipline Electives	6			First Discipline Electives	6
							Second Discipline Electives	6
				23				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412		Practice School - II	20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Mathematics with B.E. Chemical)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CHE	F211	Chemical Process Calculations	3	CHE	F241	Heat Transfer	3
	CHE	F212	Fluid Mechanics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F214	Engineering Chemistry	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				21				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Civil Engineering)							
Year	**First Semester**			**U**	**Second Semester**		**U**
I	**Same as First degree Programme**				**Same as First degree Programme**		
II	**First Semester**			**U**	**Second Semester**		**U**
	MATH F211		Mathematics III	3	ECON F211	Principles of Economics	3
	MATH F212		Optimization	3		or	
	MATH F213		Discrete Mathematics	3	MGTS F211	Principles of Management	3
	MATH F214		Elementary Real Analysis	3	MATH F241	Mathematical Methods	3
	MATH F215		Algebra I	3	MATH F242	Operations Research	3
			Humanities Elective	3	MATH F243	Graphs & Networks	3
	BITS F225		Environmental Studies	3	MATH F244	Measure & Integration	3
						Humanities Electives	5
				21			**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**						
III	**First Semester**			**U**	**Second Semester**		**U**
	MATH F311		Introduction to Topology	3	MATH F341	Introduction to Functional Analysis	3
	MATH F312		Ordinary Differential Equations	3	MATH F342	Differential Geometry	3
	MATH F313		Numerical Analysis	3	MATH F343	Partial Differential Equations	3
	CE F211		Mechanics of Solids	3	CE F241	Analysis of structures	3
	CE F231		Fluid Mechanics	**3**	CE F242	Construction Planning & Technology	3
	CE F230		Civil Engineering Materials	**4**	CE F243	Soil Mechanics	4
	CE F213		Surveying	4	CE F244	Highway Engineering	4
				23			**23**
IV	**First Semester**			**U**	**Second Semester**		**U**
	CE F320		Design of Reinforced Concrete Structures	**3**	CE F342	Water & Waste Water Treatment	4
	CE F312		Hydraulic Engineering	4	CE F321	Engineering Hydrology	**3**
	CE F313		Foundation Engineering	3	CE F343	Design of Steel Structures	3
			First Discipline Electives	6		First Discipline Electives	9
			Second Discipline Electives	3		Second Discipline Electives	3
				19			**22**
V	**First Semester**			**U**	**Second Semester**		**U**
	Second Discipline Electives			6	BITS F412 Practice School - II		20
	BTS F423T		Thesis	9			

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
				20				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			Fist Discipline Elective	6
			First Discipline Electives	3			Second Discipline Electives	6
			Second Discipline Electives	6				
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electrical & Electronics)							
Year	**First Semester**		**U**	**Second Semester**			**U**
I	**Same as First degree Programme**			**Same as First degree Programme**			
	First Semester		**U**	**Second Semester**			**U**
	MATH F211	Mathematics III	3	ECON F211	Principles of Economics		3
	MATH F212	Optimization	3		or		
	MATH F213	Discrete Mathematics	3	MGTS F211	Principles of Management		3
	MATH F214	Elementary Real Analysis	3	MATH F241	Mathematical Methods		3
II	MATH F215	Algebra I	3	MATH F242	Operations Research		3
				MATH F243	Graphs & Networks		3
		Humanities Elective	3	MATH F244	Measure & Integration		3
	BITS F225	Environmental Studies	3				
					Humanities Electives		5
			21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**						
	First Semester		**U**	**Second Semester**			**U**
	MATH F311	Introduction to Topology	3	MATH F341	Introduction to Functional		
	MATH F312	Ordinary Differential Equations	3		Analysis		3
	MATH F313	Numerical Analysis	3	MATH F342	Differential Geometry		3
	EEE F212	Electromagnetic Theory	3	MATH F343	Partial Differential Equations		3
III	EEE F211	Electrical Machines	4	EEE F243	Signals and Systems		3
	EEE F214	Electronic Devices	3	EEE F244	Microelectronic Circuits		3
	EEE F215	Digital Design	4	EEE F241	Microprocessors &		
					Interfacing		4
				EEE F242	Control Systems		3
			23				**22**
	First Semester		**U**	**Second Semester**			**U**
	EEE F311	Communication Systems	4	EEE F341	Analog Electronics		4
	EEE F313	Analog & Digital VLSI Design	3	EEE F342	Power Electronics		4
				EEE F312	Power Systems		3
IV		First Discipline Electives	6		Fist Discipline Elective		6
		Second Discipline Electives	8		Second Discipline Elective		4
			21				**21**
	First Semester		**U**	**Second Semester**			**U**
V	First Discipline Electives		3	BITS F412 Practice School - II			20
	BTS F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electronics & Communication)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
					MATH	F243	Graphs & Networks	3
			Humanities Elective	3	MATH	F244	Measure & Integration	3
	BITS	F225	Environmental Studies	3			Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	3			First Discipline Electives	6
			Second Discipline Electives	7			Second Discipline Electives	5
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Mathematics with B.E. Electronics & Instrumentation)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	3			Fist Discipline Elective	6
			Second Discipline Electives	8			Second Discipline Electives	4
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Manufacturing)							
Year	**First Semester**			**U**	**Second Semester**		**U**
I	**Same as First degree Programme**				**Same as First degree Programme**		
	First Semester			**U**	**Second Semester**		**U**
II	MATH F211		Mathematics III	3	ECON F211	Principles of Economics	3
	MATH F212		Optimization	3		or	
	MATH F213		Discrete Mathematics	3	MGTS F211	Principles of Management	3
	MATH F214		Elementary Real Analysis	3	MATH F241	Mathematical Methods	3
	MATH F215		Algebra I	3	MATH F242	Operations Research	3
			Humanities Elective	3	MATH F243	Graphs & Networks	3
	BITS F225		Environmental Studies	3	MATH F244	Measure & Integration	3
						Humanities Electives	5
				21			**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**						
	First Semester			**U**	**Second Semester**		**U**
III	MATH F311		Introduction to Topology	3	MATH F341	Introduction to Functional Analysis	3
	MATH F312		Ordinary Differential Equations	3	MATH F342	Differential Geometry	3
	MATH F313		Numerical Analysis	3	MATH F343	Partial Differential Equations	3
	MF	F212	Fluid Mechanics	3	MF F243	Manufacturing Processes	3
	MF	F214	Applied Thermodynamics	3	MF F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF F244	Kinematics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2			
				22			**21**
	First Semester			**U**	**Second Semester**		**U**
IV	MF	F313	Metal Forming & Machining	4	MF F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF F342	Computer Aided Design	4
			First Discipline Electives	6		First Discipline Electives	3
			Second Discipline Elective	6		Second Discipline Elective	6
				22			**20**
V	**First Semester**			**U**	**Second Semester**		**U**
	First Discipline Electives			6	BITS F412 Practice School - II		20
	BTS F423T		Thesis	9			

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Mechanical)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
	BITS	F225	Environmental Studies	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				22				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques-II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	6			First Discipline Electives	9
			Second Discipline Electives	3			Second Discipline Electives	3
				20				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Physics with B.E. Chemical)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CHE	F211	Chemical Process Calculations	3	PHY	F344	Advanced Physics Laboratory	3
	CHE	F212	Fluid Mechanics	3	CHE	F241	Heat Transfer	3
	CHE	F214	Engineering Chemistry	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F243	Material Science & Engineering	3
					CHE	F244	Separation Processes I	3
				21				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Civil)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F231	Fluid Mechanics	**3**	CE	F242	Construction Planning & Technology	3
	CE	F230	Civil Engineering Materials	**4**	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				23				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	**F320**	**Design of Reinforced Concrete Structures**	**3**	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	**CE**	**F321**	**Engineering Hydrology**	**3**
	CE	F313	Foundation Engineering	3				
			First Discipline Electives	9	CE	F343	Design of Steel Structures	3
			Second Discipline Electives	3	PHY	F344	Advanced Physics Laboratory	3
							First Discipline Electives	6
							Second Discipline Electives	3
				22				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from **August 2017** onwards.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
II	PHY	F214	Electricity, Magnetism &		PHY	F242	Quantum Mechanics I	3
			Optics Laboratory	2	PHY	F243	Mathematical Methods of	
			Humanities Elective	3			Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CS	F215	Digital Design	4	PHY	F344	Advanced Physics	
	CS	F214	Logic in Computer				Laboratory	3
III			Science	3	CS	F241	Microprocessors &	
	CS	F222	Discrete Structures For				Interfacing	4
			Computer Science	3	CS	F212	Database Systems	4
	CS	F213	Object Oriented		CS	F211	Data Structures & Algorithms	4
			Programming	4				
				23				**24**
	First Semester			**U**	**Second Semester**			**U**
	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of	
	CS	F342	Computer Architecture	4			Algorithms	3
IV	CS	F301	Principles of		CS	F303	Computer Networks	4
			Programming Languages	2			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS	F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electrical & Electronics)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	EEE	F211	Electrical Machines	4	EEE	F243	Signals and Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
					EEE	F242	Control Systems	3
				20				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or		EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2	PHY	F344	Advanced Physics Laboratory	3
	EEE	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	9			Second Discipline Electives	4
			Second Discipline Electives	5				
				23/24				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electronics & Communication)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors & Interfacing	4
	ECE	F211	Electrical Machines	4	ECE	F242	Control Systems	3
	ECE	F214	Electronic Devices	3	ECE	F243	Signals and Systems	3
					ECE	F244	Microelectronic Circuits	3
				20				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	9	PHY	F344	Advanced Physics Laboratory	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	5
				23				**24**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			4	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F211	Electrical Machines	4	INSTR	F242	Control Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
				20				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	9	PHY	F344	Advanced Physics Laboratory	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	4
				22				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			5	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Physics with B.E. Manufacturing)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	MF	F212	Fluid Mechanics	3	PHY	F344	Advanced Physics Laboratory	3
	MF	F214	Applied Thermodynamics	3	MF	F243	Manufacturing Processes	3
	MF	F215	Mechanical Engineering Laboratory	2	MF	F241	Machine Design & Drawing	4
	MF	F211	Mechanics of Solids	3	MF	F244	Kinetics & Dynamics of Machinery	3
	MF	F213	Materials Science & Engineering	2	MF	F242	Manufacturing Management	2
				22				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF	F342	Computer Aided Design	4
			First Discipline Electives	9	MF	F344	Engineering Optimization	2
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	4
				22				**23**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			5	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Mechanical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
	BITS	F225	Environmental Studies	3	PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	ME	F212	Fluid Mechanics	3	PHY	F344	Advanced Physics Laboratory	3
	ME	F214	Applied Thermodynamics	3	ME	F242	IC Engines	2
	ME	F215	Mechanical Engineering Lab	2	ME	F241	Machine Design & Drawing	4
	ME	F211	Mechanics of Solids	3	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F213	Materials Science & Engineering	2	ME	F243	Production Techniques I	3
				22				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques- II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	9	ME	F344	Engineering Optimization	2
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	3
				23				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

List of Courses for B.E. / M.Sc. / B.Pharm. Programmes:

The list of Discipline Core Courses and Discipline Electives for all the first degree programmes is given below. To complete the requirements of Humanities electives, a student can take courses which are normally listed under Languages and Literature, History and Philosophy, Political and social Sciences, Fine arts and Professional Arts which have also been mentioned in subsequent paragraphs.

Course No	Course Title	L	P	U
BIOTECHNOLOGY				
CORE COURSES				
BIOT F211	Biological Chemistry	3	0	3
BIOT F212	Microbiology	3	1	4
BIOT F213	Cell biology	3	0	3
BIOT F215	Biophysics	3	0	3
BIOT F241	Genetic Engineering Techniques	1	3	4
BIOT F243	Genetics	3	0	3
BIOT F244	Instrumental Methods of Analysis	1	3	4
BIOT F245	Intro to Environmental Biotechnology	3	0	3
BIOT F311	Recombinant DNA Technology	3	0	3
BIOT F314	Industrial Microbiology and Bioprocess Engineering	2	2	4
BIOT F342	Immunology	3	0	3
BIOT F343	Experiments in Biotechnology	0	3	3
BIOT F344	Downstream Processing	2	1	3
DISCIPLINE ELECTIVE COURSES				
BIOT F242	Introduction to Bioinformatics	3	0	3
BIOT F345	Proteomics	3	0	3
BIOT F346	Genomics	3	0	3
BIOT F347	Immunotechnology	3	0	3
BIOT F352	Cell and Tissue Culture Technology	3	0	3
BIOT F413	Molecular Biology of the Cell	3	0	3
BIOT F416	Introduction to Pharmaceutical Biotechnology	3	0	3
BIOT F417	Biomolecular Modeling	3	0	3
BIOT F420	Introduction to Plant Biotechnology	3	0	3
BIOT F422	Nanobiotechnology	3	0	3
BIOT F423	Drug design and delivery	3	0	3
BIOT F424	Food Biotechnology	3	0	3
BITS F467	Bioethics and Biosafety	3	0	3
CHEMICAL ENGINEERING				
CORE COURSES		**L**	**P**	**U**
CHE F211	Chemical Process Calculations	3	0	3
CHE F212	Fluid Mechanics	3	0	3
CHE F213	Chemical Engineering Thermodynamics	3	0	3
CHE F214	Engineering Chemistry	3	0	3
CHE F241	Heat Transfer	3	0	3
CHE F242	Numerical Methods for Chemical Engineers	3	0	3
CHE F243	Material Science and Engg.	3	0	3
CHE F244	Separation Processes I	3	0	3
CHE F311	Kinetics and Reactor Design	3	0	3
CHE F312	Chemical Engineering Lab I	0	3	3
CHE F313	Separation Processes II	3	0	3
CHE F314	Process Design Principles I	3	0	3
CHE F341	Chemical Engineering Lab II	0	3	3
CHE F342	Process Dynamics and Control	3	0	3
CHE F343	Process Design Principles II	3	0	3
DISCIPLINE ELECTIVE COURSES				
BIO G671	Bioconversion Technology	3	2	5
BIOT F245	Introduction to Environmental Biotechnology	3	0	3
BIOT F344	Downstream processing	2	1	3
BITS F415	Introduction to MEMS	3	1	4
BITS F416	Introduction to Nanoscience	3	0	3
BITS F417	Microfluidics and its application			4
BITS F418	Introduction to Biomedical Engineering	3	1	4
BITS F429	Nanotechnology for Renewable Energy and Environment	3	1	4
CHE F411	Environmental Pollution Control	3	0	3
CHE F412	Process Equipment Design	3	0	3
CHE F413	Process Plant Safety	3	0	3
CHE F414	Transport Phenomena	3	0	3
CHE F415	Molecular and Statistical Thermodynamics	3	0	3

Course No	Course Title	L	P	U
CHE F416	Process Plant Design Project I	-	-	3
CHE F417	Process Plant Design Project II	-	-	3
CHE F418	Modelling and Simulation in Chemical Engineering	3	0	3
CHE F419	Chemical Process Technology	3	0	3
CHE F421	Bio-chemical Engineering	3	0	3
CHE F422	Petroleum Refining Technology	3	0	3
CHE F423	Membrane Science and Engineering	3	0	3
CHE F424	Rheology of Complex Fluids	3	0	3
CHE F433	Corrosion Engineering	3	0	3
CHE F471	Advanced Process Control	3	0	3
CHE F497	Atomic and Molecular Simulations			3
CHE F498	Colloids and Interface Engineering			3
CHE G511	Fluidization Engineering	3	1	4
CHE G512	Petroleum Refining and Petrochemicals	3	1	4
CHE G513	Environmental Management Systems	3	2	5
CHE G522	Polymer Technology	3	1	4
CHE G523	Mathematical Methods in Chemical Engineering			5
CHE G524	Introduction to Multiphase flow	3	1	4
CHE G526	Nuclear Engineering	3	1	4
CHE G527	Energy Conservation and Management	3	1	4
CHE G528	Introduction to Nanoscience & Technology	3	1	4
CHE G529	Pulp & Paper Technology	3	1	4
CHE G532	Alternate Energy Resources	3	1	4
CHE G533	Petroleum Product Characterization	3	2	5
CHE G551	Advanced Separation Technology	3	2	5
CHE G552	Advanced Transport Phenomena			5
CHE G554	Computational Fluid Dynamics			4
CHE G556	Electrochemical Engineering	3	1	4
CHE G557	Energy Systems Engineering			4
CHE G558	Chemical Process Optimization			4
CHE G568	Modeling and Simulation in Petroleum Refining			4
CHE G613	Advanced Mass Transfer	3	2	5
CHE G614	Advanced Heat Transfer	3	2	5
CHE G616	Petroleum Reservoir Engineering			5
CHE G617	Petroleum Refinery Engg.	3	2	5
CHE G618	Petroleum Downstream Processing	3	2	5
CHE G619	Process Intensification	3	2	5
CHE G620	Energy Integration Analysis	3	1	4
CHE G622	Advanced Chemical Engineering Thermodynamics			5
CHE G641	Reaction Engineering			5
CHEM F325	Polymer Chemistry	3	0	3

CIVIL ENGINEERING

CORE COURSES

		L	P	U
CE F211	Mechanics of Solids	3	0	3
CE F213	Surveying	3	1	4
CE F230	Civil Engineering Materials			4
CE F231	Fluid Mechanics			3
CE F241	Analysis of Structures	3	0	3
CE F242	Construction Planning and Technology	3	0	3
CE F243	Soil Mechanics	3	1	4
CE F244	Highway Engineering	3	1	4
CE F312	Hydraulics Engineering	3	1	4
CE F313	Foundation Engineering	3	0	3
CE F320	Design of Reinforced Concrete Structures			3
CE F321	Engineering Hydrology			3
CE F342	Water & Waste Water Treatment	3	1	4
CE F343	Design of Steel Structures	3	0	3

DISCIPLINE ELECTIVE COURSES

BITS F313	Multicriterion Decision Making in Engg. and Management	3	0	3
CE F323	Introduction to Environmental Engineering	3	0	3
CE F324	Numerical Analysis	3	0	3
CE F325	Fundamentals of Rock Mechanics	3	0	3
CE F345	Computational Geomechanics	3	0	3
CE F411	Operation Research for Engineers	3	0	3
CE F412	Disaster Management	3	0	3
CE F413	Advanced Structural Design	3	0	3

Course No	Course Title	L	P	U
CE F415	Design of Prestressed Concrete Structure	3	0	3
CE F416	Computer Applications in Civil Engineering	3	1	4
CE F417	Applications of Artificial Intelligence in Civil Engg.	3	0	3
CE F419	Geotechnical Earthquake Engg. and Machine Foundation	3	0	3
CE F420	Introduction to Bridge Engineering	3	0	3
CE F421	Analysis and Design of FRP Reinforced Concrete Structures	3	0	3
CE F422	Urban Hydrology	2	1	3
CE F423	Green Buildings and Energy Conservation	3	0	3
CE F425	Airport, Railways and Waterways	3	0	3
CE F426	Geosynthetics and Reinforced Soil Structure	3	0	3
CE F427	System Modeling and Analysis	3	0	3
CE F428	Earthquake Resistant Design and Construction	3	0	3
CE F429	Design of Foundation Systems	3	0	3
CE F430	Design of Advanced Concrete Structures	3	0	3
CE F431	Principles of Geographical Information Systems	3	1	4
CE F432	Structural Dynamics	3	0	3
CE F433	Remote Sensing and Image Processing	3	1	4
CE F434	Environmental Impact Assessment	3	0	3
CE F435	Introduction to Finite Element Methods	3	0	3

COMPUTER SCIENCE

CORE COURSES		L	P	U
CS F211	Data Structures & Algorithms	3	1	4
CS F212	Database Systems	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F214	Logic in Computer Science	3	0	3
CS F215	Digital Design	3	1	4
CS F222	Discrete Structures for Computer Science	3	0	3
CS F241	Microprocessors & Interfacing	3	1	4
CS F301	Principles of Programming Languages	2	0	2
CS F303	Computer Networks	3	1	4
CS F342	Computer Architecture	3	1	4
CS F351	Theory of Computation	3	0	3
CS F363	Compiler Construction	2	1	3
CS F364	Design & Analysis of Algorithms	3	0	3
CS F372	Operating Systems	3	0	3

DISCIPLINE ELECTIVE COURSES

BITS F311	Image Processing	3	0	3
BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F364	Human – Computer Interaction	3	0	3
BITS F386	Quantum Information and Computation	3	0	3
BITS F463	Cryptography	3	0	3
BITS F464	Machine Learning	3	0	3
BITS F465	Enterprise Computing	3	1	4
BITS F466	Service Oriented Computing	3	1	4
CS F314	Software Development for Portable Devices	2	1	3
CS F401	Multimedia Computing	3	0	3
CS F 402	Computational Geometry	3	0	3
CS F407	Artificial Intelligence	3	0	3
CS F413	Internetworking Technologies	3	0	3
CS F415	Data Mining	3	0	3
CS F422	Parallel Computing	3	0	3
CS F424	Software for Embedded Systems	3	1	4
CS F441	Selected Topics from Computer Science	-	-	3
CS F444	Real Time Systems	3	0	3
CS F446	Data Storage Technologies and Networks	3	0	3
CS F468	Information Security Project	0	3	3
CS F469	Information Retrieval	3	0	3
CS G527	Cloud Computing			5
IS F311	Computer Graphics	3	0	3
IS F341	Software Engineering	3	1	4
IS F462	Network Programming	3	0	3
MATH F231	Number Theory	3	0	3
MATH F421	Combinatorial Mathematics	3	0	3
MATH F441	Discrete Mathematical Structures	3	0	3

ELECTRICAL AND ELECTRONICS ENGINEERING

CORE COURSES

EEE F211	Electrical Machines	3	1	4
EEE F212	Electromagnetic Theory	3	0	3
EEE F214	Electronic Devices	3	0	3
EEE F215	Digital Design	3	1	4
EEE F241	Microprocessors and interfacing	3	1	4
EEE F242	Control Systems	3	0	3
EEE F243	Signals & Systems	3	0	3
EEE F244	Microelectronic Circuits	3	0	3
EEE F311	Communication Systems	3	1	4
EEE F312	Power Systems	3	0	3
EEE F313	Analog & Digital VLSI Design	3	0	3
EEE F341	Analog Electronics	3	1	4
EEE F342	Power Electronics	3	1	4
MATH F212	Optimization	3	0	3

DISCIPLINE ELECTIVE COURSES

BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F415	Introduction To MEMS	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F343	Communication Networks	3	0	3
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F312	EM Fields and Microwave Engineering	3	0	3
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F411	Internet of Things	3	1	4
EEE F414	Telecommunication Switching Systems & Networks	3	0	3
EEE F416	Digital Communication	3	0	3
EEE F417	Computer Based Control System	3	0	3
EEE F418	Modern Communication Technologies	3	0	3
EEE F422	Modern Control Systems	3	0	3
EEE F425	Power System Analysis and control	3	0	3
EEE F426	Fiber Optics & Optoelectronics	3	0	3
EEE F427	Electric Power Utilization and Illumination	3	0	3
EEE F431	Mobile Telecommunication Networks	3	0	3
EEE F432	Medical Instrumentation	3	0	3
EEE F433	Electromagnetic Fields & Waves	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing	3	0	3
EEE F46	Advanced Power Systems	3	0	3
EEE F472	Satellite Communication	3	0	3
EEE F473	Wind Electrical Systems	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect NanoDevices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G626	Hardware Software Co-Design			4

ELECTRONICS AND COMMUNICATION ENGINEERING

CORE COURSES		L	P	U
ECE F211	Electrical Machines	3	1	4
ECE F212	Electromagnetic Theory	3	0	3
ECE F214	Electronic Devices	3	0	3
ECE F215	Digital Design	3	1	4
ECE F241	Microprocessors and interfacing	3	1	4
ECE F242	Control Systems	3	0	3
ECE F243	Signals & Systems	3	0	3
ECE F244	Microelectronic Circuits	3	0	3

ECE F311	Communication Systems	3	1	4
ECE F314	Electromagnetic Fields & Microwave Engineering	3	0	3
ECE F341	Analog Electronics	3	1	4
ECE F344	Information Theory & Coding	3	0	3
ECE F434	Digital Signal Processing	3	1	4
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F415	Introduction to MEMS	3	1	4
BITS F463	Cryptography	3	0	3
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F414	Telecommunication Switching Systems & Networks	3	0	3
ECE F416	Digital Communication	3	0	3
ECE F418	Modern Communication Technologies	3	0	3
ECE F431	Mobile Telecommunication Networks	3	0	3
ECE F472	Satellite Communication	3	0	3
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F313	Analog & Digital VLSI Design	3	0	3
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F411	Internet of Things	3	1	4
EEE F417	Computer Based Control System	3	0	3
EEE F422	Modern Control Systems	3	0	3
EEE F426	Fiber Optics and Optoelectronics	3	0	3
EEE F432	Medical Instrumentation	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect Nano Devices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G626	Hardware Software Co-Design			4
INSTR F412	Analysis Instrumentation	3	0	3

ELECTRONICS AND INSTRUMENTATION ENGINEERING

CORE COURSES		**L**	**P**	**U**
INSTR F211	Electrical Machines	3	1	4
INSTR F212	Electromagnetic Theory	3	0	3
INSTR F214	Electronic Devices	3	0	3
INSTR F215	Digital Design	3	1	4
INSTR F241	Microprocessors and interfacing	3	1	4
INSTR F242	Control Systems	3	0	3
INSTR F243	Signals & Systems	3	0	3
INSTR F244	Microelectronic Circuits	3	0	3
INSTR F311	Electronic Instrumentation & Instrumentation Technology	3	1	4
INSTR F312	Transducers and Measurement Systems	3	0	3
INSTR F313	Analog & Digital VLSI Design	3	0	3
INSTR F341	Analog Electronics	3	1	4
INSTR F342	Power Electronics	3	1	4
INSTR F343	Industrial Instrumentation & Control	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F312	Neural Network & Fuzzy Logic	3	0	3
BITS F415	Introduction To MEMS	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F314	Electromagnetic Fields & Microwave Engineering	3	0	3
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F311	Communication Systems	3	1	4
EEE F345	Power Apparatus & Networks	3	0	3

EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F411	Internet of Things	3	1	4
EEE F417	Computer Based Control System	3	0	3
EEE F422	Modern Control Systems	3	0	3
EEE F426	Fiber optics & Optoelectronics	3	0	3
EEE F427	Electric Power Utilization and Illumination	3	0	3
EEE F431	Mobile Telecommunication Networks	3	0	3
EEE F433	Electromagnetic Fields & Waves	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing (check number and description with BITS Image Processing)	3	0	3
EEE F472	Satellite Communication	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect Nano Devices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G626	Hardware Software Co-Design			4
INSTR F413	Advanced Process Control	3	0	3
INSTR F414	Telecommunication Switching Systems & Networks	3	0	3
INSTR F415	Digital Control	3	0	3
INSTR F419	Virtual Instrumentation	3	1	4
INSTR F420	Design of Instrumentation Systems	3	0	3
INSTR F422	Instrumentation for Petrochemical Industry	3	0	3
INSTR F432	Medical Instrumentation	3	0	3
INSTR F473	Wind Electrical Systems	3	0	3

MANUFACTURING ENGINEERING

CORE COURSES		L	P	U
MF F211	Mechanics of Solids	3	0	3
MF F212	Fluid Mechanics	3	0	3
MF F213	Materials Science & Engineering	2	0	2
MF F214	Applied Thermodynamics	3	0	3
MF F215	Mechanical Engineering Laboratory	0	2	2
MF F241	Machine Design & Drawing	3	1	4
MF F242	Manufacturing Management	2	0	2
MF F243	Manufacturing Processes	2	1	3
MF F244	Kinematics & Dynamics of Machinery	3	0	3
MF F311	Mechatronics & Automation	2	1	3
MF F312	Tool & Fixture Design	3	0	3
MF F313	Metal Forming & Machining	3	1	4
MF F341	Design of Machine Tools	3	0	3
MF F342	Computer Aided Design	3	1	4
MF F343	Casting & Welding	3	1	4
MF F344	Engineering Optimization	2	0	2

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F415	Introduction To MEMS	3	1	4
ECON F411	Project Appraisal	3	0	3
ME F340	Introduction to Sports Engineering	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F419	Total Product Integration Engineering	3	0	3
ME F424	Energy Management	3	0	3
ME F425	Additive Manufacturing	3	0	3
ME F426	Industry 4.0 in Manufacturing	3	0	3
ME F432	Computer Aided Manufacturing	2	1	3
ME F443	Quality Control Assurance and Reliability	3	0	3
ME F484	Automotive Technology	3	0	3
MF F411	Fluid Power Systems	3	1	4
MF F412	Automotive Systems	3	0	3
MF F413	Mechanical Vibrations and Acoustics	3	0	3
MF F414	Manufacturing Excellence	3	0	3
MF F418	Lean Manufacturing	3	0	3
MF F421	Supply Chain Management			4
MF F442	Advances in Materials Science	3	0	3
MF F453	Industrial Relations	3	0	3
MF F463	Maintenance and Safety	3	0	3
MF F471	Instrumentation and Control	3	0	3
MF F472	Precision Engineering	3	0	3
MF F473	Product Design and Development	3	0	3
MF F474	Product Design and Development Projects	0	0	3

MF F485	Sustainable Manufacturing	3	0	3

MECHANICAL ENGINEERING

CORE COURSES		**L**	**P**	**U**
ME F211	Mechanics of Solids	3	0	3
ME F212	Fluid Mechanics	3	0	3
ME F213	Materials Science & Engineering	2	0	2
ME F214	Applied Thermodynamics	3	0	3
ME F215	Mechanical Engineering Laboratory	0	2	2
ME F241	Machine Design & Drawing	3	1	4
ME F242	IC Engines	2	0	2
ME F243	Production Techniques I	2	1	3
ME F244	Kinematics & Dynamics of Machinery	3	0	3
ME F311	Heat Transfer	3	1	4
ME F312	Advanced Mechanics of Solids	3	0	3
ME F313	Production Techniques II	3	1	4
ME F341	Prime Movers & Fluid Machines	2	1	3
ME F342	Computer Aided Design	3	1	4
ME F343	Mechanical Vibrations	3	0	3
ME F344	Engineering Optimization	2	0	2

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F415	Introduction to MEMS	3	1	4
DE G513	Tribology	3	2	5
DE G514	Fracture Mechanics	3	2	5
DE G531	Product Design	3	2	5
ECE F242	Control Systems	3	0	3
ECON F411	Project Appraisal	3	0	3
EEE F242	Control Systems	3	0	3
INSTR F242	Control Systems	3	0	3
MATH F313	Numerical Analysis	3	0	3
ME F340	Introduction to Sports Engineering	3	0	3
E F411	Fluid Power Systems	3	1	4
ME F412	Production Planning & Control	3	0	1
ME F413	Nonlinear Vibrations	3	0	3
ME F414	Fuel Cell Science and Technology			3*
ME F415	Gas Dynamics	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F418	Rocket and Spacecraft Propulsion	3	0	3
ME F419	Total Product Integration Engg.	3	0	3
ME F420	Power Plant Engineering	3	0	3
ME F423	Microfluidics and Applications			4*
ME F424	Energy Management	3	0	3
ME F425	Additive Manufacturing	3	0	3
ME F426	Industry 4.0 in Manufacturing	3	0	3
ME F432	Computer Aided manufacturing	2	1	3
ME F433	Solar Thermal Process Engineering	3	1	4
ME F441	Automotive Vehicles	3	0	3
ME F443	Quality Control, Assurance and Reliability	3	0	3
ME F451	Mechanical Equipment Design	3	0	3
ME F452	Composite Materials & Design	3	0	3
ME F461	Refrigeration and Air conditioning	3	0	3
ME F472	Precision Engineering	3	0	3
ME F482	Combustion	3	0	3
ME F483	Wind Energy	3	0	3
ME F484	Automotive Technology	3	0	3
ME F485	Numerical Techniques for Fluid Flow and Heat Transfer	3	0	3
ME G511	Mechanism and Robotics	3	2	5
ME G512	Finite Element Methods	3	2	5
ME G514	Turbomachinery	3	2	5
ME G515	Computational Fluid Dynamics	3	2	5
ME G533	Conduction and Radiation Heat Transfer	3	2	5
ME G534	Convective Heat and Mass Transfer	3	2	5
MF F311	Mechatronics and Automation	2	1	3
MF F418	Lean Manufacturing	3	0	3
MF F421	Supply chain management			4
MF F485	Sustainable Manufacturing	3	0	3
MST G522	Advanced Composites	3	2	5

PHARMACY

CORE COURSES		**L**	**P**	**U**
BITS F219	Process Engineering	2	1	3
PHA F211	Pharmaceutical Analysis	2	1	3
PHA F212	Dispensing Pharmacy	2	1	3
PHA F213	Microbiology	2	1	3
PHA F214	Anatomy, Physiology & Hygiene	2	1	3
PHA F215*	Introduction to Molecular Biology and Immunology	3	0	3
PHA F241	Pharmaceutical Chemistry	2	1	3
PHA F242	Biological Chemistry	2	1	3

PHA F243	Industrial Pharmacy	2	1	3
PHA F244	Physical Pharmacy	2	1	3
PHA F311	Pharmacology I	2	1	3
PHA F312	Medicinal Chemistry I	2	1	3
PHA F313	Instrumental Methods of Analysis	2	1	4
PHA F314	Pharmaceutical Formulations and Biopharmaceutics	2	1	3
PHA F341	Pharmacology II	2	1	3
PHA F342	Medicinal Chemistry II	2	1	3
PHA F343	Forensic Pharmacy	2	-	2
PHA F344	Natural Drugs	2	1	3

*** To be offered to B.Pharm. students admitted in 2014 onwards in place of PHA F243**

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
MATH F212	Optimization	3	0	3
PHA F413	Pharmaceutical Management and Quality Control	3	0	3
PHA F414	Biopharmaceutics	3	0	3
PHA F415	Pathophysiology	3	0	3
PHA F416	Chemistry of Synthetic Drugs	3	0	3
PHA F417	Pharmacoeconomics	3	0	3
PHA F422	Cosmetic Science	2	1	3
PHA F432	Hospital Pharmacy	3	0	3
PHA F441	Biochemical Engineering	3	0	3
PHA F442	Applied Pharmaceutical Chemistry	3	0	3
PHA F461	Phytochemistry	2	1	3

BIOLOGICAL SCIENCES				
CORE COURSES		**L**	**P**	**U**
BIO F211	Biological Chemistry	3	0	3
BIO F212	Microbiology	3	1	4
BIO F213	Cell Biology	3	0	3
BIO F214	Integrated Biology	3	0	3
BIO F215	Biophysics	3	0	3
BIO F241	Ecology & Environmental Science	3	0	3
BIO F242	Introduction to Bioinformatics	3	0	3
BIO F243	Genetics	3	0	3
BIO F244	Instrumental Methods of Analysis	1	3	4
BIO F311	Recombinant DNA Technology	3	0	3
BIO F312	Plant Physiology	3	0	3
BIO F313	Animal Physiology	3	0	3
BIO F341	Developmental Biology	3	0	3
BIO F342	Immunology	3	0	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BIO F216	Water, Sanitation and Solid Waste Management	3	0	3
BIO F217	Laboratory for Water, Sanitation and Solid waste Management	1	2	3
BIO F231	Biology Project Laboratory			3
BIO F314	Conservation Biology	2	1	3
BIO F315	Applied Nutrition and Nutraceuticals	2	0	2
BIO F352	Cell and Tissue Culture Technology	3	1	4
BIO F411	Laboratory	0	3	3
BIO F413	Molecular Biology of Cell	3	0	3
BIO F417	Biomolecular Modelling	3	0	3
BIO F418	Genetic Engineering Techniques	1	3	4
BIO F419	Molecular Evolution	3	0	3
BIO F421	Enzymology	3	0	3
BIO F431	Reproductive Physiology	3	0	3
BIO F441	Biochemical Engineering	3	0	3
BIO F451	Bioprocess Technology	3	0	3
BIO G512	Molecular Mechanism of Gene Expression	3	2	5
BIO G513	Microbial and Fermentation Technology	3	2	5
BIO G515	Stem Cell and Regenerative Biology	3	1	4
BIO G522	Interferon Technology	3	1	4
BIO G523	Advanced and Applied Microbiology	3	2	5
BIO G524	Animal Cell Technology	3	2	5
BIO G525	Environmental Biotechnology & Waste Mgnt	3	2	5
BIO G526	Cancer Biology	3	2	5
BIO G544	Bioremediation and biometallurgy	5	0	5
BIO G545	Molecular Parasitology and Vector Biology			5
BIO G561	Advances in Recombinant DNA Technology	3	2	5
BIO G570	Recent Developments in Biology	1	0	1
BIO G612	Human Genetics	3	2	5
BIO G631	Membrane and Liposome Technology	3	1	4
BIO G632	Transgenic Technology	3	2	5
BIO G642	Experimental Techniques		4	4

BIO G643	Plant Biotechnology	3	2	5
BIO G651	Protein and Enzyme Bioengineering	3	2	5
BIO G661	Gene Toxicology	3	1	4
BIO G671	Bioconversion Technology	3	2	5
BIOT F345	Proteomics	3	0	3
BIOT F346	Genomics	3	0	3
BIOT F347	Immunotechnology	3	0	3
BIOT F416	Introduction to Pharmaceutical Biotechnology	3	0	3
BIOT F422	Nanobiotechnology	3	0	3
BIOT F424	Food Biotechnology	3	0	3
BITS F418	Introduction to Biomedical Engineering	3	1	4
BITS F467	Bioethics and Biosafety	3	0	3
CHEM F212	Organic Chemistry I	3	0	3
CHEM F213	Physical Chemistry II	3	0	3
MATH F212	Optimization	3	0	3

CHEMISTRY

CORE COURSES		**L**	**P**	**U**
CHEM F211	Physical Chemistry I	3	0	3
CHEM F212	Organic Chemistry I	3	0	3
CHEM F213	Physical Chemistry II	3	0	3
CHEM F214	Inorganic Chemistry I	3	0	3
CHEM F241	Inorganic Chemistry II	3	0	3
CHEM F242	Chemical Experimentation I	0	3	3
CHEM F243	Organic Chemistry II	3	0	3
CHEM F244	Physical Chemistry III	3	0	3
CHEM F311	Organic Chemistry III	3	0	3
CHEM F312	Physical Chemistry IV	3	0	3
CHEM F313	Instrumental Methods of Analysis	3	1	4
CHEM F341	Chemical Experimentation II	0	4	4
CHEM F342	Organic Chemistry IV	3	0	3
CHEM F343	Inorganic Chemistry III	3	0	3
PHY F212	Electromagnetic Theory I	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
CHEM F223	Colloid and Surface Chemistry	3	0	3
CHEM F320	Introductory Computational Chemistry Laboratory	0	4	2
CHEM F323	Biophysical Chemistry	3	0	3
CHEM F324	Numerical Methods in Chemistry	3	3	4
CHEM F325	Polymer Chemistry	3	0	3
CHEM F326	Solid State Chemistry	3	0	3
CHEM F327	Electrochemistry: Fundamentals and Applications	3	0	3
CHEM F328	Supramolecular Chemistry	3	0	3
CHEM F329	Analytical Chemistry	3	1	4
CHEM F330	Photophysical Chemistry	3	1	4
CHEM F333	Chemistry of Materials	3	0	3
CHEM F334	Magnetic Resonance	3	0	3
CHEM F335	Organic Chemistry and Drug Design	3	0	3
CHEM F336	Nanochemistry	3	1	4
CHEM F337	Green Chemistry and Catalysis	3	0	3
CHEM F412	Photochemistry and Laser Spectroscopy	3	0	3
CHEM F413	Electron Correlation In Atoms And Molecules	3	1	4
CHEM F414	Bio and Chemical Sensors	3	0	3
CHEM F415	Frontiers in Organic Synthesis	3	0	3
CHEM F422	Statistical Thermodynamics	3	0	3
CHEM F430	Atmospheric Chemistry	3	0	3
CHEM F431	Sustainable Chemistry using Renewables	3	0	3
CHEM G521	Environmental Chemistry			5

ECONOMICS

CORE COURSES		**L**	**P**	**U**
ECON F211	Principles of Economics	3	0	3
ECON F212	Fundamentals of Finance and Accounts	3	0	3
ECON F213	Mathematical and Statistical Methods	3	0	3
ECON F214	Economic Environment of Business	3	0	3
ECON F241	Econometric Methods	3	0	3
ECON F242	Microeconomics	3	0	3
ECON F243	Macroeconomics	3	0	3
ECON F244	Economics of Growth and Development	3	0	3
ECON F311	International Economics	3	0	3
ECON F312	Money, Banking and Financial Markets	3	0	3
ECON F313	Issues in Economic Development	3	0	3
ECON F341	Public Finance Theory and Policy	3	0	3
ECON F342	Applied Econometrics	3	0	3
ECON F343	Economic Analysis of Public Policy	3	0	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F314	Game Theory and It's Applications	3	0	3
ECON F315	Financial Management	3	0	3
ECON F314	Industrial Economics	3	0	3
ECON F345	Behavioral Economics	3	0	3
ECON F351	Indian Economic Development	3	0	3
ECON F352	Management of Banks and Financial Institutions	3	0	3
ECON F353	Energy Economics and Policy	3	0	3
ECON F354	Derivatives and Risk Management	3	0	3
ECON F355	Business Analysis and Valuation	3	0	3
ECON F356	Strategic Financial Management	3	0	3
ECON F357	Management Control System	3	0	3
ECON F411	Project Appraisal	3	0	3
ECON F412	Security Analysis and Portfolio Management	3	0	3
ECON F413	Financial Engineering	3	0	3
ECON F414	Creating and Leading Entrepreneurial Organizations	3	0	3
ECON F415	New Venture Creation	3	0	3
ECON F417	Risk Management and Insurance	3	0	3
ECON F418	Quantitative Analysis of International Trade	3	0	3
ECON F422	Functions and Working of Stock Exchanges	3	0	3
ECON F434	International Business	3	0	3
ECON F435	Marketing Research	3	0	3
ECON F471	Resources and Environmental Economics	3	0	3
FIN F314	Investment Banking and Financial Services	3	0	3
FIN F414	Financial Risk Analytics and Management	3	0	3
MATH F212	Optimization	3	0	3
MATH F242	Operations Research	3	0	3

MATHEMATICS

CORE COURSES		L	P	U
MATH F212	Optimization	3	0	3
MATH F213	Discrete Mathematics	3	0	3
MATH F214	Elementary Real Analysis	3	0	3
MATH F215	Algebra-I	3	0	3
MATH F241	Mathematical Methods	3	0	3
MATH F242	Operations Research	3	0	3
MATH F243	Graphs and Networks	3	0	3
MATH F244	Measure & Integration	3	0	3
MATH F311	Introduction to Topology	3	0	3
MATH F312	Ordinary Differential Equations	3	0	3
MATH F313	Numerical Analysis	3	0	3
MATH F341	Introduction to Functional Analysis	3	0	3
MATH F342	Differential Geometry	3	0	3
MATH F343	Partial Differential Equations	3	0	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F314	Game Theory and Its Applications	3	0	3
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F463	Cryptography	3	0	3
CS F211	Data Structures and Algorithms	3	1	4
CS F364	Design and Analysis of Algorithms	3	0	3
MATH F231	Number Theory	3	0	3
MATH F314	Algebra-II	3	0	3
MATH F353	Statistical Inference and Applications	3	0	3
MATH F354	Complex Analysis	3	0	3
MATH F378	Advanced Probability Theory	3	0	3
MATH F420	Mathematical Modeling	3	0	4
MATH F421	Combinatorial Mathematics	3	0	3
MATH F422	Numerical Methodology for Partial Differential Equations	3	1	4
MATH F423	Introduction to Algebraic Topology	3	0	3
MATH F424	Applied Stochastic Process	3	1	4
MATH F431	Distribution Theory	3	0	3
MATH F432	Applied Statistical Methods	3	0	3
MATH F441	Discrete Mathematical Structures	3	0	3
MATH F444	Numerical Solutions of Ordinary Differential Equations	3	0	3
MATH F445	Mathematical Fluid Dynamics	3	0	3
MATH F456	Cosmology	3	0	3
MATH F471	Nonlinear Optimization	3	0	3
MATH F481	Commutative Algebra	3	0	3
MATH F492	Wavelet analysis and applications	3	1	4

PHYSICS

CORE COURSES		L	P	U
PHY F211	Classical Mechanics	3	1	4
PHY F212	Electromagnetic Theory I	3	0	3
PHY F213	Optics	3	0	3
PHY F214	Electricity, Magnetism & Optics Laboratory	0	2	2
PHY F241	Electromagnetic Theory II	3	1	4
PHY F242	Quantum Mechanics I	3	0	3
PHY F243	Mathematical Methods of Physics	3	0	3
PHY F244	Modern Physics Laboratory	0	2	2
PHY F311	Quantum Mechanics II	3	0	3
PHY F312	Statistical Mechanics	3	0	3
PHY F313	Computational Physics	3	0	3
PHY F341	Solid State Physics	3	0	3
PHY F342	Atomic & Molecular Physics	3	0	3
PHY F343	Nuclear & Particle Physics	3	0	3
PHY F344	Advanced Physics Laboratory	0	3	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BIO F215	Biophysics	3	0	3
BITS F316	Nonlinear Dynamics and Chaos	3	0	3
BITS F317	Theoretical Neuroscience	3	0	3
BITS F386	Quantum Information and Computation	3	0	3
BITS F416	Introduction to Nanoscience	3	0	3
BITS F417	Microfluidics & its Applications			4
BITS F446	Pattern Recognition			3
EEE F426	Fibre Optics & Optoelectronics	3	0	3
MATH F424	Applied Stochastic Processess	3	1	4
MATH F456	Cosmology	3	0	3
PHY F215	Introduction to Astronomy & Astrophysics	3	0	3
PHY F315	Theory of Relativity	3	0	3
PHY F316	Musical Acoustics	3	0	3
PHY F317	Introduction to Radio Astronomy	3	0	3
PHY F378	Plasma Physics and its Applications	3	0	3
PHY F379	Thin Film Technology	3	0	3
PHY F412	Introduction To Quantum Field Theory	3	1	4
PHY F413	Particle Physics	3	1	4
PHY F414	Physics of Advanced Materials	3	1	4
PHY F415	General Theory of Relativity and Cosmology	3	1	4
PHY F416	Soft Condensed Matter Physics	3	1	4
PHY F417	Experimental Methods of Physics	3	1	4
PHY F418	Lasers and Applications	3	1	4
PHY F419	Advanced Solid State Physics	3	1	4
PHY F420	Quantum Optics	3	1	4
PHY F421	Advanced Quantum Mechanics	3	1	4
PHY F422	Group Theory and Applications	3	1	4
PHY F423	Special Topics in Statistical Mechanics	3	1	4
PHY F424	Advanced Electrodynamics	3	1	4
PHY F425	Advanced Mathematical Methods of Physics	3	1	4
PHY F426	Physics of Semiconductor Devices	3	1	4
PHY F427	Atmospheric Physics	3	0	3
PHY F428	Quantum Information Theory	3	0	3
PHY F431	Geometrical Methods in Physics	3	0	3
PHY F432	Classical Theory of Fields: A Symmetry Perspective			4*
PHY G512	Advanced Quantum Field Theory	3	0	3

GENERAL STUDIES – COMMUNICATION & MEDIA STUDIES STREAM

CORE COURSES		L	P	U
GS F221	Business Communication	3	0	3
GS F222	Language Lab Practice	0	3	3
GS F223	Introduction to Mass Communication	3	0	3
GS F224	Print and Audio Visual Advertising	2	1	3
GS F241	Creative Writing	2	1	3
GS F243	Current Affairs	3	0	3
GS F244	Reporting and Writing for Media	3	0	3
GS F245	Effective Public Speaking	2	1	3
GS F321	Mass Media Content and Design	2	1	3

GS F322	Critical Analysis of Literature and Cinema	3	0	3
GS F342	Computer Mediated Communication	3	0	3
GS F343	Short Film and Video Production	2	1	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F385	Introduction to Gender Studies	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F242	Cultural Studies	3	0	3
GS F311	Introduction to Conflict Management	3	0	3
GS F325	Journalism	3	0	3
GS F326	Creative Thinking	2	1	3
GS F327	Selected Reading	3	0	3
GS F333	Public Administration	3	0	3
GS F334	Global Business Technology & Knowledge Sharing	3	0	3
GS F344	Copywriting	2	0	2
HSS F227	Cross Cultural Skills	3	0	3
HSS F232	Introduction to Development Studies	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F317	Introduction to Globalization	3	0	3
HSS F319	Lighting for Theatre and Films			2
HSS F323	Organizational Psychology	3	0	3
HSS F328	Human Resource Development	3	0	3
HSS F341	Performance Design	1	2	3
HSS F343	Professional Ethics	3	0	3
HSS F346	International Relations	3	0	3

GENERAL STUDIES – DEVELOPMENTAL STUDIES STREAM

CORE COURSES		**L**	**P**	**U**
ECON F211	Principles of Economics	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F213	Development Theories	3	0	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F233	Public Policy	3	0	3
GS F234	Development Economics	3	0	3
GS F311	Introduction to Conflict Management	3	0	3
GS F312	Applied Philosophy	3	0	3
GS F331	Techniques in Social Research	3	0	3
GS F332	Contemporary India	3	0	3
GS F333	Public Administration	3	0	3
GS F334	Global Business Technology & Knowledge Sharing	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F214	Science, Technology and Modernity	3	0	3
BITS F385	Introduction to Gender Studies	3	0	3
BITS F399	Humanistic Theories of Science and Technology	3	0	3
GS F212	Environment, Development and Climate Change	3	0	3
GS F213	Development Theories	3	0	3
HSS F233	Main Trends in Indian History	3	0	3
HSS F234	Main Currents of Modern History	3	0	3
HSS F235	Introductory Philosophy	3	0	3
HSS F236	Symbolic Logic	3	0	3
HSS F312	Bureaucracy	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F343	Professional Ethics	3	0	3
HSS F344	Heritage of India	3	0	3
HSS F345	Gandhian Thoughts	3	0	3
HSS F346	International Relations	3	0	3

Project Type Courses

In addition to discipline electives mentioned above, the following project type courses are also being offered by the departments for each of their respective programmes. These courses may be taken by the students to meet the discipline elective requirements.

XXX F266	Study Project	3
XXX F366	Laboratory Project	3
XXX F367	Laboratory Project	3
XXX F376	Design Project	3
XXX F377	Design Project	3
XXX F491	Special Project	3

where XXX indicates the Degree programme. For example, CHE F266 Study Project is intended for a student of B.E. Chemical Engineering.

A student may avail a maximum of 3 Project courses to meet the Discipline Electives Requirement under the head of (Discipline) Electives with the following limitations:

(a) All of these Project courses should be

  (i) within the Discipline (for which the degree is being awarded) or

  (ii) from an allied Discipline if so specified by the Department offering the degree

(b) The projects may be chosen from under these sub-heads.

  (i) Study Projects (maximum of 1)

  (ii) Laboratory (maximum of 2)

  (iii) Design Projects (maximum of 2)

  (iv) Special Projects (maximum of 1)

A student may avail a maximum of 3 Project courses (under any of the heads mentioned above offered by any discipline as an Open Elective. However, in total a student may avail at most 5 Project courses against Electives slots in any category.

Pool of Humanities courses for students admitted in 2011 onwards in first degree programmes:

The following is the list of courses from which Humanities Electives can be taken by the students admitted in 2011 onwards in different first degree programs to meet the general institutional requirement of eight units under the Humanities elective category:

Course No.	Course Title	L	P	U
BITS F214	Science, Technology and Modernity	3	0	3
BITS F226	Soft Skills for Professionals	3	0	3
BITS F385	Introduction to Gender Studies	3	0	3
BITS F399	Humanistic Theories of Science and Technology	3	0	3
BITS F419	Management of Cross Cultural Engineering Teams	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F221	Business Communication	3	0	3
GS F223	Introduction to Mass Communication	3	0	3
GS F224	Print and Audio-Visual Advertisement	2	1	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F233	Public Policy	3	0	3
GS F234	Development Economics	3	0	3
GS F241	Creative Writing			3*
GS F242	Cultural Studies	3	0	3
GS F243	Current Affairs	3	0	3
GS F244	Reporting and Writing for Media	2	1	3
GS F245	Effective Public Speaking	2	1	3
GS F311	Introduction to Conflict Management	3	0	3
GS F312	Applied Philosophy	3	0	3
GS F313	Marxian Thoughts	3	0	3
GS F321	Mass Media Content and Design	2	1	3
GS F322	Critical Analysis of Literature and Cinema	3	0	3
GS F325	Journalism	3	0	3
GS F326	Creative Thinking	2	1	3

Course No.	Course Title	L	P	U
GS F327	Selected Reading	3	0	3
GS F331	Techniques in Social Research	3	0	3
GS F332	Contemporary India	3	0	3
GS F333	Public Administration	3	0	3
GS F343	Short Film and Video Production	2	1	3
GS F344	Copywriting	2	0	2
HSS F221	Readings from Drama	3	0	3
HSS F222	Linguistics	3	0	3
HSS F223	Appreciation of Indian Music	3	0	3
HSS F226	Postmodernism	3	0	3
HSS F227	Cross Cultural Skills	3	0	3
HSS F228	Phonetics & Spoken English	3	0	3
HSS F229	Introduction to Western Music	3	0	3
HSS F232	Introduction to Development Studies	3	0	3
HSS F233	Main Trends in Indian History	3	0	3
HSS F234	Main Currents of Modern History	3	0	3
HSS F235	Introductory Philosophy	3	0	3
HSS F236	Symbolic Logic	3	0	3
HSS F237	Contemporary Indian English Fiction	3	0	3
HSS F238	Sports and Society	3	0	3
HSS F244	Crime and New Media	3	0	3
HSS F245	Gender, Science and Technology	3	0	3
HSS F246	Philosophy of Nāgārjuna	3	0	3
HSS F266	Study Project			3
HSS F311	Introduction to Videogame Studies	3	0	3
HSS F313	Introduction to Contemporary Arts	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F316	Popular Literature and Culture of South Asia	3	0	3
HSS F317	Introduction to Globalization	3	0	3
HSS F318	Introduction to Anthropology	3	0	3
HSS F319	Lighting for Theatre and Films			2*
HSS F323	Organizational Psychology	3	0	3
HSS F325	Cinematic Adaptation	3	0	3

Course No.	Course Title	L	P	U
HSS F326	Humanities and Design	2	1	3
HSS F327	Contemporary Drama	3	0	3
HSS F328	Human Resource Development	3	0	3
HSS F329	Musicology – An – Introduction	3	0	3
HSS F330	Appreciation of Art	3	0	3
HSS F331	Sankara's Thoughts	3	0	3
HSS F332	Cinematic Art			3*
HSS F333	Comparative Religion	3	0	3
HSS F334	Srimad Bhagavad Gita	3	0	3
HSS F335	Literary Criticism	3	0	3
HSS F336	Modern Fiction	3	0	3
HSS F337	English Literary Forms and Movements	3	0	3
HSS F338	Comparative Indian Literature	3	0	3
HSS F339	Theatre Art Acting and Production	3	0	3
HSS F340	Post Colonial Literatures	3	0	3
HSS F341	Performance Design	1	2	3
HSS F342	Advanced Communicative English	3	0	3
HSS F343	Professional Ethics	3	0	3
HSS F344	Heritage of India	3	0	3
HSS F345	Gandhian Thoughts	3	0	3
HSS F346	International Relations	3	0	3
HSS F347	Introduction to Carnatic Music	3	0	3
HSS F348	Introduction to Hindustani Music	3	0	3
HSS F349	Ecocriticism	3	0	3
HSS F350	Human Rights: History, Theory & Practice	3	0	3
HSS F351	Social and Political Ecology	3	0	3
HSS F352	Technology, Work and Society	3	0	3
HSS F353	Philosophy of Aesthetics	3	0	3
HSS F354	Introduction to Islamic Economy	3	0	3
HSS F355	Dictatorship, Democracy & Development	3	0	3
HSS F356	Social Movements and Protest Politics	3	0	3
HSS F364	Political Economy of Gulf Cooperation Council States	3	0	3

Course No.	Course Title	L	P	U
HSS F365	Science of Sustainable Happiness	3	0	3
HSS F368	Asian Cinemas and Cultures	3	0	3
HSS F369	Caste and Gender in India	3	0	3
HSS F371	Cities-Life, Issues and Conflicts	3	0	3
HSS F372	Introduction to Social Psychology	3	0	3
HSS F373	Shakespeare and Popular Culture	3	0	3
HSS F374	Urban Modernity and the Renewal of Paris	3	0	3
HSS F399	Introduction to American Literature	3	0	3
SANS F111	Sanskrit	3	0	3

It may be noted that a student cannot count a course (or its equivalent) of his/her own discipline (s) as a humanities elective even if it is listed in this pool of humanities electives.

Other Courses

*BITS F225	Environmental Studies	3 0 3
BITS F311	Image Processing	3 0 3
BITS F319	Negotiation Skills and Techniques	2 0 2
BITS F320	Managerial Skills	2*
BITS F321	Legal and Economic Environment of Business	4*
BITS F333	Project on Organisational Aspects	3
BITS F334	Project on Organisational Aspects	3
BITS F372	Data Communications and Networks	3 0 3
BITS F381	TIC Projects	3
BITS F382	Reading Course	3
BITS F383	TIC Projects	3
BITS F398	Creative Multimedia	2 2 3
BITS F414	Introduction to Bioinformatics	3 0 3
BITS F416	Introduction to Nanoscience	3 0 3
BITS F417	Micro Fluidics and its Application	4*
BITS F428	Essentials of Strategic Management	3 0 3
BITS F431	Flexible Manufacturing Systems	3 2 3
BITS F441	Robotics	3
BITS F442	Remote Sensing and Image Processing	3
BITS F444	Artificial Intelligence	3
BITS F445	Neural Networks and Applications	3 0 3
BITS F446	Pattern Recognition	3
BITS F447	Multimedia Computing	3 0 3
BITS F448	Retail Management Systems	3 0 3
BITS F449	Financial Engineering	3 0 3
BIO F231	Biology Project Laboratory	3
BITS C483	Indian Wisdom for Modern Management	3 0 3
BITS F211	Introduction to IPR	1
BITS F212	Introduction to Human Rights	1
BITS F213	Introduction to Environmental studies	1
BITS F215	Applications of Bio-Medical Instrumentation Techniques in Healthcare	2 0 2
BITS F217	Environment, Development and Climate Change	3 0 3
BITS F461	Software Engineering	3
BITS F462	Renewable Energy	3 0 3
BITS F468	New Venture Creation	3 0 3
BITS F469	Financing Infrastructure Projects	3 0 3
BITS F488	Services Management Systems	3 0 3
BITS F490	Project Management	4
BITS F493	Business Analysis and Valuation	3 0 3
BITS F494	Environmental Impact Assessment	3 1 4
BITS G516	Introduction to Business Sustainability	3 0 3
BITS G517	Cross Cultural Management	3 0 3
MGTS F351	Organisational Behaviour	3 0 3
MGTS F433	Advertising and Sales Promotion	3 0 3
PHY F221	Modern Physics	3 0 3
PHY F345	Quantum Mechanics for Engineers	3 0 3

***[Students completing this course will be awarded a non-letter grade (GOOD or POOR)]**

MINOR PROGRAMMES FOR FIRST DEGREE STUDENTS

"Minor programs" are offered as options for first degree students with the intent of encouraging them to add focus to their supplemental learning (outside a major area) as well as recognizing and certifying the knowledge obtained in an area that is outside of their major area.

General Guidelines

- A minor would allow a Department (or multiple Departments) to offer a package of courses in an area/sub-area to students for whom this area/sub-area would not be part of their (major) program.
- A minor option would allow a student to pursue the study of an area or a sub-area through a set of courses but not as exhaustively as required to obtain a degree (i.e. a major) in that area.
- A minor may be inter-disciplinary (e.g. a minor in Computational Science may include courses in Numerical Analysis, Computational Physics, Computational Chemistry, and Bioinformatics among others).
- A minor will be recognized by means of a separate certificate.

Requirements for a minor

- Courses and Units Requirement:

  Each minor would be defined by coursework requirement with the following conditions:

Category	Courses	Units
Minor – Core	4 (max)	12 (max)
Minor – Electives	2 (min)	6 (min)
Minor – Total	5 (min)	15 (min)

- Elective Pool:

o The pool of electives specific to a minor may include courses from one or more disciplines and may include project / seminar type courses.

o A student may use at most one project / seminar type course to meet the requirements of a minor.

- Overlap in requirements:

o At most 2 courses (and at most 6 units) out of the above requirement (of 5 courses and 15 units) may be met by mandatory courses of the student's degree i.e. major (or degrees i.e. majors) :

  i.e. from the general institutional requirement (excluding Humanities requirement) or the (Major) discipline Core(s).

o No course may be used to meet the requirements of two different minors nor may a course be used to the meet the requirements of two majors and a minor.

- GPA requirement:

o A student – on completion of the requirements for a minor – must have maintained a cumulative GPA of 4.5 or above (out of 10) in the courses applied to the minor.

Process for declaring / obtaining a minor

- A student – if he/she chooses to pursue a minor – must declare at the end of the 2nd year that he/she will pursue a specific minor. The student will charged a small fee for logistics.
- If and when he/she completes the requirements for the minor – as stipulated above and as stipulated for the specific minor, then he/she may apply for a "minor" certificate.
- If it is verified that the requirements are met then he/she will be awarded a "minor certificate" (separate from a degree – i.e. major – certificate).
- A minor certificate will be issued only on completion of a degree (i.e. a major).

At present Nine minor programs viz. Minor in Data Science, English Studies, Entrepreneurship, Film and Media, Finance, Materials Science and Engineering, Philosophy, Economics and Politics (PEP), Physics and Public Policy have been designed. The details of which are given below:

Minor in Data Science					
Description	The minor in Data Science aims to enable students to learn the basic skills required by Data Scientist for today's world. Data Science is becoming ubiquitous to all kinds of industry and opening up new avenues of business. This minor will help students to apply knowledge from Mathematics, Statistics and Computing for analyzing data collected from different kinds of sources in their respective engineering applications and make meaningful and actionable insights.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	BITS F464	Machine Learning	3	0	3
	CS F320	Foundations of Data Science	3	0	3
	MATH F432	Applied statistical Methods	3	0	3
Electives	CS F407	Artificial Intelligence	3	0	3
	CS F415	Data Mining	3	0	3
	CS F469	Information Retrieval	3	0	3
	MATH F212	Optimization	3	0	3
	MATH F353	Statistical Inference and applications	3	0	3
	MATH F424	Applied Stochastic Processes	3	1	4
	MATH F471	Nonlinear Optimization	3	0	3

Minor in English Studies					
Description	English has a rich linguistic, literary and cultural heritage. The classic literary masterpieces of English are still widely read and appreciated. English has also evolved over centuries and is now considered as the pre-eminent means of communication in the various sectors such as business, diplomacy, mass media, education, etc., across the globe. The Minor in English Studies introduces students to the language and literary canons, and renders them with adequate exposure not only to the cultural and linguistic aspects but also to practical applications of English language and literature. In particular, the core and elective courses included in the Minor would encourage students to acquire a critical understanding of literary and linguistic analyses, and the capacity to engage meaningfully in analysis, interpretation, and explanation. The Minor also gives an opportunity for students to choose modules and develop their own interests in language or literature. Students who follow the Minor will have an enhanced understanding of the nature of the English language and literature and also of the tools needed for further independent exploration of literary and linguistic phenomena.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	GS F241	Creative Writing	2	1	3
	HSS F337	English Literary Forms and Movements	3	0	3
Electives Pool – I (Language)	GS F221	Business Communication	3	0	3
	GS F244	Reporting and Writing for Media	3	0	3
	GS F245	Effective Public Speaking	3	0	3
	HSS F222	Linguistics	3	0	3
	HSS F227	Cross Cultural Skills	3	0	3
	HSS F228	Phonetics and Spoken English	3	0	3
	HSS F342	Advanced Communicative English	3	0	3

Elective Pool-II (Literature)	GS F242	Cultural Studies	3	0	3
	GS F322	Critical Analysis of Literature and Cinema	3	0	3
	HSS F221	Readings from Drama	3	0	3
	HSS F226	Postmodernism	3	0	3
	HSS F237	Contemporary Indian English Fiction	3	0	3
	HSS F316	Popular Literature and Culture of South Asia	3	0	3
	HSS F327	Contemporary Drama	3	0	3
	HSS F330	Appreciation of Art	3	0	3
	HSS F332	Cinematic Arts	3	0	3
	HSS F335	Literary Criticism	3	0	3
	HSS F336	Modern Fiction	3	0	3
	HSS F338	Comparative Indian Literature	3	0	3
	HSS F340	Postcolonial Literatures	3	0	3
	HSS F349	Ecocriticism	3	0	3
	HSS F399	Introduction to American Literature	3	0	3

Minor in Entrepreneurship					
Description	Entrepreneurship has tremendous impact on development of economy as well as society addressing various market & societal problems through continuous value creation in terms of innovations and job creation. The minor in entrepreneurship aims to equip students from different disciplines with better understanding of entrepreneurial process, necessary skills and experience to translate ideas into real innovative products/services to new entrepreneurial ventures. In this programme, hands-on experiential learning is emphasized giving students an opportunity to learn in a team environment, design innovative products/services and create their own businesses. This will motivate students to pursue entrepreneurship as their career choice.				
Courses & Units Required	**5 courses (min)** **15 units (min)**				
	Course Number	**Course Title**	**L**	**P**	**U**
Core Courses	BITS F468	New Venture Creation	3	0	3
	BITS F482 or ECON F414	Creating and Leading Entrepreneurial Organizations	3	0	3
	ECON F212	Fundamentals of Finance and Accounting	3	0	3
Electives (minimum of 2 courses and additional units required to make the total to 15)	BITS F322	Venture Team Development and Organization	3	0	3
	BITS F323	Venture Finance	3	0	3
	BITS F324	Strategy for Entrepreneurs	3	0	3
	BITS F325	New Product and Service Design	3	0	3
	BITS F326	Design Thinking for Innovation & Entrepreneurship	3	0	3
	BITS F427	Digital Marketing	3	0	3

Minor in Film and Media					
Description	Film and its derivative forms of media such as television and advertising are dominant cultural forces in the contemporary world. The minor in Film and Media aims to provide: i. An introduction to media studies with a specific focus on film studies ii. A basic introduction to Print and Digital Media including film making and film appreciation iii. Hands-on training in writing for media and film production				
Courses & Units Required	6 courses (min) 18 units (min)				
Core Courses	**Course number**	**Course Title**	**L**	**P**	**U**
	GS F223	Introduction to Mass Communication	3	0	3
	GS F244	Reporting and Writing for Media	3	0	3
	GS F322	Critical Analysis of Literature and Cinema	3	0	3
Elective Courses	GS F224	Print and Audio Visual Advertising	3	0	3
	GS F242	Cultural Studies	3	0	3
	GS F321	Mass Media Content and Design	3	0	3
	GS F343	Short Film and Video Production	3	0	3
	HSS F332	Cinematic Arts	3	0	3

Minor in Finance					
Description	The minor in Finance aims at providing the student a grounding in the basic concepts of accounting and finance so as to complement their existing disciplinary knowledge, enrich their educational experience, enable them to make better financial decisions, and expand their career opportunities. It will also give students an opportunity to learn more about investments and quantitative applications in finance.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course umber**	**Course Title**	**L**	**P**	**U**
	ECON F212	Fundamentals of Finance and Accounting	3	0	3
	FIN F315	Financial Management	3	0	3
Elective Courses	ECON F241	Econometric methods	3	0	3
	ECON F312	Money banking and Financial markets	3	0	3
	ECON F355	Business Analysis & Valuation	3	0	3
	ECON F411	Project Appraisal	3	0	3
	ECON F413	Financial Engineering	3	0	3
	FIN F242	Introduction to Financial Mathematics	3	0	3
	FIN F243	Functions & Working of Stock Exchanges	3	0	3
	FIN F311	Derivatives & Risk Management	3	0	3
	FIN F312	Fundamentals of Taxation and Audit	3	0	3
	FIN F313	Security Analysis & Portfolio Management	3	0	3
	FIN F314	Investment Banking & Financial Services	3	0	3
	FIN F414	Financial Risk Analytics and Management	3	0	3

Minor in Materials Science and Engineering					
Description	Materials Science and Engineering is an interdisciplinary subject that makes use of knowledge from Physics, Chemistry, Engineering, Mathematics, Biology and Biotechnology, but which has its own special character. It is always evolving – new and exciting materials such as nanomaterials, high-temperature and lightweight materials, green materials and sustainable biomaterials for tissue engineering are continually emerging. The field of Material Science combines a wide knowledge base and puts it to diverse practical and commercial use.				
Courses & Units Required	5 courses (min) 15 units (min)				
	Course Number	**Course Title**	**L**	**P**	**U**
Core Courses	CHE F243 / ME F213	Materials Science and Engineering	3 2	0 0	3 2
	MST F331	Materials Characterization	3	1	4
	MST F332	Materials Processing	3	0	3
Elective Courses	BITS F416	Introduction to Nanoscience	3	0	3
	CHE F433	Corrosion Engineering	3	0	3
	CHEM F223	Colloid and Surface Chemistry	3	0	3
	CHEM F326	Solid State Chemistry	3	0	3
	CHEM F336	Nanochemistry	3	1	4
	ME F452	Composite Materials and Design	3	0	3
	MST F333	Introduction to Biomaterials	3	0	3
	MST F334	Materials for Catalytic Applications	3	0	3
	MST F335	Coating and thin film technology	3	0	3
	MST F336	Glass Technology	3	0	3
	MST F337	Materials for Energy Applications	3	0	3
	MST F338	Metals and Alloys	3	0	3
	MST F339	Polymer Materials	3	0	3
	PHY F379	Thin Film Technology	3	0	3
	PHY F414	Physics of Advanced Materials	3	1	4
	PHY F416	Soft condensed Matter Physics	3	1	4

Minor in Philosophy, Economics, and Politics					
Description	The minor in *Philosophy, Economics & Politics & (PEP)* aims at introducing students to a wide range of approaches to understand the social and human world we live in and to develop skills useful for a range of career opportunities in national and international organizations. It would particularly interest and enthuse those students who wish to complement their core expertise in science and engineering with a good grasp of the humanities and social sciences. As a multi-disciplinary minor, this option will provide a judicious mix of knowledge in social sciences (economics, sociology and politics) and the humanities (philosophy) that would enable students to draw connections among political, economic, and social phenomena as well as equip them with the necessary skills to think through complex challenges of our society in a creative and critical manner.				
Courses & Units Required	6 courses (min) 18 units (min)				
	Course umber	**Course Title**	**L**	**P**	**U**
Core Courses	ECON F211	Principles of Economics	3	0	3
	GS F211	Modern Political Concepts	3	0	3
	HSS F235	Introductory Philosophy	3	0	3
Elective Courses	BITS F 385	Introduction to Gender Studies	3	0	3
	GS F231	Dynamics of Social Change	3	0	3
	GS F234	Development Economics	3	0	3
	GS F243	Current Affairs	3	0	3
	GS F312	Applied Philosophy	3	0	3
	GS F313	Marxian Thoughts	3	0	3
	GS F332	Contemporary India	3	0	3
	GS F333	Public Administration	3	0	3
	HSS F236	Symbolic Logic	3	0	3
	HSS F315	Society, Business, and Politics	3	0	3
	HSS F322	Social and Political Ecology	3	0	3
	HSS F331	Sankara's Thoughts	3	0	3
	HSS F333	Comparative Religion	3	0	3
	HSS F343	Professional Ethics	3	0	3
	HSS F345	Gandhian Thoughts	3	0	3
	HSS F346	International Relations	3	0	3
	HSS F350	Human Rights: History, Theory and Practice	3	0	3
	HSS F353	Philosophy of Aesthetics	3	0	3
	HSS F354	Introduction to Islamic Economy	3	0	3
	HSS F355	Dictatorship, Democracy & Development	3	0	3
	HSS F356	Social Movements and Protest Politics	3	0	3

Minor in Physics					
Description	The theories in physics are all-pervading and their applications are found in varied branches of engineering and sciences. The minor in Physics aims to introduce the student to fundamental theories in physics. The core courses cover the basics and by choosing from the large pool of electives, the student will be able to pursue to a deeper level the areas of her/his interest. This minor would equip the students with the skill and knowledge which will help them in gaining insights in their own primary area of study.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course Number**	**Course Title**	**L**	**P**	**U**
	PHY F212 **or** ECE F212/ EEE F212/ INSTR F212	Electromagnetic Theory – 1 **or** Electromagnetic Theory	3	0	3
	PHY F242	Quantum Mechanics – 1	3	0	3
	PHY F312	Statistical Mechanics	3	0	3
Elective Courses	BITS F316	Nonlinear Dynamics and Chaos	3	0	3
	BITS F386	Quantum Information and Computing	3	0	3
	PHY F211	Classical Mechanics	3	1	4
	PHY F213	Optics	3	0	3
	PHY F214	Electricity Magnetism and Optics Lab	0	2	2
	PHY F215	Introduction to Astronomy and Astrophysics	3	0	3
	PHY F241	Electromagnetic Theory – 2	3	1	4
	PHY F243	Mathematical Method of Physics	3	0	3
	PHY F244	Modern Physics Lab	0	2	2
	PHY F311	Quantum Mechanics – 2	3	0	3
	PHY F313	Computational Physics	3	0	3
	PHY F315	Theory of Relativity	3	0	3
	PHY F341	Solid State Physics	3	0	3
	PHY F342	Atomic and Molecular Physics	3	0	3
	PHY F343	Nuclear and Particle Physics	3	0	3
	PHY F418	Lasers and Applications	3	1	4
	PHY F426	Physics of Semiconductors Devices	3	1	4
	PHY F427	Atmospheric Physics	3	0	3

Minor in Public Policy					
Description	The Minor in Public Policy aims at providing the students a clear and contextualised understanding of conceptual and empirical aspects of public policy, the nature of public policy interventions in India and their varying impacts. Also, it intends to provide the students an understanding of the dynamics of policymaking, central aspects of governance and core features and functions of institutions, and equip them with skills of policy analysis.				
Courses & Units Required	5 courses (min) 15 units (min)				
Core Courses	**Course umber**	**Course Title**	**L**	**P**	**U**
	GS F233	Public Policy	3	0	3
	GS F333	Public Administration	3	0	3
Elective Courses	HSS F232	Introduction to Development Studies	3	0	3
	HSS F317	Introduction to Globalisation	3	0	3
	HSS F322	Social and Political Ecology	3	0	3
	HSS F361	Urban Policy and Governance	3	0	3
	HSS F362	Local Governance and Participation	3	0	3

HIGHER DEGREE PROGRAMMES

A. Requirements

(i) M. E. and M. Pharm:

The following structure and requirements are:

1. (a) at least 12 courses and at least 48 credit units attributed to coursework; and

   (b) In addition, a Practice School (of at least 5½ months duration and 20 units) or a Dissertation (of at least 1 semester duration and 16 credit units)

2. A 4 unit course on Research Practice is mandatory for all students

   o BITS G540 Research Practice

3. Each Department may stipulate - for ea–h program a set of 4 to 5 courses (of at least 16 units and at most 20 units) per semester.

   (a) This adds up to at least 12 courses and at least 48 units of coursework but with a maximum of 15 courses and at most 60 units of coursework stipulated by the Department.

   (b) The nominal chart for a program would be as follows:

Year	I Semester	II Semester
I year	4 to 5 courses (16 to 20 units)	4 to 5 courses (16 to 20 units)
II year	4 to 5 courses (16 to 20 units)	PS / Dissertation

4. Each Department may identify one-third (1/3) to one-half (1/2) of the coursework requirement for each program as the Core Requirement.

   (a) The Core Requirement is mandatory for all students in the program.

   (b) The Core Requirement will be common across all campuses of BITS offering the same program.

5. Rest of the coursework requirement – other than the Core Requirement and the Research Practice course – may be met by electives of each student's choice.

   (a) The student must choose such electives from a Pool of Electives listed for the specific program.

   (b) The Pool of Electives may vary from campus to campus.

6. Each course in the Core Requirement or in the List of Electives must be a graduate level (5th or 6th level) course or an advanced under-graduate course (4th level) with the restriction that a student may use at the most two 4th level courses to meet the requirements in above.

7. Each Department in each campus may decide the scheduling of Core / Elective courses as per the above chart as deemed fit.

8. A student may choose to overload his/her coursework by at most one course – carrying not more than 5 units - per se–ester:

   (a) Such courses may be chosen from one of the following

(i) the pool of courses listed as Electives for the program being pursued

   (ii) a general pool of courses listed as Graduate Level Electives available for all higher degree programs

   (iii) any other course under the conditions that the stipulated pre-requisites are met and that the Head of the Department of the student and Head of the Department offering the course both provide their consent

   (b) Such courses may not be counted towards the requirement stated in 1.(a) above.

9. A student who wants to pursue Dissertation may choose between doing the Dissertation on campus and doing the Dissertation in an external industrial /

research organization. The Department must identify such locations/ organizations as suitable for a student pursuing Dissertation in that discipline. If a student exercises the option of doing his/her Dissertation in an organization other than BITS, then the Department must identify a co-supervisor for the student from within the Department.

10. The Dissertation will carry 16 credit units for the nominal duration of 1 semester.
    - o During this semester a student may not be permitted to do coursework.
    - o A student –with the consent of the Department - may ex–end the duration of the Dissertation over two semesters while concurrently doing coursework during the semester.
    - o If the student exercises option (b) then the total weight of the Dissertation will not exceed 25 credit units.
11. In addition to the above courses, the higher degree students will be required to register in the following course, unless the student clears a diagnostic test specially designed for the same.

    BITS F437 Technical Communication 3 0 3

(ii) MPH:

Total number of units required – 60 (Minimum) with a breakup as follows:

(a) Dissertation: 15 (Min) – 25 (Max) Units

OR

Practice School : 20 units

(b) Course work : 35 (Min) units

(other than Dissertation/Practice School)

Courses for the course work will be chosen from the list of Core and elective courses earmarked for each degree. Total number of courses is thirteen. In addition to these thirteen courses all the students are required to do one course on Technical Communication and two courses on Research Practice.

There is also a flexibility for students of Higher Degree Programmes to register in upto a maximum of one more elective, in addition to the prescribed number of electives. The grade obtained in the additional elective will also be counted towards the CGPA but cannot be used to meet the category-wise requirements of the degree. This additional elective can be from the pool of electives of the concerned degree or courses from other disciplines' Core and electives with the permission of HoD of the program pursued by the student and the HoD offering the course.

(iii) M.Phil.:

Total number of units required - 50 (Mi–imum) with a breakup as follows:

(a) Dissertation : 12 (Min.) - 25 (Ma–.) units

OR

Practice School : 20 units

(b) Course work : 25 units (min.)

(other than Dissertation/Practice School)

The courses for course work can be chosen from a list of General/Special courses earmarked for the degree. Wherever there is a need, courses can also be drawn from across the course offerings in various Higher Degree programmes as well as advanced First Degree level, provided the students are adequately prepared for the particular course.

(iv) M.B.A.: The course requirements of the MBA programme are spelt out in terms of courses belonging to different categories in the table below:

Category	No. of Units Required	No. of Courses Required
Core Courses	40-60	15-20
Elective(s)	12-18	4-6
Subtotal	55 (Min)	20 (Min)
PS OR Dissertation	20 16	1
Total	70 (Min)	21 (Min)

Courses for the course work will be chosen from the list of Core and elective courses earmarked for the MBA degree.

Dissertation: Normal registration for dissertation is after completion of course work. Normally 16 units of Dissertation will be assigned at the time of this registration. In case of programmes other than MBA, units upto a maximum of 25 may be permitted depending on

the total time and work put in by an individual student and the registration in more than 16 units of Dissertation will be normally available only to students who have taken higher degree courses as electives in their first degree programmes or to professionals who have shown competence in some specialized courses through their professional involvement. Concurrent registration for a nominal 8 units per semester in Dissertation with course work is also permissible for motivated, well-prepared and hardworking students. Provision exists for the Dissertation to be carried out as work-integrated dissertation at recognized off-campus centres or in an organization where the student may get employment, subject to all the stipulations of Academic Regulations.

Practice School: Registration for Practice School is possible only after the completion of all course work. Concurrent registration of other courses with Practice School is not permitted. All clauses of Academic Regulations applicable to first degree PS courses will govern the operation of this Practice School also.

B. First Degree students seeking Higher Degree admission

A first degree student can choose upto a maximum of two higher degree courses as electives for his/her first degree from the pool of general/special courses of the corresponding higher degree. When such a student seeks admission to any of the Higher Degree programme of the institute, the student may be given exemption from these courses; however, the student will have to complete the total unit requirements of the higher degree. The minimum units in Dissertation for such a candidate will be increased by the same number of units as exempted from the course work so as to earn the minimum prescribed total units.

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester

Year	First Semester		U	Second Semester		U
M.E. Biotechnology						
I	BIO G512	Molecular Mechanism of Gene Expression	5	BITS G540	Research Practice	4
				BIO G524	Animal Cell Technology	5
	BIO G542	Advanced Cell and Molecular Biology	5	BIO G643	Plant Biotechnology	5
					Elective	*
	BIO G525	Environmental Biotechnology and Waste Management	5		Elective	*
		Elective	*			
			18			20
II	BIO G523	Advanced and Applied Microbiology	5	BITS G629T	Dissertation or	16 or
		Elective	*	BITS G639	Practice School	20
		Elective	*			
		Elective	*			
		Elective	*			
			17			16/20

M.E. Chemical* [The structure of this program is given in Page IV-104]								
Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	First Semester			U	Second Semester			U
M.E. Civil – Infrastructure Engineering and Management								
I	CE	G515	Fundamentals of Systems Engineering	4	BITS	G540	Research Practice	4
	CE	G523	Transportation Systems Planning and Management	4	CE	G520	Infrastructure Planning and Management	4
	CE	G525	Water Resources Planning and Management	4			Elective	*
	CE	G527	Construction Management	4			Elective	*
				16				14
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Structural Engineering								
I	CE	G551	Dynamics of Structures	4	BITS	G540	Research Practice	4
	CE	G552	Advanced Structural Mechanics and Stability	4	CE	G615	Earthquake Engineering	4
							Elective	*
	CE	G617	Advanced Structural Analysis	4			Elective	*
	CE	G619	Finite Element Analysis	5				
				17				14
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Transportation Engineering								
I	CE	G523	Transportation Systems Planning and Management	4	BITS	G540	Research Practice	4
					CE	G518	Pavement Analysis and Design	4
	CE	G534	Pavement Material Characterization	4	CE	G524	Urban Mass Transit Planning Operations and Management	4
	CE	G535	Highway Geometric Design	4			Elective	*
	CE	G536	Traffic Engineering and Safety	4				
				16				15
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Water Resource Engineering								
I	CE	G526	Systems Approach to Water Resources Modeling	4	BITS	G540	Research Practice	4
					CE	G558	Advanced Groundwater Hydrology	4
	CE	G555	Remote Sensing and GIS in Water Resources	4	CE	G559	Soft Computing in Water Resources	4
	CE	G556	Advanced Computational Hydraulics	4			Elective	*
	CE	G557	Stochastic Hydrology	4				
				16				15
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester							
Year	**First Semester**		**U**	**Second Semester**			**U**
M.E. Communication Engineering							
	EEE G613	Advanced Digital Signal Processing	5	BITS G540		Research Practice	4
	EEE G581	RF and Microwave Engineering	5	EEE G592		Mobile and Personal	
	EEE G612	Coding Theory and Practice	5			Communication	5
		Elective	*	EEE G622		Advanced Digital Communication	5
						Elective	*
			18				17
	EEE G591	Optical Communication	5	BITS G629T		Dissertation	16
		Elective	*			or	Or
		Elective	*	BITS G639		Practice School	20
		Elective	*				
			14				16/20
M.E. Computer Science							
	CS G525	Advanced Computer Networks	5	BITS G540		Research Practice	4
	CS G526	Advanced Algorithms and		CS G513		Network Security	4
I		Complexity	5	CS G524		Advanced Computer Architecture	5
	CS C623	Advanced Operating Systems	5			Elective	*
		Elective	*				
			18				16
		Elective	*	BITS G629T		Dissertation	16
		Elective	*			or	Or
II		Elective	*	BITS G639		Practice School	20
		Elective	*				
			12				16/20
M.E. Electrical – Power Electronics and Drives							
	EEE G542	Power Electronics Converter	5	BITS G540		Research Practice	4
	EEE G541	Distribution Apparatus and		EEE G545		Control and Instrumentation Systems	5
I		Configuration	5	EEE G552		Solid State Drives	5
	EEE G543	Power Devices microelectronics				Elective	*
		and selection	3				
		Elective	*				
			18				17
	EEE G546	System Simulation	5	BITS G629T		Dissertation	16
		Elective	*			or	Or
II		Elective	*	BITS G639		Practice School	20
		Elective	*				
			14				16/20
M.E. Embedded Systems							
	BITS G553	Real Time Systems	5	BITS G540		Research Practice	4
	EEE G512	Embedded System Design	4	CS G523		Software for Embedded Systems	5
I		Elective	*	MEL G642		VLSI Architecture	5
		Elective	*			Elective	*
			17				18
	EEE G626	Hardware Software Co-Design	5	BITS G629T		Dissertation	16
		Elective	*			or	Or
II		Elective	*	BITS G639		Practice School	20
		Elective	*				
			17				16/20

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	**First Semester**			**U**	**Second Semester**			**U**
M.E. Electronics & Control								
I	EEE	G559	Advanced Power Electronics	5	BITS	G540	Research Practice	4
	EEE	G621	Advanced Electronic Circuits	5	EEE	G512	Embedded System Design	5
	INSTR	G611	Advanced Control Systems	5	EEE	G552	Solid State Drives	5
				15				14
II	EEE	G546	Systems Simulation Lab	4			Elective	*
			Elective	*			Elective	*
			Elective	*			Elective	*
				10				9
III	BITS	G629T	Dissertation	16				
			or	or				
	BITS	G639	Practice School	20				
				16/20				
M.E. Microelectronics								
I	MEL	G611	IC Fabrication Technology	5	BITS	G540	Research Practice	4
	MEL	G621	VLSI Design	5	MEL	G632	Analog IC Design	5
	MEL	G631	Physics & Modeling of		MEL	G641	CAD for IC Design	5
			Microelectronic Devices	5			Elective	*
			Elective	*				
				19				18
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				13				16/20
M.E. Manufacturing Systems Engineering								
I	EA	C412	Flexible Manufacturing Systems	4	BITS	G540	Research Practice	4
	ME	C443	Quality Control Assurance and		MSE	G512	Manufacturing Planning and	
			Reliability	3			Control	5
	ME	G511	Mechanism and Robotics	5			Elective	*
			Elective	*			Elective	*
				15				15
II	MSE	G521	World Class Manufacturing	5	BITS	G629T	Dissertation	16
	ITEB	G621	Supply Chain Management	4			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				15				16/20
M.E. Mechanical Engineering								
I	ME	C443	Quality Control Assurance and					
			Reliability	3	BITS	G540	Research Practice	4
	ME	G511	Mechanism and Robotics	5	ME	G611	Computer Aided Analysis and	
	ME	G512	Finite Element Methods	5			Design	5
			Elective	*			Elective	*
							Elective	*
				16				15
II	ME	G532	Machine Tool Engineering	5	BITS	G629T	Dissertation	16
	ME	G641	Theory of Elasticity and plasticity	5			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
M.E. Design Engineering								
I	DE	G631	Materials Testing and Technology	5	BITS	G540	Research Practice	4
	ME	G511	Mechanism and Robotics	5	ME	G611	Computer Aided Analysis and Design	5
	ME	G512	Finite Element Methods	5			Elective	*
			Elective	*			Elective	*
				18				15
II	DE	G531	Product Design	5	BITS	G629T	Dissertation	16
	DE	G611	Dynamics and Vibration	5			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20
M.E. Thermal Engineering								
I	BITS	C462	Renewable Energy	3	BITS	G540	Research Practice	4
	ME	G533	Conduction and Radiation Heat Transfer	5	ME	G535	Convective Heat and Mass Transfer	5
							Elective	*
	ME	G621	Fluid Dynamics	5			Elective	*
			Elective	*				
				16				15
II	ME	G514	Turbomachinery	5	BITS	G629T	Dissertation	16
	ME	G515	Computational Fluid Dynamics	5			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20
M. Pharma. Pharmacy								
I	PHA	G532	Quality Assurance and Regulatory Affairs	5	BITS	G540	Research Practice	4
					PHA	G611	Advanced Pharmacology	5
	PHA	G543	Clinical Research	5	PHA	G621	Advanced Medicinal Chemistry	5
	PHA	G612	Pharmacokinetics and Clinical Pharmacy	5	PHA	G632	Dosage Form Design	5
			Elective	*				
				18				19
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20

Semester-wise Pattern for Students Admitted to M. E. Sanitation Science, Technology and Management Programme in First Semester								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	SAN	G511	Sanitation Technology	5	SAN	G514	Sanitation financing and Project Management	5
	SAN	G512	Sanitation and Public Health	5	SAN	G515	Emergency Sanitation & Leadership	5
	SAN	G513	Sanitation Governance, Behaviour change and Advocacy	5	BITS	G540	Research Practice	4
			Elective I	*			Elective II	*
				18				**17**
	BITS	G562T	Dissertation	16	BITS	G563T	Dissertation	16
				16				**16**

** Minimum 3 Units*

This is the semester-wise pattern for students admitted in the given programme in First semester under track 3 option of Higher Degree programme (Page IV-109). It may be noted that the track 3 option of Higher degree structure is available in the bulletin with 1 year course work and 1 year dissertation. The Academic Governing Committee (AGC) may also look at offering this programme under track 1 and track 2 of structure of Higher degree programmes, if there is a need in future and report back to the Senate.

M. Pharma. Pharmacy – Pharmaceutics							
I	PHA G532	Quality Assurance and Regulatory Affairs	5	BITS G540	Research Practice		4
	PHA G543	Clinical Research	5	PHA G632	Dosage Form Design		5
	PHA G612	Pharmacokinetics and Clinical Pharmacy	5		Elective		*
	PHA G542	Advanced Physical Pharmaceutics	5		Elective		*
			20				15
II	PHA G617	Advanced Drug Delivery Systems	5	BITS G629T	Dissertation		16
		Elective	*		or		or
		Elective	*	BITS G639	Practice School		20
		Elective	*				
			14				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester							
Year	**First Semester**		**U**	**Second Semester**			**U**
M. Pharma. Pharmacy – Pharmaceutical Chemistry							
I	PHA G522	Chemistry of Macromolecules	4	BITS G540	Research Practice		4
	PHA G532	Quality Assurance and Regulatory Affairs	5	PHA G611	Advanced Pharmacology		5
	PHA G541	Computer Aided Drug Design	5	PHA G621	Advanced Medicinal Chemistry		5
	PHA G543	Clinical Research	5		Elective		*
			19				17
II		Elective	*	BITS G629T	Dissertation		16
		Elective	*		or		or
		Elective	*	BITS G639	Practice School		20
		Elective	*				
			12				16/20
M.E. Software System							
I	CS F415	Data Mining	3	BITS G540	Research Practice		4
	SS G514	Object Oriented Analysis and Design	4	SS G515	Data Ware Housing		5
	SS G562	Software Engineering and Management	5	SS G653	Software Architecture		5
		Elective	*		Elective		*
			15				17
II		Elective	*	BITS G629T	Dissertation		16
		Elective	*		or		or
		Elective	*	BITS G639	Practice School		20
		Elective	*				
			12				16/20

Master of Business Administration								
	MBA	C312	Managerial Economics	3	MBA	C319	Negotiation Skills & Techniques	2
	MBA	C314	Business Structure & Processes	3	MBA	C412	Human Resource Management	4
	MBA	C320	Managerial Skills	2	MBA	C416	Corporate Finance & Taxation	4
	MBA	C321	Legal and Economic Environment of Business	4	MBA	C418	Marketing	4
	MBA	C322	Management Framework and Functions	2	MBA	C419	Production & Operations Management	4
I	MBA	C411	Organizational Behaviour	4	MBA	C421	Supply Chain Management	4
	MBA	C413	Quantitative Methods	4	MBA	C471	Management Information Systems	3
	MBA	C415	Financial & Management Accounting	4				
	MBA	C431	Managerial Communication	2				
				28				25
	MBA	C422	Business and Society	4	BITS	G561	Dissertation	16
	MBA	C423	Business Policy & Strategic Management	4			or	or
	MBA	C424	International Business	3	BITS	G560	Practice School	20
II			Elective	*				
			Elective	*				
			Elective	*				
			Elective	*				
				23				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	**First Semester**			**U**	**Second Semester**			**U**
Master in Public Health								
	MPH	G510	Biostatistics & Computers in Public Health	5	MPH	G661	Research Methodology I	5
					MPH	G521	Health Care Management	4
	MPH	G512	Environmental and Occupational Health	4	MPH	G522	Preventive Nutrition & Health Promotion	4
I	MPH	G513	Public Health & Diseases	4	MPH	G523	Epidemic & Disaster Management	4
	BITS	G515	Management Principles and Practices	4	MPH	G692	Epidemology	2
					MPH	G613	Health System and Society	2
	BITS	F437	Technical Communication	3				
				20				21
	BITS	G540	Research Practice	4	BITS	G629 T	Dissertation	16
	MPH	G531	Health Economics & Financial Management	4			or	or
II					BITS	G639	Practice School	20
			Elective	*				
			Elective	*				
			Elective	*				
				17				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Phil. Chemistry Programme in First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BITS	G659	Technical Communication	4	BITS	G620	Professional Practice I	3
	CHEM	G551	Advanced Organic Chemistry	5	CHEM	G552	Advanced Inorganic Chemistry	5
	CHEM	G553	Advanced Physical Chemistry	5	CHEM	G554	Physical Methods in Chemistry	5
	CHEM	G555	Chemistry of Life Processes	4			Elective	3
				18				16
II	BITS	G621	Professional Practice II	3	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20

** Minimum 3 units*

Note: This is a currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Phil. in Liberal Studies Programme in First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	HSS	G511	Philosophical Foundations of Liberal Studies	5	BITS	G661	Research Methodology I	5
	HSS	G512	Theoretical Approaches to Liberal Studies	5	BITS	E583	Case studies I	5
	BITS	G518	Writing Seminar	5			Elective II	*
			Elective I	*			Elective III OR	5
				18			Dissertation (5 Unit)	**18**
II	BITS	G561T	Dissertation	16				
				16				

** Minimum 3 Units*

While the above semester-wise pattern shows a 3-semester structure, a meritorious student may be able to complete the programme in 2 semesters and an additional summer term. In such a case, a partial dissertation of 5 units may be taken in place of Elective 3. This will be followed by a Dissertation of 10 units during the summer term.

Semester-wise Pattern for Students Admitted to M. E. Computer Science with Specialization in Information Security with B.Sc. input									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	CS	F111	Computer Programming	4	MGTS	F211	Principles of Management	3
	BITS	F437	Technical Communication	3	MATH	F212	Optimization	3
	MATH	F113	Probability and Statistics	3	BITS	F463	Cryptography	3
	CS	F215	Digital Design	4	BITS	F345	Information Law and	
	CS	F222	Discrete Structures for				Cyber Law	3
			Computer Science	3	IS	F242	Computer Organization	4
	MATH	F231	Number Theory	3	CS	F211	Data Structures & Algorithms	4
				20				20
Summer	CS	F404	Computer Crime and Forensics					2
	CS	F213	Object Oriented Programming					4
	CS	F468	Information Security Project					3
								9
II	CS	F351	Theory of Computation	3	CS	F303	Computer Networks	4
	CS	F372	Operating Systems	3	CS	F212	Database Systems	4
	IS	F341	Software Engineering	4	CS	G517	Network and System Security	4
	CS	G524	Advanced Computer Architecture	5	CS	F364	Design and Analysis of Algorithms	3
	CS	F301	Principles of Programming Languages	2	CS	F406	Ethical Hacking	2
							Elective	*
			Elective	*				
				20 (min)				20 (min)
Summer	CS	G566	Secure Software Engineering					5
	CS	F468	Information Security Project					3
			Elective					*
								11 (min)
III	CS	G623	Advanced Operating Systems	5	BITS	G639	Practice School	20
	CS	G525	Advanced Computer					
			Networks	5				
	CS	G526	Advanced Algorithms and		Or			Or
			Complexity	5				
	BITS	G540	Research practice	4				
					BITS	G629T	Dissertation	16
			Elective	*				
				20 (min)				16 (min)

** Minimum 3 units*

Note: This is a currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

LIST OF COURSES FOR M.E./M.PHARM./ MBA PROGRAMMES:

Biotechnology

Core Courses

BIO G512	Molecular Mechanism of Gene Expression	5
BIO G523	Advanced and Applied Microbiology	5
BIO G524	Animal Cell Technology	5
BIO G525	Environmental Biotechnology and Waste Management	5
BIO G542	Advanced Cell and Molecular Biology	5
BIO G643	Plant Biotechnology	5

Elective Courses (any seven)

BIO F242	Introduction to Bioinformatics	3 0 3
BIO F417	Biomolecular Modeling	3 0 3
BIO F418	Genetic Engineering Techniques	1 3 4
BIO F421	Enzymology	3 0 3
BIO F441	Biochemical Engineering	3 0 3
BIO G510	Application of Computers and Statistics in Biology	5
BIO G513	Microbial and Fermentation Technology	3 2 5
BIO G514	Molecular Immunology	3 2 5
BIO G515	Stem Cell and Regenrative Biology	3 1 4
BIO G522	Interferon Technology	3 1 4
BIO G526	Cancer Biology	3 2 5
BIO G532	Biostatistics and Biomodelling	3 1 4
BIO G544	Bioremediation and bio-metallurgy	5
BIO G545	Molecular Parasitology & Vector Biology	5
BIO G561	Advances in Recombinant DNA Technology	3 2 5
BIO G570	Recent Developments in Biology	1 0 1
BIO G612	Human Genetics	3 2 5
BIO G631	Membrane and Liposome Technology	3 1 4
BIO G632	Transgenic Technology	3 2 5
BIO G642	Experimental Techniques	4*
BIO G651	Protein and Enzyme Bioengineering	3 2 5
BIO G661	Gene Toxicology	3 1 4
BIO G671	Bioconversion Technology	3 2 5
BIOT F422	Nanobiotechnology	3 0 3
BITS F418	Introduction to Biomedical Engineering	3 1 4
BITS F467	Bioethics and Biosafety	3 0 3

BIO G510 Application of Computers and Statistics in Biology (5) may be required to be completed as a deficiency course for ME Biotechnology Programme.

Chemical

Core Courses

CHE G523	Mathematical Methods in Chemical Engineering	5
CHE G613	Advanced Mass Transfer	5
CHE G614	Advanced Heat Transfer	5
CHE G622	Advanced Chemical Engineering Thermodynamics	5
CHE G641	Reaction Engineering	5

Elective Courses (any six)

BIO G544	Bioremediation and Biometallurgy	5
BITS F318	Science and Engineering of Solid Surfaces	3 0 3
BITS F418	Introduction to Biomedical Engineering	3 1 4
BITS F429	Nanotechnology for Renewable Energy and Environment	3 1 4
CHE F413	Process Plant Safety	3 0 3
CHE F421	Biochemical Engineering	3 0 3
CHE F423	Membrane Science and Engineering	3 0 3
CHE F424	Rheology of complex fluids	3 0 3
CHE F471	Advanced Process Control	3 0 3
CHE G512	Petroleum Refining and Petrochemicals	3 1 4
CHE G513	Environmental Management Systems	3 2 5
CHE G522	Polymer Technology	3 1 4
CHE G524	Introduction to Multiphase flow	3 1 4
CHE G525	Chemical Process and Equipment Design	3 1 4
CHE G526	Nuclear Engineering	3 1 4
CHE G527	Energy Conservation and Management	3 1 4
CHE G528	Introduction to Nano Science & Technology	3 1 4
CHE G529	Paper and Pulp Technology	3 1 4
CHE G532	Alternate Energy Resources	3 1 4
CHE G533	Petroleum Product Characterization	3 2 5
CHE G551	Advanced Separation Technology	3 2 5
CHE G553	Statistical Thermodynamics	4
CHE G554	Computational Fluid Dynamics	4
CHE G556	Electrochemical Engineering	4
CHE G557	Energy Systems Engineering	4
CHE G558	Chemical Process Optimization	4
CHE G568	Modeling and Simulation in Petroleum Refining	4
CHE G617	Petroleum Refinery Engineering	3 2 5
CHE G618	Petroleum Downstream Processing	3 2 5
CHE G619	Process Intensification	3 2 5
CHE G620	Energy Integration Analysis	3 2 5

Chemical with Specialization in Petroleum Engineering

Core Courses

CHE G523	Mathematical Methods in Chemical Engineering	5
CHE G616	Petroleum Reservoir Engineering	5
CHE G617	Petroleum Refinery Engineering	5
CHE G618	Petroleum Downstream Processing	5
CHE G622	Advanced Chemical Engineering	5

	Thermodynamics	
CHE G641	Reaction Engineering	5

Elective Courses (any six)

BIO G544	Bioremediation and Biometallurgy	5
BITS F418	Introduction to Biomedical Engineering	3 1 4
CHE F471	Advanced Process Control	3 1 4
CHE G511	Fluidization Engineering	3 1 4
CHE G513	Environmental Management Systems	3 2 5
CHE G522	Polymer Technology	3 1 4
CHE G532	Alternate Energy Resources	3 1 4
CHE G533	Petroleum Product Characterization	3 2 5
CHE G551	Advanced Separation Technology	3 2 5
CHE G567	Natural Gas Processing	4
CHE G568	Modeling and Simulation in Petroleum Refining	4
CHE G569	Petroleum Production Economics	4
CHE G613	Advanced Mass Transfer	3 2 5
CHE G614	Advanced Heat Transfer	3 2 5
CHE G619	Process Intensification	3 2 5
CHE G620	Energy Integration Analysis	3 2 5

Civil with Specialization in Infrastructure Engineering and Management

Core Courses

CE G515	Fundamentals of Systems Engineering	4
CE G520	Infrastructure Planning and Management	4
CE G523	Transportation Systems Planning and Management	4
CE G525	Water Resources Planning and Management	4
CE G527	Construction Management	4

Elective Courses (any six)

BITS F469	Financing Infrastructure Projects	3 0 3
BITS F474	Rural Infrastructure Planning	3 0 3
BITS F494	Environmental Impact Assessment	3 1 4
CE F431	Principles of Geographical Information System	3 0 3
CE F433	Remote Sensing and Image Processing	3 0 3
CE G512	Topics in Environmental Engineering	3 1 4
CE G513	Advanced Computational Techniques	3 1 4
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G517	Waste Management Systems	3 1 4
CE G518	Pavement Design & Analysis	3 1 4
CE G522	Pavement Design, Maintenance and Management	3 2 5
CE G524	Urban Mass Transit Planning, Operations and Management	3 1 4
CE G526	Systems Approach to Water Resources Modelling	3 1 4
CE G528	Selection of Construction Equipment and Modelling	3 1 4
CE G529	Construction Project Control Systems	3 1 4
CE G530	Design of Construction Operation	3 1 4
CE G531	Environmental Conservation	3 1 4
CE G533	Advanced Composite Materials for Structures	3 1 4
CE G537	Transportation Economics and Finance	3 1 4
CE G538	Project Planning & Management	3 1 4
CE G542	Water Resources and Management	3 1 4
CE G545	Airport Planning & Design	3 1 4
CE G562	Advanced Concrete Technology	3 1 4
CE G563	Stochastic Methods in Civil Engineering	3 1 4
CE G564	Structural Health Assessment and Rehabilitation	3 1 4
CE G610	Computer Aided Analysis and Design in Civil Engineering	3 2 5
CE G614	Prestressed Concrete	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G618	Design of Multi-storey Structures	3 1 4
CE G619	Finite Element Analysis	5
CE G632	Design of Foundation for Dynamic Loads	3 1 4

Civil with Specialization in Structural Engineering

Core Courses

CE G551	Dynamics of Structures	4
CE G552	Advanced Structural Mechanics and Stability	4
CE G615	Earthquake Engineering	4
CE G617	Advanced Structural Analysis	4
CE G619	Finite Element Analysis	5

Elective Courses (any six)

CE G511	Matrix Method in Civil Engineering	3 2 5
CE G513	Advanced Computational Techniques	3 1 4
CE G514	Structural Optimization	3 1 4
CE G521	Topics in Structural Engineering	3 2 5
CE G532	Advanced Soil Mechanics	3 1 4
CE G533	Advanced Composite Materials for Structures	3 1 4
CE G544	Fracture Mechanics of Concrete Structures	3 1 4
CE G553	Theory of Plates and Shells	3 1 4
CE G554	Advanced Structural Design	3 1 4
CE G562	Advanced Concrete Technology	4
CE G563	Stochastic Methods in Civil Engineering	3 1 4
CE G564	Structural Health Assessment and Rehabilitation	3 1 4
CE G610	Computer Aided Analysis and Design in Civil Engineering	3 2 5
CE G611	Computer Aided Analysis and Design	3 2 5

CE G612	Advanced Steel Structures	3 1 4
CE G613	Advanced Concrete Structures	3 1 4
CE G614	Prestressed Concrete Structures	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G618	Design of Multi-storey Structures	3 1 4
CE G620	Advanced Foundation Engineering	3 1 4
CE G621	Fluid Dynamics	3 2 5
CE G622	Soil-Structure Interaction	3 1 4
CE G623	Ground Improvement Techniques	3 1 4
CE G631	Selected Topics in Soil Mechanics and Geotechnical Engineering	3 1 4
CE G632	Design of Foundation for Dynamic Loads	3 1 4
CE G641	Theory of Elasticity and Plasticity	3 2 5

Civil with Specialization in Transportation Engineering

Core Courses

CE G518	Pavement Analysis and Design	4
CE G523	Transportation Systems Planning and Management	4
CE G524	Urban Mass Transit Planning Operations and Management	4
CE G534	Pavement Material Characterization	4
CE G535	Highway Geometric Design	4
CE G536	Traffic Engineering and Safety	4

Elective Courses (any six)

BITS F494	Environmental Impact Assessment	3 1 4
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G520	Infrastructure Planning and Management	3 1 4
CE G528	Selection of Construction Equipment and Modeling	3 1 4
CE G537	Transport Economics and Finance	3 1 4
CE G538	Project Planning & Management	3 1 4
CE G539	Introduction to Discrete Choice Theory	4*
CE G543	Traffic Flow Theory	3 1 4
CE G545	Airport Planning and Design	3 1 4
CE G546	Highway Construction Practices	3 1 4
CE G547	Pavement Failures, Evaluation and Rehabilitation	3 1 4
CE G548	Pavement Management Systems	3 1 4
CE G549	Rural Road Technology	3 1 4
CE G563	Stochastic Methods in Civil Engineering	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G619	Finite Element Analysis	3 2 5
CE G632	Design of Foundation for Dynamic Loads	3 1 4

Civil with Specialization in Water Resource Engineering

Core Courses

CE G526	Systems Approach to Water Resources Modeling	4
CE G555	Remote Sensing and GIS in Water Resources	4
CE G556	Advanced Computational Hydraulics	4
CE G557	Stochastic Hydrology	4
CE G558	Advanced Groundwater Hydrology	4
CE G559	Soft Computing in Water Resources	4

Elective Courses (any five)

BITS F494	Environmental Impact Assessment	3 1 4
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G517	Waste Management Systems	3 1 4
CE G525	Water Resources Planning and Management	3 1 4
CE G560	Hydrologic Simulation Laboratory	4
CE G561	Impact of Climate Change on Water Resources and Environment	4
CE G621	Fluid Dynamics	3 2 5

Communication Engineering

Core Courses

EEE G581	RF and Microwave Engineering	5
EEE G591	Optical Communication	5
EEE G592	Mobile and Personal Communication	5
EEE G612	Coding Theory and Practice	5
EEE G613	Advanced Digital Signal Processing	5
EEE G622	Advanced Digital Communication	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	4
BITS G553	Real Time Systems	3 1 4
BITS G554	Data Compression	3 1 4
CS F303	Computer Networks	3 0 3
CS F401	Multimedia Computing	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G555	System Specification and Modeling	3 3 4
EEE F414	Telecommunication Switching Systems and Networks	3 0 3
EEE F472	Satellite Communication	3 0 3
EEE F474	Antenna Theory and Design	3 1 4
EEE G510	RF Microelectronics	5
EEE G512	Embedded System Design	3 1 4
EEE G521	Optoelectronic Devices, Circuits and Systems	3 2 5
EEE G522	Advanced Satellite Communication	5*
EEE G582	Telecom Network Management	3 2 5
EEE G613	Advanced Digital Signal Processing	5
EEE G626	Hardware Software Co-Design	4

EEE G627	Network Embedded Application	4
EEE G641	Applied Estimation Theory	3 2 5
IS F462	Network Programming	3 0 3
MEL G621	VLSI Design	3 2 5
MEL G622	Introduction to Artificial Neural networks	2 2 4

Computer Science

Core Courses

CS G513	Network Security	4
CS G524	Advanced Computer Architecture	5
CS G525	Advanced Computer Networks	5
CS G526	Advanced Algorithms and Complexity	5
CS G623	Advanced Operating Systems	5

Elective Courses (any six)

BITS F464	Machine Learning	3 0 3
BITS G553	Real-Time Systems	5
CS F320	Foundations of Data Science	3 0 3
CS F401	Multimedia Computing	3 0 3
CS F402	Computational Geometry	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS F415	Data Mining	3 0 3
CS F422	Parallel Computing	3 0 3
CS F441	Selected topics from Computer Science	3
CS F446	Data Storage Technologies & Networks	3 0 3
CS F469	Information Retrieval	3 0 3
CS G513	Network Security	3 1 4
CS G520	Advanced Data Mining	3 1 4
CS G523	Software for Embedded Systems	3 2 5
CS G527	Cloud Computing	5
CS G541	Pervasive Computing	4
CS G551	Advance Compilation Techniques	5
CS G553	Reconfigurable Computing	5
CS G554	Distributed Data Systems	3 2 5
CS G568	Network Security Project	0 3 3
CS G612	Fault Tolerant System Design	2 3 5
EEE G512	Embedded System Design	3 1 4
EEE G582	Telecom Network management	5
EEE G627	Networked Embedded Applications	3 1 4
IS F462	Network Programming	3 0 3
SS G514	Object Oriented Analysis and Design	4
SS G515	Data Ware Housing	5
SS G552	Software Testing Methodologies	4
SS G562	Software Engineering and Management	5
SS G653	Software Architecture	5

Design Engineering

Core Courses

DE G531	Product Design	5
DE G611	Dynamics and Vibration	5
DE G631	Materials Testing and Technology	5
ME G511	Mechanism and Robotics	5
ME G512	Finite Element Methods	5
ME G611	Computer Aided Analysis and Design	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	3 1 4
DE G513	Tribology	3 2 5
DE G514	Fracture Mechanics	3 2 5
DE G522	Design Projects	3 2 5
ME F423	Micro Fluidics and its Application	4*
ME G515	Computational Fluid Dynamics	3 2 5
ME G521	Mechanical System Design	3 2 5
ME G532	Machine Tool Engineering	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G612	Plastics Engineering	3 2 5
ME G641	Theory of Elasticity and Plasticity	3 2 5
MSE G511	Mechatronics	3 2 5
MSE G531	Concurrent Engineering	3 2 5
MST G511	Nondestructive Testing Techniques	3 2 5
MST G522	Advanced Composites	3 2 5
MST G531	Experimental Stress Analysis Techniques	3 2 5

Electrical with specialization in Power Electronics & Drives

Core Courses

EEE G541	Distribution Apparatus and Configuration	5
EEE G542	Power Electronics Converter	5
EEE G543	Power Devices Microelectronics and Selection	3
EEE G545	Control and Instrumentation Systems	5
EEE G546	System Simulation Lab.	5
EEE G552	Solid State Drives	5

Elective Courses (any five)

BITS F462	Renewable Energy	3 0 3
CHE G526	Nuclear Engineering	3 1 4
EEE F422	Modern Control Systems	3 0 3
EEE F462	Advanced Power Systems	3 0 3
EEE G544	Steady State and Dynamics of Electrical Motors	3 2 5
EEE G553	Utility Applications of Power Electronics	3 0 3
EEE G554	Soft Switching Converter Technologies	3 0 3
EEE G555	Transformer and Motor Design	3 0 3
EEE G557	Drives for Electric Traction	3 0 3
EEE G558	DSP based Implementation Drivers	3 0 3
EEE G593	Power Quality	5
MEL G622	Introduction to Artificial Neural networks	2 2 4

Embedded Systems		
Core Courses		
BITS G553	Real Time Systems	5
CS G523	Software for Embedded Systems	5
EEE G512	Embedded System Design	3 1 4
EEE G626	Hardware Software Co-Design	5
MEL G642	VLSI Architecture	5
Elective Courses (any six)		
BITS F415	Introduction to MEMS	4
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G611	Distributed Processing Systems	2 2 4
CS G612	Fault Tolerant System Design	2 3 5
EEE F434	Digital Signal Processing	3 1 4
EEE G547	Device Drivers	3 2 5
EEE G594	Advanced VLSI Devices	5
EEE G595	Nanoelectronics and Nanophotonics	5
EEE G613	Advanced Digital Signal Processing	5
EEE G625	Safety Critical Embedded System Design	4
EEE G627	Network Embedded Application #	4
MEL G531	Testable Design and Fault Tolerant Computing	3 2 5
MEL G621	VLSI Design	3 2 5
MEL G622	Introduction to Artificial Neural networks	2 2 4
MEL G623	Advanced VLSI Design	5
MEL G624	Advanced VLSI Architectures	5
MEL G626	VLSI Test and Testability	5
MSE G511	Mechatronics	3 2 5
M.E. Electronics and Control		
Core Courses		
EEE G512	Embedded System Design	4
EEE G546	Systems Simulation Lab	4
EEE G552	Solid State Drives	5
EEE G559	Advanced Power Electronics	5
EEE G621	Advanced Electronic Circuits	5
INSTR G611	Advanced Control Systems	5
Elective Courses (any five)		
BITS F415	Introduction to MEMS	3 1 4
BITS G654	Advanced Instrumentation Techniques	5
EEE F422	Modern Control Systems	3 0 3
EEE G521	Optoelectronic Devices, Circuits & Systems	5
EEE G544	Steady State and Dynamics of Electric Motors	5
EEE G545	Control and Instrumentation Systems	5
EEE G553	Utility Applications of Power Electronics	3
EEE G554	Soft Switching Converter Technologies	3
EEE G556	DSP Based Control of Electric Drives	3
EEE G593	Power Quality	5
EEE G613	Advanced Digital Signal Processing	5
ME G516	Energy Systems Engineering	5
MSE G511	Mechatronics	3 2 5
Manufacturing Systems Engineering		
Core Courses		
BITS F431	Flexible Manufacturing Systems	4
ITEB G621	Supply Chain Management	4
ME F443	Quality Control Assurance and Reliability	3
ME G511	Mechanism and Robotics	5
MSE G512	Manufacturing Planning and Control	5
MSE G521	World Class Manufacturing	5
Elective Courses (any five)		
DE G522	Design Projects	3 2 5
DE G531	Product Design	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G538	Toyota Production System	3 2 5
ME G539	Computer Integrated Manufacturing	3 2 5
MSE G511	Mechatronics	3 2 5
MSE G513	Maintenance Engineering	3 1 4
MSE G514	Leadership and Managing Change	3 1 4
MSE G531	Concurrent Engineering	3 2 5
Mechanical Engineering		
Core Courses		
ME F443	Quality Control Assurance and Reliability	3
ME G511	Mechanism and Robotics	5
ME G512	Finite Element Methods	5
ME G532	Machine Tool Engineering	5
ME G611	Computer Aided Analysis and Design	5
ME G641	Theory of Elasticity and Plasticity	5
Elective Courses (any five)		
BITS F415	Introduction to MEMS	3 1 4
DE G513	Tribology	3 2 5
DE G522	Design Projects	3 2 5
DE G531	Product Design	3 2 5
DE G611	Dynamics and Vibrations	3 2 5
ME F423	Micro Fluidics and its Application	4*
ME F472	Precision Engineering	3 0 3
ME F483	Wind Energy	3 0 3
ME G513	Heating and Cooling of Buildings	3 2 5
ME G514	Turbomachinery	3 2 5
ME G515	Computational Fluid Dynamics	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G631	Advanced Heat Transfer	3 2 5

Mechanical with specialization in Thermal Engineering

Core Courses

BITS F462	Renewable Energy	3
ME G514	Turbomachinery	5
ME G515	Computational Fluid Dynamics	5
ME G533	Conduction and Radiation Heat Transfer	5
ME G534	Convective Heat and Mass Transfer	5
ME G621	Fluid Dynamics	5

Electives Courses (any five)

BITS F415	Introduction to MEMS	4*
BITS F417	Micro-fluidics and its Applications	4*
ME F433	Solar Thermal Process Engineering	3 1 4
ME F461	Refrigeration & Air-conditioning	3 0 3
ME F482	Combustion	3 0 3
ME F483	Wind Energy	3 0 3
ME G513	Heating and Cooling of Buildings	5
ME G516	Energy Systems Engineering	5
ME G535	Advanced Engineering Mathematics	5
ME G536	Thermal Equipment Design	5
ME G537	Cryogenic Engineering	5

Microelectronics

Core Courses

MEL G611	IC Fabrication Technology	5
MEL G621	VLSI Design	5
MEL G631	Physics & Modeling of Microelectronic Devices	5
MEL G632	Analog IC Design	5
MEL G641	CAD for IC Design	5

Elective Courses (any six)

BITS F415	Introduction to MEMS	3 1 4
CS G553	Reconfigurable Computing	5
CS G562	Advanced Architecture and Performance Evaluation	3 2 5
CS G612	Fault Tolerant System Design	2 3 5
EEE F434	Digital Signal Processing	3 1 4
EEE G510	RF Microelectronics	5
EEE G512	Embedded System Design	3 1 4
EEE G522	Advanced Satellite Communication	5
EEE G594	Advanced VLSI Devices	5
EEE G595	Nanoelectronics and Nanophotonics	5
EEE G613	Advanced Digital Signal Processing	5
EEE G626	Hardware Software Co-Design	4
MEL G512	Optoelectronic Devices Circuits and Systems	3 2 5
MEL G531	Testable Design and Fault Tolerant Computing	3 2 5
MEL G612	Integrated Electronics Design	2 2 4
MEL G622	Introduction to Artificial Neural networks	2 2 4
MEL G623	Advanced VLSI Design	5
MEL G624	Advanced VLSI Architectures	5
MEL G625	Advanced Analog and Mixed Signal Design	5
MEL G626	VLSI Test and Testability	5
MEL G642	VLSI Architectures	2 2 4

Pharmacy

Core Courses

PHA G532	Quality Assurance and Regulatory Affairs	5
PHA G543	Clinical Research	5
PHA G611	Advanced Pharmacology	5
PHA G612	Pharmacokinetics and Clinical Pharmacy	5
PHA G621	Advanced Medicinal Chemistry	5
PHA G632	Dosage Form Design	5

Elective Courses (any five)

BIO F417	Biomolecular Modelling	3 0 3
BITS F467	Bioethics and Biosafety	3 0 3
PHA G512	Chemistry of Natural Drugs	3 1 4
PHA G521	Molecular Biology and Immunology	3 1 4
PHA G541	Computer Aided Drug Design	3 2 5
PHA G542	Advanced Physical Pharmaceutics	3 2 5
PHA G544	Advanced Pharmaceutical Chemistry	3 2 5
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G547	Quality-by-Design in Pharmaceutical Product Development	3 2 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G614	Clinical Pharmacy and Therapeutics	3 2 5
PHA G615	Pharmacy Practice	3 2 5
PHA G616	Pharmaceutical Administration and Management	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G622	Chemistry of Natural Drugs and Macromolecules	3 2 5
PHA G642	Laboratory Projects	6
PHA G645	Molecular Pharmacology	3 0 3

PHA G546 Pharmaceutical Biostatistics (3 0 3)

may be required to be completed as a deficiency course for M. Pharm. Programme.

M. Pharm. With specialization in Pharmaceutics

Core Courses

PHA G532	Quality Assurance and Regulatory Affairs	5
PHA G542	Advanced Physical Pharmaceutics	5
PHA G543	Clinical Research	5
PHA G612	Pharmacokinetics and Clinical Pharmacy	5
PHA G617	Advanced Drug Delivery Systems	5

PHA G632	Dosage Form Design	5

Elective Courses (any five)

BITS F467	Bioethics and Biosafety	3 0 3
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G547	Quality-by-Design in Pharmaceutical Product Development	3 2 5
PHA G611	Advanced Pharmacology	2 3 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G614	Clinical Pharmacy and Therapeutics	3 2 5
PHA G616	Pharmaceutical Administration and Management	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G642	Laboratory Projects	6
PHA G645	Molecular Pharmacology	3 0 3

PHA G546 Pharmaceutical Biostatistics (3 0 3) may be required to be completed as a deficiency course for M. Pharm. With specialization in Pharmaceutics Programme.

M. Pharm. With specialization in Pharmaceutical Chemistry

Core Courses

PHA G522	Chemistry of Macromolecules	4
PHA G532	Quality Assurance and Regulatory Affairs	5
PHA G541	Computer Aided Drug Design	5
PHA G543	Clinical Research	5
PHA G611	Advanced Pharmacology	5
PHA G621	Advanced Medicinal Chemistry	5

Elective Courses (any five)

BITS F467	Bioethics and Biosafety	3 0 3
PHA G512	Chemistry of Natural Drugs	3 1 4
PHA G544	Advanced Pharmaceutical Chemistry	3 2 5
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G612	Pharmacokinetics and Clinical Pharmacy	3 2 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G618	Reterosynthetic Analysis	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G642	Laboratory Projects	6
PHA G645	Molecular Pharmacology	3 0 3

PHA G546 Pharmaceutical Biostatistics (3 0 3) may be required to be completed as a deficiency course for M. Pharm. With specialization in Pharmaceutical Chemistry Programme.

Software Systems

Core Courses

CS F 415	Data Mining	3
SS G514	Object Oriented Analysis and Design	4
SS G515	Data Ware Housing	5
SS G562	Software Engineering and Management	5
SS G653	Software Architecture	5

Elective Courses (any six)

BITS F464	Machine Learning	3 0 3
BITS G553	Real-Time Systems	5
CS F401	Multimedia Computing	3 0 3
CS F402	Computational Geometry	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS F422	Parallel Computing	3 0 3
CS F441	Selected topics from Computer Science	3
CS F446	Data Storage & Networks	3 0 3
CS F469	Information Retrieval	3 0 3
CS G523	Software for Embedded Systems	3 2 5
CS G524	Advanced Computer Architecture	5
CS G525	Advanced Computer Networks	5
CS G526	Advanced Algorithms and Complexity	5
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G568	Network Security Project	0 3 3
CS G612	Fault Tolerant System Design	2 3 5
CS G623	Advanced Operating Systems	5
IS F462	Network Programming	3 0 3
SS G513	Network Security	3 1 4
SS G520	Advanced Data Mining	3 1 4
SS G527	Cloud Computing	5
SS G551	Advance Compilation Techniques	5
SS G552	Software Testing Methodologies	4
SS G554	Distributed Data Systems	3 2 5

Master of Business Administration

Core Courses

MBA G501	Managerial Economics	3
MBA G502	Business Structure and Processes	3*
MBA G503	Managerial Skills	2
MBA G504	Legal and Economic Environment of Business	4*
MBA G505	Management Framework and Functions	2 0 2
MBA G506	Negotiation Skills and Techniques	2 0 2
MBA G510	Human Resource Management	4
MBA G511	Organizational Behavior	4
MBA G513	Quantitative Methods	4
MBA G515	Financial and Management Accounting	4
MBA G516	Corporate Finance and Taxation	4
MBA G517	Business and Society	4
MBA G518	Marketing	4
MBA G519	Production and Operations Management	4
MBA G520	Business Policy and Strategic	4

	Management	
MBA G521	Supply Chain Management	4
MBA G524	International Business	4
MBA G531	Managerial Communication	2*
MBA G571	Management Information Systems	4
Elective Courses For Engineering & Technology Management		
MBA G512	Manufacturing Strategy	4
MBA G514	Technology Management	3 0 3
MBA G522	Total Quality Management	4
MBA G523	Project Management	4
MBA G525	R & D Management	3 0 3
MBA G529	Recent Advances in ETM	4
MBA G539	Six Sigma	3 1 4
MBA G552	Total Productive Maintenance	4
MBA G577	Supply Chain Analytics	3 1 4
MBA G578	Game Theory and Business Strategy	3 0 3
MBA G582	Creating and Leading Entrepreneurial Organization	3 0 3
For IT Enabled Services Management		
MBA G526	Database Management Systems	4
MBA G527	e-Business and Internet Marketing	4
MBA G528	Internet Security and Cyber-laws	4
MBA G551	Internetworking Technologies	3 0 3
MBA G581	Expert Systems	4
MBA G582	Creating and Leading Entrepreneurial Organization	3 0 3
MBA G588	Services Management System	3 0 3
MBA G589	Enterprise Resource Planning	3 0 3
MBA G622	Software Project Management	4
For Finance		
FIN F414	Financial Risk Analytics & Management	3 0 3
MBA G507	International Financial Markets & Services	3 0 3
MBA G508	Functions and Working of Stock Exchanges	3 0 3
MBA G509	Investment Banking and Financial Services	3 0 3
MBA G530	Project Appraisal	3 0 3
MBA G532	Risk Management and Insurance	3 0 3
MBA G536	Strategic Financial Management	3 0 3
MBA G537	Security Analysis and Portfolio Management	3 0 3
MBA G575	Financial Engineering	3 0 3
MBA G582	Creating and Leading Entrepreneurial Organization	3 0 3
MBA G593	Business Analysis and Valuation	3 0 3
For Marketing		
MBA G533	Advertising and Sales Promotion	3 0 3
MBA G534	Introduction to Business Sustainability	3 0 3
MBA G538	Marketing Models	3 0 3
MBA G542	Consumer Behaviour	3 0 3
MBA G562	Services Marketing	3 0 3
MBA G563	Industrial Marketing	3 0 3
MBA G574	Retail Management Systems	3 0 3
MBA G576	Digital Marketing	3 0 3
MBA G582	Creating and Leading Entrepreneurial Organization	3 0 3
MBA G583	Marketing Research	3 0 3
MBA G586	Product and Brand Management	3 0 3
For Human Resources		
MBA G535	Cross Cultural Management	3 0 3
MBA G553	Organizational Change and Development	3 0 3
MBA G554	Innovative Leadership	3 0 3
MBA G555	International Human Resource Management	3 0 3
MBA G556	Performance Management	3 0 3
MBA G582	Creating and Leading Entrepreneurial Organization	3 0 3

Master in Public Health Core Courses		
BITS G515	Management Principles and Practices	4*
MPH G510	Biostatistics & Computers in Public Health	5
MPH G512	Environmental & Occupational Health	4
MPH G513	Public Health & Diseases	4
MPH G515	Communication in Health Care	4
MPH G521	Health Care Management	4
MPH G522	Preventive Nutrition & Health Promotion	4
MPH G523	Epidemic & Disaster Management	4
MPH G531	Health Economics & Financial Management	4
MPH G613	Health Systems and Society	2
MPH G661	Research Methodology I	5
MPH G692	Epidemiology	2
Elective Courses (any three)		
BITS F467	Bioethics and Biosafety	3 0 3
MPH C431	Accounting & Finance	4
MPH G535	Family & Community Health Measures	3
MPH G537	Law & Ethics in Public Health	3
MPH G538	Telemedicine	3
MPH G539	Inter-sectoral co-ordination in Health Services	3
MPH G540	Role of Voluntary Bodies/NGO's in Public Health	3
MPH G665	Hospital Operations Management	3
MPH G681	Strategic Management	3

M. Phil. Chemistry

Core Courses

CHEM G551	Advanced Organic Chemistry	5*
CHEM G552	Advanced Inorganic Chemistry	5*
CHEM G553	Advanced Physical Chemistry	5*
CHEM G554	Physical Methods in Chemistry	5*
CHEM G555	Chemistry of Life Processes	5*

Elective Courses (any four)

BIO G513	Microbial and Fermentation Technology	5*
BITS G654	Advanced Instrumentation Techniques	5*
CHEM F412	Photochemistry and Laser Spectroscopy	3 0 3
CHEM F422	Statistical Thermodynamics	3 0 3
CHEM C431	Stereochemistry and Reaction Mechanism	3 0 3
CHEM G513	Advanced Nuclear and Radio Chemistry	5*
CHEM G521	Environmental Chemistry	5*
CHEM G531	Recent Advances in Chemistry	5*
CHEM G541	Chemical Applications of Group Theory	5*
CHEM G556	Catalysis	4*
CHEM G557	Solid Phase Synthesis and Combinatorial Chemistry	4*
CHEM G558	Electronic Structure Theory	5*
CHEM G559	Bioinorganic Chemistry	4*
CHEM G561	Heterocyclic Chemistry	5*
CHEM G562	Solid State Chemistry	4*
CHEM G563	Advanced Statistical Mechanics	5*
EEE F432	Medical Instrumentation	3 0 3
PHA G621	Advanced Medicinal Chemistry	2 3 5

DCA is empowered to add the following course as a deficiency course on case by case basis if the student is found to be deficient in Mathematics.

CHEM C453	Mathematics for Chemists	4*

* This is the total units and its break-up in terms of lectures and practical/seminars/project may be announced from time to time through the timetable.

M. Phil. in Liberal Studies

Core Courses

BITS E583	Case Study I	5
BITS G518	Writing Seminar	5
BITS G561T	Dissertation	16
BITS G661	Research Methodology I	5
HSS G511	Philosophical Foundations of Liberal Studies	5
HSS G512	Theoretical Approaches to Liberal Studies	5

Elective Courses

The 3 Electives will be fulfilled by taking one or more of the following courses or any other discipline course subject to approval by the department.

BITS E573	Study in Advanced Topics I	5
BITS E574	Study in Advanced Topics II	5
BITS E584	Case Studies II	4

M.E. COMPUTER SCIENCE WITH SPECIALIZATION IN INFORMATION SECURITY WITH B.SC. INPUT

Core Courses

BITS F345	Information Law and Cyber Law	3 0 3
BITS F437	Technical Communication	3 0 3
BITS F463	Cryptography	3 0 3
BITS G540	Research Practice	4
CS F111	Computer Programming	3 1 4
CS F211	Data Structures & Algorithms	3 1 4
CS F212	Database Systems	3 1 4
CS F213	Object Oriented Programming	3 1 4
CS F215	Digital Design	3 1 4
CS F222	Discrete Structures for Computer Science	3 0 3
CS F301	Principles of Programming Languages	2 0 2
CS F303	Computer Networks	3 1 4
CS F342	Computer Architecture	3 1 4
CS F351	Theory of Computation	3 0 3
CS F364	Design and Analysis of Algorithms	3 0 3
CS F372	Operating Systems	3 0 3
CS F404	Computer Crime and Forensics	2 0 2
CS F406	Ethical Hacking	2 2 3
CS F468	Information Security Project	0 3 3
CS G517	Network & Systems Security	4
CS G524	Advanced Computer Architecture	3 0 5
CS G525	Advanced Computer Networks	3 2 5
CS G526	Advanced Algorithms and Complexity	3 2 5
CS G566	Secure Software Engineering	5
CS G568	Network Security Project	0 3 3
CS G623	Advanced Operating Systems	3 2 5
IS F242	Computer Organization	3 1 4
IS F341	Software Engineering	3 1 4
MATH F113	Probability and Statistics	3 0 3
MATH F212	Optimization	3 0 3
MATH F231	Number Theory	3 0 3
MGTS F211	Principles of Management	3 0 3

Elective Courses

CS F401	Multimedia Computing	3 0 3
CS F402	Computational Geometry	3 0 3

CS F407	Artificial Intelligence	3 0 3
CS F415	Data Mining	3 0 3
CS F441	Selected topics from Computer Science	3
CS F446	Data Storage Technologies & Networks	3 0 3
CS F451	Combinatorial Mathematics	3 0 3
CS G501	Mobile Computing	5
CS G514	Object Oriented analysis and Design	2 2 4
CS G527	Cloud computing	5
CS G557	Distributed Computing	5
CS G559	Database Security	5
CS G564	Advanced Cryptography	5
IS F322	Software Testing	2 1 3

M.E. Sanitation Science, Technology and Management

Core Courses

BITS G540	Research Practice	4*
SAN G511	Sanitation Technology	3 2 5
SAN G512	Sanitation and Public Health	3 2 5
SAN G513	Sanitation Governance, Behaviour change and Advocacy	5*
SAN G514	Sanitation financing and Project Management	5*
SAN G515	Emergency Sanitation & Leadership	5*

Elective Courses

BIO G525	Environmental Biotechnology & Waste Management	3 2 5
BITS G513	Study in Advanced Topics	5
CHE G513	Environmental Management System	3 2 5
MPH G510	Biostatistics & Computers in Public Health	5

In addition to above courses, the students will be required to register in the following courses as deficiency courses if they have not done it during their First Degree programme:

- BIO F216 Water, Sanitation and Solid Waste Management
- BIO F217 Laboratory for Water, Sanitation and Solid Waste Management
- CE F342 Water & Waste Water Treatment

LIST OF GENERAL/SPECIAL COURSES FOR M.PHIL. PROGRAMMES

BIO G511	Population and Quantitative Genetics	5
BIO G522	Interferon Technology	2 2 4
BIO G541	Neural Network Analysis	5
BIO G551	Membrane Biology	5
BITS G511	Advanced Project	5
BITS G513	Study in Advanced Topics	5
BITS G514	Environmental Health	3 0 3
BITS G644	Development and use of Computer Software	5
BITS G654	Advanced Instrumentation Techniques	5
CHEM G511	Nuclear and Radio Chemistry	5
CHEM G513	Advanced Nuclear and Radiochemistry	5
CHEM G521	Environmental Chemistry	5
CHEM G531	Recent Advances in Chemistry	5
CHEM G541	Chemical Applications of Group Theory	5
CHEM G551	Advanced Organic Chemistry	5
CHEM G552	Advanced Inorganic Chemistry	5
ECON G511	Dynamic Modelling and Control of National Economies	5
ECON G521	Modern Cost Engineering	5
ECON G531	Theory of Macroeconomic Policy	5
ECON G541	Economic Systems Analysis	5
ENGL G511	Growth of the English Language	5
ENGL G512	Language and S & T	5
ENGL G513	Social Impact of S & T	5
ENGL G521	Principles of Language Teaching	5
ENGL G522	Aesthetics and Technology	5
ENGL G531	Applied Linguistics	5
ENGL G541	Interpretation of Literature	5
ENGL G551	Information Technology Lab. I	5
ENGL G561	Information Technology Lab. II	5
ENGL G571	Applied Communication I	5
ENGL G581	Applied Communication II	5
ENGL G591	Project Formulation and Preparation	5
ENGL G611	Twentieth Century English Literature	5
ET G511	Science and Technology Dynamics	5
ET G521	Hi-Tech Management	5
ET G531	Systems Engineering	5
ET G541	Overview of Technology	5
HUM G511	Introduction to Health System	3 0 3
MATH G511	Design and Analysis of Algorithms	5
MATH G512	Selected Topics in Advanced Mathematics for Engineering Situations	5
MATH G521	Applied Functional Analysis	5
MATH G531	Number Theory	5
MATH G541	Advanced Methods in Discrete Mathematics	5
MATH G611	Algebraic Number Theory	5
MATH G612	Riemann Surfaces	5
MATH G621	Fibre Bundles	5
MATH G622	Algebraic Geometry	5

MATH G632	Lie Groups & Lie Algebras	5
MATH G642	Complex Manifolds	5
MGTS G511	Advanced Marketing Theories and Advertising	5
MGTS G521	Business Policy - Structure and Organization	5
MGTS G531	Recent Advances in Organization Behaviour Theory	5
MGTS G541	Management Information and Decision Support Systems	5
MGTS G551	Frontiers in Financial Management	5
MGTS G561	Institutional Finance & Project Appraisal	5
PHY G511	Theoretical Physics	5
PHY G521	Nuclear and Particle Physics	5
PHY G531	Selected Topics in Solid State Physics	5
PHY G541	Physics of Semiconductor Devices	5
SKILL G611	Computer Operation and Software Development I	5
SKILL G612	Computer Operation and Software Development II	5
SKILL G621	Computer Maintenance I	5
SKILL G622	Computer Maintenance II	5
SKILL G631	Professional Communication I	5
SKILL G632	Professional Communication II	5
SKILL G641	Modern Experimental Methods I	5
SKILL G642	Modern Experimental Methods II	5
SKILL G651	Techniques in Development Management I	5
SKILL G652	Techniques in Development Management II	5
SKILL G661	Research Methodology I	5
SKILL G662	Research Methodology II	5

All courses given above are unstructured. Actual structuring will be done from time to time.

COMMON COURSES FOR HIGHER DEGREES

BITS F437	Technical Communication	3 0 3
BITS G529	Research Project I	6
BITS G539	Research Project II	6
BITS G540	Research Practice	4
BITS G619	Professional Practice	4
BITS G620	Professional Practice I	3
BITS G621	Professional Practice II	3
BITS G629T	Dissertation	25(Max.)
BITS G639	Practice School	20
BITS G649	Reading Course	5

NOTE: Courses with 4 level numbers given above are advanced level electives from the offering of the Integrated First Degree programmes.

COMMON POOL OF ELECTIVES FOR HIGHER DEGREES

BITS G513	Study in Advanced Topics	5
BITS G649	Reading Course	5

NOTE: The courses from this pool will be available as electives to all higher degree students subject to approval from higher degree counseling committee.

REVISED CURRICULUM STRUCTURE FOR M.E. / M.PHARM. PROGRAMS

[This structure is applicable for students admitted in 2014 or after into the M.E. Chemical Engineering program including any specializations thereof.]

(a) General Structure of M.E. / M.Pharm. programs

Keeping in mind the increasing interest on behalf of the Departments to involve Higher Degree students in research and to provide options for students' interested in pursuing research, there is provision of certain flexibilities of pursuing Dissertation of duration between one semester and two semesters for these Higher Degree programs as illustrated below.

(i) Duration and Requirements to define a program

- Duration of the program: 4 semesters (2 years)
- Number of Credit Units: 64 (min).
- Coursework: 8 courses and 32 units (min)
- PS/Dissertation: 16 units (min) to 32 units: (max)

(ii) Structure

Prescribed coursework to meet the requirements of the program may not exceed 20 units per semester.

The program is structured primarily as a coursework track wherein the student pursues three semesters of coursework and pursues either a Practice School or a Dissertation for the entire last semester:

or alternatively, to enable a research track wherein the student pursues two semesters of coursework and starts his/her Dissertation in the third semester (possibly concurrent with coursework) and spends the entire fourth semester pursuing Dissertation.

The options are depicted below:

Track 1

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses -16 to 20 units)
II	Coursework (4 or 5 courses -16 to 20 units)	BITS G639 Practice School (20 units) OR BITS G562T Dissertation (16 units)

Track 2

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses - 16 to 20 units)
II	Coursework (2 courses - 7 to 9 units) AND BITS G564T Dissertation (9 units)	BITS G563T Dissertation (16 units)

Track 3

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses - 16 to 20 units)
II	BITS G562T Dissertation (16 units)	BITS G563T Dissertation (16 units)

(Course Description for BITS G562/BITS G563/BITS G564 is the same as BITS G629T; BITS G562T or BITS G564T is a pre-requisite for BITS G563T).

(iii) Flexibilities and Constraints

In addition to the above requirements:

a) a student may be prescribed one or more deficiency courses;

b) a student may overload at most one course per semester when he/she is pursuing only coursework (i.e. no overload during dissertation semesters irrespective of whether he/she is pursuing concurrent coursework);

while this overloaded course need not be within the student's discipline but it will be subject to pre-requisites and operational conditions such as approval of the Heads of Department concerned.

In all, the workload per semester for a student may not exceed

i. 25 units when the student is pursuing only coursework but the limit may be relaxed for students who are prescribed deficiency courses.

ii. 19 units when the student is pursuing concurrent coursework and dissertation (so that the student may pursue 9 units of dissertation and 2 courses of at most 5 units each)

iii. 16 units when the student is pursuing full semester of dissertation

iv. 20 units when the student is pursuing full semester of Practice School.

Operational Aspects and Implementation

It is to be noted that the revised curriculum structure has been designed without prejudice to the existing programs i.e. given the existing structure and flexibilities of M.E./M.Pharm. programs all three tracks are operable.

The above structure will be made applicable for all students admitted to an M.E./M.Pharm program in 2014 or after under the proviso:

- for any new M.E. / M.Pharm. program starting from Academic Year 2014-15 all three tracks mentioned above will be enabled.

(b) Specializations within an M.E./M.Pharm. program

These programs are structured in such a way that a specialization can be obtained by a student:

- The coursework requirement proposed in the structure above can be categorized as follows:
  - o Core: 6 courses / 30 units (max.)
  - o Specialization **(if applicable)** : 3 courses / 12 units (min.) to 6 courses / 30 units (max.)
  - o Some Specialization courses may be mandatory and some may be electives.
  - o Total of Core and Specialization courses may not exceed 7 courses / 32 units.
  - o A Research Practice or a Research Methodology course will be prescribed for all programs as part of the coursework requirement.
  - o Rest of the coursework requirement may be obtained via other electives within the discipline but not necessarily within the specialization.

The name of the degree will be common (e.g. M.E. in Chemical Engineering) and only this will appear in the degree certificate whereas the name of the specialization will be mentioned only in the transcript.

(c) Structure of M.E. (Chemical Engineering) and specializations within

(i) Structure of M.E. (Chemical Engineering)

Year	Semester I	U	Semester II	U
I	CHE G622 Advanced Chemical Engineering Thermodynamics	5	CHE G641 Reaction Engineering	5
	CHE G523 Mathematical Methods in Chemical Engineering	5	CHE G552 Advanced Transport Phenomena	5
	Elective I	*	BITS G661 Research Methodology I	5
	Elective II	*	Elective III	*
	Total	16 (min)	**Total**	16 (min)
	Semester III		**Semester IV**	
II	Elective IV to Elective VII	16 (min)	PS / Dissertation	16/20
	OR Elective IV AND Elective V AND Dissertation (9 units)	16 (min)		
	OR Dissertation (16 units)	16		
	Total	**16(min)**	**Total**	**16/20**

Structure of M.E. (Chemical Engineering) – Specialization in Nuclear Engineering

The structure of M.E. (Chemical Engineering) with specialization in Nuclear Engineering will be the same as the chart given above for M.E. (Chemical Engineering) with the added constraint that at least 3 electives should be from the pool of Specialization electives for Nuclear Engineering (given below).

Pool of Specialization Electives for Nuclear Engineering

Course No	Course Title	Units		
		L	P	U
CHE G559	Reactor Physics and Engineering			5
CHE G560	Nuclear Fuel Cycle and Waste Management			5
CHE G561	Nuclear Reactor Control and Instrumentation			4
CHE G562	Thermal Hydraulics and Heat Transfer			4
CHE G563	Nuclear Chemical Engineering			4
CHE G564	Nuclear Materials and Radiation Damage			4
CHE G565	Radiation and Radio Isotopes Applications			4
CHE G566	Nuclear Safety, Security and Safeguards			4

Structure of M.E. (Chemical Engineering) – Specialization in Petroleum Engineering

The structure of M.E. (Chemical Engineering) with specialization in Petroleum Engineering will be the same as the chart given above for M.E. (Chemical Engineering) with the added constraint that at least 3 electives should be from the pool of Specialization electives for Petroleum Engineering (given below).

Pool of Specialization Electives for Petroleum Engineering

Course No.	Course Title	Units		
		L	P	U
CHE G533	Petroleum Product Characterization	3	2	5
CHE G567	Natural Gas Processing			4
CHE G568	Modeling and Simulation in Petroleum Refining			4
CHE G569	Petroleum Production Economics			4
CHE G616	Petroleum Reservoir Engg.			5
CHE G617	Petroleum Refinery Engineering			5
CHE G618	Petroleum Downstream Engg.			5

Ph.D. PROGRAMME

Structure

1. Course Work

The various categories of courses, for the whole possible range of input of Ph.D. students are described in the Academic Regulations. In most cases, this course work would consist of courses which are required to be completed for a higher degree programme of the Institute. Departures from these normal situations are described in the Academic Regulations.

2. Ph.D. Qualifying Examination

Every student admitted to Ph.D. must pass the qualifying examination which is based on two areas chosen by the candidate depending on his intended area of research and courses done. The qualifying examination tests the student's knowledge, grasp of fundamentals and his ability to use them in unknown situations.

3. Foreign Language when required

The foreign language will be prescribed as an eligibility requirement for the Ph.D. only when the supervisor and/or the Academic-Graduate Studies and Research Division (AGSRD) have made recommendations for the same justifying its need for the particular topic of research and the literature available and this recommendation has been accepted by the Research Board. Otherwise English or an Indian language, as the case may be, would suffice the requirement of the foreign language.

4. Teaching Practice/Practice Lecture Series/ Research Methodology

BITS C791T	Teaching Practice I	1
BITS E661	Research Methodology	1

The above two separate and independent courses, to be taken one at a time, are designed and operated to provide cumulative experience for a Ph.D. student in the practice of teaching.

BITS E793T	Practice Lecture Series I	1

This course is in lieu of the Teaching Practice I and designed and operated to provide cumulative experience for a Ph.D. student in the Practice of teaching in his own professional setting where it is not feasible to operate the teaching practice courses. The student will deliver a predetermined series of technical talks before a professional audience as approved by Dean (AGSRD)

5. Seminar/Independent Study

1. BITS C797T Ph.D. Seminar (Min) 2

   While the total minimum number of units is 2, registration is done for one unit in each semester/term until the submission of the thesis.

2. BITS C790T Independent Study (Min) 2

   A student may be asked to register in this course in lieu of BITS C797T by Dean, Research & Consultancy if situation so warrants. While the total number of units is 2, registration is done for one unit in each semester/term until the submission of the thesis.

6. Thesis

BITS C799T Ph.D. Thesis (Min) 40

While the total minimum units assigned to this course are 40, the distribution of the units between different semesters/terms would be determined by the Dean, Academic Research Division (ARD).

7. General

The `Doctoral Counselling Committee (DCC)' consisting of Take from annexure monitors the academic progress of Ph.D. students similar to the monitoring of academic progress of students of integrated First Degree and Higher Degree programmes by the ACB. The decisions of the DCC are reported to the Research Board and the Senate.

A Doctoral Advisory Committee (DAC) is appointed by the DRC for each candidate admitted to the Ph.D. programme. This committee consists of at least two faculty members from the broad area in which the candidate opts to pursue the Ph.D

Ph.D. Aspirants Scheme for Professionals

This programme enables experienced personnel and professionals working in industries and R&D organizations that collaborates with BITS to work for a Ph.D. degree of the Institute in their respective work environment. This makes it possible for practicing professionals to be offered the same challenges that are traditionally offered to teachers in universities. Candidates, sponsored by their organizations, work for the Ph.D. degree without any dislocation from their work environment on research problems relevant to their organizations.

Admission to this programme is done through what is known as Ph.D. Aspirants Scheme. Ph.D. Aspirants will be first asked to write the qualifying examination. The Ph.D. qualifying examination is based on two areas chosen by the candidate depending on his intended area of research and courses done. The institute recognizes that there may be professionals who might not possess a degree equivalent to a higher degree of the institute, but has gained knowledge and skills through experience (substantiated by documentary evidence), which could be treated as equivalent to one of the higher degrees of the institute. For convenience of operation, for these cases, the institute has devised a higher degree programme called M.Phil (Applied). A list of courses for M.Phil.(Applied) is given below, from which a minimum number of 8 courses are to be chosen.

M.Phil. (Applied)

BITS E511	Computer Applications I	4
BITS E512	Computer Applications II	4
BITS E521	Technical Communication I	4
BITS E522	Technical Communication II	4
BITS E531	Social, Behavioral & Economic Sciences I	4
BITS E532	Social Behavioral & Economic Sciences II	4
BITS E533	Modern Experimental Techniques-I	4
BITS E534	Modern Experimental Techniques-II	4
BITS E535	Management Methods & Techniques I	4
BITS E536	Management Methods & Techniques II	4
BITS E537	Systems Sciences and Engineering I	4
BITS E538	Systems Science and Engineering II	4
BITS E541	Chemical and Life Science I	4
BITS E542	Chemical and Life Science II	4
BITS E543	Instrumentation Engineering I	4
BITS E544	Instrumentation Engineering II	4
BITS E545	Project and Consultancy I	4
BITS E546	Project and Consultancy II	4
BITS E547	Public Administration I	4
BITS E548	Public Administration II	4
BITS E551	Physical and Mathematical Sciences I	4
BITS E552	Physical and Mathematical Sciences II	4
BITS E561	Use of English for Professional Purposes I	4
BITS E562	Use of Eng. for Professional Purposes II	4
BITS E571	Methods of Planning and Development I	4
BITS E572	Methods of Planning and Development II	4
BITS E573	Study in Advanced Topics I	5
BITS E574	Study in Advanced Topics II	5
BITS E583	Case Studies I	4
BITS E584	Case Studies II	4
BITS E591	Science and Technology Development I	4
BITS E592	Science and Technology Development II	4
BITS E593	Reading Course I	5
BITS E594	Reading Course II	5
BITS E611	Internship I	20
BITS E612	Internship II	20
BITS E661	Research Methodology I	5
BITS E662	Research Methodology II	5

Note: *No direct admission to M.Phil.(Applied) will be done. Courses described above will be used for students admitted to the Ph.D. programmes under the Ph.D. Aspirant Scheme.*

PART V

OFF- CAMPUS WORK-INTEGRATED LEARNING PROGRAMMES





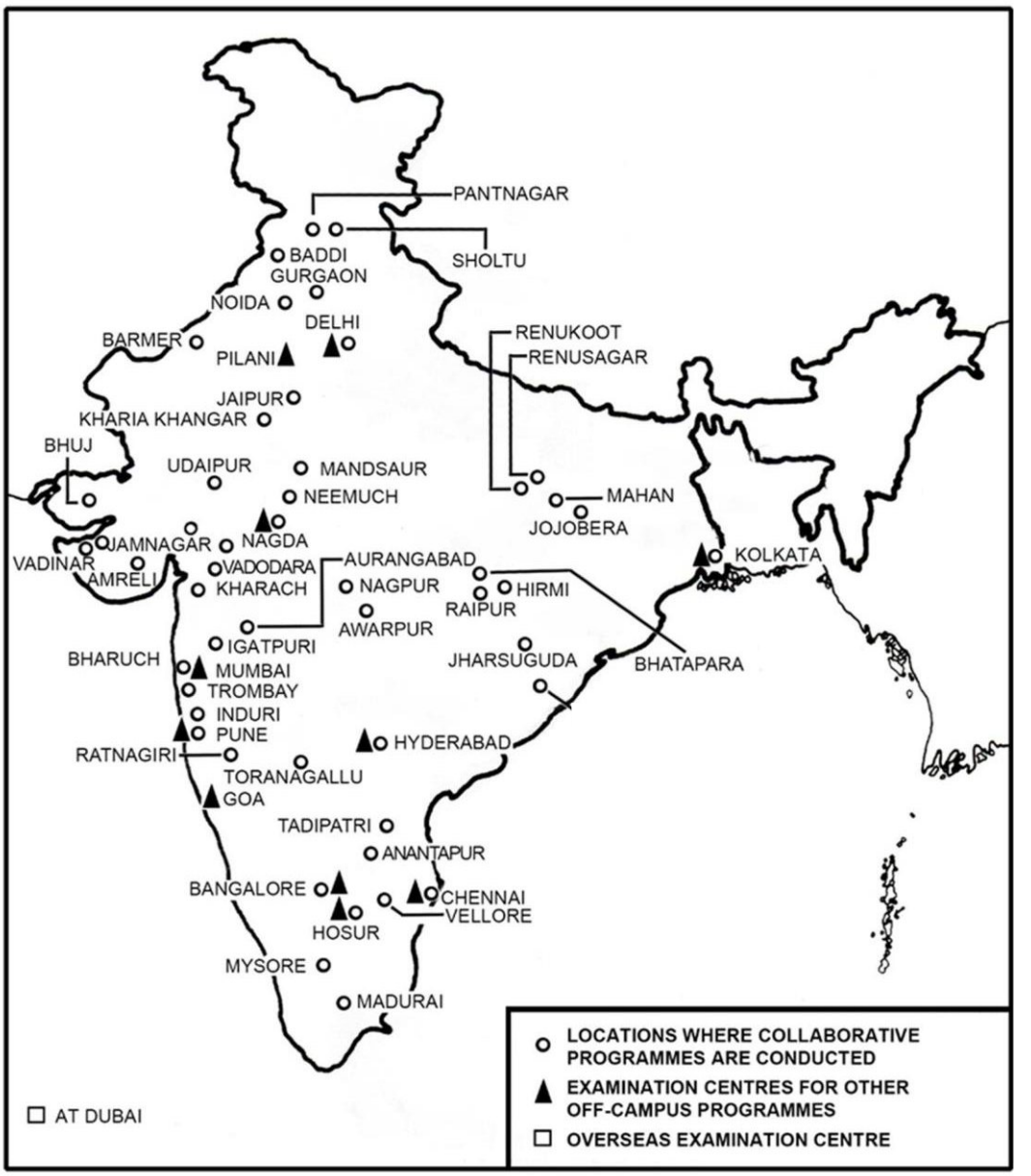






MAP OF BITS WORK-INTEGRATED LEARNING & COLLABORATIVE PROGRAMMES

2019-2020



Introduction

Since 1979, the Institute has been participating in the human resources development activities of the industries by evolving several degree programmes that integrate the working environment of the employees with the learning environment required by the Institute. These programmes are offered in several domains like Information Technology, Engineering Technology and Management.

The Institute conducts **Work Integrated Learning Programmes (WILP)** as a means of continuing education for employed professionals to meet the Learning & Development needs of a diverse spectrum of industries. These programmes are a conducted through a collaborative arrangement between BITS Pilani and the collaborating organization / industry, whose ultimate aim is to build competencies and to attain advancement of technical workplace skills.

Salient Features of WILP

For the conduct of Work Integrated Learning programmes, the basic requirement is the participation of the collaborative organizations. Such a collaboration includes extending physical and other facilities and by agreeing to integrate their work requirements with the academic requirements of the Institute for the pursuit of the programme. The WILP Division of the Institute operates these programmes.

The Work Integrated Learning Programmes are offered in two modes: Programmes that are designed to meet exclusive requirements of specific collaborating organizations are offered as Enterprise Education Solutions for sponsored employees, with classes organized in the premises of the collaborating organizations. Programmes designed to meet the generic industry requirements are offered as Programmes for Individual students from various organizations. Instruction in such programmes is typically delivered through technology.

The Work Integrated Learning Programmes are characterized by the following salient features:

1. Enrollment is permitted only to suitably qualified, employed professionals having specified educational qualifications, with adequate and relevant work experience, to programmes that are closely aligned with their work profiles.

2. Enrollment also requires endorsement of the employer, and a commitment from the employer to provide necessary support (including that of a qualified mentor) and facilities to enable effective work integrated learning. The rationale for permitting only qualified employed professionals to enroll under WILP alongwith the consent from the employer is with the objective that the skill and knowledge enhancement attained by the employee through these WILP would ultimately benefit, add value to the organization and increase productivity.

3. A judicious combination of synchronous and asynchronous modes of instruction is used, for regular and effective interaction between the students and faculty members, to maintain the necessary academic rigor and standards of instruction.

4. WILP are characterized by person-centered approach with the same rigor and standards at par with the on-campus system of education. There is no replacement of inter-personal communication of conventional classroom based education, since all courses are conducted in a manner akin to actual classroom teaching ensuring two-way communication between experienced faculty of BITS and the students.

5. The pedagogy of WILP is based on the successful and established methodologies followed by BITS for on-campus education system without compromising on the duration of the programme, methodology of study, assessment and programme

completion requirements which are comparable to programmes offered on-campus. All the programmes under WILP follow a credit-based system at par with the on-campus education system.

6. For each WILP course there is an instructor who is a BITS faculty responsible for the conduct of the course, as well as a qualified mentor (being a senior professional from the student's own organization who agrees to act as a mentor and a resource person) at the work place to provide structured guidance to the employee throughout the duration of the programme, which helps in strengthening the work-study integration.

7. All programmes are designed to meet the industry needs, and hence require application of concepts learnt in the classroom. Therefore, the Institute provides several technology enabled tools like simulators, virtual labs and remote labs to enable experiential learning. Such labs are equipped with contemporary computational simulators and remote operating equipment. Students spend sufficient time in learning, practicing and experimenting industry oriented problems designed and developed by BITS faculty in collaboration with industry experts.

The currently operative programmes are given in Table on pages V-4 to V-6. The curriculum structure and semesterwise pattern of courses for the currently operative programmes are given on Pages V-12 & V-79.

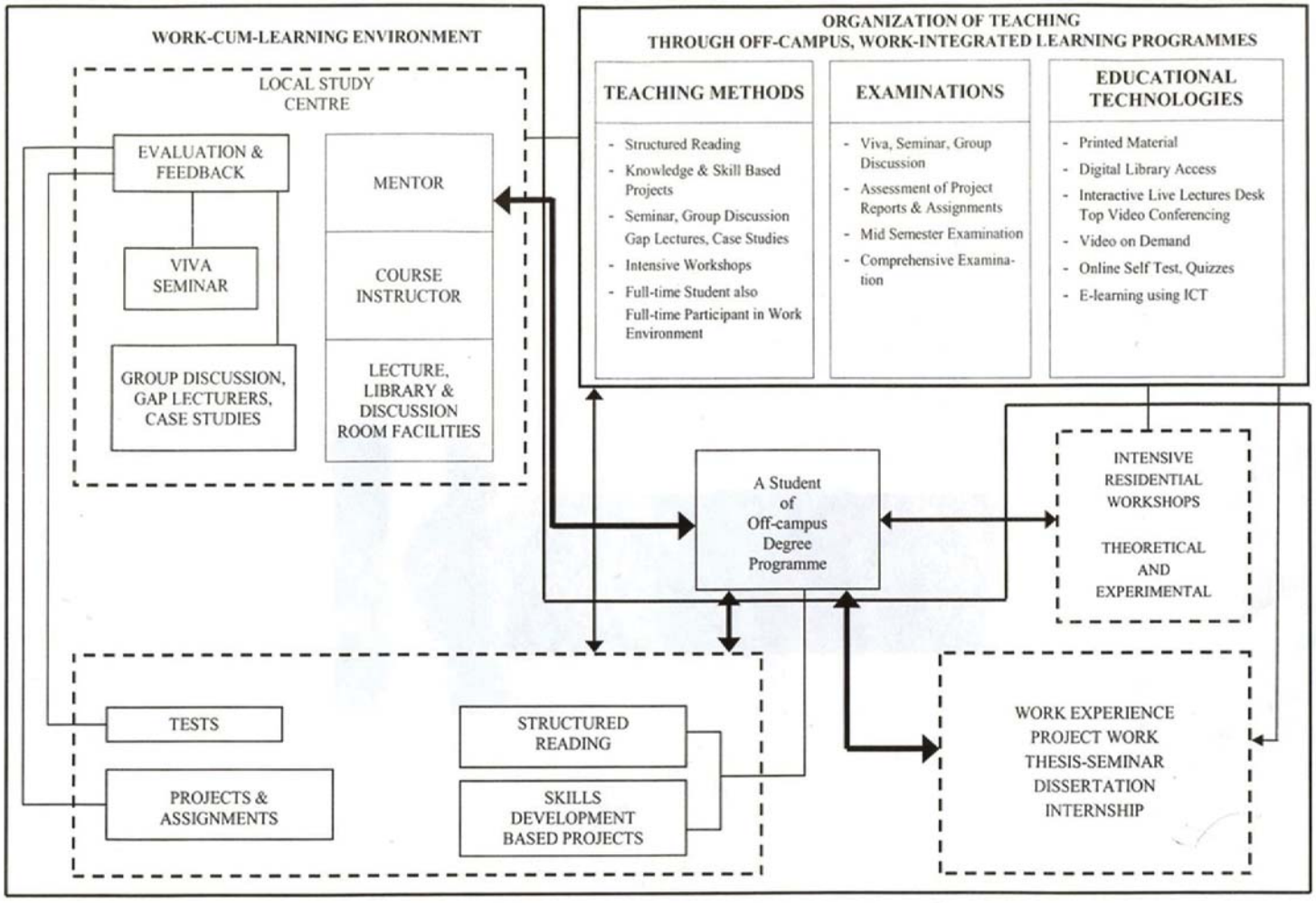


Figure 1: Person-centred Approach in the Off-campus Work-Integrated Learning Programme

Table: Currently Operative Work-Integrated-Learning Programmes at a Glance

Programmes	Collaborating / Sponsoring Organization
B.Sc. Programme	
1. Design & Computing	- Designed for the HRD needs of a diverse spectrum of IT Industries, and HCL Technologies, Noida
2. Pharmaceutical Sciences	- Designed for the HRD needs of a diverse spectrum of Pharmaceutical Industries, and Dr. Reddy's Laboratories, Hyderabad
B.Tech. Programmes	
1. Engineering Design	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
2. Engineering Technology	- Designed for the HRD needs of a diverse spectrum of Engineering Industries and John Deere, Pune
3. Information Systems	- Designed for the HRD needs of a diverse spectrum of IT Industries and Wipro Bangalore
4. Manufacturing Technology	- Kirloskar Oil Engines, Kolhapur, Bharat Forge, Pune, Tata Motors, Jamshedpur; TACO, Pune; Maruti Suzuki, Gurgaon; Mahindra Motor Vehicles; Cummins, Pune
5. Power Engineering	- Aditya Birla Group, Tata Power, JSW Energy – Mumbai
6. Process Engineering	- Aditya Birla Group, Mumbai; JSW Steel, Toranagallu; Vedanta, Jharsuguda; BPCL, Mumbai
M.Sc. Programmes	
1. Business Analytics	- Designed for the HRD needs of a diverse spectrum of IT Industries
2. Information Systems	- Designed for the HRD needs of a diverse spectrum of IT Industries
M.B.A. Programmes	
1. Consultancy Management	- Designed for the HRD needs of a diverse spectrum of consulting firms
2. Finance	- Designed for the HRD needs of business organizations
3. Hospital and Health Systems Management	- Designed for the HRD needs of a diverse spectrum of Hospitals and Healthcare organizations
4. Manufacturing Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
5. Quality Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries

M.Tech. Programmes	
1. Automotive Electronics	- Designed for the HRD needs of a diverse spectrum of Automotive Industries
2. Automotive Engineering	- Designed for the HRD needs of a diverse spectrum of Automotive Industries, Tata Technologies, Tata Motors, Pune; Mercedes Benz
3. Computing Systems & Infrastructure	- Designed for the HRD needs of a diverse spectrum of IT Industries, and Wipro, Bangalore, VMware
4. Data Science & Engineering	- Designed for the HRD requirements of a diverse spectrum of IT Industries
5. Design Engineering	- Designed for the HRD needs of a diverse spectrum of Engineering Industries, SKF and John Deere, Pune
6. Digital Manufacturing	- Designed for the HRD needs of a diverse spectrum of Digital Industries
7. Embedded Systems	- Designed for the HRD needs of a diverse spectrum of IT Industries, Cisco, Bangalore; UTC Bangalore and Hyderabad.
8. Environmental Engineering	- Goa State Pollution Control Board, Goa
9. Manufacturing Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
10. Microelectronics	- Designed for the HRD needs of a diverse spectrum of IT Industries; Synopsys, Bangalore; Samsung, Gurgaon; Aricent Technologies
11. Pharmaceutical Operations and Management	- Designed for the HRD needs of a diverse spectrum of Pharmaceutical Industries, and Sun Pharmaceutical Industries, Vadodara; Lupin, Mumbai
12. Quality Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
13. Software Engineering	- Wipro Technologies, Dell, SAP Labs, Sabre, EMC, Oracle, Lowe's Services, Bangalore; Avaya, Tech Mahindra, Pune; Capgemini; Qualcomm, Hyderabad
14. Software Systems	- Designed for the HRD requirements of a diverse spectrum of IT Industries; Wipro Technologies, Bangalore; TCS, Hyderabad; Cisco, Synopsys, Bangalore; Samsung, Gurgaon; Aricent Technologies, Mercedes-Benz, Bangalore
15. Systems Engineering	- Wipro Infotech, Bangalore
16. Telecommunications & Software Engineering	- Designed for the HRD needs of a diverse spectrum of Telecom Industries
17. Transportation Engineering	- PWD, Goa

Post Graduate Diploma Programmes	
1. Finance	Designed for the HRD needs of a diverse spectrum of business organizations
2. Manufacturing Management	- Designed for the HRD needs of a diverse spectrum of Manufacturing organizations
Post Graduate Certificate Programmes	
1. Artificial Intelligence and Machine Learning	- Designed for the HRD needs of a diverse spectrum of IT industries
2. Big Data & Analytics	- Designed for the HRD needs of a diverse spectrum of IT industries
3. Big Data Engineering	- Designed for the HRD needs of a diverse spectrum of IT industries
4. General Management	- Designed for the HRD needs of a diverse spectrum of Engineering industries
5. Internet of Things	- Designed for the HRD needs of a diverse spectrum of IT industries
6. Manufacturing Practice	- Designed for the HRD needs of a diverse spectrum of Manufacturing organizations
Certificate Programmes	
1. Manufacturing Practice	- Designed for the HRD needs of a diverse spectrum of Manufacturing organizations
2. General Management	- Designed for the HRD needs of a diverse spectrum of Engineering industries

Note: The Institute looks for the viable minimum number (around 50) of candidates sponsored by an organization or a group of organizations in any centre for a degree programme. Any organization interested in having a dialogue with the Institute for offering any collaborative and innovative programme directed towards the human resource development needs of their industry may write to the Institute. The Institute has an open mind to offer any of the existing programmes or devise any other new programme.

Admission Modality

1. The Institute is one of the very few universities in India, which has ventured into work integrated learning programmes in science and technology areas. In order to maintain the standard as well as rigour required in these areas, the Institute could cater only to those inputs, which have the facilities and environment for such a learning process. So the Institute treats these degree programmes as continuing technical education programmes for employed professionals. Hence admissions are given normally to candidates who are already employed in relevant professional domains and whose employing organizations sponsor them in their academic pursuit subject to the candidates having the required academic qualifications and relevant work experience. The Institute looks for candidates who have the necessary computer, laboratory and other physical facilities including access to Email and Internet, as well as certain intellectual input in terms of guidance by superior / co-officer / professional expert preferably from the workplace of the candidate who will be termed as Mentor, while the candidate is in pursuit of studies.

II. These degree programmes are work-integrated learning programmes. Hence, for students to get admission to these programmes, they must be engaged in work in the relevant professional areas. The final offer of admission would be based on candidate's educational background, academic achievements, work profile, relevant work experience, profile of the employing organization and Mentor's profile.

III. If the number of applications for a particular programme is less than a critical number, that programme may not be offered in that semester.

IV. Once the candidate accepts the admission offer and confirms registration, any request for deferment of admission to a subsequent semester cannot be entertained. The candidate can only withdraw from the registered semester.

Fees Structure

The fees schedule applicable for all programmes is as follows:

Admission Fees : Rs. 16,500/-

Each Semester Fees : Rs. 50,000/-

A candidate who has been offered admission will have to pay Rs. 66,500/- (Admission fees and Semester fees for the Starting Semester of the programme) immediately on receiving the Admit Offer Letter. Any candidate who desires to discontinue from the programme after confirmation of admission & registration for the courses specified in the admit offer letter will forfeit the total amount of fees paid.

Note 1: Certain specific facilities such as access to a digital library or virtual laboratories, if provided, may be charged extra in addition to the above mentioned fees.

Note 2: For the examination centre at Dubai, in addition to the semester fees, for each semester there will be an examination centre fees of 1000 UAE Dirhams or equivalent per semester out of which 500 UAE Dirhams is to be paid at the time of appearing in Mid-semester Tests at Dubai exam centre for that semester, and the remaining 500 UAE Dirhams is to be paid at the time of appearing in Comprehensive Examinations at Dubai exam centre for that semester.

Educational Process

The education in the work integrated learning programmes is characterized by person-centered approach where the rigour and standards are maintained on par with Institute's system of education on-campus. These programmes judiciously combine the flexibility and ingenuity of the continuing education system with the regular features of the on-campus education system. Also, the learning and evaluation process draws upon the successful and established methodologies followed by the Institute.

The work integrated learning environment of a student consists of two broad-based facets:

1. Academic Environment created by BITS faculty drawn from different disciplines.

2. Student's own Work Environment from which assignments, projects, seminars etc., may emerge to integrate theory and practice. A (locally-based) Mentor imparts structured guidance and conducts certain evaluation components (see Role of Mentor' below).

Central to the educational philosophy of the Institute being the dialectical link between theory and practice, the student's own work environment provides an ideal ground where theory could be meaningfully combined with practice through Assignments, Case Studies, Laboratory-Oriented Projects, Work Experience, In-service Training, Internship, Thesis-Seminar, Project Work and Dissertation. These evaluation components and courses search for evidence of self-study, time planning, conceptual understanding & application of the concepts in a real-life situation, self-reliant articulation, enthusiasm for, awareness of and participation in new pedagogy. One of the distinctive features of this system is the complete formalization of pursuit of education at the work-learning environment. An organization creates a work learning environment by providing academic sponsorship for the candidates as well as infrastructural facilities such as place for conducting formal classes / mentor interactions / examination apart from library, computer and laboratory access. The work learning environment form a strict requirement in order to infuse a strong component of teacher-student contact through course instructors as well as Mentor (a senior officer of the student's own organization). Thus work-learning environment is a very important component of the person-centered learning process. There is in the design, a clear arrangement of periodic personal discussion in the work-learning environment with the students so that their progress is directly monitored by planned interaction. Further, the students at the work-learning environment receive help from mentors. Throughout the student's learning process, which is conducted in his own work place, through systematic self-study, and self-learning process, the student remains continually in contact with the course instructors for any clarifications. Thus the operation is an imaginative combination of the contact hours and tutoring of the on-campus system with the student-centered self-study feature of the off-campus system and an organizational and pedagogic commitment of the collaborating organizations. The student is at once, a full-time student as well as full-time employee.

Work Integrated Learning: For each course offered by the Institute, there would be an Instructor, who is a BITS faculty, drawn from the relevant discipline. He is charged with the responsibility of the conduct of that course. This will be in terms of preparing question papers, evaluation of answer papers and answering student's queries. He will also prepare instruction manuals, question bank, supplementary notes, etc. wherever required in order to strengthen the course.

For each course, there will be a handout, which will spell out the plan of study and evaluation scheme, apart from other details. The evaluation schedule is also announced in the beginning of the semester itself. All details pertaining to the operation of the course including study plan are shared with the students through this document.

The BITS, Pilani model of cooperative education has a structured method of integrating education with practical work experience, faculty-student interaction as well as mentor-employer involvement. Further, the BITS model of education deploys ICT both in synchronous and asynchronous modes. Synchronous instruction through Internet based desktop video conferencing enables effective interaction between students and faculty. Asynchronous instruction, including on-demand lectures and electronic mail through list servers, is more flexible as it accommodates multiple learning levels and schedules. In addition, intensive residential contact classes are held for various programmes at the Institute campus as well as at the locations of various organizations. Thus, the BITS, Pilani model emphasizes on acquisition of knowledge and skills through mediated information and instruction, encompassing all technologies, in the work-integrated learning environment.

The Role of a Mentor: A Mentor is a senior officer of the student-employee who has been nominated by his employing organization or is a person in a senior position willing to undertake

and discharge the academic responsibilities on his own volition. It is expected of the Mentor to possess adequate qualifications to guide the student. Typically for the B.Tech. / M.Sc. programmes, the mentor is expected to have minimum educational qualification of the level of Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech. / B.S. / M.Sc. / A.M.I.E., and for the M.B.A. / M.Tech. programmes the mentor is expected to have a minimum educational qualification of the level of Higher Degree of BITS or its equivalent such as M.E. / M.Tech. / M.S / M.Phil.

The Mentors would assist the course instructors in terms of the following:

b) Achieving the set of academic objectives specified by the instructors;

c) Verifying if a student is indeed adhering to the plan of study given in the handout;

d) Monitoring involvement of the student in self-study, time planning, understanding of concepts and their use, developing self-reliant articulation, awareness of and enthusiasm for new pedagogy, responsibility to meet deadlines, develops familiarity with the library, etc.

e) Conducting certain evaluation components like Seminars, Assignments, Case Studies and Projects.

Additional features include:

(a) Courseware (pre-recorded digital content) developed by BITS faculty for certain courses.

(b) Course Handouts which provide a detailed plan of study, evaluation scheme, and experiential learning components. ***It is the responsibility of each student to acquire textbooks and other reference materials recommended for each course.***

(c) Curricula designed on S&T approach for modernizing the workbench by purposeful acquisition of scientific methods and modern skills.

(d) Intensive contact sessions (where required) conducted at any of the BITS campuses or at the collaborating organizations. The contact sessions could include one or more of the following:

- Special Lectures
- Field, Library and Laboratory work
- Projects
- Tutorials
- Case discussions
- Seminars
- Social activities.

Evaluation Methodology

Evaluation for a given course is internal and continuous and has the following features:

- Quizzes, Assignments, Projects, Case Studies, spread over a semester for making the course relevant and meaningful to the work learning environment of the students;
- Written examinations – one at the mid-semester point and a comprehensive examination at the end of semester. These examinations are conducted at specified exam centres of BITS in a centralized manner under the supervision of BITS faculty.
- For programmes offered for individuals, the Institute presently has examination centres at Bangalore, Chennai, Coimbatore, Delhi, Goa, Hyderabad, Kolkata, Mumbai, Pilani and Pune in India, and at Dubai in UAE.
- Strict adherence to the evaluation schedule as announced through the course handout at the start of the semester.
- The Institute follows continuous system of internal evaluation and letter grades A, A-, B, B-, C, C-, D, E carrying grade points 10, 9, 8, 7, 6, 5, 4, 2 respectively are awarded for all courses other than Dissertation / Project Work / Project for which only non-letter grades namely EXCELLENT, GOOD, FAIR, POOR are awarded. If a student does not offer adequate opportunity for evaluation in a course, reports such as RRA (Require to Register Again) may be awarded.
- The final grading in a course is done by tabulating in descending order (equivalently a histogram) the total marks of all students in a

particular course. The performance of the course will be analyzed in terms of average, highest and lowest marks and dividing lines between various clusters. Gaps between clusters and the nature of clusters will guide drawing the dividing lines between various grades. In a normal class of large size, the C-band will usually include the average mark. This is not a hard and fast rule and exceptions may arise in cases of small classes or a skewed histogram etc.

- The Cumulative Grade Point Average (CGPA) on a 10 Scale basis is used to describe the overall performance of a student in all courses for which LETTER GRADES are awarded.

$$CGPA = \frac{U_1G_1 + U_2G_2 + U_3G_3 + ... + U_nG_n}{U_1 + U_2 + U_3 + ... + U_n}$$

Where U_1, U_2, U_3, … U_n denote units associated with the courses taken by the student and G_1, G_2, G_3,…G_n denote grade points of the letter grades awarded in the respective courses. Non-Letter grades do not go into computation of CGPA.

- In the case of Integrated First Degree programmes the final division for the degree is decided on the basis of CGPA and there are three classifications, namely Distinction (CGPA 9.00 or more), First Division (CGPA 7.00 or more but less than 9.00) and Second Division (CGPA 4.50 or more but less than 7.00). However, no Division will be awarded in diploma, higher degrees and Ph.D. programmes.
- Subject to fulfilling the Academic Regulations of the Institute, the student will be issued at the end of each semester a grade sheet and at the end of the programme a Transcript and Provisional Certificate followed by the Final Degree Certificate. The grade sheet / transcript – provisional certificate will be withheld when a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.
- The minimum academic requirements for higher degree programmes stipulate that a student obtains a CGPA of 5.50 and no E grade in any course. For the Integrated First Degree programmes such as B.S. and B.Tech. programmes, a student should obtain a CGPA of 4.50 and no E grade in any course. Students who fail to meet the minimum academic requirements are placed under the purview of Academic Monitoring Board (AMB), which monitors their progress, and gives guidance so that they are properly rehabilitated at the earliest.
- The Institute's Academic Regulations must be consulted for additional details.

Some Stipulations

(a) All degrees offered through Work Integrated Learning Programmes are equivalent to the corresponding degrees offered on-campus, and for admissions to any higher degree programme of the Institute, these degrees will not be distinguished from on-campus degrees.

(b) In any examination, as far as possible, the direct interactive process of the evaluation would be made at a place nearest to the work location of the candidates. Wherever there is not adequate number of candidates, the Institute will be free to demand that all candidates come to one of the campuses or other examination centers for this purpose.

(c) In case of organization specific collaborative programmes, a student who is admitted to the Institute because of sponsorship from an organization will cease to be a student if he discontinues employment from the organization. In case of other programmes, the student may be allowed to continue if the new organization in which he is employed agrees to sponsor him for the degree and if the work integrated learning environment is relevant to the degree programme. However, if the person becomes unemployed he may not be continued because of the requirement of work integrated learning environment for the degree, which may no longer be available to the student.

(d) Any student admitted to a programme may be allowed to transfer to another programme provided he is eligible for the same and is supported by his work environment and sponsorship of his employer.

(e) Since every student admitted to work integrated learning programme is treated as a full-time student and a full time employee, it

is essential that such a student be not enrolled for any degree or diploma programme, part-time or otherwise, in any other university. If it is found that a student is admitted / registered in some other university for degree programme, then his admission / registration will be cancelled.

Operating Definitions of Certain Key Terms

1. A course is a component of knowledge, which serves as the irreducible minimum building block in the curriculum or syllabus.
2. A programme of studies is a set of courses constituting the requirements of a degree.
3. A regular student is one who is enrolled for a degree programme.
4. A collaborating organization is an organization that helps the Institute in setting up the necessary facilities and in the running of classes and laboratories for all students. Such an organization may simultaneously be also a sponsoring organization.
5. A sponsoring organization is an organization, which fulfills one or more of the following features:
   a) The organization is the employer of the student and pays fully / partly the fees/dues of the student and also provides facilities required for the learning process.
   b) The organization is an employer of the student but does not pay the fees/dues of the student. Nonetheless the organization agrees to encourage and actively participate in the special nature of the educational process for the mutual benefit of the organization and the employee.
6. An Associate Student is one who is allowed to register in any of the courses offered in each semester with an ultimate goal of obtaining a diploma/degree or without any such ambition. The treatment of these students will be different from that of the casual students in that these students will be registered on credit and not on audit basis and may be admitted for a degree or a diploma, if situation so warrants. Further, admission procedure and the fee structure may also differ in contrast to the casual students. Presently the Institute considers only sponsored candidates from structured collaborative programmes for admission as Associate Student.

Duration: This may vary from programme to programme depending upon the input qualification, experience, nature as well as the need of the collaborating organizations including the viability and feasibility of course offerings.

The curriculum details of programmes and semesterwise pattern of courses given in the following pages indicate the currently operational details for various programmes, which are subject to change if the situation warrants.

B.Sc. Programmes for Trainees / Working Professionals

Normal Input:	Trainees / Employed professionals who have completed their 10+2 (in Science stream) or equivalent educational qualification with minimum 60% aggregate marks.
Completion requirement	Successful completion of the B.Sc. degree programme would require completion of minimum of 23 courses (105 units minimum) with a CGPA of at least 4.50.
Nominal duration	The nominal duration of a B.Sc. programme will be 8 semesters.

Curriculum Structure of B.Sc. Programmes

Category	Number of Courses Required	Number of Units Required
I. Foundation Courses	8-12	24-40
II. Discipline Courses Discipline Core Electives	10-16 4-6	34-58 12-24
Coursework Sub-Total	**28 courses (min)**	**90 units (min)**
III. Project Courses	Min 1 and Max 2	15-20 units
Total	**29 courses (min)**	**105 Units (min)**

Note: Concurrent registration in at most two courses (upto 8 units) along with a Project Course may be permitted if the total units in that semester do not exceed 15.

B.Sc. (Design & Computing)

Input Qualification
Trainees / Employed professionals who have completed their 10+2 (Math and Physics) educational qualification with minimum of 60% aggregate marks.
Normal Duration: Eight semesters

Programme Structure

Foundation courses

Course No.	Course Title	Units
BSDC* ZC242	Cultural Studies	3
BSDC* ZC351	Writing Practice	3
BSDC* ZC231	Dynamics of Social Change	3
BSDC* ZC236	Symbolic Logic	3
BSDC* ZC322	Critical Analysis of Literature and Cinema	3
BSDC* ZC111	Probability & Statistics	3
BSDC* ZC355	Statistical Inferences and Applications	3
BSDC* ZC234	Linear Algebra and Optimization	3
BSDC* ZC112	Electrical Sciences	3
BSDC* ZC142	Computer Programming	4

Core courses

Course No.	Course Title	Units
BSDC* ZC312	Evolution of Design	3
BSDC* ZC328	Humanities and Design	3
BSDC* ZC326	Creative Thinking	3
BSDC* ZC316	Computing and Design	3
BSDC* ZC224	Print and Audio-Visual Advertisement	3
BSDC* ZC222	Discrete Structures for Computer Science	3
BSDC* ZC215	Digital Design	4
BSDC* ZC353	Computer Organization and Architecture	4
BSDC* ZC411	Data Structures	4
BSDC* ZC317	Algorithm Design	3
BSDC* ZC313	Object Oriented Programming and Design	4
BSDC* ZC365	Human Computer Interaction	3
BSDC* ZC412	Software Design Principles	4
BSDC* ZC311	Information Security	3

Pool of Electives

Course No.	Course Title	Units
BSDC* ZC344	Professional Ethics	3
BSDC* ZC511	Organizational Behaviour	3
BSDC* ZC211	Principles of Economics	3
BSDC* ZC330	Appreciation of Art	3
BSDC* ZC350	Human Rights: History, Theory and Practice	3
BSDC* ZC352	Advanced Writing Course	3
BSDC* ZC214	Science, Technology and Modernity	3
BSDC* ZC354	Introduction to Architecture	3
BSDC* ZC342	Computer Mediated Communication	3
BSDC* ZC432	Applied Statistical Methods	3
BSDC* ZC364	Operating Systems	3
BSDC* ZC481	Computer Networks	3
BSDC* ZC315	Web Programming	3

Course No.	Course Title	Units
BSDC* ZC413	Database Design	4
BSDC* ZC314	Software Development for Portable Devices	3
BSDC* ZC343	Software Engineering	4
BSDC* ZC327	Systems Programming	3
BSDC* ZC329	Design for Social Media	3

Project Type Courses

Course No.	Course Title	Units
BSDC* ZC229T	Design Project	5
BSDC* ZC499T	Capstone Project	15

Semester-wise Pattern

Course No.	Course Title	Units	Course No.	Course Title	Units
First Year					
BSDC* ZC151	Writing Practice	3	BSDC* ZC231	Dynamics of Social Change	**3**
BSDC* ZC236	Symbolic Logic	3	BSDC* ZC142	Computer Programming	**4**
BSDC* ZC112	Electrical Sciences	**3**	BSDC* ZC222	Discrete Structures for Computer Science	**3**
BSDC* ZC111	Probability & Statistics	3	BSDC* ZC225	Environmental Studies	**3**
	Total	**12**		**Total**	**13**
Second Year					
BSDC* ZC215	Digital Design	4	BSDC* ZC353	Computer Organization and Architecture	**4**
BSDC* ZC356	Data Structures	4	BSDC* ZC313	Object Oriented Programming and Design	**4**
BSDC* ZC234	Linear Algebra & Optimization	3	BSDC* ZC242	Cultural Studies	**3**
BSDC* ZC226	Creative Thinking	3	BSDC* ZC312	Evolution of Design	3
	Total	**14**		**Total**	**14**
Summer Term					
BSDC* ZC229T Design Project 5 Units					
Third Year					
BSDC* ZC317	Algorithm Design	**3**	BSDC* ZC412	Software Design Principles	**4**
BSDC* ZC322	Critical Analysis of Literature and Cinema	**3**	BSDC* ZC316	Computing and Design	**3**
BSDC* ZC328	Humanities and Design	**3**	BSDC* ZC355	Statistical Inferences and Applications	**3**
	Elective	3/4		Elective	**3/4**
	Total	**12/13**		**Total**	**13/14**
Fourth Year					
BSDC* ZC311	Information Security	3	BSDC* ZC499T	Capstone Project	**15**
BSDC* ZC365	Human Computer Interaction	**3**			
	Elective	3/4			
	Elective	3/4			
	Total	**12/14**		**Total**	**15**

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing collaborating organization.

B.Sc. (Pharmaceutical Sciences)

Type of Input
Trainees / Employed professionals who have completed their 10+2 (including Mathematics/Biology, Physics, and Chemistry as subjects) or equivalent educational qualification, with minimum 60% aggregate marks.
Nominal Duration: Eight semesters

Programme Structure

Foundation Courses

Course No.	Course Title	Units
	Humanities Foundation	
PS* ZC221	Business Communication	3
PS* ZC313	Technical Report Writing	3
PS* ZC343	Professional Ethics	3
	Mathematics Foundation	
PS* ZC111	Probability and Statistics	3
PS* ZC113	General Mathematics - I	3
PS* ZC114	General Mathematics - II	3
PS* ZC235	Linear Algebra & Optimization	3
	Science and Engineering Foundation	
PS* ZC318	Fundamentals of Transport Processes	4
	Other Courses	
PS* ZC225	Environmental Studies	3

Core Courses

Course No.	Course Title	Units
PS* ZC112	Human Anatomy and Physiology	3
PS* ZC222	Pharmaceutical Quality & GMP	4
PS* ZC223	Fundamentals of Biochemistry and Microbiology	4
PS* ZC231	Physical and Inorganic Chemistry	3
PS* ZC234	Techniques in Pharmaceutical Analysis	4
PS* ZC241	Pharmaceutical Chemistry	3
PS* ZC244	Physical Pharmacy	3
PS* ZC311	Pharmaceutical Unit Operations – I	3
PS* ZC312	Pharmaceutical Unit Operations – II	3
PS* ZC314	Pharmaceutical Jurisprudence in India	3
PS* ZC331	Pharmaceutical Formulations – I	3
PS* ZC332	Pharmaceutical Formulations – II	4
PS* ZC341	Drug Discovery and Action	4
PS* ZC342	Medicinal Chemistry	3
PS* ZC344	Natural Drugs	3

Pool of Electives

Course No.	Course Title	Units
PS* ZC212	Basic Statistical Process Control	3
PS* ZC213	Scale-up of Pharmaceutical Operations	3
PS* ZC214	Utilities in Pharmaceutical Operations	3
PS* ZC224	Novel Drug Delivery Systems	3
PS* ZC232	Chemistry of Synthetic Drugs	3
PS* ZC233	Pharmaceutical Packaging	3
PS* ZC321	Chemical Process Calculations	3
PS* ZC322	Pharmaceutical Quality by Design	3
PS* ZC323	Sterile Pharmaceutical Products	3
PS* ZC324	Name Reactions in Chemical Synthesis	3
PS* ZC361	Environmental Pollution Control	3
PS* ZC414	Biopharmaceutics	3

Project Type Courses

Course No.	Course Title	Units
PS* ZC229T	Project	5
PS* ZC499T	Capstone Project	15

B.Sc. (Pharmacutical Sciences)
Semesterwise Pattern

Course No.	Course Title	Units	Course No.	Course Title	Units
First Year					
PS* ZC113	General Mathematics - I	3	PS* ZC114	General Mathematics - II	3
PS* ZC231	Physical & Inorganic Chemistry	3	PS* ZC311	Pharmaceutical Unit Operations - I	3
PS* ZC112	Human Anatomy and Physiology	3	PS* ZC241	Pharmaceutical Chemistry	3
PS* ZC313	Technical Report Writing	3	PS* ZC221	Business Communication	3
	Total	12		**Total**	12
Second Year					
PS* ZC235	Linear Algebra & Optimization	3	PS* ZC111	Probability and Statistics	3
PS* ZC312	Pharmaceutical Unit Operations – II	3	PS* ZC331	Pharmaceutical Formulations – I	3
PS* ZC244	Physical Pharmacy	3	PS* ZC341	Drug Discovery and Action	4
PS* ZC223	Fundamentals of Biochemistry and Microbiology	4	PS* ZC234	Techniques in Pharmaceutical Analysis	4
	Total	13		**Total**	14
Summer Term					
PS* ZC229T Project 5 Units					
Third Year					
PS* ZC332	Pharmaceutical Formulations – II	4	PS* ZC318	Fundamentals of Transport Processes	4
PS* ZC342	Medicinal Chemistry	3	PS* ZC344	Natural Drugs	3
PS* ZC314	Pharmaceutical Jurisprudence in India	3	PS* ZC222	Pharmaceutical Quality & GMP	4
	Elective	3/4		Elective	3/4
	Total	13/14		**Total**	14/15
Fourth Year					
PS* ZC343	Professional Ethics	3	PS* ZC499T	Capstone Project	15
PS* ZC225	Environmental Studies	3			
	Elective	3/4			
	Elective	3/4			
	Total	12-14		**Total**	15

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B.Tech. Programmes

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Curriculum requirements: Completion of the **B.Tech.** degree would require completion of coursework of minimum 24 courses (84 units minimum) and one Project Work (16 units minimum), adding up to a total of 100 units (minimum).

Nominal duration: The nominal duration of truncated B.Tech. programs will be 7 semesters.

Curriculum Structure for B.Tech. programs for working professionals:

Category	**Number of Courses Required**	**Number of Units Required**
I Foundation Courses	5-10	15-40
II Discipline Courses		
Discipline Core	8-12	26-48
Discipline Electives	3-9	9-36
Coursework Sub-Total	**24 courses (min)**	**84 units (min)**
III Project Work#	1	16
Total	**25 courses (min)**	**100 units (min)**

#Note: Concurrent registration in one course (upto 4 units) alongwith Project Work may be permitted.

B. TECH. (ENGINEERING DESIGN))
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements :

Foundation Courses: 9 courses (32 units min.)
Discipline Core : 11 courses (40 units min.)
Discipline Electives : 4 courses (12 units min.)
Coursework sub total : 24 courses (84 units min.)
Project Work : 16 units

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (9)			
Mathematics Foundation	ED* ZC233	Calculus	4
	ED* ZC235	Linear Algebra & Optimization	3
Technical Arts / Professional Courses	ED* ZC164	Computer Programming	4
	ED* ZC241	Technical Report Writing	3
	ED* ZC 231	Principles of Management	3
Engineering Foundation	ED* ZC232	Engineering Materials	3
	ED* ZC261	Mechanical Technology	4
	ED* ZC211	Electrical and Electronics Technology	4
	ED* ZC251	Engineering Measurements	4
Discipline Courses			
Core (11)	ED* ZC321	Mechanics of Solids	3
	ED* ZC245	Fluid Mechanics & Machines	4
	ED* ZC332	Mechanical Engineering Design-I	4
	ED* ZC322	Kinematics & Dynamics of Machines	3
	ED* ZC311	Manufacturing Processes	4
	ED* ZC453	Product Design & Development	4
	ED* ZC342	Mechanical Engineering Design-II	4
	ED* ZC434	Quality Control, Assurance & Reliability	4
	ED* ZC433	Mechanical Vibrations & Acoustics	3
	ED* ZC441	Automotive Vehicles	3
	ED* ZC436	Computer Aided Design	4
Electives (any 4)	ED* ZC471	Management Information Systems	3
	ED* ZC324	Mechatronics & Automation	4
	ED* ZC325	Fluid Power Systems	4
	ED* ZC452	Composite Materials and Design	4
	ED* ZC454	Reverse Engineering and Rapid Prototyping	4

B. TECH. (ENGINEERING DESIGN)

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	ED* ZC211	Electrical and Electronics Technology	4	ED* ZC164	Computer Programming	4
	ED* ZC232	Engineering Materials	3	ED* ZC235	Linear Algebra and Optimization	3
	ED* ZC233	Calculus	4	ED* ZC251	Engineering Measurements	4
	ED* ZC261	Mechanical Technology	3	ED* ZC321	Mechanics of Solids	3
		Total	14		Total	14
II	ED* ZC245	Fluid Mechanics and Machines	4	ED* ZC342	Mechanical Engineering Design-II	4
	ED* ZC311	Manufacturing Processes	4	ED* ZC436	Computer Aided Design	4
	ED* ZC322	Kinematics & Dynamics of Machines	3	ED* ZC453	Product Design & Development	4
	ED* ZC332	Mechanical Engineering Design-I	4		Discipline Elective	3(min.)
		Total	15		Total	15
III	ED* ZC433	Mechanical Vibrations & Acoustics	3	ED* ZC241	Technical Report Writing	3
	ED* ZC434	Quality Control, Assurance & Reliability	4	ED* ZC231	Principles of Management	3
	ED* ZC441	Automotive Vehicles	3		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	13		Total	12
	ED* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B. TECH. (ENGINEERING TECHNOLOGY)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses: 10 courses (35 units min.)

Discipline Core : 9 courses (34 units min.)

Discipline Electives : 5 courses (15 units min.)

Coursework sub total : 24 (84 units min.)

Project Work : 16 units

Category-wise Programme Structure:

Sub-Category	Course No.	Course Title	Units
Foundation Courses (10)			
Mathematics Foundation	MATH ZC233	Calculus	4
	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
Technical Arts / Professional Courses	TA ZC164	Computer Programming	4
	TA ZC312	Technical Report Writing	3
	MGTS ZC211	Principles of Management	3
Engineering Foundation	ENGG ZC232	Engineering Materials	3
	ENGG ZC241	Mechanical Technology	4
	ENGG ZC111	Electrical & Electronics Technology	4
	TA ZC233	Engineering Measurements	4
Discipline Courses			
Core (9)	ET ZC413	Engineering Design	4
	ET ZC423	Essentials of Project Management	3
	ET ZC344	Instrumentation & Control	4
	ENGG ZC242	Maintenance & Safety	3
	ET ZC234	Manufacturing Processes	4
	ET ZC342	Materials Management	4
	ET ZC412	Production Planning & Control	4
	ET ZC434	Quality Control, Assurance & Reliability	4
	ET ZC426	Plant Layout and Design	4
Electives (any 5)	ET ZC352	Energy Management	4
	ET ZC362	Environmental Pollution Control	3
	EA ZC412	Flexible Manufacturing Systems	4
	BITS ZC471	Management Information Systems	3
	ET ZC415	Manufacturing Excellence	4
	ET ZC323	Mechatronics & Automation	4
	ES ZC343	Microprocessors & Microcontollers	3
	ET ZC348	Additive Manufacturing	4
	ET ZC349	IoT in Manufacturing	4

B. TECH. (ENGINEERING TECHNOLOGY)
Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	ENGG ZC111	Electrical & Electronics Technology	4	AAOC ZC111	Probability & Statistics	3
	ENGG ZC232	Engineering Materials	3	TA ZC232	Engineering Measurements	4
	MATH ZC233	Calculus	4	MATH ZC234	Linear Algebra & Optimization	3
	TA ZC164	Computer Programming	4	ENGG ZC241	Mechanical Technology	4
		Total	15		Total	14
II	ENGG ZC242	Maintenance & Safety	3	ET ZC344	Instrumentation & Control	4
	ET ZC234	Manufacturing Processes	4	ET ZC342	Materials Management	4
	ET ZC413	Engineering Design	4	ET ZC423	Essentials of Project Management	3
	ET ZC412	Production Planning & Control	4	ET ZC426	Plant Layout & Design	4
		Total	15		Total	15
III	ET ZC434	Quality Control, Assurance & Reliability	4	MGTS ZC211	Principles of Management	3
		Discipline Elective	3(min.)	TA ZC312	Technical Report Writing	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	13		Total	12
	BITS ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B. TECH. (INFORMATION SYSTEMS)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses: 8 courses (27 units min.)
Discipline Core : 10 courses (39 units min.)
Discipline Electives : 6 courses (18 units min.)
Course work sub total : 24 (84 units min.)
Project Work : 16 units

Category-wise Programme Structure:

Sub-category	Course No.	Course Title	Units
Foundation Courses (8)			
Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
	MATH ZC222	Discrete Structures for Computer Science	3
	MATH ZC233	Calculus	4
Technical Arts / Professional Courses	TA ZC163	Computer Programming	4
	TA ZC312	Technical Report Writing	3
	MGTS ZC211	Principles of Management	3
Engineering Foundation	ES ZC264	Digital Electronics and Microprocessors	4
Discipline Courses			
Core (10)	IS ZC467	Computer Networks	4
	IS ZC353	Computer Organization & Architecture	4
	IS ZC363	Data Structures & Algorithms	4
	IS ZC337	Database Systems & Applications	4
	IS ZC373	Compiler Design	4
	IS ZC313	Object Oriented Programming & Design	4
	IS ZC364	Operating Systems	4
	IS ZC343	Software Engineering	4
	IS ZC327	Systems Programming	4
	IS ZC328	Software Testing	3
Electives (6)	BITS ZC471	Management Information Systems	3
	IS ZC423	Software Development for Portable Devices	3
	IS ZC415	Data Mining	3
	IS ZC472	Computer Graphics	3
	IS ZC446	Data Storage Technologies & Networks	3
	EA ZC473	Multimedia Computing	3
	IS ZC462	Network Programming	3
	IS ZC422	Parallel Computing	3
	IS ZC424	Software for Embedded Systems	3

B. TECH. (INFORMATION SYSTEMS)
Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC233	Calculus	4	IS ZC327	Systems Programming	4
	TA ZC163	Computer Programming	4	MATH ZC234	Linear Algebra & Optimization	3
	ES ZC263	Digital Electronics and Microprocessors	4	IS ZC363	Data Structures and Algorithms	4
		Total	15		Total	15
II	IS ZC353	Computer Organization & Architecture	4	IS ZC373	Compiler Design	4
	IS ZC337	Database Systems & Applications	4	IS ZC343	Software Engineering	4
	IS ZC364	Operating Systems	4	IS ZC467	Computer Networks	4
	AAOC ZC111	Probability and Statistics	3	IS ZC328	Software Testing	3
		Total	15		Total	15
III		Discipline Elective	3(min.)	MGTS ZC211	Principles of Management	3
		Discipline Elective	3(min.)	TA ZC312	Technical Report Writing	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	12		Total	12
	BITS ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

B. TECH. MANUFACTURING TECHNOLOGY
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses:	9 courses		(32 units min.)
Discipline Core	:	11 courses	(40 units min.)
Discipline Electives	:	4 courses	(12 units min.)
Coursework sub total	:	24 courses	(84 units min.)
Project Work	:	16 units (min.)	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (9)			
Mathematics Foundation	MT* ZC233	Calculus	4
	MT* ZC235	Linear Algebra & Optimization	3
Technical Arts / Professional Courses	MT* ZC221	Computer Programming	4
	MT* ZC241	Technical Report Writing	3
	MT* ZC 231	Principles of Management	3
Engineering Foundation	MT* ZC236	Engineering Materials	3
	MT* ZC251	Mechanical Technology	4
	MT* ZC112	Electrical and Electronics Technology	4
	MT* ZC213	Engineering Measurements	4
Discipline Courses			
Core (11)	MT* ZC261	Mechanics of Solids	3
	MT* ZC245	Fluid Mechanics & Machines	4
	MT* ZC342	Machine Design	4
	MT* ZC344	Metal Forming and Machining	4
	MT* ZC315	Casting and Welding	4
	MT* ZC331	Production Planning & Control	4
	MT* ZC418	Lean Manufacturing	4
	MT* ZC434	Quality Control, Assurance & Reliability	4
	MT* ZC312	Tool and Fixture Design	3
	MT* ZC421	Essentials of Project Management	3
	MT* ZC432	Computer Aided Manufacturing	3
Electives (any 4)	MT* ZC412	Flexible Manufacturing Systems	4
	MT* ZC324	Mechatronics & Automation	4
	MT* ZC343	Materials Management	4
	MT* ZC346	Instrumentation & Control	4
	MT* ZC347	Microprocessors and Microcontrollers	3
	MT* ZC471	Manufacturing Excellence	4
	MT* ZC311	Automobile Technology-I	4
	MT* ZC312	Automobile Technology-II	4
	MT* ZC332	Operations Research	4
	MT* ZC234	Maintenance & Safety	3
	MT* ZC452	Composite Materials and Design	4

B. TECH. MANUFACTURING TECHNOLOGY

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	MT* ZC233	Calculus	4	MT* ZC235	Linear Algebra and Optimization	3
	MT* ZC261	Mechanics of Solids	3	MT* ZC251	Mechanical Technology	4
	MT* ZC236	Engineering Materials	3	MT* ZC213	Engineering Measurements	4
	MT* ZC112	Electrical and Electronics Technology	4	MT* ZC221	Computer Programming	4
		Total	14		Total	15
II	MT* ZC245	Fluid Mechanics & Machines	4	MT* ZC349	IoT in Manufacturing	4
	MT* ZC315	Casting and Welding	4	MT* ZC331	Production Planning and Control	4
	MT* ZC344	Metal Forming and Machining	4	MT* ZC342	Machine Design	4
	MT* ZC348	Additive Manufacturing	4		Discipline Elective	3(min.)
		Total	16		Total	15
III	MT* ZC418	Lean Manufacturing	4	MT* ZC241	Technical Report Writing	3
	MT* ZC432	Quality Control Assurance and Reliability	4	MT* ZC231	Principles of Management	3
	MT* ZC421	Essentials of Project Management	3		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	14		Total	12
	MT* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Kirloskar Oil Engines, Kolhapur, Bharat Forge, Pune, Tata Motors, Jamshedpur; TACO, Pune; Maruti Suzuki, Gurgaon; Mahindra Motor Vehicles, Cummins, Pune

B. TECH. (POWER ENGINEERING)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:	9 courses (31 units min.)
Discipline Core	:	10 courses (36 units min.)
Discipline Electives	:	5 courses (17 units min.)
Coursework sub total	:	24 courses (84 units min.)
Project Work	:	16 units

Sub- Category	Course No	Course Title	Unit
Foundation Courses (9)			
Mathematics Foundation	POW* ZC233	Calculus	4
	POW* ZC234	Linear Algebra & Optimization	3
General Awareness / Technical Arts	POW* ZC164	Computer Programming	4
	POW* ZC232	Principles of Management	3
	POW* ZC321	Technical Report Writing	3
Engineering Foundation	POW* ZC112	Electrical & Electronics Technology	4
	POW* ZC343	Microprocessors & Microcontrollers	3
	POW* ZC231	Thermodynamics	3
	POW* ZC242	Engineering Measurements	4
Discipline Courses (10)			
Core (10)	POW* ZC434	Quality Control, Assurance & Reliability	4
	POW* ZC313	Power Plant Engineering	4
	POW* ZC314	Prime Movers & Fluid Machines	4
	POW* ZC342	Power System Engineering I	3
	POW* ZC344	Instrumentation & Control	4
	POW* ZC421	Essentials of Project Management	3
	POW* ZC431	Maintenance & Safety	3
	POW* ZC316	Power Electronics	4
	POW* ZC441	Power System Engineering II	3
	POW* ZC315	Transport Phenomena	4
Electives (any 5)	POW* ZC332	Energy Management	4
	POW* ZC411	Environmental Pollution Control	3
	POW* ZC412	Power System Operation and Control	3
	POW* ZC413	Process Control	3
	POW* ZC422	Power System Drawing & Design	3
	POW* ZC452	Renewable Energy	3
	POW* ZC471	Power Electronics & Drives	3
	POW* ZC481	Plant Layout & Design	4

B. TECH. (POWER ENGINEERING)

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

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Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	POW* ZC112	Electrical & Electronics Technology	4	POW* ZC234	Linear Algebra & Optimization	3
	POW* ZC164	Computer Programming	4	POW* ZC242	Engineering Measurements	4
	POW* ZC231	Thermodynamics	3	POW* ZC343	Microprocessors & Microcontrollers	3
	POW* ZC233	Calculus	4	POW* ZC315	Transport Phenomena	4
		Total	15		Total	14
II	POW* ZC342	Power System Engineering I	3	POW* ZC434	Quality Control, Assurance & Reliability	4
	POW* ZC344	Instrumentation & Control	4	POW* ZC314	Prime Movers and Fluid Machines	4
	POW* ZC431	Maintenance & Safety	3	POW* ZC441	Power System Engineering II	3
	POW* ZC313	Power Plant Engineering	4		Discipline Elective	3(min.)
		Total	14		Total	14
III	POW* ZC316	Power Electronics	4	POW* ZC321	Technical Report Writing	3
	POW* ZC421	Essentials of Project Management	3	POW* ZC232	Principles of Management	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	13		Total	12
	POW* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Aditya Birla Group, Tata Power, JSW Energy – Mumbai

B. TECH. (PROCESS ENGINEERING)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:	8 courses	(28 units min.)
Discipline Core	:	9 courses	(35 units min.)
Discipline Electives	:	7 courses	(21 units min.)
Coursework sub total	:	24 courses	(84 units min.)
Project Work	:	16 units	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (8)			
Mathematics Foundation	PE* ZC233	Calculus #	4
	PE* ZC235	Linear Algebra & Optimization #	3
	PE* ZC113	Probability and Statistics	3
Technical Arts / Professional Courses	PE* ZC164	Computer Programming #	4
	PE* ZC211	Principles of Management #	3
	PE* ZC313	Technical Report Writing #	3
Engineering Foundation	PE* ZC231	Engineering Materials #	3
	PE* ZC213	Engineering Measurements #	4
	PE* ZC112	Electrical & Electronics Technology #	4
Discipline Courses			
Core	PE* ZC321	Chemical Process Calculations	3
	PE* ZC311	Chemical Engineering Thermodynamics	4
	PE* ZC318	Fundamentals of Transport Processes	4
	PE* ZC319	Unit Operations – I	4
	PE* ZC352	Energy Management	4
	PE* ZC452	Process Plant Safety and Environment	4
	PE* ZC453	Process Control & Instrumentation	4
	PE* ZC322	Process Design Principles	4
	PE* ZC412	Process Equipment Design	4
Elective Courses			
Electives	PE* ZC434	Quality Control Assurance & Reliability	4
	PE* ZC314	Power Plant Engineering	4
	PE* ZC234	Manufacturing Processes	4
	PE* ZC411	Production Planning and Control	4
	PE* ZC342	Materials Management	4
	PE* ZC353	Industrial Engineering	3
	PE* ZC423	Essentials of Project Management	3
	PE* ZC361	Environmental Pollution Control	3
	PE* ZC383	Extractive Metallurgy	3
	PE* ZC385	Fertilizer Technology	3
	PE* ZC382	Cement Technology	3
	PE* ZC384	Fibre & Cellulosic Technology	3
	PE* ZC214	Pharmaceutical Analysis	3
	PE* ZC221	Disinfection & Sterilization Processes	3
	PE* ZC344	Pharmaceutical Quality Control & Regulatory Affairs	3
	PE* ZC252	Mineral Beneficiation & Agglomeration	3
	PE* ZC262	Iron Making	3
	PE* ZC273	Advances in Material Science & Testing	3
	PE* ZC312	Steel Making & Casting	3
	PE* ZC362	Steel Processing	3
	PE* ZC320	Unit Operations – II	4
	PE* ZC323	Corrosion Engineering	3
	PE* ZC324	Chemical Reaction Engineering	3
	PE* ZC272	Furnace Technology	3
	PE* ZC442	Advances in Materials Science	3

Mandatory Foundation Course

B. TECH. (PROCESS ENGINEERING)

Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having minimum two years work experience in relevant domains.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	PE* ZC112	Electrical & Electronics Technology	4	PE* ZC352	Energy Management	4
	PE* ZC231	Engineering Materials	3	PE* ZC213	Engineering Measurements	4
	PE* ZC233	Calculus	4	PE* ZC235	Linear Algebra & Optimization	3
	PE* ZC164	Computer Programming	4	PE* ZC321	Chemical Process Calculations	3
		Total	15		Total	14
II	PE* ZC311	Chemical Engineering Thermodynamics	4	PE* ZC322	Process Design Principles	4
	PE* ZC318	Fundamentals of Transport Processes	4	PE* ZC412	Process Equipment Design	4
	PE* ZC319	Unit Operations – I	4		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	15		Total	15
III	PE* ZC452	Process Plant Safety & Environment	4	PE* ZC313	Technical Report Writing	3
	PE* ZC453	Process Control & Instrumentation	4	PE* ZC211	Principles of Management	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	14		Total	12
	PE* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Aditya Birla Group, Mumbai; JSW Steel, Toranagallu; Vedanta, Jharsuguda; BPCL, Mumbai

Master of Science (M.Sc.) programmes

Program Structure:

Normal Input: Three-year undergraduate degree in relevant disciplines.

Curriculum requirements: Completion of the **M.Sc.** degree programme would require completion of coursework of minimum 15 courses (52 units minimum) and one Project / Thesis / Practice School (8 – 20 units), adding up to a total of 72 units minimum.

Nominal duration: The nominal duration of a M.Sc. programme will be 4 semesters.

Curriculum Structure for M.Sc. programs:

Category	**Number of Courses Required**	**Number of Units Required**
I Foundation Courses	2-8	6-32
II Discipline Courses		
Discipline Core	5-10	15-40
Discipline Electives	2-6	6-20
Coursework Sub-Total	**15 courses (min)**	**52 units (min)**
III Project / Thesis / Practice School	1	8 -20
Total	**16 courses (min)**	**72 units (min)**

Note: Concurrent registration in two courses (upto 8 units) alongwith Project is to be permitted.

M.Sc. (BUSINESS ANALYTICS)
Curriculum Structure

Type of Input: Employed professionals working in a variety of business domains, holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics, with minimum one year work experience in relevant domains.

Nominal Duration: Five Semesters

Curriculum Structure

Foundation courses

Course No.	Course Title	Units
BA* ZG522	Business Data Mining	4
BA* ZG521	Financial Management	4
BA* ZC413	Introduction to Statistical Methods	3
BA* ZC471	Management Information Systems	3
BA* ZC411	Marketing	4
BA* ZC412	Models and Applications in Operations Research	4
BA* ZG621	Supply Chain Management	4

Core courses

Course No.	Course Title	Units
BA* ZG524	Advanced Statistical Methods	4
BA* ZC415	Analytics for Competitive Advantage	4
BA* ZG525	Big Data Analytics	4
BA* ZG523	Introduction to Data Science	3
BA* ZC414	Optimization Methods for Analytics	4
BA* ZG512	Predictive Analytics	4

Pool of electives

Course No.	Course Title	Units
BA* ZC418	Advanced Financial Modeling	4
BA* ZC420	Data Visualization	3
BA* ZC417	Financial Risk Analytics	4
BA* ZC425	HR Analytics	4
BA* ZC416	Investment Banking Analytics	4
BA* ZC422	Marketing Analytics	4
BA* ZC421	Marketing Models	4
BA* ZC423	Retail Analytics	4
BA* ZC424	Supply Chain Analytics	4
BA* ZC426	Real-time Analytics	4
BA* ZG537	Text Analytics	4

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	BA* ZC411	Marketing	4	BA* ZG521	Financial Management	4
	BA* ZC471	Management Information Systems	3	BA* ZG522	Business Data Mining	4
	BA* ZC412	Models and Applications in Operational Research	4	BA* ZG621	Supply Chain Management	4
	BA* ZC413	Introduction to Statistical Methods	3	BA* ZG523	Introduction to Data Science	3
		Total	14		Total	15
II	BA* ZG524	Advanced Statistical Methods	4	BA* ZC415	Analytics for Competitive Advantage	4
	BA* ZG525	Big Data Analytics	4		Elective 1	(3 min)
	BA* ZG512	Predictive Analytics	4		Elective 2	(3 min)
	BA* ZC414	Optimization Methods for Analytics	4		Elective 3	(3 min)
		Total	16		Total	13 (min)
III		Elective 4	(3 min)			
	BA* ZG625T	Project	10			
		Total	13 (min)			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

M.Sc. (INFORMATION SYSTEMS)
Curriculum Structure

Normal Input: Employed professionals holding a B.Sc. or BCA degree with adequate preparation in Mathematics, and having minimum one year work experience in relevant domains.

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Nominal duration: 5 semesters.

Curriculum Requirements :

Foundation Courses: 5 courses (17 units min.)
Discipline Core : 9 courses (36 units min.)
Discipline Electives : 4 courses (12 units min.)
Coursework sub total : 18 courses (65 units min.)
Project : 8 units

Category-wise Programme Structure:

Sub- Category	Course No	Course Title	Unit
Foundation Courses (5)			
Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
	MATH ZC222	Discrete Structures for Computer Science	3
General Awareness / Technical Arts	TA ZC163	Computer Programming	4
Engineering Foundation	ES ZC264	Digital Electronics and Microprocessors	4
Discipline Courses			
Core	IS ZC373	Compiler Design	4
	IS ZC467	Computer Networks	4
	IS ZC353	Computer Organization & Architecture	4
	IS ZC363	Data Structures & Algorithms	4
	IS ZC337	Database Systems & Applications	4
	IS ZC313	Object Oriented Programming & Design	4
	IS ZC364	Operating Systems	4
	IS ZC343	Software Engineering	4
	IS ZC327	Systems Programming	4
Electives (4)	CS ZG551	Advanced Compilation Techniques	5
	CS ZG623	Advanced Operating Systems	5
	IS ZC444	Artificial Intelligence	3
	BITS ZC471	Management Information Systems	3
	IS ZC472	Computer Graphics	3
	EA ZC473	Multimedia Computing	3
	IS ZC415	Data Mining	3
	IS ZC422	Parallel Computing	3
	IS ZC423	Software Development for Portable Devices	3
	IS ZC424	Software for Embedded Systems	3
	IS ZC446	Data Storage Technologies & Networks	3
	IS ZC462	Network Programming	3

M.Sc. (INFORMATION SYSTEMS)
Semesterwise Pattern

Normal Input: Employed professionals holding a B.Sc. or BCA degree with adequate preparation in Mathematics, having minimum one year work experience in relevant domains.

Nominal duration: 5 semesters.

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC234	Linear Algebra & Optimization	3	IS ZC327	Systems Programming	4
	TA ZC163	Computer Programming	4	AAOC ZC111	Probability and Statistics	3
	ES ZC263	Digital Electronics and Microprocessors	4	IS ZC363	Data Structures and Algorithms	4
		Total	15		Total	14
II	IS ZC353	Computer Organization & Architecture	4	IS ZC373	Compiler Design	4
	IS ZC337	Database Systems & Applications	4	IS ZC343	Software Engineering	4
	IS ZC364	Operating Systems	4	IS ZC467	Computer Networks	4
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	15		Total	15
III	BITS ZC426T	Project	8			
		Discipline Elective	3(min.)			
		Discipline Elective	3(min.)			
		Total	14			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

MBA programmes

Input Qualification:

The students admitted to the proposed four-semester MBA programs must:

(i) hold an Integrated First Degree of BITS or its equivalent and

(ii) be employed professionals with adequate work experience in relevant domains.

Curriculum Requirements for MBA programs

The nature of the input to these programs and the objectives / orientation of Work Integrated Learning Programs are different from those of the on-campus programs. Students interested in these programs are seeking continuing higher management education and focus in the chosen technical domain of study, which would enable their career progression within their industry. It is also to be observed that learning and coursework in these programs are integrated within a professional / technical environment.

Based on these facts and observations the curriculum has been designed to be in strong alignment with on-campus program at the core but with sufficient flexibility for customization to meet specific requirements of a target student population.

Completion of the program would require:

(i) At least 13 courses (totaling at least 52 units) towards coursework, and

(ii) Project (12 units).

The Department concerned may identify 4 to 8 courses out of the coursework requirement for each program as the **Management Core** requirement, and 4 to 6 courses of the coursework requirement for each program as the **Domain Core** requirement. The core requirements are mandatory for all students in a given program. However in certain highly specialized areas, some variation in the core requirements may be permitted. Rest of the coursework must be completed through elective courses.

The curriculum requirements common to all MBA programs is given below:

Category	No. of Units Required	No. of Courses Required
Management Core	24-40	6-8
Domain Core	16-25	4-6
Electives	3-15	1-3
Subtotal	52 (min)	13 (min)
Project	12	1
Total	64 (min)	14 (min)

Project: As Project is based on the work environment of the student, the number of units for Project may be kept as 12. Normally, the Project is to be undertaken in the final semester of the program.

MBA in Consultancy Management
Curriculum Structure

Type of Input:

- Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one year work experience in relevant domains.
- Employed professionals holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics, and minimum 2 years work experience in relevant domains.

Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:

(a) At least 13 courses (totaling at least 52 units) towards coursework, and

(b) Project (12 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC411	Marketing	4
MBA ZC415	Financial and Management Accounting	4
MBA ZC416	Managerial Economics	4
MBA ZC417	Quantitative Methods	4
MBA ZG511	Managing People & Organizations	4
MBA ZG521	Financial Management	4
MBA ZG526	Operations Management	4

Consultancy Core (5 Courses)

Course No.	Course Title	Units
MBA ZG515	Consulting and People Skills	4
MBA ZG523	Project Management	4
MBA ZG525	Business Process Analysis	4
MBA ZG541	Consultancy Practice	4
MBA ZG634	Strategic Change Management	4

Pool of Electives

Course No.	Course Title	Units
MBA ZG513	Enterprise Resource Planning	4
MBA ZG514	Leadership & Managing Change	4
MBA ZG535	Decision Analysis	4
MBA ZG621	Supply Chain Management	4
MBA ZG641	Management Information & Decision Support Systems	5

Project

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Consultancy Management

Type of Input: Employed professionals working in Consulting and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains. Candidates holding other qualifications such as M.Com. / ACA / ACS may also be considered on a case by case basis.

Duration: Four Semesters

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial & Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG526	Operations Management	4
	MBA ZG511	Managing People & Organizations	4	MBA ZG541	Consultancy Practice	4
		Total	16		Total	16
II	MBA ZG515	Consulting & People Skills	4	MBA ZG623T	Project	12
	MBA ZG634	Strategic Change Management	4		Elective	4(min)
	MBA ZG523	Project Management	4			
	MBA ZG525	Business Process Analysis	4			
		Total	16		Total	16(min)

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MBA ZC415	Financial & Management Accounting	4
				MBA ZC416	Managerial Economics	4
				MBA ZC417	Quantitative Methods	4
				MBA ZG511	Managing People & Organizations	4
					Total	16
II	MBA ZC411	Marketing	4	MBA ZG515	Consulting & People Skills	4
	MBA ZG521	Financial Management	4	MBA ZG634	Strategic Change Management	4
	MBA ZG526	Operations Management	4	MBA ZG523	Project Management	4
	MBA ZG541	Consultancy Practice	4	MBA ZG525	Business Process Analysis	4
		Total	16		Total	16
III	MBA ZG623T	Project	12			
		Elective	4(min)			
		Total	16(min)			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

MBA in Finance

Type of Input:

- Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one year work experience in relevant domains.
- Employed professionals holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics, and minimum 2 years work experience in relevant domains.

Nominal Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 14 courses (totaling at least 56 units) towards coursework, and
(b) Project (8 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC411	Marketing	4
MBA ZC415	Financial and Management Accounting	4
MBA ZC416	Managerial Economics	4
MBA ZC417	Quantitative Methods	4
MBA ZG511	Managing People & Organizations	4
MBA ZG521	Financial Management	4
MBA ZG611	Strategic Management and Business Policy	4

Finance Core (4 Courses)

Course No.	Course Title	Units
FIN ZG512	Global Financial Markets and Products	4
FIN ZG513	Management of Banks & Financial Institutions	4
FIN ZG514	Derivatives & Risk Management	4
FIN ZG518	Multinational Finance	4

Pool of Electives

Course No.	Course Title	Units
FIN ZG519	Business Analysis & Valuation	4
FIN ZG520	Security Analysis & Portfolio Management	4
FIN ZG522	Mergers, Acquisitions, and Corporate Restructuring	4
FIN ZG523	Market Risk Management	4
FIN ZG524	Credit Risk Management	4
FIN ZG525	Operational Risk Management	4
FIN ZG526	Advanced Risk Models	4
FIN ZG527	International Regulatory Framework for Banks	4
FIN ZG528	Venture Capital & Private Equity	4
MBA ZG535	Decision Analysis	4

Project

Course No.	Course Title	Units
MBA ZG622T	Project	8

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial and Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG611	Strategic Management and Business Policy	4
	MBA ZG511	Managing People & Organizations	4	FIN ZG512	Global Financial Markets and Products	4
		Total	**16**		**Total**	**16**
II	FIN ZG513	Management of Banks & Financial Institutions	4		Elective 2	4
	FIN ZG514	Derivatives & Risk Management	4		Elective 3	4
	FIN ZG518	Multinational Finance	4	MBA ZG622T	Project	8
		Elective 1	4			
		Total	**16**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

MBA in Hospital & Health Systems Management

Input criteria: Employed professionals in the healthcare industry, holding an Integrated **First Degree of BITS** or its equivalent / MBBS or its equivalent, with at least one year of relevant work experience.

Nominal Duration: Four semesters

Curriculum requirements:
Completion of the programme would require:
(a) Atleast 13 courses (totaling atleast 52 units) towards coursework; and
(b) Project (12 units)

Programme Structure

MANAGEMENT CORE (5 Courses)

Course No.	Course Title	Units
MBA ZC415	Financial and Management Accounting	4
MBA ZG521	Financial Management	4
MBA ZC416	Managerial Economics	4
MBA ZC411	Marketing	4
MBA ZC417	Quantitative Methods	4

DOMAIN CORE (7 Courses)

Course No.	Course Title	Units
HHSM ZG513	Biostatistics & Epidemiology	4
HHSM ZG516	Epidemic & Disaster Management	4
HHSM ZG517	Healthcare Management	4
HHSM ZG614	Hospital Operations Management	4
HHSM ZG631	Introduction to Health Systems & Environmental Health	4
HHSM ZG615	Service Quality Excellence in Healthcare	4
HHSM ZG617	Strategic Management of Healthcare Organizations	4

ELECTIVES (1 course to be chosen from the pool of electives)

Course No.	Course Title	Units
MBA ZG535	Decision Analysis	4
MBA ZG514	Leadership & Managing Change	4
MBA ZG523	Project Management	4

PROJECT

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Hospital & Health Systems Management

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial and Management Accounting	4	MBA ZG521	Financial Management	4
	MBA ZC416	Managerial Economics	4	HHSM ZG516	Epidemic & Disaster Management	4
	MBA ZC411	Marketing	4	HHSM ZG631	Introduction to Health Systems & Environmental Health	4
	MBA ZC417	Quantitative Methods	4	HHSM ZG615	Service Quality Excellence in Healthcare	4
		Total	**16**		**Total**	**16**
II	HHSM ZG513	Biostatistics & Epidemiology	4	MBA ZG623T	Project	12
	HHSM ZG517	Healthcare Management	4		Elective 1	4
	HHSM ZG614	Hospital Operations Management	4			
	HHSM ZG617	Strategic Management of Healthcare Organizations	4			
		Total	**16**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

MBA in Manufacturing Management
Curriculum Structure

Type of Input: Employed professionals working in Manufacturing and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 13 courses (totaling at least 52 units) towards coursework, and
(b) Project (12 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC411	Marketing	4
MBA ZC415	Financial and Management Accounting	4
MBA ZC416	Managerial Economics	4
MBA ZC417	Quantitative Methods	4
MBA ZG511	Managing People & Organizations	4
MBA ZG521	Financial Management	4
MBA ZG611	Strategic Management & Business Policy	4

Manufacturing Core (4 courses)

Course No.	Course Title	Units
MBA ZG522	Total Quality Management	4
MBA ZG526	Operations Management	4
MBA ZG537	Lean Manufacturing	5
MBA ZG621	Supply Chain Management	4

Pool of Electives

Course No.	Course Title	Units
MBA ZG513	Enterprise Resource Planning	4
MBA ZG523	Project Management	4
MBA ZG535	Decision Analysis	4
MBA ZG514	Leadership & Managing Change	4
MBA ZG641	Management Information & Decision Support Systems	5

Project

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Manufacturing Management

Type of Input: Employed professionals working in Manufacturing and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial and Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG611	Strategic Management & Business Policy	4
	MBA ZG511	Managing People & Organizations	4	MBA ZG526	Operations Management	4
		Total	16		Total	16
II	MBA ZG522	Total Quality Management	4	MBA ZG623T	Project	12
	MBA ZG621	Supply Chain Management	4		Elective	4(min)
	MBA ZG537	Lean Manufacturing	5			
		Elective	4(min)			
		Total	17(min)		Total	16(min)

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MBA ZC415	Financial and Management Accounting	4
				MBA ZC416	Managerial Economics	4
				MBA ZC417	Quantitative Methods	4
				MBA ZG511	Managing People & Organizations	4
					Total	16
II	MBA ZC411	Marketing	4	MBA ZG522	Total Quality Management	4
	MBA ZG521	Financial Management	4	MBA ZG621	Supply Chain Management	4
	MBA ZG611	Strategic Management & Business Policy	4	MBA ZG537	Lean Manufacturing	5
	MBA ZG526	Operations Management	4		Elective	4(min)
		Total	16		Total	17(min)
III	MBA ZG623T	Project	12			
		Elective	4(min)			
		Total	16(min)			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

MBA in Quality Management
Curriculum Structure

Type of Input: Employed professionals working in Quality and allied business domains, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 13 courses (totaling at least 52 units) towards coursework, and
(b) Project (12 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC411	Marketing	4
MBA ZC415	Financial and Management Accounting	4
MBA ZC416	Managerial Economics	4
MBA ZC417	Quantitative Methods	4
MBA ZG511	Managing People & Organizations	4
MBA ZG521	Financial Management	4
MBA ZG611	Strategic Management & Business Policy	4

Quality Core (4)

Course No.	Course Title	Units
MBA ZG524	Quality Management Systems	5
MBA ZG522	Total Quality Management	4
MBA ZG526	Operations Management	4
MBA ZG531	Statistical Quality Control	5

Pool of Electives

Course No.	Course Title	Units
MBA ZG641	Management Information & Decision Support Systems	5
MBA ZG523	Project Management	4
MBA ZG535	Decision Analysis	4
MBA ZG661	Software Quality Management	4
MBA ZG514	Leadership & Managing Change	4
MBA ZG621	Supply Chain Management	4

Project

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Quality Management
Semesterwise pattern

Type of Input: Employed professionals working in Quality and allied business domains, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial & Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG611	Strategic Management & Business Policy	4
	MBA ZG511	Managing People & Organizations	4	MBA ZG526	Operations Management	4
		Total	**16**		**Total**	**16**
II	MBA ZG522	Total Quality Management	4	MBA ZG623T	Project	12
	MBA ZG524	Quality Management Systems	5		Elective	4(min)
	MBA ZG531	Statistical Quality Control	5			
		Elective	4(min)			
		Total	**18(min)**		**Total**	**16(min)**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Four-semester M.Tech. programmes

Input Qualification:

The students admitted to the proposed four-semester M.Tech. programs must

(i) hold an Integrated First Degree of BITS or its equivalent and

(ii) be employed professionals with adequate work experience in a relevant industry.

Curriculum Requirements for M.Tech. programs

The nature of the input to these programs and the objectives / orientation of Work Integrated Learning Programs are different from those of the on-campus programs. These programs may be offered across a broad spectrum of (i) technical disciplines and specializations with as well as (ii) industry domains and cross-disciplinary subjects. It is also to be observed that learning and coursework in these programs are integrated within a professional / technical environment.

Based on these facts and observations, the curriculum has been designed in such a way to broadly enable different combinations of subjects at a higher degree level. In particular, the structure will enable Departments to offer an M.Tech. program in a broad discipline with or without specialization, or offer an M.Tech. program in a specialized area within a discipline or across multiple disciplines.

A. Completion of the program would require:

i. At least 12 courses (totaling at least 48 units) towards coursework nominally spread over three semesters and

ii. Dissertation (16 units) in one semester, that is usually the final semester.

B. The Department(s) offering a specific program must then categorize the coursework requirement as follows:

i. **Core**: 8 courses / 30 units (max.)

ii. **Specialization** (if applicable):

a. 3 courses / 12 units (min.) to 6 courses / 30 units (max.)

b. Some Specialization courses may be mandatory and some may be electives.

iii. Total of Core and Specialization courses may not exceed 10 courses (and 45 units).

iv. Rest of the coursework requirement may be obtained via general electives within the discipline but not necessarily within the specialization.

v. At most 3 courses out of the total of 12 taken by a student may be at the 4th level – the rest must be higher degree courses (i.e. specifically, 5th or 6th level).

Eight-semester Integrated M.Tech. programme

Curriculum Structure for an Integrated M.Tech. programme:

The curriculum structure and requirements of the eight-semester Integrated M.Tech. programme will include the requirements of the corresponding Integrated First Degree programme and four-semester M.Tech. programme, with the following provisions:

1. The electives requirement of the Integrated First Degree programme will be subsumed by the coursework requirement of the Integrated M.Tech. programme, and
2. The Project Work requirement of the Integrated First Degree programme, will be subsumed by the Dissertation requirement of the Integrated M.Tech. programme.

Given these provisions, the following requirements for the curriculum are proposed:

Category	Number of Courses Required	Number of Units Required
I Foundation Courses	5-10	15-32
II Discipline Courses		
Discipline Core	12-16*	42-66*
Discipline Electives	6-12	20-36
Sub-Total	18 - 22 courses#	64 - 80 units
Course-Work Sub-Total	28 courses (min)	96 units (min)
III DISSERTATION	1	16
Total	29 courses (min)	112 units (min)

* Nominally, each course is of 3 units. But, at least two of the Discipline courses are required to be of 4 units or higher.

\# At least eight of these courses must be Higher Degree courses (i.e. specifically, 5th or 6th level)

Specializations (if applicable)

The Department(s) offering **specializations** within a specific Integrated M.Tech. programme should ensure that the following requirements are met:

1. Specialization (if applicable):
    a. 3 courses / 12 units (min.) to 6 courses / 30 units (max.)
    b. Some specialization courses may be mandatory and some may be electives.
2. Rest of the elective requirements may be obtained through general electives within the discipline, but not necessarily within the specialization.

M. Tech. (Automotive Electronics)

Type of Input: Employed professionals holding a B.E./B.Tech. degree in Automotive/ EEE /ECE/Instrumentation/Mechatronics or equivalent, with minimum one year work experience in relevant domains.

Nominal Duration: Four Semesters

Programme Structure:

Core Courses

Course No.	Course Title	Units
AEL* ZC441	Automotive Vehicles	3
AEL* ZC442	Advanced Driver Assistance Systems	4
AEL* ZG510	Automotive Control Systems	5
AEL* ZG512	Embedded System Design	4
AEL* ZG513	Automotive Communication Systems	5
AEL* ZG533	Autotronics	5
AEL* ZG534	Automotive Networking	4

Pool of Electives

Course No.	Course Title	Units
AEL* ZC443	Connected Cars	4
AEL* ZG514	Robust and Intelligent Systems Design	5
AEL* ZG517	Automotive Systems Engineering	4
AEL* ZG518	Electric and Hybrid Vehicles	4
AEL* ZG519	Automotive Security	4
AEL* ZG531	Product Design	5
AEL* ZG554	Reconfigurable Computing	5
AEL* ZG557	Artificial and Computational Intelligence	5
AEL* ZG621	Safety Critical Advanced Automotive Systems	4
AEL* ZG626	Hardware Software Co-Design	5
AEL* ZG631	Automotive Diagnostics and Interfaces	5

Dissertation

Course No.	Course Title	Units
AEL* ZG628T	Dissertation	16

Semesterwise pattern

M. Tech. (Automotive Electronics)						
Year	**First Semester**			**Second Semester**		
	Course No.	**Course Title**	**Units**	**Course No.**	**Course Title**	**Units**
I	AEL* ZC441	Automotive Vehicles	3	AEL* ZC442	Advanced Driver Assistance Systems	4
	AEL* ZG533	Autotronics	5	AEL* ZG513	Automotive Communication Systems	5
	AEL* ZG512	Embedded System Design	4	AEL* ZG534	Automotive Networking	4
	AEL* ZG510	Automotive Control Systems	5		Elective I	4/5
	Total		17	Total		17-18
II		Elective II	4/5	AEL* ZG628T	Dissertation	16
		Elective III	4/5			
		Elective IV	4/5			
		Elective V	4/5			
	Total		16-20	Total		16

M. Tech. Automotive Engineering

Curriculum Structure

Input Requirements

Employed professionals in Automotive Industries and holding an Integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
AE* ZG511	Mechatronics	5
AE* ZG516	Advances in Internal Combustion Engines	4
AE* ZG517	Automotive Systems Engineering	4
AE* ZG524	Vehicle Dynamics	4
AE* ZG633	Advances in Vehicle Body Structures	4

Pool of Electives (21)

Course No.	Course Title	Units
AE* ZG510	Automotive Control Systems	5
AE* ZG512	Embedded Systems Design	4
AE* ZG513	Maintenance Engineering	5
AE* ZG514	Advanced Automotive Systems	4
AE* ZG515	Non-Destructive Testing	5
AE* ZG518	Electric and Hybrid Vehicles	4
AE* ZG519	Automotive Security	4
AE* ZG520	World Class Manufacturing	5
AE* ZG522	Advanced Vehicle Acoustics	4
AE* ZG523	Project Management	4
AE* ZG531	Product Design	5
AE* ZG532	Computer Aided Engineering	5
AE* ZG535	Advanced Engineering Mathematics	5
AE* ZG542	Just-in-time Manufacturing	4
AE* ZG611	Computational Fluid Dynamics & Heat Transfer	4
AE* ZG612	Advances in Materials, Composites & Plastics	4
AE* ZG613	Tribology	5
AE* ZG614	Fracture Mechanics	5
AE* ZG615	Advanced Engine Technology	5
AE* ZG621	Durability, Crash & Safety Engineering	4
AE* ZG622	Advanced Manufacturing Processes	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M. Tech. Automotive Engineering
Semesterwise Pattern

Type of Input: Employed professionals in Engineering Industries and holding an Integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	AE** ZG517	Automotive Systems Engineering	4	AE** ZG524	Vehicle Dynamics	4
	AE** ZG511	Mechatronics	5	AE** ZG633	Advances in Vehicle Body Structures	4
	AE** ZG516	Advances in Internal Combustion Engines	4		Elective	(4 min)
		Elective	(4 min)		Elective	(4 min)
Total			**17**	**Total**		**17**
II		Elective	(4 min)	AE** ZG628T	Dissertation	16
		Elective	(4 min)			
		Elective	(4 min)			
		Elective	(4 min)			
Total			**16**	**Total**		**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Tata Technologies and Tata Motors, Pune; Mercedes Benz, Bangalore

M. Tech. (Computing Systems & Infrastructure)

Curriculum for M.Tech. (Computing Systems & Infrastructure) programme

Type of Input

The students admitted to the M.Tech. Computing Systems & Infrastructure programme must:

(i) Hold an Integrated First Degree of BITS or its equivalent in relevant disciplines, and

(ii) Be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Programme Structure

Core Courses (6)

Course No.	Course Title	Units
CSI** ZG525	Advanced Computer Networks	5
CSI** ZG527	Cloud Computing	5
CSI** ZG522	Design and Operation of Data Centers	5
CSI** ZG538	Infrastructure Management	4
CSI** ZG524	Middleware Technologies	4
CSI** ZG513	Network Security	4

Pool of Electives (11)

Course No.	Course Title	Units
CSI** ZC446	Data Storage Technologies and Networks	3
CSI** ZC463	Cryptography	3
CSI** ZG511	IT Infrastructure Projects & Processes	3
CSI** ZG523	Introduction to Data Science	3
CSI** ZG528	Cyber Physical Systems	4
CSI** ZG514	Data Warehousing	5
CSI** ZG515	Introduction to DevOps	4
CSI** ZC462	Network Programming	3
CSI** ZG656	Networked Embedded Applications	4
CSI** ZG533	Service-Oriented Computing	4
CSI** ZC424	Software Development for Portable Devices	3
CSI** ZG582	Telecom Network Management	5
CSI** ZG526	Web Technologies	4
CSI** ZG520	Wireless & Mobile Communication	5
CSI** ZG518	Database Design & Applications	5

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	CSI** ZG513	Network Security	4	CSI** ZG522	Design and Operation of Data Centers	5
	CSI** ZG525	Advanced Computer Networks	5	CSI** ZG538	Infrastructure Management	4
	CSI** ZG527	Cloud Computing	5		Elective 2	(3 min)
		Elective 1	(3 min)		Elective 3	(3 min)
		Total	17		Total	15
II	CSI** ZG524	Middleware Technologies	4	CSI** ZG628T	Dissertation	16
		Elective 4	(3 min)			
		Elective 5	(3 min)			
		Elective 6	(3 min)			
		Total	13		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Wipro Bangalore

Integrated M. Tech. (Computing Systems & Infrastructure)

Type of Input

The students admitted to the Integrated M.Tech. Computing Systems & Infrastructure programme must:

(i) Hold a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, and

(ii) Be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: Eight Semesters

Programme Structure

Foundation Courses (5)

	Course NO.	Course Title	Units
Mathematics Foundation	CSI** ZC132	Linear Algebra & Optimization	3
	CSI** ZC213	Probability & Statistics	3
	CSI** ZC252	Discrete Structures for Computer Science	3
Engineering Foundation	CSI** ZC263	Digital Electronics & Microprocessors	4
Technical Arts / Professional Course	CSI** ZC163	Computer Programming	4

Core Courses (15)

Course No.	Course Title	Units
CSI** ZG525	Advanced Computer Networks	5
CSI** ZG527	Cloud Computing	5
CSI** ZC467	Computer Networks	4
CSI** ZC353	Computer Organization & Architecture	4
CSI** ZC446	Data Storage Technologies & Networks	3
CSI** ZC363	Data Structures & Algorithms	4
CSI** ZC337	Database Systems & Applications	4
CSI** ZG522	Design and Operation of Data Centers	5
CSI** ZG538	Infrastructure Management	4
CSI** ZG511	IT Infrastructure Projects & Processes	3
CSI** ZG524	Middleware Technologies	4
CSI** ZG513	Network Security	4
CSI** ZC313	Object Oriented Programming & Design	4
CSI** ZC364	Operating Systems	4
CSI** ZC327	Systems Programming	4

Pool of Electives (13)

Course No.	Course Title	Units
CSI** ZC463	Cryptography	3
CSI** ZG528	Cyber Physical Systems	4
CSI** ZG514	Data Warehousing	5
CSI** ZC311	Information Security	3
CSI** ZG523	Introduction to Data Science	3
CSI** ZG515	Introduction to DevOps	4
CSI** ZC462	Network Programming	3
CSI** ZG656	Networked Embedded Applications	4
CSI** ZG533	Service Oriented Computing	4
CSI** ZC424	Software Development for Portable Devices	3
CSI** ZG582	Telecom Network Management	5
CSI** ZG526	Web Technologies	4
CSI** ZG520	Wireless & Mobile Communication	5

Integrated M. Tech. (Computing Systems & Infrastructure)

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	CSI** ZC132	Linear Algebra & Optimization	3	CSI** ZC213	Probability & Statistics	3
	CSI** ZC252	Discrete Structures for Computer Science	3	CSI** ZC353	Computer Organization & Architecture	4
	CSI** ZC163	Computer Programming	4	CSI** ZC363	Data Structures & Algorithms	4
	CSI** ZC263	Digital Electronics & Microprocessors	4	CSI** ZC327	Systems Programming	4
		Total	**14**		**Total**	**15**
II	CSI** ZC337	Database Systems & Applications	4	CSI** ZC313	Object Oriented Programming & Design	4
	CSI** ZC364	Operating Systems	4	CSI** ZC446	Data Storage Technologies & Networks	3
	CSI** ZC467	Computer Networks	4	CSI** ZG511	IT Infrastructure Projects & Processes	3
		Elective 1	(3 min)		Elective 2	(3 min)
		Total	**15 (min)**		**Total**	**(13 min)**
III	CSI** ZG513	Network Security	4	CSI** ZG522	Design and Operation of Data Centers	5
	CSI** ZG525	Advanced Computer Networks	5	CSI** ZG538	Infrastructure Management	4
	CSI** ZG527	Cloud Computing	5		Elective 4	(3 min)
		Elective 3	(3 min)		Elective 5	(3 min)
		Total	(17 min)		Total	(15 min)
IV	CSI** ZG524	Middleware Technologies	4	CSI** ZG628T	Dissertation	16
		Elective 6	(3 min)			
		Elective 7	(3 min)			
		Elective 8	(3 min)			
		Total	**(13 min)**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Wipro Bangalore

M.Tech. Data Science & Engineering
Curriculum Structure

Type of Input	Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech. or M.Sc. / MCA with minimum one-year work experience in relevant domains.
Nominal Duration	Four Semesters

Programme Structure

Core courses (6)

Course No.	Course Title	Units
DSE* ZC413	Introduction to Statistical Methods	3
DSE* ZC415	Data Mining	3
DSE* ZC416	Mathematical Foundations for Data Science	4
DSE* ZG516	Computer Organization & Software Systems	5
DSE* ZG519	Data Structures and Algorithms Design	5
DSE* ZG523	Introduction to Data Science	3

Pool of Electives (15)

Course No.	Course Title	Units
DSE* ZC414	Optimization Methods for Analytics	5
DSE* ZC420	Data Visualization	3
DSE* ZC421	Ethics for Data Science	3
DSE* ZC426	Real Time Analytics	4
DSE* ZC444	Artificial Intelligence	3
DSE* ZC465	Machine Learning	4
DSE* ZG515	Data Warehousing	5
DSE* ZG517	Systems for Data Analytics	5
DSE* ZG521	Graphs – Algorithms and Mining	5
DSE* ZG522	Big Data Systems	5
DSE* ZG524	Deep Learning	4
DSE* ZG525	Natural Language Processing	3
DSE* ZG526	Probabilistic Graphical Models	4
DSE* ZG527	Advanced Topics in Data Processing	5
DSE* ZG537	Information Retrieval	4
DSE* ZG554	Distributed data systems	5
DSE* ZG555	Data visualization and Interpretation	5
DSE* ZG556	Stream Processing and Analytics	5
DSE* ZG557	Artificial and Computational Intelligence	5

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing collaborating organization.

M.Tech. Data Science & Engineering

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech. or M.Sc. / MCA with minimum one-year work experience in relevant domains.

Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	DSE* ZC415	Data Mining	3	DSE* ZC413	Introduction to Statistical Methods	3
	DSE* ZC416	Mathematical Foundations for Data Science	4	DSE* ZG523	Introduction to Data Science	3
	DSE* ZG519	Data Structures and Algorithms Design	5		Elective-I	
	DSE* ZG516	Computer Organization and Systems Software	5		Elective-II	
		Total	17		Total	15 (min)
II		Elective-III		DSE*ZG628T	Dissertation	16
		Elective-IV				
		Elective-V				
		Elective-VI				
		Total	16 (min)		Total	16

M. Tech. Design Engineering
Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Design Engineering must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. in relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
DE* ZG512	Finite Element Methods	5
DE* ZG541	Product Design	5
DE* ZG561	Mechanisms and Robotics	5
DE* ZG611	Dynamics & Vibrations	5
DE* ZG631	Materials Technology & Testing	5

Pool of Electives (7)

Course No.	Course Title	Units
DE* ZC415	Introduction to MEMS	4
DE* ZG511	Mechatronics	5
DE* ZG514	Fracture Mechanics	5
DE* ZG515	Computational Fluid Dynamics	5
DE* ZG521	World-Class Manufacturing	5
DE* ZG522	Advanced Composites	5
DE* ZG523	Project Management	4
DE* ZG525	Mechanical System Design	5
DE* ZG531	Concurrent Engineering	5
DE* ZG532	Quality Assurance and Reliability	5
DE* ZG542	Machine Tool Engineering	5
DE* ZG535	Advanced Engineering Mathematics	5
DE* ZG621	Computer Aided Analysis & Design	5
DE* ZG641	Theory of Elasticity and Plasticity	5
DE* ZG513	Tribology	5

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M.Tech. Design Engineering

Type of Input: Employed professionals holding an Integrated First Degree of BITS in Mechanical Engineering or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	DE** ZG512	Finite Element Methods	5	DE** ZG541	Product Design	5
	DE** ZG611	Dynamics & Vibrations	5	DE** ZG561	Mechanisms & Robotics	5
	DE** ZG631	Materials Technology & Testing	5		Elective	5
		Elective	5		Elective	5
		Total	**20**		**Total**	**20**
II		Elective	5	DE** ZG628T	Dissertation	16
		Elective	4			
		Elective	5			
		Elective	5			
		Total	**19**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Designed for the HRD needs of a diverse spectrum of Engineering Industries. Collaborating Organizations: SKF and John Deere, Pune

M.Tech. (Digital Manufacturing)

Input Requirements

The students admitted to the four-semester M.Tech. Digital Manufacturing must:

(i) hold a B.E. / B.Tech. degree in EEE/Instrumentation/Mechatronics relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards course work and
b) Dissertation (16 units)

The course work requirement for the programme would consist of a set of core courses (7) and elective courses (at least 5). The core course requirement is mandatory for all students in the programme. Rest of the course work must be completed through elective courses.

Programme Structure

Core Courses

Course No	Course Title	Units
DM* ZC472	Precision Engineering	3
DM* ZG511	Mechatronics	5
DM* ZG521	Design for Additive Manufacturing	5
DM* ZG531	High Precision Manufacturing	4
DM* ZG612	Advances in Materials, Composites and Plastics	4
DM* ZG622	Industrial IoT	4
DM* ZG631	Additive Manufacturing Process	5

Electives

Course No	Course Name	Units
DM* ZC412	Flexible Manufacturing Systems	4
DM* ZG512	Embedded System Design	4
DM* ZG522	Behavioral Operations	4
DM* ZG532	Big Data Analytics in Manufacturing	4
DM* ZG533	Manufacturing Planning and Control	5
DM* ZG534	Sustainable Manufacturing	5
DM* ZG535	Cyber Security in Manufacturing	4
DM* ZG541	Product Design	5
DM* ZG561	Mechanisms and Robotics	5

Semester-wise Pattern

Year	Course No.	Course Title	U	Course No.	Course Title	U
I	**Semester I**			**Semester II**		
	DM* ZG511	Mechatronics	**5**	DM* ZC472	Precision Engineering	**3**
	DM* ZG521	Design for Additive Manufacturing	**5**	DM* ZG612	Advances in Materials, Composites and Plastics	**4**
	DM* ZG531	High Precision Manufacturing	**4**	DM* ZG622	Industrial IoT	**4**
		Elective – 1	**4 (min)**		Elective – 2	**4 (min)**
		Total	**18 (min)**		**Total**	**15 (min)**
II	**Semester III**			**Semester IV**		
	DM* ZG631	Additive Manufacturing Process	**5**	DM* ZG629T	Dissertation	**16**
		Elective – 3	**4 (min)**			
		Elective – 4	**4 (min)**			
		Elective – 5	**4 (min)**			
		Total	**17 (min)**		**Total**	**16**

M.Tech. Embedded Systems
Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Embedded Systems must:

(i) Employed Professionals holding an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (4)

Course No.	Course Title	Units
ES* ZC424	Software for Embedded Systems	3
ES* ZG512	Embedded System Design	4
ES* ZG553	Real Time Systems	5
ES* ZG641	Hardware Software Co-Design	5

Pool of Electives (25)

Course No.	Course Title	Units
ES* ZC441	Robotics	3
ES* ZC446	Data Storage Technologies & Networks	3
ES* ZC481	Computer Networks	3
ES* ZG511	Mechatronics	5
ES* ZG513	Network Security	4
ES* ZG514	Mechanisms & Robotics	5
ES* ZG520	Wireless & Mobile Communication	5
ES* ZG523	Project Management	4
ES* ZG524	Real Time Operating Systems	5
ES* ZG525	Avionics Systems	5
ES* ZG526	Advanced Computer Networks	5
ES* ZG531	Pervasive Computing	4
ES* ZG532	Testability for VLSI	5
ES* ZG545	Control & Instrumentation for Systems	5
ES* ZG554	Reconfigurable Computing	5
ES* ZG556	DSP Based Control of Electric Drives	3
ES* ZG571	Optical Communication	5
ES* ZG573	Digital Signal Processing	3
ES* ZG611	Advanced Control Systems	5
ES* ZG612	Fault Tolerant System Design	5
ES* ZG613	Advanced Digital Signal Processing	5
ES* ZG621	VLSI Design	5
ES* ZG625	Safety Critical Embedded System Design	4
ES* ZG642	VLSI Architecture	4
ES* ZG651	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. Embedded Systems

Type of Input: Employed professionals holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	ES** ZG512	Embedded System Design	4	ES** ZC424	Software for Embedded System	3
	ES** ZG553	Real Time Systems	5		Elective	(3 min)
		Elective	(3 min)		Elective	(3 min)
		Elective	(3 min)		Elective	(3 min)
		Total	15		Total	12
II	ES** ZG641	Hardware Software Co-Design	5	ES** ZG628T	Dissertation	16
		Elective	(3 min)			
		Elective	(3 min)			
		Elective	(3 min)			
		Total	14		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Cisco, Bangalore; UTC Bangalore and Hyderabad

M.Tech. Environmental Engineering
Curriculum Structure

Input requirements

Employed Professionals with minimum one year work experience in Environmental Science / Engineering and allied areas holding an Integrated First Degree of BITS or its equivalent such as B.E / B.Tech / or M.Sc. in relevant disciplines (Chemistry, Chemical Engineering, Civil Engineering, Biology, Microbiology, Biotechnology, Mechanical Engineering) with adequate preparation in Mathematics.

Normal Duration: 4 Semesters

Core Courses (5)

Course No	Course Title	Units
EE* ZG511	Environmental Chemistry	5
EE* ZG512	Environmental Biotechnology	5
EE* ZG513	Applied Transport Phenomena	5
EE* ZG514	Environmental Sampling and Analytical Methods	5
EE* ZG515	Environmental Management Systems	5

Pool of Electives (10)

Course No	Course Title	Units
EE* ZG521	Physico – Chemical Treatment Principles & Design for Wastewater systems	4
EE* ZG522	Biological Treatment Principles & Design for Wastewater systems	4
EE* ZG523	Environmental Statistics	4
EE* ZG611	Energy Generation and Management in Waste Treatment Plants	4
EE* ZG612	Environmental Remote Sensing and GIS	4
EE* ZG613	Environmental Systems Modelling	4
EE* ZG614	Air Pollution Control Technologies	4
EE* ZG621	Solid Waste Management	4
EE* ZG622	Environmental Process Engineering	4
EE* ZG623	Environmental Impact and Risk Assessment	4

M.Tech. Environmental Engineering

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters.

Semester wise pattern for students admitted in First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	EE** ZG511	Environmental Chemistry	5	EE** ZG512	Environmental Biotechnology	5
	EE** ZG515	Environmental Management Systems	5		Elective	(4 min)
		Elective	(4 min)		Elective	(4 min)
		Elective	(4 min)		Elective	(4 min)
		Total	18		Total	17
II	EE** ZG513	Applied Transport Phenomena	5	EE** ZG628T	Dissertation	16
	EE** ZG514	Environmental Sampling and Analytical Methods	5			
		Elective	(4 min)			
		Elective	(4 min)			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Goa Pollution Control Board, Goa

M.Tech. Manufacturing Management

Curriculum Structure

Input Qualification

The students admitted to the four-semester M.Tech. in Manufacturing Management must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Manufacturing Management Core (7)

Course No.	Course Title	Units
MM ZG515	Quantitative Methods	4
MM ZG522	Total Quality Management	4
MM ZG523	Project Management	4
MM ZG533	Manufacturing Planning and Control	5
MM ZG537	Lean Manufacturing	5
MM ZG541	Product Design	5
MM ZG621	Supply Chain Management	4

Pool of Electives (7)

Course No.	Course Title	Units
MM ZC412	Flexible Manufacturing Systems	4
MM ZC441	Human Resource Management *	4
MM ZG512	Manufacturing Strategy	4
MM ZG513	Maintenance Engineering	5
MM ZG514	Leadership and Managing Change *	4
MM ZG534	Sustainable Manufacturing	4
MM ZG535	Decision Analysis	4
MM ZG611	Strategic Management & Business Policy *	4
MM ZG627	Managerial Corporate Finance *	4
MM ZC472	Precision Engineering	3
MM ZG539	Six Sigma	4

Note: A student may be allowed to take upto 3 courses from among the specified management domain electives which are indicated by an '*'.

M.Tech. Manufacturing Management

Type of Input: Employed professionals working in Manufacturing and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains.

Duration: Four Semesters

Special Feature: This Work Integrated Learning Programme is designed for the HRD requirements of a diverse spectrum of Engineering / Manufacturing Industries.

Semesterwise pattern for students admitted in the First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	MM ZG533	Manufacturing Planning & Control	5	MM ZG621	Supply Chain Management	4
	MM ZG522	Total Quality Management	4	MM ZG537	Lean Manufacturing	5
	MM ZG515	Quantitative Methods	4	MM ZG523	Project Management	4
	MM ZG541	Product Design	5		Elective	4 (min)
		Total	18		Total	17(min)
II		Elective	4 (min)	MM ZG628T	Dissertation	16
		Elective	4 (min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	16(min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MM ZG533	Manufacturing Planning & Control	5
				MM ZG522	Total Quality Management	4
				MM ZG515	Quantitative Methods	4
				MM ZG541	Product Design	5
					Total	18
II	MM ZG621	Supply Chain Management	4		Elective	4 (min)
	MM ZG537	Lean Manufacturing	5		Elective	4 (min)
	MM ZG523	Project Management	4		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	17(min)		Total	16(min)
III	MM ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Microelectronics
Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Microelectronics must:

(iii) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(iv) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
MEL* ZG611	IC Fabrication Technology	5
MEL* ZG621	VLSI Design	5
MEL* ZG631	Physics & Modelling of Microelectronic Devices	5
MEL* ZG632	Analog IC Design	5
MEL* ZG641	CAD for IC Design	5

Pool of Electives (17)

Course No.	Course Title	Units
MEL* ZC415	Introduction to MEMS	4
MEL* ZG510	RF Microelectronics	5
MEL* ZG511	Design & Analysis of Algorithms	5
MEL* ZG512	Optoelectronic Devices, Circuit & Systems	5
MEL* ZG520	Wireless & Mobile Communication	5
MEL* ZG524	Real Time Operating Systems	5
MEL* ZG526	Embedded System Design	4
MEL* ZG531	Testability for VLSI	5
MEL* ZG553	Real Time Systems	5
MEL* ZG554	Reconfigurable Computing	5
MEL* ZG573	Digital Signal Processing	3
MEL* ZG613	Advanced Digital Signal Processing	5
MEL* ZG623	Advanced VLSI Design	5
MEL* ZG625	Advanced Analog and Mixed Signal Design	5
MEL* ZG642	VLSI Architecture	4
MEL* ZG651	Hardware Software Co-Design	5
MEL* ZG652	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M.Tech. Microelectronics

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	MEL* ZG621	VLSI Design	5	MEL* ZG611	IC Fabrication Technology	5
	MEL* ZG631	Physics & Modeling of Microelectronic Devices	5	MEL* ZG632	Analog IC Design	5
		Elective	(4 min)	MEL* ZG641	CAD for IC Design	5
		Elective	(4 min)		Elective	(5 min)
		Total	17		Total	20
II		Elective	(4 min)	MEL* ZG628T	Dissertation	16
		Elective	5 (min)			
		Elective	5 (min)			
		Elective	5 (min)			
		Total	19		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating Organizations: Samsung, Gurgaon

Integrated M.Tech. Microelectronics

Normal Duration: Eight Semesters

Type of Input: The students admitted to the Integrated M.Tech. Microelectronics programme must:

(a) hold a B.Sc. degree or its equivalent in relevant disciplines with adequate coursework in Mathematics and Physics

(b) be employed professionals with minimum one-year work experience in relevant domains.

Curriculum structure

Foundation Courses: (6)

Type of foundation	Course No.	Course Title	Units
Mathematics Foundation	MEL* ZC234	Linear Algebra and Optimization	3
	MEL* ZC222	Discrete Structures for Computer Science	3
	MEL* ZC111	Probability & Statistics	3
Engineering Foundation	MEL* ZC112	Electrical Sciences	3
	MEL* ZC411	Signals and Systems	3
Technical Arts/Professional Course	MEL* ZC164	Computer Programming	4

Core Courses: (13)

Course No.	Course Title	Units
MEL* ZC215	Digital Design	4
MEL* ZC363	Data Structures and Algorithms	4
MEL* ZC321	Control Systems	3
MEL* ZC244	Microelectronic Circuits	3
MEL* ZC241	Microprocessor and Interfacing	4
MEL* ZC364	Analog Electronics	4
MEL* ZC342	Computer Architecture	4
MEL* ZG573	Digital Signal Processing	3
MEL* ZG621	VLSI Design	5
MEL* ZG631	Physics & Modeling of Microelectronic Devices	5
MEL* ZG611	IC Fabrication Technology	5
MEL* ZG632	Analog IC Design	5
MEL* ZG641	CAD for IC Design	5

Pool of Electives: (22)

Course No.	Course Title	Units
3rd and 4th level courses		
MEL* ZC464	Machine Learning	3
MEL* ZC382	Communication Systems	4
MEL* ZC214	Electronic Devices	3
MEL* ZC444	Artificial Intelligence	3
MEL* ZC415	Introduction to MEMS	4
MEL* ZC477	Modeling of Field Effect NanoDevices	3
5th and 6th level courses		
MEL* ZG510	RF Microelectronics	5
MEL* ZG511	Design & Analysis of Algorithms	5
MEL* ZG512	Optoelectronic Devices, Circuit & Systems	5
MEL* ZG520	Wireless & Mobile Communication	5
MEL* ZG526	Embedded System Design	4
MEL* ZG531	Testability for VLSI	5
MEL* ZG553	Real Time Systems	5
MEL* ZG554	Reconfigurable Computing	5
MEL* ZG613	Advanced Digital Signal Processing	5
MEL* ZG623	Advanced VLSI Design	5
MEL* ZG625	Advanced Analog and Mixed Signal Design	5
MEL* ZG642	VLSI Architecture	4
MEL* ZG651	Hardware Software co-Design	5
MEL* ZG656	Networked Embedded Applications	4
MEL* ZG626	High-Speed Signaling: Jitter Modeling, Analysis, and Budgeting	4
MEL* ZG627	Power Integrity Analysis and Management for Integrated Circuits	4

Proposed Semester wise Pattern

Year	Course No.	Course Title	U	Course No.	Course Title	U
		Semester I			**Semester II**	
I	MEL* ZC234	Linear Algebra and Optimization	**3**	MEL* ZC111	Probability & Statistics	**3**
	MEL* ZC112	Electrical Sciences	**3**	MEL* ZC215	Digital Design	**4**
	MEL* ZC164	Computer Programming	**4**	MEL* ZC363	Data Structures and Algorithm	**4**
	MEL* ZC222	Discrete Structures for Computer Science	**3**	MEL* ZC321	Control Systems	**3**
		Total	**13**		**Total**	**14**
		Semester III			**Semester IV**	
II	MEL* ZC244	Microelectronic Circuits	**3**	MEL* ZC364	Analog Electronics	**4**
	MEL* ZC411	Signals & Systems	**3**	MEL* ZG573	Digital Signal Processing	**3**
	MEL* ZC241	Microprocessor and Interfacing	**4**	MEL* ZC342	Computer Architecture	**4**
		Elective	**3 (min)**		Elective	**3 (min)**
		Total	**13 (min)**		**Total**	**14 (min)**
		Semester V			**Semester VI**	
III	MEL* ZG621	VLSI Design	**5**	MEL* ZG632	Analog IC Design	**5**
	MEL* ZG631	Physics & Modeling of Microelectronic Devices	**5**	MEL* ZG641	CAD For IC Design	**5**
	MEL* ZG611	IC Fabrication Technology	**5**		Elective	**3 (min)**
		Elective	**3 (min)**		Elective	**3 (min)**
		Total	**18 (min)**		**Total**	**16(min)**
		Semester VII			**Semester VIII**	
IV		Elective	**3 (min)**	MEL* ZG628T	Dissertation	**16**
		Elective	**3 (min)**			
		Elective	**4 (min)**			
		Elective	**4 (min)**			
		Total	**14 (min)**		**Total**	**16**

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

M.Tech. Pharmaceutical Operations and Management

Curriculum Structure

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Core Courses

Course No.	Course Title	Units
POM* ZG534	Advanced Pharmaceutical Technology	5
POM* ZG515	Pharmaceutical Administration and Management	5
POM* ZG525	Pharmaceutical Process Development and Scale-up	4
POM* ZG522	Quality Assurance and Regulatory Affairs	5

Pool of Electives

Course No.	Course Title	Units
POM* ZG551	Advanced Physical Pharmaceutics	5
POM* ZG511	Disinfection and Sterilization	4
POM* ZG512	Dosage Form Design	5
POM* ZG513	Financial Management	4
POM* ZC441	Human Resource Management	4
POM* ZG545	Intellectual Property Rights and Pharmaceuticals	3
POM* ZC471	Management Information Systems	3
POM* ZG531	Manufacturing Organization and Management	5
POM* ZG541	Modern Analytical Techniques	4
POM* ZG542	Production and Operations Management	4
POM* ZG523	Project Management	4
POM* ZG521	Statistical Process Control	5
POM* ZG611	Strategic Management & Business policy	5
POM* ZG621	Supply Chain Management	4
POM* ZG631	TQM Tools and Techniques	5

Dissertation

Course No.	Course Title	Units
POM* ZG628T	Dissertation	16

Note: In the above programme structure, the symbol '*' in the course numbers, shall be substituted by the letters representing the collaborating organization.

M.Tech. Pharmaceutical Operations and Management

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	POM* ZG515	Pharmaceutical Administration and Management	5	POM* ZG534	Advanced Pharmaceutical Technology	5
	POM* ZG522	Quality Assurance & Regulatory Affairs	5		Elective	(5 min)
		Elective	(5 min)		Elective	(3 min)
		Elective	(5 min)		Elective	(3 min)
		Total	20		Total	16
II	POM* ZG525	Pharmaceutical Process Development & Scale-up	4	POM* ZG628T	Dissertation	16
		Elective	(4 min)			
		Elective	(4 min)			
		Elective	(5 min)			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Designed for the HRD needs of a diverse spectrum of Pharmaceutical Industries. Collaborating Organizations: Lupin, Mumbai; Sun Pharmaceutical Industries, Vadodara

M.Tech. in Quality Management
Curriculum Structure

Input Qualification

The students admitted to the four-semester M.Tech. in Quality Management must:

(v) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Quality Management Core (7)

Course No.	Course Title	Units
QM ZG515	Quantitative Methods	4
QM ZG523	Project Management	4
QM ZG524	Quality Management Systems	5
QM ZG526	Operations Management	5
QM ZG528	Reliability Engineering	5
QM ZG531	Statistical Quality Control	5
QM ZG532	Total Quality Management	4

Pool of Electives (7)

Course No.	Course Title	Units
QM ZC441	Human Resource Management	4
QM ZG514	Leadership & Managing Change	4
QM ZG535	Decision Analysis	4
QM ZG536	Design of Experiments	4
QM ZG611	Strategic Management & Business Policy	4
QM ZG661	Software Quality Management	4
QM ZG663	Concurrent Engineering	5
QM ZC472	Precision Engineering	3
QM ZG539	Six Sigma	4

Project

Course No.	Course Title	Units
BITS ZG628T	Dissertation	16

M.Tech. Quality Management

Type of Input: Employed professionals working in Quality and allied services, holding an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains.

Duration: Four Semesters

Special Feature: This Work Integrated Learning Programme is conducted in collaboration with Indian Institute of Quality Management (IIQM), Jaipur.

Semesterwise pattern for students admitted in the First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	QM ZG524	Quality Management Systems	5	QM ZG531	Statistical Quality Control	5
	QM ZG532	Total Quality Management	4	QM ZG526	Operations Management	5
	QM ZG515	Quantitative Methods	4	QM ZG523	Project Management	4
	QM ZG528	Reliability Engineering	5		Elective	(4 min)
		Total	18		Total	18
II		Elective	(4 min)	QM ZG628T	Dissertation	16
		Elective	(4 min)			
		Elective	(4 min)			
		Elective	(4 min)			
		Total	16		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				QM ZG521	Quality Management Systems	5
				QM ZG532	Total Quality Management	4
				QM ZG515	Quantitative Methods	4
				QM ZG528	Reliability Engineering	5
					Total	18
II	QM ZG531	Statistical Quality Control	5		Elective	(4 min)
	QM ZG526	Operations Management	4		Elective	(4 min)
	QM ZG523	Project Management	4		Elective	(4 min)
		Elective	(4 min)		Elective	(4 min)
		Total	17		Total	16
III	QM ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (4-semester)
Curriculum Structure

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Core Courses

Course No.	Course Title	Units
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG651	Software Architectures	5
SE* ZG622	Software Project Management	4
SE* ZG552	Software Testing Methodologies	4

Pool of Electives

Course No.	Course Title	Units
SE* ZC424	Software Development for Portable Devices #	3
SE* ZC434	Software for Embedded Systems #	3
SE* ZG652	Software Maintenance Management #	4
SE* ZG661	Software Quality Management #	4
SE* ZG517	Usability Engineering #	5
SE* ZG566	Secure Software Engineering #	5
SE* ZG533	Service Oriented Computing #	4
SE* ZG544	Agile Software Processes #	4
SE* ZG623	Advanced Operating Systems	5
SE* ZG527	Cloud Computing	5
SE* ZC467	Computer Networks	4
SE* ZC425	Data Mining	3
SE* ZC446	Data Storage Technologies & Networks	3
SE* ZG519	Data Structures & Algorithms Design	5
SE* ZG515	Data Warehousing	5
SE* ZG518	Database Design & Applications	5
SE* ZG511	Design & Analysis of Algorithms	5
SE* ZG573	Digital Signal Processing	3
SE* ZG554	Distributed Data Systems	5
SE* ZG526	Embedded System Design	4
SE* ZG626	Hardware Software Co-Design	5
SE* ZC473	Multimedia Computing	3
SE* ZC462	Network Programming	3
SE* ZG513	Network Security	4
SE* ZG531	Pervasive Computing	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5
SE* ZC465	Machine Learning	4

Note 1: Atleast two courses (minimum 7 units) from among those marked with a '**#**' must be chosen as electives.
Note 2: In the above programme, the symbol '*' in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. Software Engineering

Type of Input & Duration : Employed professionals holding an Integrated First Degree of BITS or its equivalent, with minimum one-year work experience in relevant domains.

Normal Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	SE* ZG512	Object Oriented Analysis & Design	4	SE* ZG552	Software Testing Methodologies	4
		Elective		SE* ZG622	Software Project Management	4
		Elective		SE* ZG651	Software Architectures	5
		Elective			Elective	
		Total			Total	
II		Elective		SE* ZG628T	Dissertation	16
		Elective				
		Elective				
		Elective				
		Total			**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating organizations: Wipro Technologies, Dell, SAP Labs, Sabre, EMC, Oracle, Bangalore; Avaya, Tech Mahindra, Pune; Capgemini, Mumbai; Qualcomm, Hyderabad

Integrated M.Tech. Software Engineering

Curriculum Structure

Input Qualification

The students admitted to the **Integrated M.Tech. Software Engineering** programme must:

(i) hold a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, and

(ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: Eight semesters

Programme Structure:

Foundation Courses

Mathematics Foundation	SE* ZC132	Linear Algebra & Optimization #	3
	SE* ZC213	Probability and Statistics #	3
	SE* ZC252	Discrete Structures for Computer Science #	3
Engineering Foundation	SE* ZC264	Digital Electronics and Microprocessors #	4
Technical Arts / Professional Courses	SE* ZC241	Principles of Management	3
	SE* ZC312	Technical Report Writing	3
	SE* ZC142	Computer Programming #	4
	SE* ZC222	Advanced Programming Techniques	3

Mandatory Foundation Courses

Core Courses

Course No.	Course Title	Units
SE* ZC373	Compiler Design	4
SE* ZC467	Computer Networks	4
SE* ZC353	Computer Organization & Architecture	4
SE* ZC363	Data Structures & Algorithms	4
SE* ZC324	Database Systems & Applications	4
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZC313	Object Oriented Programming & Design	4
SE* ZC464	Operating Systems	4
SE* ZG651	Software Architectures	5
SE* ZC343	Software Engineering	4
SE* ZG552	Software Testing Methodologies	4
SE* ZG622	Software Project Management	4
SE* ZC333	Systems Programming	4

Pool of Electives

Course No.	Course Title	Units
SE* ZC424	Software Development for Portable Devices #	3
SE* ZC434	Software for Embedded Systems #	3
SE* ZG652	Software Maintenance Management #	4
SE* ZG661	Software Quality Management #	4
SE* ZG517	Usability Engineering #	5
SE* ZG566	Secure Software Engineering #	5
SE* ZG533	Service Oriented Computing #	4
SE* ZG544	Agile Software Processes #	4
SE* ZG623	Advanced Operating Systems	5
SE* ZG527	Cloud Computing	5
SE* ZC481	Computer Networks	3
SE* ZC425	Data Mining	3
SE* ZC446	Data Storage Technologies & Networks	3
SE* ZG519	Data Structures & Algorithms Design	5
SE* ZG515	Data Warehousing	5
SE* ZG518	Database Design & Applications	5
SE* ZG511	Design & Analysis of Algorithms	5
SE* ZG573	Digital Signal Processing	3
SE* ZG554	Distributed Data Systems	5
SE* ZG526	Embedded System Design	4
SE* ZG626	Hardware Software Co-Design	5
SE* ZC473	Multimedia Computing	3
SE* ZC462	Network Programming	3
SE* ZG513	Network Security	4
SE* ZG531	Pervasive Computing	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5
SE* ZC472	Computer Graphics	3
SE* ZC465	Machine Learning	4

Integrated M.Tech. Software Engineering
Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	SE* ZC252	Discrete Structures for Computer Science	3	SE* ZC313	Object Oriented Programming & Design	4
	SE* ZC132	Linear Algebra & Optimization	3	SE* ZC332	Systems Programming	3
	SE* ZC142	Computer Programming	4	SE* ZC353	Computer Organization & Architecture	4
	SE* ZC261	Digital Electronics & Microprocessors	3	SE* ZC363	Data Structures & Algorithms	4
		Total	**13**		**Total**	**15**
II	SE* ZC213	Probability & Statistics	3	SE* ZC416	Complier Design	3
	SE* ZC322	Database Systems & Applications	3	SE* ZC461	Software Engineering	3
	SE* ZC422	Operating Systems	3	SE* ZC421	Computer Networks	3
		Elective	3 (min)		Elective	3 (min)
		Total	**12 (min)**		**Total**	**12 (min)**
III	SE* ZG512	Object Oriented Analysis & Design	4	SE* ZG651	Software Architectures	5
		Elective	3 (min)	SE* ZG552	Software Testing Methodologies	4
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	**15 (min)**		**Total**	**14 (min)**
IV	SE* ZG622	Software Project Management	4	SE* ZG628T	Dissertation	16
		Elective	3(min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	**15 (min)**		**Total**	**16**

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating organizations: Wipro Technologies, Dell, SAP Labs, Sabre, EMC, Oracle, Bangalore; Avaya, Tech Mahindra, Pune; Capgemini, Mumbai; Qualcomm, Hyderabad

M.Tech. Software Systems (4-semester) with specializations

Curriculum Structure

Input Requirements

Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one year work experience in relevant domains.

Normal duration: Four semesters

Programme Structure

Core Courses

Course No.	Course Title	Units
SS ZG519	Data Structures & Algorithms Design *	5
SS ZG518	Database Design & Applications *	5
SS ZG526	Distributed Computing	5
SS ZG514	Object Oriented Analysis & Design	4
SS ZG653	Software Architectures	5

* Dean, WILP may be permitted the operational flexibility of substituting these courses with others from the elective pool(s) based on certain input criteria.

General Pool of Electives

Course No.	Course Title	Units
CS ZG551	Advanced Compilation Techniques	5
CS ZG623	Advanced Operating Systems	5
IS ZC444	Artificial Intelligence	3
IS ZC472	Computer Graphics	3
SS ZG516	Computer Organization & Software Systems	5
IS ZC365	Human Computer Interaction	3
EA ZC473	Multimedia Computing	3
IS ZC422	Parallel Computing	3
SS ZG681	Cyber Security	4

Curriculum for 4-semester M.Tech. Software Systems with specializations

Specializations:

1. **Software Engineering:**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives
   b. **List of electives:**

Course No.	Course Title	Units
SS ZG566	Secure Software Engineering	5
SS ZG562	Software Engineering & Management	5
IS ZC424	Software for Embedded Systems	3
SS ZG652	Software Maintenance Management	4
SS ZG622	Software Project Management	4
SS ZG661	Software Quality Management	4
SS ZG552	Software Testing Methodologies	4
SS ZG547	Usability Engineering	5

2. **Data Analytics:**

   a. **Requirements:**

      i. 4 courses / 16 units (min)

      ii. All courses are to be chosen from a designated pool of electives

   b. **List of electives:**

Course No.	Course Title	Units
SS ZG548	Advanced Data Mining	4
SS ZG536	Advanced Statistical Techniques for Analytics	4
IS ZC425	Data Mining	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG515	Data Warehousing	5
SS ZG554	Distributed Data Systems	5
SS ZG537	Information Retrieval	4
IS ZC465	Machine Learning	4

3. **Networks and Networked Systems**

   a. **Requirements:**

      i. 4 courses / 16 units (min)

      ii. All courses are to be chosen from a designated pool of electives

   b. **List of electives:**

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
SS ZG527	Cloud Computing	5
IS ZC481	Computer Networks	3
BITS ZC463	Cryptography	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG538	Infrastructure Management	4
EA ZC451	Internetworking Technologies	3
IS ZC462	Network Programming	3
SS ZG513	Network Security	4
SS ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

4. Embedded Systems

a. Requirements:

i. 4 courses / 16 units (min)

ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
EEE ZG512	Embedded System Design	4
SS ZG626	Hardware Software Co-Design	5
SS ZG656	Networked Embedded Applications	4
SS ZG531	Pervasive Computing	4
CS ZG524	Real Time Operating Systems	5
BITS ZG553	Real Time Systems	5
IS ZC314	Software Development for Portable Devices	3
IS ZC424	Software for Embedded Systems	3

5. Telecommunications

a. Requirements:

i. 4 courses / 16 units (min)

ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
EEE ZG573	Digital Signal Processing	3
EEE ZG512	Embedded System Design	4
EEE ZG571	Optical Communication	5
EEE ZG572	Satellite Communication	5
EEE ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

M.Tech. Software Systems (4 semesters)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech../ M.Sc./ MCA in relevant disciplines, with minimum one year work experience in relevant domains.

Normal Duration: Four Semesters

Special Feature: This WILP is designed for the HRD requirements of a diverse spectrum of IT Industries.

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	SS ZG514	Object Oriented Analysis & Design	4	SS ZG653	Software Architectures	5
	SS ZG519	Data Structures & Algorithms Design	5		Elective 2	3(min)
	SS ZG518	Database Design & Applications	5		Elective 3	3(min)
		Elective 1	3 (min)		Elective 4	4(min)
		Total	17(min)		Total	15(min)
II	SS ZG526	Distributed Computing	5	BITS ZG628T	Dissertation	16
		Elective 5	3(min)			
		Elective 6	4(min)			
		Elective 7	4(min)			
		Total	16(min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				SS ZG514	Object Oriented Analysis & Design	4
				SS ZG519	Data Structures & Algorithms Design	5
				SS ZG518	Database Design & Applications	5
					Elective 1	3 (min)
					Total	17(min)
II	SS ZG653	Software Architectures	5	SS ZG526	Distributed Computing	5
		Elective 2	3(min)		Elective 5	3(min)
		Elective 3	3(min)		Elective 6	4(min)
		Elective 4	4(min)		Elective 7	4(min)
		Total	15(min)		Total	16(min)
III	BITS ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Designed for the HRD requirements of a diverse spectrum of IT Industries. Collaborative Organizations: Wipro Technologies, Bangalore; TCS, Hyderabad; Cisco, Bangalore; Samsung , Gurgaon

Integrated M.Tech. Software Systems
Curriculum Structure

Input Qualification

The students admitted to the **Integrated M.Tech. Software Systems** programme must:

i) hold a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, and

ii) be employed professionals with minimum one-year work experience in relevant domains.

Normal Duration: Eight semesters

Curriculum Structure

Completion of the programme would require, completion of:

Foundation Courses	: 5 courses	(16 units min.)
Discipline Core	: 12 courses	(44 units min.)
Discipline Electives	: 11 courses	(36 units min.)
Course work sub total	: 28 courses	(96 units min.)
Dissertation	: 16 units	

Programme Structure:

Foundation Courses

Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization *	3
	AAOC ZC111	Probability and Statistics *	3
	MATH ZC222	Discrete Structures for Computer Science *	3
Engineering Foundation	ES ZC263	Digital Electronics and Microprocessors *	4
Technical Arts / Professional Courses	MGTS ZC211	Principles of Management	3
	TA ZC312	Technical Report Writing	3
	TA ZC163	Computer Programming *	4

***** Mandatory Foundation Courses

Core Courses

Course No.	Course Title	Units
IS ZC373	Compiler Design	4
IS ZC467	Computer Networks	4
IS ZC353	Computer Organization & Architecture	4
IS ZC363	Data Structures & Algorithms	4
IS ZC337	Database Systems & Applications	4
SS ZG526	Distributed Computing	5
SS ZG514	Object Oriented Analysis & Design	4
IS ZC313	Object Oriented Programming & Design	4
IS ZC364	Operating Systems	4
SS ZG653	Software Architectures	5
IS ZC343	Software Engineering	4
IS ZC327	Systems Programming	4
IS ZC328	Software Testing	3

General Pool of Electives

Course No.	Course Title	Units
CS ZG551	Advanced Compilation Techniques	5
CS ZG623	Advanced Operating Systems	5
IS ZC444	Artificial Intelligence	3
IS ZC472	Computer Graphics	3
EA ZC473	Multimedia Computing	3
IS ZC422	Parallel Computing	3
SS ZG681	Cyber Security	4

Specializations:

1. **Software Engineering**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives
   b. **List of electives:**

Course No.	Course Title	Units
SS ZG566	Secure Software Engineering	5
IS ZC424	Software for Embedded Systems	3
SS ZG652	Software Maintenance Management	4
SS ZG622	Software Project Management	4
SS ZG661	Software Quality Management	4
SS ZG552	Software Testing Methodologies	4
SS ZG547	Usability Engineering	5

2. **Data Analytics**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives
   b. **List of electives:**

Course No.	Course Title	Units
SS ZG548	Advanced Data Mining	4
IS ZC425	Data Mining	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG515	Data Warehousing	5
SS ZG554	Distributed Data Systems	5
SS ZG537	Information Retrieval	4
IS ZC465	Machine Learning	4

3. **Networks and Networked Systems**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
SS ZG527	Cloud Computing	5
BITS ZC463	Cryptography	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG538	Infrastructure Management	4
IS ZC462	Network Programming	3
SS ZG513	Network Security	4
SS ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

4. Embedded Systems

a. Requirements:

i.4 courses / 16 units (min)

ii.All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
EEE ZG512	Embedded System Design	4
SS ZG626	Hardware Software Co-Design	5
SS ZG656	Networked Embedded Applications	4
SS ZG531	Pervasive Computing	4
CS ZG524	Real Time Operating Systems	5
BITS ZG553	Real Time Systems	5
IS ZC314	Software Development for Portable Devices	3
IS ZC424	Software for Embedded Systems	3

5. Telecommunications

a. Requirements:

i. 4 courses / 16 units (min)

ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
EEE ZG573	Digital Signal Processing	3
EEE ZG512	Embedded System Design	4
EEE ZG571	Optical Communication	5
EEE ZG572	Satellite Communication	5
EEE ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

Integrated M.Tech. Software Systems

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC234	Linear Algebra & Optimization	3	IS ZC327	Systems Programming	4
	TA ZC163	Computer Programming	4	IS ZC353	Computer Organization & Architecture	4
	ES ZC263	Digital Electronics & Microprocessors	4	IS ZC363	Data Structures & Algorithms	4
		Total	14		Total	16
II	AAOC ZC111	Probability & Statistics	3	IS ZC373	Complier Design	4
	IS ZC337	Database Systems & Applications	4	IS ZC343	Software Engineering	4
	IS ZC364	Operating Systems	4	IS ZC467	Computer Networks	4
		Elective	3 (min)		Elective	3 (min)
		Total	14 (min)		Total	15 (min)
III	SS ZG514	Object Oriented Analysis & Design	4	SS ZG653	Software Architectures	5
		Elective	3 (min)		Elective	3 (min)
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	15 (min)		Total	16 (min)
IV	SS ZG526	Distributed Computing	5	BITS ZG628T	Dissertation	16
		Elective	3(min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	16 (min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MATH ZC222	Discrete Structures for Computer Science	3
				MATH ZC234	Linear Algebra & Optimization	3
				TA ZC163	Computer Programming	4
				ES ZC263	Digital Electronics & Microprocessors	4
					Total	14
II	IS ZC313	Object Oriented Programming & Design	4	AAOC ZC111	Probability & Statistics	3
	IS ZC327	Systems Programming	4	IS ZC337	Database Systems & Applications	4
	IS ZC353	Computer Organization & Architecture	4	IS ZC364	Operating Systems	4
	IS ZC363	Data Structures & Algorithms	4		Elective	3 (min)
		Total	16		Total	14 (min)
III	IS ZC373	Complier Design	4	SS ZG514	Object Oriented Analysis & Design	4
	IS ZC343	Software Engineering	4		Elective	3 (min)
	IS ZC467	Computer Networks	4		Elective	4 (min)
		Elective	3 (min)		Elective	4 (min)
		Total	15 (min)		Total	15 (Min)
IV	SS ZG653	Software Architectures	5	SS ZG526	Distributed Computing	5
		Elective	3 (min)		Elective	3 (min)
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	16 (min)		Total	16 (Min)
V	BITS ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Designed for the HRD requirements of a diverse spectrum of IT Industries. Collaborative Organizations: Wipro Technologies, Bangalore; TCS, Hyderabad; Cisco, Bangalore; Samsung, Gurgaon

M.Tech. Systems Engineering
Curriculum Structure

Input Requirements

Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one-year work experience in relevant domains.

Normal duration : Four Semesters

Programme Structure

Core Courses : None.

Pool of Electives

Course No.	Course Title	Units
SE* ZG527	Cloud Computing	5
SE* ZC425	Data Mining	3
SE* ZC446	Data Storage Technologies & Networks	3
SE* ZG514	Data Warehousing	5
SE* ZC451	Internetworking Technologies	3
SE* ZC473	Multimedia Computing	3
SE* ZC462	Network Programming	3
SE* ZG513	Network Security	4
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG531	Pervasive Computing	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG553	Real Time Systems	5
SE* ZG622	Software Project Management	4
SE* ZG661	Software Quality Management	4
SE* ZG552	Software Testing Methodologies	4
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5

Note: In the above programme, the symbol '*' in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. Systems Engineering

Year	First Semester		U	Second Semester		U
I	SE* ZG514	Data Warehousing	5	SE* ZG661	Software Quality Management	4
	SE* ZG512	Object Oriented Analysis & Design	4	SE* ZG531	Pervasive Computing	4
	SE* ZG524	Real Time Operating Systems	5	SE* ZC425	Data Mining	3
	SE* ZG520	Wireless & Mobile Communication	5	SE* ZG552	Software Testing Methodologies	4
		Total	19		Total	15
II	SE* ZG622	Software Project Management	4	SE* ZG628T	Dissertation	16
	SE* ZG527	Cloud Computing	5			
	SE* ZG582	Telecom Network Management	5			
	SE* ZG513	Network Security	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborative Organizations: Wipro Infotech, Bangalore

M.Tech. Telecommunications and Software Engineering
Curriculum Structure

Input Requirements

Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one year work experience in relevant domains.

Normal duration: Four semesters

Programme Structure

Core Courses : None.

Pool of Electives

Course No	Course Title	Units
SE* ZG525	Advanced Computer Networks	5
SE* ZC421	Computer Networks	3
SE* ZG514	Data Warehousing	5
SE* ZG518	Database Design & Applications	5
SE* ZG516	Embedded System Design	4
SE* ZC452	Mobile Telecom Networks	3
SE* ZC473	Multimedia Computing	3
SE* ZG513	Network Security	4
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG591	Optical Communication	5
SE* ZG572	Satellite Communication	5
SE* ZG651	Software Architectures	5
SE* ZG622	Software Project Management	4
SE* ZG552	Software Testing Methodologies	4
SE* ZG659	Technical Communication	4
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5

Note: In the above programme, the symbol '*' in the course numbers, can be substituted by the letters representing the collaborating organization.

Semesterwise pattern

Year	First Semester	U	Second Semester	U
I	SE* ZC421 Computer Networks	3	SE* ZC473 Multimedia Computing	3
	SE* ZG512 Object Oriented Analysis & Design	4	SE* ZG520 Wireless and Mobile Communication	5
	SE* ZG516 Embedded System Design	4	SE* ZG651 Software Architectures	5
	SE* ZG622 Software Project Management	4	SE* ZG552 Software Testing Methodologies	4
	Total	15	Total	14
II	SE* ZG513 Network Security	4	SE* ZG628T Dissertation	16
	SE* ZG518 Database Design and Applications	5		
	SE* ZG525 Advanced Computer Networks	5		
	SE* ZG582 Telecom Network Management	5		
	Total	19	Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborating organization: Avaya, Pune

M.Tech. Transportation Engineering

Type of Input: Employed professionals in engineering industries and holding an Integrated First Degree of BITS in Civil Engineering or its equivalent, with minimum one year work experience in relevant domains.

Nominal Duration: Four Semesters

Programme Structure

Core Courses

Course No	Course Title	Units
TE* ZG535	Highway Geometric Design	4
TE* ZG518	Pavement Analysis and Design	4
TE* ZG534	Pavement Material Characterization	4
TE* ZG536	Traffic Engineering and Safety	4
TE* ZG523	Transportation Systems Planning and Management	4
TE* ZG524	Urban Mass Transit Planning, Operations and Management	4

Pool of Electives (any six)

Course No	Course Title	Units
TE* ZG511	Soil Mechanics for Highway Engineering	4
TE* ZG512	Soil Exploration and Field Techniques	4
TE* ZG513	Reinforced Soil Structures for Transportation Engineering	4
TE* ZG514	Advanced Concrete Technology in Transportation Engineering	4
TE* ZG515	GIS Applications in Transportation Engineering	4
TE* ZG516	CAD Laboratory in Transportation Engineering	4
TE* ZG517	Road Safety and Audit	4
TE* ZG519	Pavement Evaluation Field Project	4
TE* ZG521	Environmental Impact Assessment	4
TE* ZG520	Infrastructure Planning and Management	4
TE* ZG528	Selection of Construction Equipment and Modeling	4
TE* ZG537	Transportation Economics and Finance	4
TE* ZG539	Introduction to Discrete Choice Theory	4
TE* ZG543	Traffic Flow Theory	4
TE* ZG545	Airport Planning and Design	4
TE* ZG546	Highway Construction Practices	4
TE* ZG547	Pavement Failures, Evaluation and Rehabilitation	4
TE* ZG548	Pavement Management Systems	4
TE* ZG549	Rural Road Technology	4
TE* ZG616	Bridge Engineering	4
TE* ZG619	Finite Element Analysis	5
TE* ZG623	Ground Improvement Techniques	4

M.Tech. Transportation Engineering

Year	First Semester		U	Second Semester		U
I	TE* ZG534	Pavement Material Characterization	4	TE* ZG518	Pavement Analysis and Design	4
	TE* ZG535	Highway Geometric Design	4	TE* ZG536	Traffic Engineering and Safety	4
		Elective	(4 min)		Elective	(4 min)
		Elective	(4 min)		Elective	(4 min)
		Total	(16 min)		Total	16 (min)
II	TE* ZG523	Transportation Systems Planning and Management	4	TE* ZG628T	Dissertation	16
	TE* ZG524	Urban Mass Transit Planning, Operations and Management	4			
		Elective	(4 min)			
		Elective	(4 min)			
		Total	(16 min)		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

Collaborative Organizations: PWD, Goa

POST GRADUATE DIPLOMA

Curriculum Structure:

Normal Input: Three-year undergraduate degree in relevant disciplines. with adequate work experience in relevant domains.

Nominal duration: Two semesters.

Curriculum Structure for Post-graduate Diploma programme:

Category	Number of Courses Required	Number of Units Required
Core	4-8	14-36
Electives	0-4	0-18
Total	**8 courses (min)**	**28 to 36 units**

Post Graduate Diploma (Finance)

Type of Input: Employed professionals working in finance and allied business domains, holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics.

Duration: Two Semesters

Programme Structure

Core Courses

Course No.	Course Title	Units
FIN ZG514	Derivatives & Risk Management	4
FIN ZC415	Financial and Management Accounting	4
FIN ZG521	Financial Management	4
FIN ZG512	Global Financial Markets and Products	4
FIN ZG513	Management of Banks & Financial Institutions	4
FIN ZG518	Multinational Finance	4

Pool of Electives

Course No.	Course Title	Units
FIN ZG519	Business Analysis & Valuation	4
FIN ZG520	Security Analysis & Portfolio Management	4
FIN ZG528	Venture Capital & Private Equity	4
FIN ZG522	Mergers, Acquisitions, and Corporate Restructuring	4
FIN ZG523	Market Risk Management	4
FIN ZG524	Credit Risk Management	4
FIN ZG525	Operational Risk Management	4
FIN ZG526	Advanced Risk Models	4
FIN ZG527	International Regulatory Framework for Banks	4

Semester wise pattern

Year	First Semester		U	Second Semester		U
I	FIN ZG512	Global Financial Markets and Products	4	FIN ZG514	Derivatives & Risk Management	4
	FIN ZG513	Management of Banks & Financial Institutions	4	FIN ZG518	Multinational Finance	4
	FIN ZC415	Financial and Management Accounting	4		Elective 1	4
	FIN ZG521	Financial Management	4		Elective 2	4
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Post Graduate Diploma (Manufacturing Management)
Post Graduate Diploma (Manufacturing Management

Type of Input:
1. Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, with adequate work experience in relevant domains.
2. Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, and a Post-graduate Certificate in Manufacturing Practice, with adequate work experience in relevant domains, for admission into the second semester of the programme with a credit transfer of up to 16 units from the said certificate.

Nominal Duration: Two Semesters

Programme Structure

Core courses

Course No.	Course Title	Units
PDMM* ZC415	Financial and Management Accounting	4
PDMM* ZG537	Lean Manufacturing	5
PDMM* ZC416	Managerial Economics	4
PDMM* ZG511	Managing People & Organizations	4
PDMM* ZC411	Marketing	4
PDMM* ZG526	Operations Management	4
PDMM* ZC417	Quantitative Methods	4
PDMM* ZG522	Total Quality Management	4

Semesterwise pattern

Course No.	Course Title	Units
First Semester		
PDMM* ZG511	Managing People & Organizations	4
PDMM* ZG522	Total Quality Management	4
PDMM* ZG526	Operations Management	4
PDMM* ZG537	Lean Manufacturing	5
Second Semester		
PDMM* ZC411	Marketing	4
PDMM* ZC415	Financial and Management Accounting	4
PDMM* ZC416	Managerial Economics	4
PDMM* ZC417	Quantitative Methods	4

Post Graduate Certificate Programme
(Artificial Intelligence and Machine Learning)

Type of Input:	Employed professionals holding a M.Sc. degree with mathematics/statistics with adequate work experience in relevant domains or Employed professionals holding a four-year B.Tech. degree or its equivalent in relevant disciplines.
Expected Learning Hours:	~440 hours
Minimum Requirement for Certification	Successful completion of the certificate programme would require completion of all the courses with a minimum C- grade in each course
Marginal Deficiency	Students without sufficient exposure to Python programming language will have to complete the deficiency course/module on Python before the start of the certificate programme. However, the performance in the deficiency course/module will not be accounted in the calculation of CGPA and will not be part of the requirement for certification.

List of Courses

Course No.	Course Title	Units
PCAM* ZC211	Regression	2
PCAM* ZC111	Feature Engineering	1
PCAM* ZC311	Classification	3
PCAM* ZC221	Unsupervised Learning and Association Rule Mining	2
PCAM* ZC231	Text Mining	2
PCAM* ZC241	Deep Learning and Artificial Neural Networks	2
PCAM* ZC321	Capstone Project	3
	Total	15

Note: In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing collaborating organization.

Post Graduate Certificate Programme
(Big Data & Analytics)

Type of Input	Employed professionals holding a three-year undergraduate degree in relevant disciplines, with adequate preparation in Mathematics and Computer Programming, as well as adequate work experience in relevant domains.
(Expected) Learning Hours	~ 230 hours
Minimum Requirement for Certification	Successful completion of the Certificate Programme would require: 1. Completion of all courses with a minimum C- grade in each course. 2. Obtaining a minimum CGPA of 5.00
Marginal Deficiency	Students without sufficient exposure to courses like Data Structures & Algorithms, Database Systems, and Object Oriented Programming using Java would be prescribed deficiency modules. While the student must complete the deficiency modules before start of the program, the performance in the deficiency modules will not be accounted in the calculation of CGPA and will not be part of the requirement for certification.

List of Courses

Course No.	Course Title	Units
CBDA ZG511	The Hadoop Framework	1
CBDA ZG521	ETL & Batch Processing with Hadoop	2
CBDA ZG531	Big Data Analytics with Spark	3
CBDA ZG541	Capstone Project	2
	Total	**8**

Post Graduate Certificate Programme
(Big Data Engineering)

Type of Input:	Employed professionals holding a three-year undergraduate degree in relevant discipline, with adequate preparation in Mathematics and Computer Programming, as well as adequate work experience in relevant domains.
(Expected) Learning Hours	~ 315 hours
Minimum Requirement for Certification	Successful completion of the Certificate Programme would require: 1. Completion of all courses with a minimum C- grade in each course. 2. Obtaining a minimum CGPA of 5.00
Marginal Deficiency	Students without sufficient exposure to courses like Data Structures & Algorithms and Database Systems would be prescribed deficiency modules. While the student must complete the deficiency modules before start of the program, the performance in the deficiency modules will not be accounted in the calculation of CGPA and will not be part of the requirement for certification.

List of courses

Course No.	Course Title	Units
CBDE ZG511	Foundations of Big Data Systems	2
CBDE ZG521	Platforms for Big Data	2
CBDE ZG531	Processing Big Data - ETL & Batch Processing	2
CBDE ZG541	Processing of Real-Time Data and Streaming Data	1
CBDE ZG551	Big Data Analytics	1
CBDE ZG571	Capstone Project	3
	Total	11

Post Graduate Certificate Programme
(General Management)

Type of Input: Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, with adequate work experience in relevant domains.

Expected Learning Hours: ~480 hours

Minimum Requirement for Certification : Successful completion of the Certificate Programme would require:
Obtaining a minimum CGPA of 5.50

Semesterwise Pattern

Course No.	Course Title	Units
PCGM* ZC411	Marketing	4
PCGM* ZC415	Financial and Management Accounting	4
PCGM* ZC417	Quantitative Methods	4
PCGM* ZC416	Managerial Economics	4

Post Graduate Certificate Programme
(Internet of Things)

Type of Input:	Employed professionals holding an Integrated First Degree of BITS or its equivalent in Electrical & Electronics Engineering or Computer Science or other relevant discipline with adequate work experience in relevant domains.
(Expected) Learning Hours	~ 650 hours
Minimum Requirement for Certification	Successful completion of the Certificate Programme would require: 1. Completion of all courses with a minimum C- grade in each course. 2. Obtaining a minimum CGPA of 5.00

List of courses

Course No.	Course Title	Units
CIOT ZG511	IoT Technology and Applications	3
CIOT ZG521	Hardware Architectures for IoT	4
CIOT ZG531	Communication and Networking Technologies in IoT	3
CIOT ZG541	Sensors, Actuators, and Signal Processing	3
CIOT ZG551	Software and Programming in IoT	4
CIOT ZG561	Data Management in IoT	2
CIOT ZG571	Capstone Project	3
	Total	22

Post Graduate Certificate
(Manufacturing Practice)

Type of Input: Employed professionals holding a three-year undergraduate degree or its equivalent in relevant disciplines, with adequate work experience in relevant domains.

Expected Learning Hours: ~510 hours

Minimum Requirement for Certification : Successful completion of the Certificate Programme would require:
Obtaining a minimum CGPA of 5.50

Semesterwise Pattern

Course No.	Course Title	Units
PCMP* ZG511	Managing People & Organizations	4
PCMP* ZG526	Operations Management	4
PCMP* ZG537	Lean Manufacturing	5
PCMP* ZG522	Total Quality Management	4

Certificate in Manufacturing Practice

Type of Input: Employed professionals holding a Technical Diploma or its equivalent, with adequate work experience in relevant domains.

Expected Learning Hours: ~390 hours

Minimum Requirement for Certification: Successful completion of the Certificate Programme would require: Obtaining a minimum CGPA of 4.50

Semester wise pattern

Course No.	Course Title	Units
CMP* ZC411	Managing People & Organizations	3
CMP* ZC426	Operations Management	3
CMP* ZC437	Lean Manufacturing	4
CMP* ZC422	Total Quality Management	3

Certificate in General Management

Type of Input: Employed professionals holding a Technical Diploma or its equivalent, with adequate work experience in relevant domains.

Expected Learning hours: ~360 hours

Minimum Requirement for Certification: Successful completion of the Certificate Programme would require: Obtaining a minimum CGPA of 4.50

Semesterwise Pattern

Course No.	Course Title	Units
CGM* ZC411	Marketing	3
CGM* ZC421	Financial and Management Accounting	3
CGM* ZC431	Quantitative Methods	3
CGM* ZC414	Managerial Economics	3

PART VI

COURSE DESCRIPTIONS (On-Campus)



LEGEND

The numbers that appear at the end of each course title like 3 0 3, 0 9 3, 2 3 3 etc. indicate the lecture hours per week, the practical/seminar/project hours per week and the number of units in that order. Wherever a single number (with or without*) appears, it indicates only total units and its break up in terms of lectures and practicals/seminar/project may be announced from time to time through the timetable whenever it is needed.

PART VI: COURSE DESCRIPTIONS *(On-Campus)*

See enclosed CD for Contents

Biological Sciences VI-1
Biotechnology VI-6
BITS VI-9
Civil Engineering VI-20
Chemical Engineering VI-31
Chemistry VI-40
Computer Science VI-46
Design Engineering VI-53
Electronics and Communication Engineering VI-54
Economics VI-56
Electrical and Electronics Engineering VI-61
English VI-69
Finance VI-70
General Studies VI-72
Humanities and Social Sciences VI-75
Humanities VI-81
Instrumentation VI-81
Information Systems VI-84
Internet Technology & e-Business VI-86
Mathematics VI-87
Master of Business Administration VI-91
Mechanical Engineering VI-96
Microelectronics VI-102
Manufacturing Engineering VI-103
Management VI-106
Public Health VI-107
Manufacturing Systems Engineering VI-109
Materials Science and Technology VI-109
Music VI-111
Pharmacy VI-112
Physics VI-117
M.E. Sanitation Science, Technology & Management VI-122
Sanskrit VI-123
Skill Area VI-123
Software Systems VI-124

This part gives a detailed description of all the courses.

Offering of courses: The academic calendar consists of two regular semesters. The summer term is not part of the academic calendar except where specifically stated. The offering of courses shall always depend on the normal unfolding of these courses for regular students who should be able to negotiate all the courses required as compulsory or electives as they proceed within the stated number of years in the programme. Very often any departure from this practice is subject to the overall facilities available. It will be invariably taxing of facilities to help the largest number of students when possible. For instance, same course is offered in both the semesters where only one is necessary, in the pattern described above. Depending upon the need and the facilities, Dean Instruction decides the courses that will be offered in any particular semester and this information will be made available through a course-wise timetable at the beginning of every semester.

It will be clear from the above discussion that a student who wishes to exercise his choice of electives can do so only through courses available in the timetable and not courses which are mentioned in the bulletin. Nonetheless, students can easily guess, on the basis of previous timetables, which courses are likely to be offered in what semester and make an advance planning to the extent it is possible. Similarly, a student who has backlog will find that he is already out of phase with the pattern that has been described earlier and therefore has to work out a strategy for himself by which he reduces fouling up as much as it is possible for him to do so.

While registration in a particular course or set of courses is governed by Academic Regulations, for easy reference the following general guidelines together with specific points are listed.

1. The Dean, Instruction may introduce or withdraw courses in categories which are taken on the basis of electives or options.
2. Registration in any course can be made only with the prior permission of the Dean, ARC.
3. Although the detailed break-up of the units in terms of hours for lecture and practical classes are presented without designating tutorial hours, every student will be required to attend these tutorial classes as and when required by the Dean, Instruction.
4. In the structure of a programme a block of courses follow in a particular sequence semester after semester. The mere fact that no specific restriction has been put does not permit unwarranted jumbling of this sequence. This sequence is presented in semesterwise pattern for each programme.
5. The lists of courses to be followed invariably have numbers attached to each course. These numbers generally determine the level at which the course is to be normally registered. However on the same plane there are courses which are specially designed for group C programmes and are not available to students of groups A&B programmes. Appropriate sections of the Bulletin may be consulted.
6. Sometimes a particular course has a prerequisite condition which has to be fulfilled before one can register in that course, or has to be waived with the consent of the Dean, Instruction.
7. For registration in certain specific courses like Specialized Discipline Courses, Higher Degree Courses, apart from the prerequisite, there will also be requirement of prior preparation. Academic regulations must be consulted for this.
8. For students registered in courses of Off-Campus Work Integrated Learning and Collaborative Programmes corresponding instructions have been detailed in PART V.

Note: The items mentioned above are not exhaustive. For precise rules reference should be made to Academic Regulations.

Course Description for all On-campus Programmes

Biological Sciences

BIO F110 Biology laboratory **0 2 1**

An introductory level course where students would perform selected experiments of biology in the laboratory so that they appreciate the concepts learnt in theory course. Experiments related to Microscopy and micrometry, quantification of biological macromolecules, chlorophyll estimation, measurement of solvent potential of plant tissue, measurement of parameters related to cell cycle, Experiments related to hematology, DNA quantification from the plant organs; Water analysis.

BIO F111 General Biology **3 0 3**

Living systems and their properties; major biological compounds; basic physiological processes; introduction to genetics; environment and evolution.

BIO F201 Introductory Biology **3 1 4**

Living systems and their properties; classification of organisms; biochemical pathways operative in organisms; introductory genetics, Introductory recombinant DNA technology, ecology and environmental scienes and related basic labs.

BIO F211 Biological Chemistry **3 0 3**

The molecular process of life presents us with a seemingly never ending succession of chemical mechanisms of almost incredible fascination. This course is introduced at the cellular and molecular level and focus upon bio -macromolecules, biosynthesis of macromolecules, energy yielding and requiring processes, genetic information etc. This would help going for higher level activities, appreciation of biochemical problems, evaluation and problem solving. It also includes theory of techniques used in biochemistry and related experiments.

BIO F212 Microbiology **3 1 4**

Introduction and classification of microbes; structure, physiology and genetics of microbial cell; isolation, cultivation, physiological and biochemical characterization of microbes; host parasite relationship; microbiology of soil, water and food; physical chemical methods of controlling microbes; antimicrobial drugs; clinical microbiology; and related lab components.

BIO F213 Cell Biology **3 0 3**

Types and properties of cells; microscopy; membrane structure, function and transport; endomembrane system and its functions; nuclear organization and functions; ribosomes and protein synthesis; cytoskeleton; cell communication; cell cycle, cell growth and cancer; apoptosis; techniques, related experiments and applications of cell biology.

BIO F214 Integrated Biology **3 0 3**

The Integrative Biology course is a course which bridges as well as opens new vistas to a student taking up bioogy. The course covers two tracks, essentially. The first track introduces the student to the ordering that helps biologists to actually study the vast diversity of the living world. This track would encompass questions related to the origin and evolutionary pathways followed in Nature, as well as the methods followed by biologists to systematically categorize and document them. The second track highlights the uses and applications of biology in everyday life – whether in the economic or in the social realms. Together, the course projects the subject in a way from which the student can choose and implement his biological knowledge vis-à-vis his/her interests.

BIO F215 Biophysics **3 0 3**

A study of molecules and their interaction forces; bio-energetics and physical techniques as applied to biological phenomena and related labs.

BIO F216 Water,Sanitation and Solid Waste Management **3 0 3**

unicipal Solid Waste Management in Developing Countries, Planning and Design of Sanitation Systems and Technologies, Introduction to Household Water Treatment and Safe Storage, Introduction to Faecal sludge management.

BIO F217 Laboratory for Water,Sanitation and Solid waste Management **1 2 3**

Chemical oxygen and Biological oxygen demand of wastewater, Total organic carbon analysis, Phosphorus analysis, Kjeldahl Nitrogen analysis – for waste water, estimation of total solids and volatile solids in organic waste, biochemical methane potential of organic waste, struvite precipitation from wastewater and analysis by XRD Microbial fuel cell for wastewater treatment, detection of methanogens by fluorescence microscopy, atomic absorption spectrophotometric analysis of arsenic in water composting of faecal sludge.

BIO F231 Biology Project Laboratory **3**

The course includes projects involving laboratory investigation or laboratory development in Biology. The course is normally available to students of second or higher level. The course must coterminate with a project report.

BIO F241 Ecology and Environmental Sciences **3 0 3**

Biotic and abiotic components of environment; limiting factors; regional ecology; ecosystem productivity and trophism; population and community ecology; succession and evolution; pollution; environmental biotechnology; Indian environmental movement. Associated with related labs.

BIO F242 Introduction to Bioinformatics **3 0 3**

Introduction to genomic & Proteomics, Biological databases and data mining, sequence similarity search and sequence alignment algorithms, Phylogenetic tree construction algorithms, Protein structure predication and structure analysis, use of software package in Bioinformatics; Related lab components.

BIO F243 Genetics **3 0 3**

Facts and theories of heredity, their relation to the present state of biological theory in general; elements of population genetics; genetics and species concept and related labs.

BIO F244 Instrumental Methods of Analysis **1 3 4**

Principles, configuration, applications of instruments like mass spectrophotometer, NMR,UV, IR, X-ray apparatus, atomic spectrophotometer, Fluorescence Spectroscopy, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA,TGA, Thermo Cycler-PCR, SDS-PAGE, ELISA etc. The course is specially designed for students in the first degree majoring in experimental sciences and would require groups of students to work with the above instruments in order to appreciate the potentiality of such modern instrumental methods of analysis.

BIO F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

BIO F311 Recombinant DNA Technology **3 0 3**

The course deals with theoretical aspects and lab exposure to selected experiments of recombinant DNA manipulation. Emphasis will be placed on procedures to create chimeric molecules using examples from actual experimental work. Vector designing, PCR, qPCR, DNA sequencing, in-vitro mutagenesis, cloning in prokaryotic and eukaryotic systems and whole genome approaches will be covered with related lab components.

BIO F312 Plant Physiology **3 0 3**

Basic functional processes in plants; Plant tissue system, Plant-water relations, Gaseous exchange, Stomatal regulations, Mineral nutrition and absorption, Transport of material, Growth and development, Hormones and PGRs, Photoperiodism, Vernalization, Plant defense mechanisms, Stress Physiology and related lab components.

BIO F313 Animal Physiology **3 0 3**

Principles and concepts underlying the function of tissues and organ systems in animals, with emphasis on mammalian systems and integration of systems at the level of the whole organism. Several biological systems are considered, including respiratory, circulatory, nervous, endocrine, immune, excretory, muscles, skeletal and reproductive systems. Laboratory session will help to study function of any organ system; Related lab components.

BIO F314 Conservation Biology **2 1 3**

Biological diversity: its measurement, value and crisis; conservation at ecosystem, population and species levels; protection, management and res-toration of ecosystems; sustainable development and community-based conservation; conservation legislation. Course practicum will be effected through classroom and field activities.

BIO F315 Applied Nutrition and Nutraceuti- 3 0 3
cals

This course will provide a broad framework for understanding the significance of food and nutrition to human health and well-being. Beginning with basic concepts in nutritional biochemistry & microbiology, this course will expand into applied nutrition themes — malnutrition – under-nutrition *versus* over-nutrition, nutrigenomics, clinical nutrition, functional foods & nutraceuticals, food safety and security. The course will also include themes such as industrial development of functional and genotype-specific foods and beverages (example, infant-food formulations), fortified foods, phytochemicals, nutritional databases & personalized nutritional plan, using suitable case-studies

BIO F341 Developmental Biology **3 0 3**

Scope and problems in developmental biology; major model organisms (vertebrates, invertebrates and plants) and their life cycles; patterning and axis formation; morphogenesis; organogenesis; nervous system; germ cells and sex; cell differentiation and stem cells; growth, ageing and regeneration; applications of developmental biology. The course will emphasize universal principles that govern the process of development; Related lab components.

BIO F342 Immunology **3 0 3**

Introduction to immune system, cell mediated and humoral immunity, immune system in health and disease immunity to infectious diseases, immune mechanisms involved in cancer, immunodeficiency and autoimmunity. Vaccination and transplantation Immunology; Related lab components.

BIO F352 Cell and Tissue Culture Technology **3 1 4**

Theories and practices on *in vitro* techniques for plants and animals, development of normal and tumor cell lines, somatic hybridization, monoclonal antibody production, hairy root cultures, secondary metabolite production, scale-up strategies for large scale production of biomass.

BIO F366 Lab Project **3**

BIO F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F376 Design Project **3**

BIO F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F411 Laboratory **0 9 3**

Specially designed for M.Sc. Biological Sciences; cannot be taken by others under any circumstances.

This laboratory course is designed only for M.Sc. Biological Sciences students and aims to expose the students to and build competence in selected techniques of modern biology.

BIO F413 Molecular Biology of Cell **3 0 3**

Introduction of eukaryotic cell cycle, genetic regulation of cell cycle and differential gene expression during developmental process. In addition, the postulated functions of hitherto accepted non-essential DNA and the functioning of higher eukaryotic genes with unexpected structures in eukaryotic genomes would also be covered.

BIO F417 Biomolecular Modelling **3 0 3**

Biomolecular Conformation, Structural genomics and proteomics, protein folding, Forecefield, Simulation, Conformational analysis, ab initio structure prediction, comparative modeling, lattice models, usage of modeling packages.

BIO F418 Genetic Engineering Techniques **1 3 4**

Experiments on the common molecular biology techniques used in gene manipulation in bacteria and plants; gene cloning procedure in bacteria – from isolation of plasmids to screening of recombinant clones; polymerase chain reaction (PCR) and its applications; gene and protein expression analysis; DNA sequencing; Agrobacterium-mediated gene transfer in plants and introduction to plant cell culture techniques; Use of software for molecular biology.

BIO F419 Molecular Evolution **3 0 3**

Introduction of evolution of macromolecules, reconstruction of evolutionary history of genes and organisms, evolutionary adaptation to temperature, water solute adaptation, dynamics of genes in populations, rates and pattern of nucleotide substitution, evolution of gene duplication and domain shuffling, concreted evolution of multigene family, genome organization and evolution, roles of mutation and selection in molecular evolution.

BIO F421 Enzymology **3 0 3**

Enzyme nomenclature and classification; isolation and purification; structures; kinetics; regulation of enzymatic reactions; evaluation of enzymes and other proteins.

BIO F431 Reproductive Physiology **3 0 3**

Study of sexual cycles; biochemistry of fertilisation; control of ovarian functions; gonadotropins; pheromones and mammalian reproduction.

BIO F441 Biochemical Engineering **3 0 3**

Principles of Chemical Engineering applied to Bioprocesses; Kinetic Models for growth, substrate utilization and product formation; Biological reaction kinetics and applied enzyme catalysis; immobilized biocatalysts; Bioreactor Design and Operation; Fermentation, Upstream & Downstream processing; Novel Bioreactor Configurations; Transport phenomena in Bioprocesses; Instrumentation and control; Bioprocess Optimization and Scale up; Industrial Protein Purification Techniques; Commercial Enzymes & Biopharmaceuticals; Bioprocess Patenting, Economics & Feasibility Studies.

BIO F451 Bioprocess Technology **3 0 3**

Bioprocess Principles; Kinetics of Biomass production, substrate utilization and product formation; Kinetics of enzyme catalyzed reactions and applied enzyme catalysis; Fermentation process parameters and controls, Upstream & Downstream processing; Bioreactor Design & Operation; Transport processes in Bioreactors; Novel Bioreactor Configurations; Immobilized biocatalysts; Bioconversion; Protein Purification; Industrial applications of Bioprocesses; Bioprocess Patenting & Economics.

BIO F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

BIO G510 Application of Computers and Statistics in Biology **5**

to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization. Introduction to computer and its components; operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc.; principles of software creation; processing concepts, flow charting and algorithms, programming constructs, programming languages, program development sequence; information systems: need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

BIO G511 Population and Quantitative Genetics **5**

Gene pool, allele frequency, genotype frequency, Hardy-Weinberg equilibrium & its complications, non-random breeding, genetic drift, genetic load, gene flow, selection, intensity of selection pressure, inbreeding & artificial selection, natural selection & polymorphism, neutral theory & evolution speciation.

BIO G512 Molecular Mechanism of Gene Expression **3 2 5**

Prokaryotic and eukaryotic genomes and their topology: DNA - protein interactions; RNA transcription and transcriptional control; DNA replication; transcription in yeast; RNA processing; translation; mechanism of gene expression in pro and eukaryotes.

BIO G513 Microbial and Fermentation Technology **3 2 5**

Metabolic Stoichiometry- energetics, fundamentals of microbes and their morphology, Stoichiometry of cell growth and product formation, fermentation kinetics, phases of growth in batch culture, continuous culture and fed-batch cultures, kinetics of cell growth, product formation and substrate utilization-substrate and product inhibition kinetics, enzyme technology. Industrial Biotechnology- strain selection and improvement, media formulation and sterilization strategies, industrial applications, fermentation and product recovery, preparation of alcohols, antibiotics, organic acids, enzymes, bakery and dairy products, biopharmaceuticals, vaccine production.

BIO G514 Molecular Immunology **3 2 5**

This course will deal extensively with topics like molecular basis of T and B cell antigen recognition and activation. Immunity to microbes and diseases caused by humoral and cell mediated immune responses will be covered and emphasis placed on congenital and acquired immunodeficiencies. Advanced topics like antibody engineering will be discussed with the help of review articles.

BIO G515 Stem Cell and Regenerative Biology **3 1 4**

Introduction to stem cells and regenerative biology; embryonic stem cells, adult stem cells, manipulation of stem cells for replacing cells in diseased tissues; transplantation of embryonic and adult stem cells, replacing congenitally defective organs and damaged organs, tissue engineering, biodegradable and biocompatible materials, nano-devices, and regulatory perspectives.

BIO G516 Fermentation Processes **(5*)**

Introduction to Fermentation, fermentation processes, microbial organisms in fermentation, strain isolation, improvement and preservation, media formulation, sterilization, metabolic pathways and engineering, metabolite overproduction, detailed case studies on food fermentation including cheese, dairy products, bakery foods, wine, brandy, beer, and food related fermentation including single cell protein, baker's yeast, enzymes, organic acids, antibiotics, amino acids, bio-fuel, industrial alcohol. Preparation of vaccine, insecticides, alkaloids. Microbial transformation, Bioleaching, Fermentation economics.

BIO G517 Recombinant DNA Technology **(3*)**

The course deals with theoretical aspects of recombinant DNA manipulation. Emphasis will be placed on procedures to create chemeric molecules using examples from actual experimental work. Vector designing, polymerase chain reaction, invitro mutagenesis and cloning in prokaryotic and eukaryotic vectors will be covered.

BIO G522 Interferon Technology **3 1 4**

Characterization, Functional activity, broad pleiotropic agents, antiviral, anti-angiogenic, antitumor, anti-proliferative, immunomodulatory effect, specific receptor binding, mechanisms, sequencing, classification, Dosage formulation Therapeutic study, side effects, molecular manipulation and activity profile.

BIO G523 Advanced and Applied Microbiology **3 2 5**

Molecular taxonomy, Systematic Microbiology; Study of molecular diversity of microorganisms, clinical microbiology, human-microbe interaction, molecular plant-microbe interaction, applied microbiology and synthetic microbiology.

BIO G524 Animal Cell Technology **3 2 5**

Animal cell and tissue culture from various organisms, types of cell lines, development and maintenance of cell lines, manipulation and applications of cell culture technology for Biotechnological research and therapeutics implication.

BIO G525 Environmental Biotechnology and Waste Management **3 2 5**

Applications of biotechnology to the management of environmental problems, role of biotechnology in increasing plant and animal production through biological insecticides, herbicide resistance, mineral cycling, conservation of genetic resources and biological nitrogen-fixation. Use of biotechnological processes in pollution control, bioremediation of toxicants, treatment of domestic and industrial waste will be emphasized. Ethical issues related with the release of genetically modified organisms would also be covered.

BIO G526 Cancer Biology **3 2 5**

Basic concepts and molecular basis of cancer, Growth, Regulation and Metastasis, Cancer Immune system Interaction, Cancer therapy, Cancer and Environment, Cancer and society.

BIO G532 Biostatistics and Biomodelling **3 1 4**

Probability analysis variables in biology; standard deviation and standard errors; correlation and correlation coefficient; regression analysis; significance test; chi-square and goodness of fit; applications of computers in statistics; handling of software on enzyme kinetics and protein sequence analysis; computer analysis of nucleic acid structure.

BIO G541 Neural Network Analysis **5**

Basic concepts, Characteristics of nerve cells and neurons, Definition of artificial neurons, Algorithms, network topology and functions, Neural network application for learning, expert systems, knowledge representation, speech recognitions and synthesis, visual perception and pattern recognition and language processing: Emphasis will be on a comparative study with biological systems.

BIO G542 Advanced Cell and Molecular Biology **5**

Eukaryotic cell cycle: restriction point, G1 phase progression, role of cyclins, cancer cell cycles; growth factors and their interaction with receptors: PDGF, EGF, VEGF, FGF, TGF; stress responses: mechanisms molecular biology with special reference to hypoxia; extracelular matrix and adhesion molecules; cytokines: sources, molecular structure, targets and mechanisms of action; apoptosis, caspases and necrosis.

BIO G544 Bioremediation and Bio-metallurgy **5**

Applications of microbial metabolism for removal of toxic material from environmental sample and recovery of metals from low grade ore; metal- microbe interaction, comparison of conventional and microbe based processes of treating toxic waste material; steps in bioremediation processes such as preparation of biomass through genetic manipulations, immobilization, batch or continuous processes;applications of microbes in bioleaching process and recovery of copper, gold and nickel with case studies.

BIO G545 Molecular Parasitology & Vector Biology **5**

Biology of parasitic diseases and their transmission in human and animal population by vectors/carriers. molecular aspects of parasite and vector biology, modes of infection, life cycles of parasite and vector, host - parasite interactions, infectivity pattern, mechanisms of drug resistance and immune evasion, methods of diagnosis, prophylaxis, treatments to parasitic diseases and vector control measures.

BIO G551 Membrane Biology **5**

Concepts of biological membrane, Membrane constituents phospholipids, glycolipids and cholesterol; Membrane bilayers, amphipathic molecules, Self-assembly process; Membrane proteins, lateral and transverse diffusion, fluid mosaic model, Membrane permeability; Organization and dynamics of membrane, Signal transduction, role of carbohydrate components of membrane, Red-cell membrane proteins, Tools and techniques in membrane study: electron microscope, X-ray study, autoradiography and spectrometry. Immune response, Surface properties, Kinetics of membrane-bound processes.

BIO G561 Advances in Recombinant DNA Technology **3 2 5**

Recent advances in high---throughput genomics, proteomics and large---scale mutagenesis; genomics techniques like transcriptome arrays and arrays for whole genome analysis; proteomics analysis techniques like 2D PAGE and MS; understanding genome and protein structures and protein interactions through yeast/bacterial two---hybrid systems; large scale mutagenesis and interference.

BIO G570 Recent Developments in Biology **1 0 1**

The students will be exposed to recent advances / research in the area including but not restricted to animal, plants or microbial systems. There will be emphasis placed on understanding the applications and benefits of the in silico and/or wet lab approaches to the selected topics.

BIO G612 Human Genetics **3 2 5**

Epigenetic and Chromosomal Control of Gene Expression: DNA methylation, Genomic imprinting and mammalian development. DNA damage & repair: Damage control during replication and mitosis, Genome stability and checkpoint control, Disorders related to aberrant DNA repair. Molecular genetics of inherited disorders. Cancer genetics: Genetic analysis of various cancers, tumor suppressor genes, metabolic polymorphisms and cancer susceptibility. Genomics & Proteomics: Human genome project and its applications in Gene therapy, novel drug design approaches.

BIO G631 Membrane and Liposome Tech. **3 1 4**

Membrane structure and biogenesis: techniques for the study of membrane structure and properties; model of membranes; molecular transport mechanisms; techniques of artificial membrane productions; liposomes - structure and characteristics; carrier mechanisms for targeting therapeutic agents; industrial applications of liposomes.

BIO G632 Transgenic Technology **3 2 5**

Transgenic techniques as replacements of traditional breeding practices; understanding faulty gene pool; development of commercial and economically viable tissue culture and their genetic improvement through r-DNA strategies; development of recombinant transplants for improved genomic system.

BIO G641 Cell & Tissue Culture Technology **2 2 4**

Plant and animal cell culture from various organism; types of cell lines; development and maintenance of cell lines; tissue culture for viral growth, hybridization and gene manipulation; hybridoma technology and protoplast fusion.

BIO G642 Experimental Techniques **4**

Specially designed laboratory course which aims to impart training in selected range of techniques such as, salt fractionation, dialysis, PAGE with discontinuous buffer solution, Western Blotting, Ion-exchange chromatography and Gel filtration, Genomic DNA extraction from Human Blood, bacteria, purification of DNA and analysis, polymerase chain reaction, single, double and partial restriction digestion, construction of genomic DNA library, Southern Blotting, Karyotyping, short term lymphocyte culture, RNA extraction and quantification.

BIO G643 Plant Biotechnology **3 2 5**

Plant cell and tissue culture, media constituents, micro propagation and other culture techniques, their applications and limitations, germplasm storage, secondary metabolite production, therapeutic protein and antibody production through plants, promoter designing and inducible promoters, molecular markers and their applications, approaches to influence metabolite partitioning and quality and quantity of plant storage products.

BIO G651 Protein and Enzyme Bioengineering **3 2 5**

Sources, isolation, purification and storage of protein and/or enzymes; kinetics of enzyme catalyzed reactions; biocatalyst reaction engineering; techniques of production and recovery of enzymes; protein and enzyme modification; clinical and industrial applications of free and immobilized enzymes.

BIO G661 Gene Toxicology **3 1 4**

Origin and fundamentals of Gene Toxicity; genotoxic effects in plants and mammalian systems; screening and measurements of genetoxicants; techniques in gene toxicology and their application to human, agricultural and environmental monitoring.

BIO G671 Bioconversion Technology **3 2 5**

Waste and by-product utilization; downstream processing; biogas production; principles of biodegradation process parameters; bioreactor design and operation; exploitation of waste streams enzyme-based bioconversions of high value products.

Biotechnology

BIOT F211 Biological Chemistry **3 0 3**

Chemistry and functions of constituents of cells and tissues; introduction to enzymes; metabolism of carbohydrates, lipids, aminoacids; nucleic acids and protein synthesis; vitamins and hormones.

BIOT F212 Microbiology **3 1 4**

Introduction and classification of microbes; structure and physiology of microbial cell; infection and immunity; host parasite relationship; microbiology of milk, air, water and food; physical and chemical methods of controlling microbes; experiments for isolation, cultivation, physiological and biochemical characterization of microbes.

BIOT F213 Cell Biology **3 0 3**

Fundamental processes of life at cellular and sub-cellular levels, cell environments, membrane transport, cell movements, division and control mechanisms.

BIOT F215 Biophysics **3 0 3**

A study of molecules and their interaction forces; bioenergetics and physical techniques as applied to biological phenomena.

BIOT F241 Genetic Engineering Techniques **1 3 4**

Experiments on the common molecular biology techniques used in gene manipulation in bacteria and plants; gene cloning procedure in bacteria – from isolation of plasmids to screening of recombinant clones; polymerase chain reaction (PCR) and its applications; gene and protein expression analysis; DNA sequencing; Agrobacterium-mediated gene transfer in plants and introduction to plant cell culture techniques; Use of software for molecular biology.

BIOT F242 Introduction to Bioinformatics **3 0 3**

Introduction to genomics and proteomics, human genome and other sequencing projects, biological databases and data mining, sequence similarity search and sequence alignment, protein structure prediction and structure analysis, use of software packages in Bioinformatics.

BIOT F243 Genetics **3 0 3**

Facts and theories of heredity, their relation to the present state of biological theory in general; elements of population genetics; genetics and species concept.

BIOT F244 Instrumental Methods of Analysis **1 3 4**

Principles, configuration, applications of instruments like mass spectrophotometer, NMR, UV, IR, X-ray apparatus, atomic spectrophotometer, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA, TGA, etc.

BIOT F245 Introduction to Environmental Biotechnology **3 0 3**

Industrial processes, incorporating design and monitoring of waste treatment technologies; microbial removal and degradation of organics pollutants, phytoremediation of soil and water contaminated with toxic metals and radionuclides, wetlands as treatment processes, biofilms, biofilters for vapor-phase wastes, and composting; biosensors in environmental analysis, molecular biology applications in environmental engineering and genetic engineering of organisms for bioremediation.

BIOT F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

BIOT F311 Recombinant DNA Technology **3 0 3**

The course deals with theoretical aspects of recombinant DNA manipulation. Emphasis will be placed on procedures to create chemeric molecules using examples from actual experimental work. Vector designing, polymerase chain reaction, invitro mutagenesis and cloning in prokaryotic and eukaryotic vectors will be covered.

BIOT F314 Industrial Microbiology and Bio process Engineering **2 2 4**

Principles and application of fermentation technology with respect to production of value added biotechnological products and strategies of improving production; development of biological processes associated with raw materials preparation to product recovery, relevant to industries as diverse as medical, food and environmental protection.

BIOT F342 Immunology **3 0 3**

Introduction to immune system, cell mediated and humoral immunity, allergy, mechanisms of hypersensitivity reactions, immunity to infectious diseases, immune mechanisms involved in cancer and transplantation immunology.

BIOT F343 Experiments in Biotechnology **0 3 3**

Advanced molecular biology techniques such as genomic DNA isolation, plasmid DNA, single, double & partial digestion, construction of genomic DNA library, PCR, polymorphism in studies, southern blotting, RNA isolation, Real Time PCR, protein expression and analysis and immuno-histochemical techniques.

BIOT F344 Downstream Processing **2 1 3**

Recovery and purification of biologically – produced products including biomass itself, extracellular and intracellular components; Strategies to recover and purify products, separation of insoluble products, cell disruption, separation of soluble products, finishing steps for purification, integration of reaction and separation.

BIOT F345 Proteomics **3 0 3**

This course deals with the introduction to proteome, significance and analysis of post-translational modification of proteins, protein-protein interaction. Functions of all protein will be discussed in light of the standard prokaryotic and eukaryotic models. Emphasis will be given on methods of proteomic research, proteome analysis, resolution and identification of proteins.

BIOT F346 Genomics **3 0 3**

This course provides an introduction to the field of genomics. It also covers the structure of the human genome, and the strategies that were used to map and sequence the genome, and details how genomic sequence information is utilized for pharmacogenomics, drug discovery and diagnostics. The course also introduces post-genomics technologies such as bioinformatics, functional genomics and comparative genomics.

BIOT F347 Immunotechnology **3 0 3**

Immunotechnology is a specialised course, which deals with biotechnological aspects of immunological mechanisms Hybridoma technology and production of monoclonal antibodies, antibody engineering using genetic manipulations, alternatives to hybridoma technology for monoclonal antibodies, designing and building of mAb genes, primary and secondary libraries for antibody genes. Emphasis will be given on the production of humanized and human antibodies. Uses of monoclonal antibodies in diagnosis, therapy of allergic diseases, vaccine production, abzyme, purification, quantification and cytogenetic analysis.

BIOT F352 Cell and Tissue Culture Technology **3 0 3**

This course will provide an introduction to theory and application of tissue culture technologies. The details of animal and plant tissue culture will be covered including design of media and large scale production of the animal and plant cells. The course also covers the various techniques of preserving the animal cell lines.

BIOT F366 Lab Project **3**

BIOT F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIOT F376 Design Project **3**

BIOT F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIOT F413 Molecular Biology of the Cell **3 0 3**

This course is designed to impart knowledge of molecular biology of the cell. Students will understand the various concepts related to cell structure and function at molecular level. : Molecular biology and nucleus, ultrastructure and cytochemical studies, membrane structure and function. Organelle involved in intracellular transport and cell signaling , cell sorting Cell junctions and adhesion molecules, Cell division and the Cell Cycle.

BIOT F416 Introduction to Pharmaceutical Biotechnology **3 0 3**

The course is designed to provide advances in drug development, drug delivery systems and pharmaceutical specialties including polypeptides, proteins, viruses, DNA and antibiotics. It covers relevant aspects for the development of new bi technology based drugs, target identification, downstream processing and formulation. Special emphasis is given on understanding the mechanisms and process involved in diseases.

BIOT F417 Biomolecular Modeling **3 0 3**

The course is designed to provide students the first hand experience of potential utility of biomolecular modeling especially in concurrent pharmaceutical research, and in cell and structural biology. It describes the functionality, advantages, and limitations of standard computing strategies for the simulation of biomolecules. Biomolecular Conformation, Structural genomics and Proteomics, Protein folding, Forecefield, simulation, Conformational analysis ,abinitio structure predictioncomparative modeling, lattice models, usage of modeling packages.

BIOT F420 Introduction to Plant Biotechnology **3 0 3**

Introduction to plant tissue culture, Micropropagation, Somaclonal variation, meristem culture, Anther culture, Cell suspension culture, Secondary metabolite production, Protoplast isolation and Fusion, cryopreservation, Techniques for Plant Transformation – Agrobacterium and Biolistics, Transgenics in crop Improvement.

BIOT F422 Nanobiotechnology **3 0 3**

The course deals with the principles and application of nano- and micro-fabrication methods to build tools for exploring the biological systems. The course includes interdisciplinary aspects of biology and nanotechnology on the principles of microfabrication techniques with a focus on nanoparticles, drug delivery systems, and interations with molecular and cellular level for biomedical and biological research applications.

BIOT F423 Drug design and delivery **3 0 3**

The objective of this course is to give insight into the principles of drug discovery and molecular mechanism of drug action. The course is designed for applications in the pharmaceutical and biotechnology related to identifying and optimizing a drug candidate for clinical development. Special emphasis is given on rational and systematic approaches to the development of novel classes of drugs against diseases and effective treatment.

BIOT F424 Food Biotechnology **3 0 3**

The course gives an overview on presence of microorganisms, their activity and control in food. It explores the scientific methods for measuring microorganisms and their products. Preservation techniques of foods, food safety, quality controls and food borne diseases are also discussed. The course also covers food fermentation and use of various microorganisms in preparation of fermented foods at industrial level.

BITS

BITS F111 Thermodynamics **3 0 3**

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of nonreacting mixtures.

BITS F112 Technical Report Writing **2 0 2**

Overview of communication, elements of effective writing, formal reports, types of reports, preparatory steps for writing reports, methods and sources of data, use of illustrations, oral presentation.

BITS F113 General Mathematics I **3 0 3**

I. Review of coordinate geometry, Theory of equations, Progression and series, permutations and combinations, Binomial theorem, Functions: Trigonometric (with identities), Transcendental.

II. One Dimensional Calculus: Limit and continuity, Differentiation, Integration. Applications of derivatives and definite integration.

BITS F114 General Mathematics II **3 0 3**

I. Polar coordinates, Function of several variables, Multiple integrals, Vector valued functions.

II. Complex functions and their analyticity.

III. First order and second order ordinary differential equations, Laplace transformations and its applications to ordinary differential equations.

BITS F201 Material Science and Engineering **3 0 3**

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

BITS F211 Introduction to IPR **1**

Importance & relevance of IPR's in the globalised era; legislation covering IPR's in India; patents, copyrights, trademarks, industrial designs, trade secrets, geographical indications; procedures for filing IPR's in India, WTO, TRIPS agreement and their relevance to agriculture, industry education and service sector and others.

BITS F212 Introduction to Human Rights **1**

Relevance of human rights education in India: evolution of human rights and duties, human rights: international norms, human rights and duties in India, redressal mechanisms for human rights violations, deprivation of human rights: core issues; women and human rights and duties, good governance, science and technology and human rights.

BITS F213 Introduction to Environmental Studies **1**

Ecosystems, evolution and biodiversity; impact of population and economic growth on the environment; sustainable development and use of resources such as water, food, and energy; environmental quality – waste management, air and water pollution, hazards such as global warming, ozone layer depletion, acid rain, and nuclear accidents; sustaining environmental quality- economic, social, political and ethical issues.

BITS F214 Science, Technology and Modernity **3 0 3**

Interrelationship between science, technology and modern society; forms in which beliefs and values of a modern society shape sciences and technologies; forms in which scientific discoveries and technological developments influence and shape modern societies. Scientific Revolution and the emergence of modernity as a social condition; Enlightenment promise of progress within the economic system of capitalism. Some critiques of the received view; recent phase of capitalism and the role of technology in globalization.

BITS F215 Applications of Bio-Medical Instrumentation Techniques in Healthcare **2 0 2**

Introduction to biomechanics, neuro-prosthetics based on function- sensory, motor, neuro prosthetics; based on regulation- person, auto regulated as adjuncts or alternates to therapy, implants, prosthetics for vision, audition, pain relief, pharmako-kinetic studies, brain-machine interface –methods, rapid prototyping technique in developing artificial bones, tissues, tendons, cartilages, and various applications of these techniques in improvement of health-care.

BITS F217 Environment, Development and Climate Change **3 0 3**

Specific topics on environment, development and climate change; regional, national and international climate debates; review of international climate negotiations such as Kyoto, Copenhagen and other declarations; environment problems: causes, sustainability and policies; population, resources and sustainability; population dynamics, capacity and conservation; food security, poverty, impact and global solutions; energy resources: renewable, wind, oil, natural gas, nuclear energy; growth, technology and greenhouse gas emissions, carbon credit; regional impacts of climate change and adaptation strategies; techniques in modeling; water resources and pollution: monsoon, drought, rainwater harvesting, traditional practices in water conservation; case studies.

BITS F218 General Mathematics III **3 0 3**

Linear equations and matrices, Determinants, Basis of R^n, Eigen Value, Eigen Vector, Linear transformations on R^n.

Linear Programming: Geometric Solutions, Simplex Method, Duality, Post optimal Analysis, Transportation and Assignment Problem. Nonlinear Programming (Unconstrained optimization).

BITS F219 Process Engineering **2 1 3**

Processes and equipment's involved in extraction and clarification; mixing and granulation; preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions, etc.; galenical products like infusions, decoctions, tinctures, extracts, etc.

BITS F221 Practice School I **5**

BITS F225 Environmental Studies **3 0 3**

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, overview of natural resources, environmental pollution, social issues and the environment, and environmental impact assessment.

BITS F226 Soft Skills for Professionals **3 0 3**

Social Skills: Personality development, Emotional intelligence, Etiquette. Study Skills: Communication Skills, Academic writing Presentations and Public Speaking, Interviews, Group Discussion. Career Planning Skills: Creative thinking, Ethical Values, Capacity Building: Learn Unlearn & Relearn/Domain knowledge, Leadership and Team Management, Decision making/ Negotiation, Time and Stress Management.

BITS F231 Practice School I **5**

BITS F241 Practice School I **5**

All the above courses are run during the summer term only. The operation of all these three courses will be identical in nature. However, BITS F221 will be a required course for all integrated First Degree students with Practice School option. This course is also a prerequisite for BITS F412 Practice School II. BITS F231 may be available only to those students who have successfully cleared BITS F221 and BITS F241 may be available only to those students who have successfully cleared BITS F231. Thus BITS F231 and BITS F241 can be taken by highly motivated students if facilities are available after satisfying the needs of students who have to compulsorily register in BITS F221.

BITS F311 Image Processing **3 0 3**

Introduction to Image Processing and Imaging systems, Image sampling, Transforms, Enhancement and Restoration, Coding and Communications, Image Compression, Image understanding, Neural network and PR Approaches.

BITS F312 Neural Networks and Fuzzy Logic **3 0 3**

Introduction to neural networks, neural dynamics; activations and signals; activation models; unsupervised and supervised learning rules and their domain of applications; architectures of neural systems; Fuzzy sets, fuzzy binary relations; fuzzy logic, fuzzy reasoning; applications in decision making, control theory, adaptive fuzzy and neural control systems and their comparison; Concepts in control systems : stability, state variable, controllability, regression and optimization; mathematical models in control; conventional controllers : design, tuning; Relations, design of fuzzy control systems; control using ANN; Hybrid control, Neuro-fuzzy, GA and bio-inspired optimized control; Case studies on applications of neural, fuzzy and hybrid techniques.

BITS F313 Multicriterion Decision Making in Engineering and Management 3 0 3

Introduction, Single Objective Optimization, Estimation of weights, Multiobjective optimization, Classification Methods, Discrete Multicriterion Decision Making, Fuzzy Logic based discrete MCDM, Correlation coefficients and group decision making, Advanced topics of decision making, Case studies.

BITS F314 Game Theory and Its Applications 3 0 3

Strategic thinking, Rational choice, Dominance, Rationalizability, Nash equilibrium, Best response functions, Duopoly models and Nash equilibrium therein, Electoral competition, Pure strategy, Mixed strategy, Extensive forms, Sub-game perfect Nash equilibrium, Bayesian Nash equilibrium, Select Applications of Game Theory.

BITS F315 Introduction to Cognitive Neuroscience 3 0 3

Introduction, Methods of Cognitive Neuroscience, Sensation and Perception, Attention & Action, Memory, Emotions, Psycholinguistics, Network Neuroscience, Consumer Neuroscience, Social Cognition and Metacognition.

BITS F316 Nonlinear Dynamics and Chaos 3 0 3

Chaos – definitions, characteristics, and measures; Examples of chaotic systems; Nonlinear dynamics and chaos – state space, Poincare sections, Iterated maps, Period-doubling; Quasi-periodicity, Intermittency, fractals; computer simulations of chaotic systems; Selected topics and applications of chaos theory; Examples will be drawn from different disciplines in science, engineering, and social sciences.

BITS F317 Theoretical Neuroscience 3 0 3

Introduction to nervous system: Neurons; central and peripheral nervous systems; nerves; ganglions; brain areas; Neural circuits – few examples; Single neuron modelling: Electrical properties of a neuron; Action potential; Integrate and fire models;Conductance based models - Hodgkin-Huxley model, Morris-Lecar model; Cable equation; Multicompartment models for dendrites; Models for synapses; FitzHugh-Nagumo model; Networks of neurons: Feed forward network; Recurrent networks; Excitatory-Inhibitory networks; Stochastic networks; Encoding and decoding:Firing rate; Spike-train statistics; Receptive fields;Reverse correlation methods; Static nonlinearities;Discrimination; Population decoding; Spike-train decoding; Shannon entropy; Mutual information;Entropy maximization and information; Current trends in theoretical neuroscience.

BITS F319 Negotiation Skills and Techniques 2 0 2

Overview, Negotiation styles, Negotiation process, Tactics in Negotiation, Handling conflicts in negotiation, Best Alternative to a Negotiated Agreement, Communication - Key to Effective Negotiating, Non-verbal communication in Negotiations, Emotions: dealing with others and ourselves, International negotiations, Cross Cultural Issues in Negotiations, Power in negotiation, Workplace Negotiations, Turning Negotiation into a Corporate Capability, Do's and Don'ts of Negotiations, Negotiating over the telephone/ Electronic media, Ethics in negotiation, Negotiation-Exercise.

BITS F320 Managerial Skills 2*

The role of manager, team building and goal setting, basics of supervision, leadership, decision making, negotiation skills and techniques, how managers communicate, how to interview, process of induction, training and development, delegation, how to appraise employees, how to manage time, use of committees, how to handle meetings, how to handle complaints.

BITS F321 Legal and Economic Environment of Business 4*

Indian contracts act, sale of goods act, negotiable instruments act, companies act, corporate tax laws, consumer protection and unfair trade practices act, FEMA, Industrial policy, macroeconomic environment, fiscal and monetary policy, overview of Indian economy, economic indicators.

BITS F322 Venture Team Development and Organization 3 0 3

Building and managing high performance teams; Multidisciplinary teams; Virtual teams; Homogeneity and diversity in teams; Team building – inspiration , interdependence, interaction and integrity; Leadership; Motivation; Compensation and ESOPs; Negotiation Skills and techniques; Interpersonal skills; Communication skills; Conflict Management; Decision making; SMART goals; Perception and bias; Cultural and emotional intelligence; Permanent and contingent workforce; Causes and remedies of dysfunctional teams.

BITS F323 Venture Finance 3 0 3

Developing Financial Projections, Alternate forms of Financing, Venture Financing Decisions, Business Valuation and Equity Financing; Angel and Venture Capital Funds; Financing for Growth, IPO and Exit.

BITS F324 Strategy for Entrepreneurs 3 0 3

Developing vision, mission, goals, objectives for an enterprise; Internal and external business environment; Formulating a business model; New entry strategy; Assessing market segments and competition; Blue ocean strategy and red ocean strategy; Investor profile; Porter's generic strategies and five forces model; Boston Consulting Group (BCG) matrix; SWOT analysis; General Electrical Matrix; Core competency; Growth strategies; Stability strategies; Renewal strategies; Indirect assault strategies; Competitor growth limiting strategies; Functional strategies; Strategic myopia.

BITS F325 New Product and Service Design **3 0 3**

New product and service design: standardization, mass customization, delayed differentiation, modular design, and robust design. Defining requirements and specifications. Technical, business and financial feasibility of design. Prototyping, manufacturing and testing. Product and Service lifecycle. Customer satisfaction and sustainability. Reliability. Legal and Ethical considerations.

BITS F326 Design Thinking for Innovation & Entrepreneurship **3 0 3**

Design thinking and innovation mind-set; Creative confidence; Design thinking process; Design thinking – need finding and empathy; Idea generation; Prototyping and experimentation; Human centred design ethos; Innovation through brainstorming; Innovation through prototyping; Innovation by design; Case studies for innovation in all spheres: product, service, business, finance/investments, marketing; Designing a startup; Designing in teams; Designing to use; Design thinking in innovation to handle the unexpected; Innovating within the framework of entrepreneurship.

BITS F331 Quantum Computation and nformation **3 0 3**

History and scope, introduction to quantum information, quantum bits (qubits), quantum parallelism, teleportation etc; Basic ideas of quantum systems - two-state systems, evolution of states, superposition, entanglement, quantum measurement, decoherence; Basic ideas of computation theories and models : computational resources, complexity; Quantum Gates - single qubit and multiple qubit gates, controlled gates, universal gates, measurement; Quantum algorithms - Deutsch', Shor's and Grover's Algorithms; quantum circuits, quantum Fourier Transform and applications, quantum search algorithm; Physical Implementation of quantum computation Compression and transmission of quantum information, quantum noise, error-correction, coding and cryptography, complexity, fault-tolerant computation.

BITS F333 Project on Organisational Aspects **3**

These courses involve projects related to thrust areas where students are expected to get involved with planning, organisation and execution of new ideas and concepts. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BITS F334 Project on Organisational Aspects **3**

These courses involve projects related to thrust areas where students are expected to get involved with planning, organisation and execution of new ideas and concepts. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BITS F343 Fuzzy Logic and Applications **3 0 3**

Fuzzy sets, fuzzy binary relations; fuzzy logic, fuzzy reasoning; applications in decision making, control theory, expert systems, artificial intelligence etc.

BITS F345 Information Law and Cyber Law **3 0 3**

Information related crimes and Cyber-crimes and methods to contain them; National and International laws and IT acts. Economic considerations related to the use and management of digital data; Legal and policy issues, rights, responsibilities, and potential liabilities of parties in information exchange and digital transactions; Cyber laws; Introduction to intellectual property, IPR, legal and technical aspects; Digital rights management: Tools, Standards and Techniques.

BITS F351 Nonlinear Dynamics and Chaos **3 0 3**

Dissipative systems; Bifurcations in maps & differential equations (1-d, 2-d, 3-d) – saddle node, transcritical, pitchfork, Hopf, etc.; Application of bifurcation analysis to various systems in natural & engineering sciences; Chaos; Routes to chaos; Quasiperiodicity; Intermittency; Fractals & strange attractors; Conservative systems.

BITS F364 Human Computer Interaction **3 0 3**

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

BITS F372 Data Communications and Networks **3 0 3**

Communication Concepts; Data and Voice Communications; Hardware Systems and Configurations; Network Topologies and Design Aspects; Protocols; Networking Software; Local Area Networks; Network Security and Management; Emerging Trends in Communications.

BITS F381 TIC Projects **3**

These courses provide an avenue for first degree students who are normally in third year or in a higher class, to earn a letter grade credit for doing projects under the Technology Innovation Centre. These projects are sponsored by the industries which come to the Institute under the scheme for participating in Technology Innovation Centre. The projects are also supervised and monitored by the personnel from industry who visit as Associate Faculty. These courses are unstructured and would require all the rigor which the industry would demand.

BITS F382 Reading Course **3**

BITS F383 TIC Projects **3**

These courses provide an avenue for first degree students who are normally in third year or in a higher class, to earn a letter grade credit for doing projects under the Technology Innovation Centre. These projects are sponsored by the industries which come to the Institute under the scheme for participating in Technology Innovation Centre. The projects are also supervised and monitored by the personnel from industry who visit as Associate Faculty. These courses are unstructured and would require all the rigor which the industry would demand.

BITS F385 Introduction to Gender Studies **3 0 3**

Introduction to gender studies, Sociological theories about gender, Women's access to education, interest, access and role in science and technology from gender perspective, Gender bias, work place, women and employment opportunities, Women and Politics, women in *Panchayati Raj* Institutions, women and family, women and violence, dowry, women and law, women's movements, feminism, women and human rights, women and media, gender equity-policy issues, women and development.

BITS F386 Quantum Information and Computation **3 0 3**

History and scope, introduction to quantum information, quantum bits (qubits), quantum parallelism, teleportation etc. Basic ideas of quantum systems, two-state systems, evolution of states, superposition, entanglement, quantum measurement, decoherence. Basic ideas of computation theories and models, computational resources, complexity. Quantum Gates: single qubit, multiple qubit gates, controlled gates, universal gates, measurement. Quantum algorithms, Deutsch', Shor's and Grover's Algorithms, quantum circuits. Quantum Fourier Transform and applications, Quantum Search Algorithm. Physical Implementation of quantum computation. Compression and transmission of quantum information, quantum noise, error-correction, coding and cryptography, complexity, fault-tolerant computation.

BITS F398 Creative Multimedia **2 2 3**

Imaginative and creative communication skills, interactive multimedia applications incorporating various aspects of rich media; digital screen design, typography, non linear editing, animation techniques, sound design and editing, testing and managing multimedia products, post production techniques.

BITS F399 Humanistic Theories of Science and Technology **3 0 3**

Ways of considering the interrelationship among three of the major dimensions of our culture: its science, its technology and its humanistic orientation. Alternative ways of thinking about science and technology, diverse approaches of humanistic scholarship to studying science and technology, along with their historical sources. Approaches by social scientists to analyze technical fields of science and technology.

BITS F407 Selected Readings **2 0 3**

The course is intended to nurture the students critical thinking and to enhance their skills at information gathering and expressing. Selected readings from books in the areas of History, Science & Technology, Culture, Literature, Art, Philosophy, Psychology, Religion, Development Concepts and Trends etc. will be assigned to the students. A set of books will be identified in at least two broad areas for study and analysis.

BITS F412 Practice School II **20**

BITS F413 Practice School II **20**

The above two courses will be operated identically with stipulated prior preparation conditions as per the Academic Regulations. BITS F412 is a required course for all students with Practice School option either for a single degree or for one of the degrees under dual degree scheme. BITS C413 has been created as a required course if a dual degree student is permitted a Practice School option for a second degree after he has completed Thesis option for one degree.

BITS F414 Introduction to Bioinformatics **3 0 3**

Introduction to genomics and proteomics, Human genome and other sequencing projects; Biological database and data mining; Similarity search and sequence alignment; Protein structure prediction and structure analysis; Use of software package in bioinformatics.

BITS F415 Introduction to MEMS **3 1 4**

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

BITS F416 Introduction to Nanoscience **3 0 3**

Introduction; nanoscience in nature; fundamental science behind nanomaterials; synthesis and properties of nanomaterials; tools to study the properties, size and shape determinations, application of nanomaterials in science, engineering and biomedical field; future trends.

BITS F417 Microfluidics and Its Application **4***

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for microfluidic devices, microvalves, micropumps, microflow sensors, microfluidics for life sciences: micromixers, microneedles, microfilters, microseparators, microreactors, modeling and simulation on CAD tool.

BITS F418 Introduction to Biomedical Engineering **3 1 4**

Introduction; Engineering principals applied for physiological phenomena; Bio implant materials:Metallic, ceramics; Polymeric materials for bio applications; Protein-biomaterial surface Interactions;Modification of surface of the biomaterials; Tissue engineering;Drug delivery systems, principals,and applications; Biomedical sensors; Modeling and simulation.

BITS F419 Management of Cross-cultural Engineering Teams **3 0 3**

Characteristics of open technological innovation in competitive global market. The dynamic interaction between technological innovation and market competition – the S-curves. Standard battles to shape the dominant design of a new technology – Cross-the-Chasm and timing of entry. Competitive strategy of companies in different market segments – the Segment-Zero Principle.Commoditization of technology and product on global market – out-sourcing and off-shoring. Blueocean strategy to innovate new breakthrough products.

BITS F421T Thesis **16**

BITS F422T Thesis **16**

The above two courses will be operated identically with stipulated prior preparation conditions as per the Academic Regulations. BITS F421 is a required course for all students with Thesis option either for a single degree or for one of the degrees under dual degree scheme. BITS F421 and BITS F422 have been created as required courses if a dual degree student is permitted Thesis option for a second degree after he has completed Thesis option for one degree.

BITS F423T Thesis **9**

BITS F424T Thesis **9**

Course description of the above two courses is same as given under BITS F421T/BITS F422T. However Thesis with this course number will be available with concurrent coursework for at most 9 Units over a full semester duration.

BITS F427 Digital Marketing **3 0 3**

Fundamentals of e-Business and Internet Marketing, e-Business Models and Frameworks, Digital Marketing Strategy, Online Public Relations, Search Engine Optimization and Marketing, Content Marketing, E-Mail Marketing, Social Media Marketing, Mobile Marketing, Optimizing Customer and User Experience, Web Analytics.

BITS F428 Essentials of Strategic Management **3 0 3**

Difference between Strategy and Organizational effectiveness; Tools for internal and external strategic analyses; Environmental Scanning and Industry Analysis; Market opportunities and internal sources of competitive advantage; Value chain analysis; Corporate level, Business level and Functional strategies; Strategy implementation.

BITS F429 Nanotechnology for Renewable Energy and Environment **3 1 4**

Basics of nano physics, macro vs. nano. Solar cells: Organic solar cell, quantum dot solar cell, dye sensitized solar cell. Self cleaning in solar panel. Fuel cell: Nano electrode and catalysts. Batteries: Nano electrode based batteries. Catalysts: H2 production and H2 storage. Carbon nano tube for energy. wind energy: Nanocomposites, nanocoating, and nanolubricants. Nanotechnology as tool for sustainability. Environmental fate & transport of nanomaterials. Nanomaterials for ground water remediation. Nanomaterials as adsorbents. Toxicity of nanomaterials, Ecotoxicological impacts of nanomaterials, Societal implications of nanotechnology.

BITS F430 Renewable Energy Laboratory **0 2 2**

Experiments on generation of photovoltaic power, wind energy, geothermal energy, fuel cell energy, piezoelectric energy harvesting, smart grid, micro grid, etc.

BITS F431 Flexible Manufacturing Systems **3 2 4**

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

BITS F433 Supply Chain Analytics **3 1 4**

Introduction to supply chain analytics, Data understanding and data preparation, Supply chain performance , Descriptive analytics, Predictive analytics and setting up the problem, Supply chain forecasting, studying holt, winter and ARIMA models, Supply chain Network Planning, Multi echelon network optimization, Supply chain sales and operations planning, Supply chain segmentation, Vehicle routing problems, Supervised and Unsupervised learning, Use of Bayesian networks in supply chain, Simulation and SC models, Supply chain risk management.

BITS F437 Technical Communication **3 0 3**

Overview of technical communication, verbal and non-verbal communication, elements of effective writing, technical report, technical proposal, research paper, dissertation, thesis, presentations and group discussions.

BITS F441 Robotics **3**

The objective of this course is to make the students familiar with Robotics, the main components of kinematics, sensors, transmission and drives, control systems, intelligence and vision, geometric modelling and reasoning, assembly planning, grasping, collision avoidance, mobile robots, force strategies, uncertainty analysis, and representation of visual world.

BITS F442 Remote Sensing and Image Processing **3**

Introduction to remote sensing; types of sensors; earth resource sensors; Landsat; IRS; SPOT; microwave remote sensing; SAR; SLAR; thermal infrared remote sensing; data analysis; image processing; smoothing; filtering; image averaging;enhancement techniques; transforms; FFT; PCA; segmentation; gradient operators; pattern recognition; ML classifier; minimum distance classifier; other classifiers; ISODATA clustering; feature selection; divergence; canonical analysis; recent developments in remote sensing; LIDAR; imaging spectroscopy etc.

BITS F444 Artificial Intelligence **3**

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving.

BITS F445 Neural Networks and Applications **3 0 3**

Introduction to neural networks and fuzzy systems' neural dynamics; activations and signals; activation models; unsupervised and suprvised learning rules and their domain of applications; architectures of neural systems; adaptive fuzzy and neural control systems and their comparison; case studies on fuzzy and neural control systems.

BITS F446 Pattern Recognition **3**

The object of this course is to study the principles and available techniques for the analysis and design of pattern recognition system, introduction to pattern classification by distance functions, and likelihood functions, trainable pattern classifiers: deterministic and statistical approach.

BITS F447 Multimedia Computing **3 0 3**

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codecs, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

BITS F448 Retail Management Systems **3 0 3**

Retailing history and theories, basic retail management process, retail industry in Indian and abroad, shopper behavior in retailing, retailing formats and location related issues, category management, supply chain management in retail, retail buying, store layout and design, point of purchase communication, retail pricing strategy, building store loyalty and technology in retailing. Case studies and projects in retailing, specially focusing on Indian scenarios.

BITS F449 Financial Engineering **3 0 3**

Introduction; Review of Markets, Players, and Conventions; Cash Flow Engineering with Forward Contracts; Engineering Simple Interest Rate Derivatives; Swap Engineering; Report Market Strategies; Dynamic Replication Methods and Synthetics; Mechanics of Options; Options Engineering with Applications; Pricing Tools; Applications of Fundamental Theorem of Finance; Fixed Income Engineering; Tools for Volatility Engineering: Volatility Swaps and Volatility Trading; Engineering of Equity Instruments: Pricing and Replication, computational methods such as Monte Carlo Simulation.

BITS F461 Software Engineering **3**

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BITS F462 Renewable Energy **3 0 3**

Introduction of renewable energy, advantages, potential, status of development, broad details of different renewable energy systems such as solar, wind, biomass, microhydel, geothermal etc; Renewable energy development policy, Renewable energy industries, international co-operation, HRD and career growth opportunities, consultancy areas and future thrust areas in renewable energy development.

BITS F463 Cryptography **3 0 3**

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

BITS F464 Machine Learning **3 0 3**

Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical/probabilistic methods, genetic algorithms; in ductive/analytic/reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

BITS F465 Enterprise Computing **3 1 4**

Overview of enterprise applications and their architecture-Building distributed multi tier applications using enterprise java–Packaging and deploying enterprise applications into application servers- Development of web applications using java servlets -java server pages and java server faces - Usage of JDBC for database driven enterprise applications -Enterprise java support for building soap and Rest enabled web services-Enterprise application integration using software components -Enterprise java beans-Message based communication between enterprise application components using JMS-Need for handling data persistence in database driven applications in an object-oriented manner –Usage of java persistence API for handling data persistence-Need for security of enterprise applications-Securing enterprise java applications using java based Glassfish application server-Configuring glassfish server for SSL security-Working with Realms, Users, Groups, and Role for client authentication-Overview of dot net framework for building distributed enterprise applications-Dot net framework: windows presentation foundation windows communication foundation-asp.net and ado.net

BITS F466 Service Oriented Computing **3 1 4**

Introduction to Web Services: Distributed computing using software component technologies like DCOM and EJBs-overview about Service Oriented Architecture- RPC and Document centric SOAP enabled web services-Describing information using XML -SAX and DOM based XML parsers-XSLT-XPath. SOAP Protocol for web services- Describing Web Services using WSDL-Publishing and Finding web services using UDDI Registry-UDDI SOAP APIs-Inquiry APIs-Publisher APIs. Web Services security –Need for secured web service-confidentiality of web service invocation using XML encryption and its advantages over SSL security -Integrity of soap message using xml digital signing-Maintaining confidentiality and integration together for soap messages -Authentication mechanisms for Web service client – Security Assertion Markup Language- Incorporating saml assertions for web service client authentication- IP layer security for web service- Need for work flow of web services-Usage of Business Process Execution Language for describing workflow of web services-Rest web service, its protocol and usage-Usage of Ajax in invoking Rest web service-Role played by web services in cloud computing.

BITS F467 Bioethics and Biosafety **3 0 3**

Introduction to the need and issues governing biosafety, legal, ethical and social implications of human gene manipulation, guidelines for research in transgenic organisms and plants, socio-economic impacts of biotechnological experiments, GLP and MGP and CPCSEA guidelines, patent processing, ethics in stem cell research, animal cloning and organ transplants, environmental pollution-hazards and control, public education and participation in biosafety.

BITS F468 New Venture Creation **3 0 3**

Entrepreneurship as career option, idea to opportunity – market analysis and segmentation, presenting a pitch deck, building the startup team, competition analysis, lean startups, product development, intellectual property, sales and marketing, business models, financing, launching a business, growth and exit strategy, social entrepreneurship, business plan presentation skills.

BITS F469 Financing Infrastructure Projects **3 0 3**

Investment decisions in infrastructural projects: benefit cost analysis, measurement problems, indirect estimation methods of benefits; Cost of capital: private and public money, different schools of thought on social capital- cases; Multiple projects and constraints: linear and integer programming models, goal programming formulation; Financing infrastructure projects: venture capital, sources of capital–private and public participation, modes of cooperation such as BOOT and BOT national and international sources, international agencies, borrowing terms and conditionalities; Public policy issues, leasing and mortgaging, evaluation issues, infrastructural mutual funds, valuation aspects; Real options, value of option for delay, abandonment and vacant land – judgmental assessment of options; post review and administrative issues in project management, international (cross country) projects, implementation issues.

BITS F482 Creating and Leading Entrepreneurial Organizations **3 0 3**

Fundamentals of entrepreneurship; elements of leadership; identifying business opportunities; market study and research; business plans; finance, issues in raising finance; venture capitalist evaluation of business plans, technical aspects for the project, corporate strategies for growth; legal aspect to entrepreneurship, people skills, marketing and branding; creativity and communication.

BITS F488 Services Management Systems **3 0 3**

Understanding Services, the Service Sector today, Designing the Service Enterprise, Technological Issues, Structuring Service Operations, Processes Management, Staffing for Services, Functions of Services Management System, Client Relationships, Measuring and Reporting Services.

BITS F489 Enterprise Resource Planning **3 0 3**

Introduction to ERP; Re-engineering and ERP systems; ERP planning, design, and implementation; ERP systems – sales and marketing; ERP systems – accounting and finance; ERP systems – production and materials management; ERP systems – human resources; Managing and ERP project; Supply chain management and e-Market place.

BITS F493 Business Analysis and Valuation **3 0 3**

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

BITS F494 Environmental Impact Assessment **3 1 4**

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

BITS G501 Biostatistics **5**

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Introduction to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; experimental design in clinical trials and validation; basic techniques in optimization.

BITS G511 Advanced Project **5**

This course is designed to permit treatment of an advanced area in a discipline or interdisciplinary pursuit to meet the objectives of acquisition of additional competence by the student and also development of new areas of study or lab. The course will be characterized by minimum formal contact and maximum self- study under immediate supervision by the teacher.

BITS G512 Object Oriented Programming **2 2 4**

Basics of object oriented programming: objects, classes, instances; inheritance; polymorphism; operator overloading; static and dynamic binding; small talk, C++, cases from other object oriented languages like Ada, Loop, Flavors, Objective-C, etc.; object oriented software engineering.

BITS G513 Study in Advanced Topics **5**

In this course students will be assigned study work in advanced areas of professional interest. Each student will work under the overall supervision and guidance of a faculty member and will in the end submit a project report encompassing critical review of the material studied.

The organisation and evaluation of the course would be achieved through seminars, group discussions, project report etc. The course will be conducted by the team of teachers who provide guidance for study work.

BITS G514 Environmental Health **3 0 3**

Environmental Health and its importance, water pollution, air pollution, automobile pollution, pollution due to chemicals used in agricultural sector, handling and disposal of domestic and industrial refuse, incineration of waste materials, techniques for studying, monitoring and controlling pollution, effect on health, vector control, effect of high frequency electromagnetic radiation, nuclear radiation, hazardous wastes, occupational health.

BITS G515 Management Principles and Practices **4***

Management concepts and functions; Decision process; Marketing variables, analysis and research; Services marketing; Financial transactions and statements; Financial planning and control; Manpower planning and development; Personnel appraisal, General administration.]

BITS G518 Writing Seminar **3 2 5**

Understanding claims structures; multiple rhetorical contexts and diverse persuasion strategies in classical, Rogerian and the Toulminian framework; Analyzing arguments rhetorically; Analyzing visual arguments, overview of anthology of arguments, re-evaluating sources and presenting new operational definitions; Project

BITS G521 Fourth Generation Languages and Applications **1 3 4**

Nature of 4GLs; application generators; RDBMS and 4GLs; SQL based 4GLs; 4GLs and development of information systems and decision support systems; other types of 4GLs; case studies.

BITS G522 Software Development Standards **1 3 4**

Standards and their role in software development; Institutions involved in formulating and promoting standards; operating environment standards; POSIX; software design standards; diagramming standards; coding standards; language design, code generation and usage standards; software portability and standards; standards in software development tools; standards in compilers and interpreters; open systems; OSI; user interface standards.

BITS G529 Research Project I **6**

BITS G539 Research Project II **6**

This is a package of two courses dealing with an advanced pursuit in terms of a study project or a lab project in assigned areas of professional interest. Each student will work under the overall supervision and guidance of an assigned teacher. The second course may be a continuation of the task engaged in the first course; or the two courses may be independent of each other. Each course must end with a well-defined project report outlining all the investigative efforts and conclusions.

BITS G540 Research Practice **4***

This course is designed to train the students towards acquiring competence in research methodologies. The course will be conducted in terms of actual participation in Research and Development Work. Each student will be assigned to a faculty member to work on specified projects. The student will be required to present a number of seminars in his research area in a structured manner.

BITS G541 User Interfaces **1 3 4**

Emerging importance of user interfaces; user interface management systems; designing UIMS toolkits; hardware and OS aids in user interface development; human & psychological factors in user interface design; theories, principles and guidelines; emerging interaction styles; menu selection systems, command languages, direct manipulation; interaction device; hypertext; standards in user interface design and implementation; case studies from Domain Dialog; Apple's user interface; Open Look; OSF/Motif.

BITS G553 Real Time Systems **3 1 4**

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

BITS G554 Data Compression **3 1 4**

Introduction: the need for data compression. Information theory and data compression; Entropy, Relative entropy and mutual information. Fano's inquality. Types of information sources, and source extension. Asymptotic equipartition property and data compression. Entropy rates of stochastic processes. Kraft inequality, Prefix codes, Huffman codes and Arithmetic coding. Quantization and Rate distortion theory. Lossy image compression techniques based on DCT, VQ and Fractals. Introduction to wavelets: continuous and discrete wavelet transforms. Filter banks and wavelets. Frames and tight frames. Wavelet packets. Wavelet based signal processing. Joint source and channel coding.

BITS G560 Practice School **20**

BITS G561T Dissertation **25 (Max)**

BITS G612 Methods and Techniques of Systems Engineering **2 3 5**

This course would cover various systems engineering methods and techniques in the context of their application to the design, implementation and operation of large, humanly-contrived soft systems. The techniques would be chosen from amongst linear programming, integer programming, queuing theory, inventory control, simulation, maintenance models sampling techniques, forecasting techniques, decision models, network scheduling methods etc. These would be applied in the context of resource planning, facility location, manpower planning, financial management, decision-making, maintenance issues, construction and operation scheduling; planning research issues; social assessment of technology; issues of technology-economy nexus etc.

BITS G613 Systems Analysis for Large Systems **2 3 5**

System thinking and approach; concepts of systems with special reference to large, humanly-contrived soft systems; review of mathematical techniques and principles of economics and management required for systems engineering of such systems; modelling and systems engineering methodology for large soft systems.

BITS G619 Professional Practice **4**

This course will aim to achieve a professional development of the student in the context of the overall goal of his/her programme. Depending upon the profession, this course will be conducted in terms of actual participation in professional activities such as teaching, laboratory organization, course development, organizational development, R&D work, design, production, data organization, data preparation or management of institutions/ hospitals/voluntary organizations, etc. The course will also deal with communication aspects such as teaching a course, presenting a paper in the seminar/conference, articulating ideas and concepts to professional audience/customers, etc. This course will also deal with the laws and ethics concerned with the profession of an individual.

BITS G620 Professional Practice I **3**

BITS G621 Professional Practice II **3**

These two courses, to be offered in two consecutive semesters, are designed to train the students towards acquiring competence in teaching as well as in research methodologies. The course will be conducted in terms of actual participation in professional activities such as teaching, laboratory organization, course development, R & D work, etc. Each student will be assigned under a faculty member to work on specified projects, and to assist the faculty in teaching and research activities. The student will be required to present a number of seminars in a group in a structured manner.

BITS G624 Computer Based Simulation and Modelling **2 3 5**

Discrete event simulation on computers; Systems simulation & simulation languages; GASP & GPSS; Continuous simulation - languages and modelling techniques; Forrester's models; case studies.

BITS G629T Dissertation **25 (Max)**

This is a required component for all higher degree students except for those who opt and are selected for practice school programme. The unit requirements will vary from 12 to 25 units. It may be registered for one full semester (12 to 25 units) after completing all courses or may be registered for varied units (4 to 10 units) along with other courses.

BITS G630T Dissertation **25 (Max)**

This is a required component for all higher degree students except for those who opt and are selected for practice school programme. The unit requirements will vary from 12 to 25 units. It may be registered for one full semester (12 to 25 units) after completing all courses or may be registered for varied units (4 to 10 units) along with other courses.

BITS G639 Practice School **20**

A higher degree student if permitted can register in this course in lieu of Dissertation only after the completion of all course work. Concurrent registration of other courses with this course is not permitted. All clauses of Academic Regulations applicable to First Degree Practice School courses will govern the operation of this course.

BITS G640 Practice School **20**

A higher degree student if permitted can register in this course in lieu of Dissertation only after the completion of all course work. Concurrent registration of other courses with this course is not permitted. All clauses of Academic Regulations applicable to First Degree Practice School courses will govern the operation of this course.

BITS G641 Management Information and Decision Support Systems **2 3 5**

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

BITS G644 Development and Use of Computer Software **5**

Concepts and operations of processors; concept, capabilities and types of software; review and case studies of computer applications. Principles and use of standard software packages. Principles of software creation: processing concepts, flowcharting and algorithms, programming constructs, programming languages, program development sequence. Concepts of data and information: files and databases, logical data storage structures. Information Systems: need, significance, concepts, their Analysis, Design and Implementation. Software Engineering: software life cycle, with special reference to software planning, software requirements and software maintenance. The course would terminate with a term paper on a specialised area of the development and use of computer software.

BITS G649 Reading Course **5**

BITS G651 Project Formulation and Preparation **2 3 5**

This course is designed to inculcate principles of technical documentation as required within S&T organizations. Through this course, students are expected to acquire familiarity with several of the following: Proposals, feasibility reports, formal project reports, short reports, memos, negotiations, contracts, etc. In the process principles of project formulation and evaluation, such as technical considerations; performance specifications; preliminary block diagrams, types and analysis of contracts; cost estimation concepts, work breakdown structure; project data preparation, scheduling facilities etc., would be introduced. The course would invariably include the preparation of a detailed report embodying as many of the above concepts as appropriate.

BITS G654 Advanced Instrumentation Tecniques **5**

Generalized approach to measuring systems; performance characteristics of instruments; primary sensing elements and transducers; analog and digital signal conditioning operations; microprocessors in instrumentation; applied process control instrumentation; General purpose and analytical instruments covering spectroscopic, separation, atomic absorption instruments UV-VIS-IR,GLC, HPLC, etc; Instrumentation practices in typical R&D laboratories; instrumentation case studies covering selection, quality assurance, system design, etc; Hands on experience in operation of sophisticated instrumentation systems.

BITS G659 Technical Communication **3 1 4**

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; précis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

BITS N101T Physical Fitness, Health and Wellness **1**

Basic Exercise - warm-up and warm-down exercise, Calisthenics and its importance, Cardio-respiratory or endurance exercises - various forms of endurance exercise, exercise with intensity and duration for physical wellness; strength training exercise; various strength exercises and their importance, free hand weight training; flexibility exercise and wellness and relaxation exercise including stretching & yoga. This course can be taken only on audit.

Civil Engineering

CE F211 Mechanics of Solids **3 0 3**

Introduction to mechanics of rigid bodies and deformable bodies, Thermal stresses, Equilibrium of forces, Bending moment and shear force diagrams for determinate beams and frames, Analysis of statically determinate trusses; Flexural and shear Stresses in beams, Combined stresses, Stresses and strains on inclined planes, Introduction to torsion, Torsion in shafts, Slope and deflection in beams due to bending, Introduction to Energy Methods, Stresses in thin cylindrical shells, Suspension cables, Failure theories, Buckling of columns using Euler's Theory.

CE F212 Transport Phenomena **3 0 3**

Concepts and definitions, Fluid pressure and measurement, Hydrostatics, Buoyancy, Fundamentals of fluid flow and Kinematics of Fluid in Motion, Flow Analysis using Control Volume Approach and its applications in conservation of mass, momentum and energy, Analysis of flow through pipes, Differential forms of the fundamental laws, Viscous fluid flow Analysis, Navier-Stokes Equations, Study of Flow pattern through Orifices and Mouthpieces, Notches and Weirs and Dimensional analysis and similitude.

CE F213 Surveying **3 1 4**

Overview of Traditional Surveying Techniques like Chain surveying, Compass surveying and Plane Table Surveying, Traverse Computations and Adjustments, Levelling, Contouring, Curve Setting: Different methods of setting Simple Circular Curve, Compound Curve, Reverse Curve, Trigonometric Levelling, Tachometric Surveying, Surveying with GPS / DGPS and Total Stations and Electronic Distance Measurement, Introduction to aerial photogrammetry.

CE F214 Construction Materials **3 0 3**

Different types of cements, chemical composition, properties and tests, coarse and fine aggregate for concrete, tests on aggregates, grading of aggregates and its effect on concrete properties, chemical and mineral admixtures, properties and tests on fresh and hardened concrete; transportation and placing of concrete, nondestructive testing of concrete, durability of concrete, quality control and acceptance criteria of concrete, Factors in the choice of mix proportions, Proportioning of concrete mixes by various methods – BIS method of mix design.; Special Concretes such as fibre reinforced concrete, high performance concrete, self consolidating concrete etc., Manufacturing/ sources, classification, applications, properties and testing of bricks, blocks, tiles, stones, aggregates, puzzolanas, flyash, lime, wood, timber, paints, tar, bitumen, cutback, emulsion, modified bitumen, steel, non-ferrous metals, polymeric material, geosynthetics, etc. Low cost and waste material in construction. Latest, BIS, IRC & ASTM specifications and guidelines of all above mentioned material, Construction equipments, classification, selection and economics.

CE F230 Civil Engineering Materials **3 2 4**

Different types of cements, chemical composition, properties and tests, coarse and fine aggregate for concrete, tests on aggregates, grading of aggregates and its effect on concrete properties, chemical and mineral admixtures, properties and tests on fresh and hardened concrete; transportation and placing of concrete, non-destructive testing of concrete, durability of concrete, quality control and acceptance criteria of concrete, Factors in the choice of mix proportions, Proportioning of concrete mixes by various methods – BIS method of mix design; Introduction to special concretes. Manufacturing/sources, classification, applications, properties and testing of bricks, blocks, tiles, aggregates, lime, timber, paints, glass, bitumen, cutback, emulsion, modified bitumen, steel, non-ferrous metals, polymeric materials, geo-synthetics, etc. Low cost and waste material in construction. Latest, BIS, IRC & ASTM specifications and guidelines of all above mentioned material, and construction equipment.

CE F231 Fluid Mechanics **3 0 3**

Concepts and definitions; compressibility of fluids, Fluid pressure and measurement, Fluid statics, Buoyancy, Rigid body motion, Fluid Kinematics, Conservation laws: Control Volume approach, Differential analysis of fluid flow, Study of flow pattern through Orifices and mouthpieces, Notches and weirs, Analysis of flow through pipes, Viscous fluid flow analysis: Analysis of flow through pipes, Dimensional analysis and similitude.

CE F241 Analysis of Structures **3 0 3**

Static and kinematic Indeterminacy, Energy principles; Force Methods of analysis: strain energy method, consistent deformation method, Displacement Methods of analysis: Slope-deflection method, Moment distribution method; Introduction

to Matrix Methods of structural analysis: Flexibility and Stiffness Methods, Influence Line Diagrams; Analysis of Moving/Rolling loads (for determinate structures), Introduction to approximate analysis of frames and trusses, Analysis of Three-hinged, two-hinged and fixed Arches, Analysis of indeterminate trusses. Exposure to relevant software.

CE F242 Construction Planning and Technology **3 0 3**

Principal components of a building system and their interrelationships, functional planning and requirements of a building and its components using relevant codes, building processes, types and construction of foundation systems, masonry, walls, floors, roofs, vertical transportation, doors, windows, building finishes, plumbing services, damp proofing, temporary supporting structures; introduction to planning and scheduling of projects, construction project network analysis, Introduction to quantity estimation, costing and valuation, contracts, tenders, engineering economy and cost benefit analysis of a project, introduction to building information modeling, computer applications in construction management. Exposure to relevant software.

CE F243 Soil Mechanics **3 1 4**

Introduction, Origin and classification of soils, index properties of soil, Compaction characteristics of different soils, lab and field compaction, quality control, Effective stress principle, capillarity, Darcy's law, permeability, Seepage through soils: piping, quicksand condition, flow nets, flow through dams, filters, Stress in soils due to applied loads, Boussinesq equatin, Newmark's Influence Chart, Approximate Method, Compressibility and consolidation characteristics, Consolidation Settlement, Shear Strength and Mohr-Coulomb strength criterion, direct, UCS and triaxial shear tests, strength of loose and dense sands, pore pressures, Skempton's coefficients. Site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and geophysical tests, immediate settlement based on elastic theories and in-situ tests. Exposure to relevant software.

CE F244 Highway Engineering **3 1 4**

Overview of basic characteristics of Transportation systems, social factors and strategic consideration, Road development plans, Highway development projects in India, Road Development organizations, Stages in highway alignment and Detailed project Report preparation, Introduction to transportation planning, Geometric design Standards: Cross section elements, sight distances, horizontal and vertical alignments, Pavement Material Characterization: Aggregate testing and blending, Bitumen and Bituminous Concrete testing and mixture design protocols, introduction to Superpave Mixture Design protocols, IRC methods for the design of flexible and rigid highway pavements, Overview of different stages in flexible and rigid highway construction, Overview of Highway Evaluations and Maintenance, Traffic Engineering: Traffic Characteristics, Highway capacity and level of service concepts, Traffic measurement and analysis, Traffic signals, parking studies and analysis, traffic accidents, Introduction to Intelligent Transportation Systems. Exposure to relevant software.

CE F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CE F311 Design of Concrete Structures **3 1 4**

Engineering properties of different concreting materials; Design Philosophies; Concepts of Limit State Method; Limit State Design for flexure of Singly and doubly reinforced rectangular and flanged section beams, one-way and two-way slabs; Design for Bond, anchorage and development length; Design of beams with rectangular and Flanged sections for Shear; Limit state of serviceability for beams and slabs; Limit State Design for collapse of columns subjected to axial, axial plus uni-axial bending and axial and bi-axial bending; Design of Footings; Design of Stair Cases.

CE F312 Hydraulics Engineering **3 1 4**

Behaviour of real fluids: boundary layer theory, turbulent flow through conduits; analysis of closed-conduit hydraulic systems including pipes, valves, fittings, and pumps, water hammer in pipes, pipe networks analysis: Hardy cross method and linear graph method; Open channel hydraulics: uniform and non-uniform flow; flow past immersed bodies: drag and lift; Analysis of Impact of jets; Introduction to fluid machinery.

CE F313 Foundation Engineering **3 0 3**

Earth Pressure theories, Retaining structures, design and checks for stability, General requirement for satisfactory performance of shallow foundations, general, local and punching shear failures, bearing capacity, settlement, tilt and rotation of foundations, proportioning of Shallow Foundations, footings on layered soils and slopes, Deep foundations, capacity of single and group Piles, laterally loaded pile, Stability of slopes, Introduction to Ground Improvement Techniques and geosynthetics with applications, Introduction to machine foundations for different type of machines, Introduction to geotechnical earthquake engineering and liquefaction of soils, computer applications in foundation design.

CE F320 Design of Reinforced Concrete Structures **3 0 3**

Design Philosophies: Concepts of working stress in comparison with limit state method; Limit state design for flexure of Singly and doubly reinforced rectangular and flanged section beams; one-way and two-way slabs; Design for bond, anchorage and development length; Design of beams for shear; Limit state of serviceability for beams and slabs; Limit state design for collapse of columns subjected to axial, uni-axial and bi-axial bending; Design of simple footings; Design of simple stair cases.

CE F321 Engineering Hydrology **3 0 3**

Introduction to hydrometeorology; Precipitation measurement and analysis; Hydrologic abstractions; Stream flow measurement; Runoff and hydrographs; Floods; flood routing; Ground water hydrology; Sediment transport; Introduction to irrigation engineering, Introduction to dams, spillways, diversion head-works and distribution systems.

CE F323 Introduction to Environmental Engineering **3 0 3**

Introduction to environmental systems; Material (conservative and non-conservative systems) and energy balances; Risk Assessment; Water pollution and management; Air pollution and management; Essentials of Solid waste management; environmental noise pollution and its control; radioactive waste management; Modelling of Environmental systems; Introduction to Environmental impact assessment ; Legislations

CE F324 Numerical Analysis **3 0 3**

Solution of Linear Algebraic System of Equations, Storage Schemes and techniques to a System of Large number of Equation, Numerical Solutions by Interpolation, Integration of Functions containing Singularities, Finite Element Method, Solutions of Initial and Boundary Value Problems, Boundary Integral Element Method, Solution of Non Linear System of Equations.

CE F325 Fundamentals of Rock Mechanics **3 0 3**

Internal structure of Earth; Types of rocks and geological features; Intact rock and rock mass; Shear strength; Rock mass classification systems; Rock slope failure mechanisms; Convergence Confinement Method, Ground and Support Reaction Curves, Longitudinal Deformation Profile, Construction of Metro Tunnels, Cut and Cover Method, Tunnel Boring Machine; Stresses in rocks, Rock burst, Squeezing ground conditions; Methods for improvement of rock mass response.

CE F341 Hydrology & Water Resources Engineering **3 0 3**

Hydrological Cycle and Budget; Precipitation Measurement and Analysis; Hydrologic Abstractions; Stream Flow analysis and concepts of hydrograph; Hydrologic measurements; Statistical analysis in hydrology; Ground Water hydrology; Flood Routing; Water withdrawals and uses, Introduction to dams, spillways, diversion head-works and distribution systems, River basin management, Reservoir planning and multi-purpose reservoirs, hydropower engineering, Systems analysis techniques in planning and practical applications.

CE F342 Water & Waste Water Treatment **3 1 4**

Water supply and waste water systems; capacity requirements; analysis of water and waste water; treatment requirements; unit operations and processes of treatment, design of treatment units; disposal of waste water and sludge; design of sewers and water distribution networks; rural sanitation; effluent re-purification and reuse.

CE F343 Design of Steel Structures **3 0 3**

Introduction to Limit State Design and Plastic design, Limit state design of bolted and welded connections, Eccentric connection, Design of Tension Members, Design of Compression Members, Design of Beams, Design of plate girders, Column bases. Exposure to relevant software.

CE F345 Computational Geomechanics **3 0 3**

General Theory of Elasticity; Analysis of Stress and Strain, Spherical and Deviatoric Stress Tensors, General state of stress in three-dimensions in cylindrical coordinate system, Three-dimensional Mohr's stress Circle, Strain Transformation, Octahedral Strains, Mohr's Circle for Strain, Equations of Compatibility for Strain; Pore pressure and stress-strain response of soil due to undrained loading, Volume Change Behaviour, Peak State and Dilatancy, Rowe's Dilatancy Theory; Critical State Parameters, Failure line in p′-q space and e-p′ space, Soil Yielding, Strain Hardening and Strain Softening; Introduction to failure theories of soils, their relative merits and demerits and applicability for different types of soil; Computer Applications; Suitability of the failure models in real-time geotechnical problems.

CE F366 Lab Project **3**

CE F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CE F376 Design Project **3**

CE F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CE F411 Operation Research for Engineers **3 0 3**

Linear programming, Simplex method, Duality and sensitivity analysis, Transportation model and its variants, Integer linear programming, Nonlinear programming, Introduction to Multi-objective optimization and case study, Game theory, Evolutionary computation, Inventory models, Queuing system, Decision making under certainty, risk, and uncertainty.

CE F412 Disaster Management **3 0 3**

Definitions, types of hazards, natural and man-made disasters, impact, causes and effects, damages, coping mechanism and relief assistance, disaster continuum, preparedness, prevention, mitigation, warning and management, vulnerability assessment, rehabilitation and reconstruction after disasters, pre disaster planning for earthquakes, cyclones, floods, draught and famine, disaster resistant constructions, non-structural and structural mitigation measures, guiding principles of mitigation, education and training for disasters, disaster case studies, computer use in disaster scenario development.

CE F413 Advanced Structural Design **3 0 3**

Design of concrete chimneys, water tanks, retaining walls, bunkers and silos, Design of steel tanks, towers, Roof trusses and Gantry Girder design, Design of plate girders, Design of Beam-Columns.

CE F414 Introduction to Environmental Engineering **3 0 3**

Environmental pollution; essentials of solid waste management; environmental noise pollution and its control; water quality significance; air quality management; industrial site selection criteria environmental impact assessment-case studies-computer applications.

CE F415 Design of Prestressed Concrete Structure **3 0 3**

Introduction to basic concepts of prestressing; load balancing technique prestressing systems; analysis of prestress; losses in prestress; deflection; design of anchorage zone, design of prestressed concrete girders.

CE F416 Computer Applications in Civil Engineering **3 1 4**

The basics and use of recent Civil Engineering Software related to Hydraulics, Structures, Transportation, Geo-technology and Construction Planning and Management etc., Practical assignments on industry related problems using the above software.

CE F417 Applications of Artificial Intelligence in Civil Engineering **3 0 3**

Introduction to Artificial Intelligence and soft computing; Neural networks: Introduction, models, and its application in civil engineering, fuzzy logic and its application in decision making, Clustering; Genetic algorithms; Expert systems; Introduction to machine learning (Support Vector Machine), case studies.

CE F419 Geotechnical Earthquake Engineering and Machine Foundation **3 0 3**

Seismic hazard, Engineering seismology, Wave propagation, Dynamic Soil Properties, Dynamic bearing capacity, Seismic design of foundation, Seismic slope stability, Dynamic earth pressure, Seismic design of retaining structure, Liquefaction, Design of machine foundation, Soil improvement techniques, Seismic design codes.

CE F420 Introduction to Bridge Engineering **3 0 3**

Investigations for bridges, types of bridges and loading standards, selection of bridge type, analysis of culverts and girder bridges, pier and abutments, different types of bridge foundations.

CE F421 Analysis and Design of FRP Reinforced Concrete Structures **3 0 3**

Course description is to be developed.

CE F422 Urban Hydrology **2 1 3**

Urban hydrology, Hydrological and planning models, Urban flooding: Planning, forecasting and mitigation strategies, General circulation models and downscaling approaches, Management of Syphonic rainwater systems and detention facilities, sustainable urban drainage systems, Impact of anthropogenic activities, case studies.

CE F423 Green Buildings and Energy Conservation **3 0 3**

Climate zones and sun path diagram, thermal comfort, heat flow through building materials, energy efficient building design factors like site planning, plan form and orientation, construction techniques, materials and finishes, natural day lighting and ventilation strategies, thermal performance of building elements, Efficient water management in buildings, Green building rating system, Vernacular architecture and its use in contemporary design, Case studies of contemporary green buildings.

CE F425 Airport, Railways and Waterways **3 0 3**

Airports: Characteristics of aircrafts related to airport design; runway orientation, length, capacity, configuration and number, taxiway layout, high-speed exit taxiway, terminal building functional areas, visual aids; grading and drainage; Railways: component of railway tracks, train resistance and tractive power, curves and super elevation, switches and crossing, signalling and interlocking, high speed tracks, track stresses. Tunnelling: necessity of tunnels, ventilation, lighting and drainage; Water transportation: nature of water transportation, classes of harbours, desirable features of harbour site, planning and design of port faculties; Pipeline transportation systems: need and planning.

CE F426 Geosynthetics and Reinforced Soil Structure **3 0 3**

Geo-synthetics: classification, functions, applications, properties & testing, Applications and advantages of reinforced soil structure. Principles, concepts and mechanism of reinforced soil. Soil-reinforcement interface friction. Behaviour of Rein-

forced earth walls, basis of wall design, internal and external stability condition, Codal provisions; Seismic design consideration. Bearing capacity improvement and design of foundations resting on reinforced soil; embankments on soft soils; Design of reinforced soil slopes, Indian experiences. Use of geosynthetics for separations, drainage and filtration. Use of geosynthetics in roads, airports and railways, India Road Congress, AASHTO and other relevant guidelines; randomly distributed fiber reinforced soil. Soil nailing. Geocell, PVD, Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills – material aspects and stability considerations; Use of jute, coir, natural Geotextiles, waste products such as scrap tire, LDPE and HDPE strips, as reinforcing material.

CE F427 System Modeling and Analysis **3 0 3**

Systems and system's approach, Modelling of physical system and non-physical system, Continuous and discrete systems, Time domain analysis, Frequency response, Steady-space analysis.

CE F428 Earthquake Resistant Design and Construction **3 0 3**

Earthquake resistant design philosophy. Ground motion characterization, response spectra and design spectra. Free and forced vibration analysis of single and multiple degree of freedom system. Seismic analysis and design of buildings and other structures as per relevant codes. Seismic design of foundations and liquefaction of soil, Earthquake resistant construction and detailing for masonry & concrete structure as per relevant codes.

CE F429 Design of Foundation Systems **3 0 3**

Evaluation and interpretation of soil properties, dynamic properties of soil, geophysical and seismic methods, Stress in soil mass due to applied load, various methods of settlement analysis, static and dynamic bearing capacity of footings, bearing capacity of footings resting on layered soils and footing on or near slopes, tilt, rotation and horizontal displacement of foundations subjected to eccentric-inclined loads, foundations on rocks, seismic design of shallow foundations, analysis of raft foundations, circular and annular rafts, structural design of shallow foundations, pile foundations load capacity and settlements, various methods of analysis of laterally loaded Pile Foundations, uplift capacity, piles subjected to dynamic loads, seismic design of pile foundations, structural design of pile foundations, static and dynamic earth pressure theories, stability analysis of retaining walls, reinforced earth wall design, machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbogenerator, IS code provisions on foundations, codal provisions on structural and earthquake resistant design of foundations.

CE F430 Design of Advanced Concrete Structures **3 0 3**

Design of footings and stair cases, Determination of deflection and crack width in beams and slabs, Design of flat slabs, Design of beam column joints, Design of circular Slabs, Design of Retaining walls, Design of beams curved in plan.

CE F431 Principles of Geographical Information Systems **3 1 4**

Introduction to Geographical Information Systems(GIS), Spatial data models, Coordinate systems and geo-referencing, Map projections, Databases and database management systems, Spatial databases, Interpolation methods: Deterministic and Statistical. Digital elevation models and their applications, Network analysis, GNSS, Strategies for development, implementation and management of GIS, Next generation GIS, Case studies on use of GIS from various fields such as water and land resources, environment, transportation; Introduction to remote sensing & Image processing.

CE F432 Structural Dynamics **3 0 3**

Free and forced vibrations, single and multi-degree systems, continuous systems, response of various systems to different excitations, damping; numerical evaluation of dynamic response, frequency domain analysis, mode superposition, direct integration for dynamic response.

CE F433 Remote Sensing and Image Processing **3 1 4**

Overview, Fundamental concepts of remote sensing, Air photo Interpretation, Multispectral, Thermal and hyper spectral Scanning, Microwave remote sensing, Photographic Systems, Photogrammetry, Digital Image Processing, Image File format, Pre-Processing of Data, Enhancement techniques, Image Transformations, Image classification, Spatial Filtering, Applications.

CE F434 Environmental Impact Assessment **3 0 3**

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

CE F435 Introduction to Finite Element Methods **3 0 3**

Element properties, Isoparametric formulations, analysis of framed structures, plane stress, plane strain, and axisymmetric problems, analysis of plate bending, FEM Software applications in Civil Engineering, Introduction to FEM programming. Exposure to relevant software.

CE F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

CE G511 Matrix Methods in Civil Engineering **3 2 5**

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

CE G512 Topics in Environmental Engineering **3 1 4**

Collection and disposal of solid wastes; air pollution and control; stream sanitation; rural water supply and sanitation.

CE G513 Advanced Computational Techniques **3 1 4**

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

CE G514 Structural Optimization **3 1 4**

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

CE G515 Fundamentals of Systems Engineering **3 1 4**

Linear Programming, Queuing Theory, Inventory Control, Simulation, Maintenance models sampling techniques, Forecasting techniques, Decision models, Network scheduling, application to Resources planning, financial Management, facility location, decision making Maintenance issues, construction & operational issues for Civil Engg. System.

CE G516 Multicriteria Analysis in Engineering **3 1 4**

Introduction, Conventional optimization, Multi-objective Optimization, Fuzzy logic and its extensions, in multi-objective optimization, Multicriterion Decision Making, Deterministic analysis, Stochastic analysis, Fuzzy analysis, Classification problems, Hybrid approaches in Decision Making, Genetic Algorithms, Artificial Intelligence, Artifical Neural networks, Practical applications in Engineering.

CE G517 Waste Management Systems **3 1 4**

Introduction, Wastewater and Solid Wastes, Collection and Transportation, Waste Disposal Systems, Land Treatment, Wastewater Management Methods, Wetland and Aquatic Treatment, Landfilling, Incineration, Energy from Wastes, Recycling, Composting, Reduction, Reuse and Recovery, Risk management, Case studies.

CE G518 Pavement Analysis and Design **3 1 4**

Types of pavements, flexible, rigid and semi-rigid; components of pavement structure; stresses and strains in flexible and rigid pavements: layered systems, visco-elastic solutions; stresses and deflections in rigid pavements; computer programmes for analysis of stresses and deflections in rigid pavements; traffic loadings, load equivalency factors, traffic projections and analysis; material characterization as input to pavement design; flexible pavement design and rigid pavement design using IRC, AASHTO, PCA methods; design of overlays; pavement deterioration, pavement performance and use of HDM-4; pavement drainage design.

CE G520 Infrastructure Planning and Management **3 1 4**

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction

(M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

CE G521 Topics in Structural Engineering **3 2 5**

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

CE G522 Pavement Design, Maintenance and Management **3 2 5**

Materials for road construction: specifications and tests on binder, aggregate and soil; Asphalt mix design; Pavement structure; Stresses in flexible and rigid pavements; Design of flexible and rigid pavements; Pavement Management System (PMS) implementation and operation; Data base requirements; Road condition surveys; Data management; Pavement condition analysis; Determination of maintenance and rehabilitation needs at network level; Panel inspection; Prioritization and optimization; Budgets, programmes and plans of action.

CE G523 Transportation Systems Planning and Management **3 1 4**

System and environment; sequential transportation systems planning: trip generation, trip distribution, modal split and traffic assignment. Transportation Systems Management (TSM) actions: traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions; planning for pedestrians, parking planning; Methods of accident data collection and analysis.

CE G524 Urban Mass Transit Planning, Operations and Management **3 1 4**

Modes of public transportation and application pf each to urban travel needs; Comparison of transit modes and selection of technology and transit service; Estimating demand in transit planning studies and functional design of transit routes; Terminal design; Management and operation of transit systems, Model for operational management; Fleet and crew management; Terminal management; Fiscal management.

CE G525 Water Resources Planning and Management **3 1 4**

Introduction; Quantitative and qualitative assessment of water resources; Engineering principles applied to the management of water resources; Hydrographic and project surveys; Watershed management; Measurement techniques in water resources engineering; Gains of water resources planning to the society; Water economics; Computer utilization areas; Project discussions; Laboratory experiments.

CE G526 Systems Approach to Water Resources Modeling **3 1 4**

Introduction to system analysis; Water management models: types and significance; Fundamentals of model development; Model solution techniques (computational methods) such as computer aided optimization, simulation, statistical analysis and reliability considerations; Model calibration and verification; Modeling of water quality subsystems and water quantity subsystems in various water bodies and its methods of analysis.

CE G527 Construction Management **3 1 4**

Industry profile, parties involved, contracts, bonds, bidding, changes, pre-planning, construction management approach and partnering; Planning and scheduling, net-work based scheduling systems (CPM), Resource management, Network acceleration, PERT probabilistic approach.

CE G528 Selection of Construction Equipment and Modeling **3 1 4**

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

CE G529 Construction Project Control Systems **3 1 4**

Concepts, planning and organization; bar charts and schedule networks; CPM computer software, Resource management; Optimal project duration; Project estimates; Budgeting and cash flow; Project control; PERT and line of balance; Project simulation; Materials management and information systems; Claims; Corrective actions; Total quality management; Equipment economics; Nature of design projects: (1) design of project scheduling networks, (2) design of construction operations, (3) development of project breakdown structure, and (4) development of project cash flow design.

CE G530 Design of Construction Operations **3 1 4**

Techniques for the design and analysis of construction operations to maximize productivity and minimize resource idleness; Queuing theory, line of balance, simulation, probabilistic and statistical methods applied to construction; An actual construction operation will be modeled and analyzed as part of the course in the context of a term project.

CE G531 Environmental Conservation **3 1 4**

Environmental management; impact of development schemes; essentials of an environmental policy and an environmental act; environmental issues and priorities, ecological effects of current development process; energy resources and water resources planning; Economics of pollution control; National conservation strategy; Organisations dealing with environmental conservations.

CE G532 Advanced Soil Mechanics **3 1 4**

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi infinite elastic soils; vibration problems.

CE G533 Advanced Composite Materials for Structures **3 1 4**

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

CE G534 Pavement Material Characterization **3 1 4**

Soils: Origin, properties of soils, tests on soils; aggregates: origin, classification, requirements, properties, importance of aggregate gradation; bituminous materials: origin, preparation, properties and tests, criterion for selection of different binders, modified binders; bituminous emulsions and cutbacks: preparation, characteristics, uses and tests; bitumen mix design: marshall method and superpave procedure; mechanical properties of bituminous mixes: resilient modulus, dynamic modulus, visco-elastic and fatigue characteristics. cement concrete pavement materials: requirements and design of mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.

CE G535 Highway Geometric Design **3 1 4**

Highway functional classification; route layout and selection, design controls and criteria: turning paths, driver performance, traffic characteristics; highway capacity; access control; safety; environment; Elements of design: sight distance, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves; highway cross-sectional elements and their design; at-grade Inter-sections – sight distance consideration and principles of design, canalization, mini roundabouts, layout of roundabouts, inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design.

CE G536 Traffic Engineering and Safety **3 1 4**

Road users and their characteristics; traffic studies- volume, speed, origin-destination (O-D) and delay studies; analysis and interpretations of traffic studies; traffic forecasting; capacity and level of service analysis; traffic characteristics at unsignalized and signalized intersections; design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination; traffic controls: signs, markings, street furniture; traffic regulations; parking studies; nature of traffic problems and their solutions; traffic safety: accidents- data collection and analysis; causes and prevention.

CE G537 Transportation Economics and Finance **3 1 4**

Need for economic evaluation; concept of total transport cost; fixed and variable costs, elasticity of demand, marginal costs; value of travel time, accident costs; methods of economic evaluation; taxation in road transport, user charges: fees and tolls; highway legislation; investment policies and pricing, issues in financing and subsidy policy, public private partnership (PPP) options in transport sector: BOT, BOOT, BOLT; feasibility studies, identification and sharing of risks in PPP projects, operation and management agreements.

CE G538 Project Planning and Management **3 1 4**

Foundations of project management: project life cycle, environment, selection, proposal, scope, ToR standardization; work break down structure; network scheduling: critical path method (CPM), programme evaluation and review technique (PERT), planning and scheduling of activity networks; resource planning: allocation, schedule compression, precedence diagram, generalized activity network; estimation of project cost, earned value analysis, monitoring project progress; quality assurance; contract administration and management; mechanization and advanced process control; quality audit; milestones, bonus and penalties; dispute resolution; capacity building and skill development.

CE G539 Introduction to Discrete Choice Theory **4***

Introduction, element of choice process, individual preferences, behavioral choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbors; application of fuzzy logic and artificial neural network in discrete choice modeling.

CE G542 Water Resources and Management **3 1 4**

Water resources system for different utilization; theory and analytical methods for minimum cost and optimum development; analysis and design of multi-purpose water resources system; engineering and economic principles applied to the management of water resources.

CE G543 Traffic Flow Theory **3 1 4**

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic

models; car-following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

CE G544 Fracture Mechanics of Concrete Structures **3 1 4**

Types of failure, Types of fracture, Modes of fracture, Fracture criteria, Energy release rate, Stress intensity factor (SIF), SIF of more complex cases, , Elastic plastic analysis through J-integral, Crack tip opening displacement, Test methods, Fatigue failure, Fracture mechanics of concrete: Need for fracture in concrete, Linear Elastic fracture models, Elasto-plastic fracture models, Nonlinear fracture models, RILEM fracture energy, softening of concrete, fracture process zone, size effect, Interface fracture, Fracture behaviour of special concretes, Numerical analysis.

CE G545 Airport Planning and Design **3 1 4**

Air Transport-structure and organization; forecasting air travel demand: trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport planning: site selection, layout plan, orientation and length of runway; airport capacity and configuration; geometric design of runway, taxiway and aprons; passenger terminal function, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport drainage; pavement design; airport access problem; environmental impact of airports.

CE G546 Highway Construction Practices **3 1 4**

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing of the road construction area; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MORTH specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction; field quality control ; road making machinery.

CE G547 Pavement Failures, Evaluation and Rehabilitation **3 1 4**

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

CE G548 Pavement Management Systems **3 1 4**

Components of pavement management systems, pavement maintenance measures; pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipment; evaluation of pavement distress modeling and safety; pavement performance prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM-IV models, comparison of different deterioration models, functional and structural condition deterioration models; ranking and optimization methodologies: Recent developments, economic optimization of pavement maintenance and rehabilitation.

CE G549 Rural Road Technology **3 1 4**

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

CE G551 Dynamics of structures **3 1 4**

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration, analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

CE G552 Advanced Structural Mechanics and Stability **3 1 4**

Analysis of stress and strain in three dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degree of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to postbuckling of plates.

CE G553 Theory of Plates and Shells **3 1 4**

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series, membrane theory of shells, and case study on plates and shells using numerical tools.

CE G554 Advanced Structural Design **3 1 4**

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall, water tank, towers, etc using both the steel and concrete materials. Modeling of structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

CE G555 Remote Sensing and GIS in Water Resources **4***

Basic concepts of Remote Sensing (RS) and image processing; photogrammetry; global positioning system and its application in water resources; fundamentals of GIS; map projection; spatial data modeling and analysis; integration of hydrologic models and RS & GIS with relevance to surface and ground water resources. advanced aspects of RS & GIS; case studies.

CE G556 Advanced Computational Hydraulics **4***

Ordinary and partial differential equations; finite difference schemes and their variations, finite element methods and their variations; implicit and explicit types; accuracy, convergence and stability; applications to steady and unsteady flows in various fields in hydraulics; one-, two- and three-dimensional flows; Case Studies.

CE G557 Stochastic Hydrology **4***

Basics of statistics in hydrology, discrete and continuous distributions and their applications to hydrological variables; parameter estimation; hypothesis testing; regression analysis; classification and characteristics of time series; autocorrelation analysis; univariate and multivariate stochastic models; spectral analysis; case studies.

CE G558 Advanced Groundwater Hydrology **4***

Aquifers - hydraulic characteristics of aquifers (confined and unconfined). Basic principles of ground water flow; Techniques of artificial recharge; Well design; groundwater recharge basins and injection wells; flow into aquifer with different boundaries and special cases; ground water models (digital and analog models): groundwater pollution, contaminant transport, remediation and legislation.

CE G559 Soft Computing in Water Resources **4***

Introduction and role of soft computing techniques such as fuzzy logic, expert systems, evolutionary algorithms in water resources engineering; classical sets and fuzzy sets; membership functions; defuzzification; basics of expert systems and relevant terminology; Procedure for development of knowledge base and handling of uncertainty; fundamentals of evolutionary algorithms; case Studies.

CE G560 Hydrologic Simulation Laboratory **4***

Role of simulation and optimization modeling in water resources; data mining techniques in hydrology; database management; applicability of hydraulic and hydrologic related simulation models and softwares; applicability of optimization based models and softwares.

CE G561 Impact of Climate Change on Water Resources Systems **4**

Introduction to anthropogenic climate change; impact of climate change on hydrology and water resources; global climate teleconnections; various modeling approaches including general circulation models and downscaling approaches; selection criteria; climate predictability and forecasting; limitations and uncertainties; adaptability to climate change; Case Studies.

CE G562 Advanced Concrete Technology **4**

Components of concrete; chemical properties of cement & cementitious paste; heat of hydration; microstructure of cementitious paste; properties of aggregates; chemistry of mineral admixtures;chemistry of chemical admixtures; characterization of powdered and solid block concrete; effect of concrete composition on properties of fresh concrete; rheology of concrete; effect of concrete composition on properties of hardened concrete; shrinkage and creep; correlation between micro- and specimen level properties, interfacial transition zone (ITZ); durability of concrete; prediction of concrete service life; techniques for nondestructive evaluations (NDE) of concrete; green concrete; concrete with alkali activated binders (AAB); difference between alkali –activated binders and blended cements.

CE G563 Stochastic Methods in Civil Engineering **3 1 4**

Uncertainty, Discrete and Continuous distributions, Hypothesis testing, Classification and characteristics of time series, Autocorrelation analysis, Multivariate data analysis by logistic regression, discriminant analysis, cluster analysis, factor analysis, queuing theory, Reliability analysis, Statistical quality control, Introduction to univariate and multivariate stochastic models, markov chain and their properties, introduction to Transition probability, case studies.

CE G564 Structural Health Assessment and Rehabilitation **3 1 4**

Introduction, Overview of present repair, retrofitting, and strengthening practices, Distress identification, Repair management, Causes of deterioration and durability aspects, Holistic models of Deterioration of RCC, Durability Aspects, Intrinsic and extrinsic causes an stage of Distress, Condition survey and Non-destructive Evaluation, Classes of Damages and Repair Classification, Structural Analysis and Design, Reserve Strength, Evaluation of Building Configuration, Repair materials and their selection, Rehabilitation and Retrofitting Methods, Analysis and Design of Externally FRP and ECC Strengthened Structures , Retrofitting using External Unbonded Post-tensioning and Near Surface Mounted FRP Rebars, Durability Based Design of FRP Reinforced/Strengthened Bridge Girders, Case Study Problems.

CE G610 Computer Aided Analysis and Design in Civil Engineering **3 2 5**

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of preprocessor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

CE G611 Computer Aided Analysis and Design **3 2 5**

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

CE G612 Advanced steel Structures **3 1 4**

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

CE G613 Advanced concrete Structures **3 1 4**

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

CE G614 Prestressed Concrete Structures **3 1 4**

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

CE G615 Earthquake Engineering **3 1 4**

Single and multi degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

CE G616 Bridge Engineering **3 1 4**

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

CE G617 Advanced Structural Analysis **3 1 4**

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three dimensional analysis of structures; shear deformations, shear wall analysis; interactive software development for analysis of structures.

CE G618 Design of Multi-Storey Structures **3 1 4**

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

CE G619 Finite element analysis **3 2 5**

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

CE G620 Advanced Foundation Engineering **3 1 4**

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

CE G621 Fluid Dynamics **3 2 5**

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

CE G622 Soil-Structure-Interaction **3 1 4**

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.

CE G623 Ground Improvement Techniques **3 1 4**

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

CE G631 Selected Topics in Soil Mechanics and Geotechnical Engineering **3 1 4**

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends.

CE G632 Design of Foundations for Dynamic Loads **3 1 4**

Evaluation and interpretation of geotechnical reports, selecting foundation design parameters from laboratory and field tests, Selection of foundation, Analysis and design of strip, isolated & combined footing, circular and ring foundation, Design of raft foundation using conventional rigid method, Coefficient of subgrade reaction, Winkler model for footings and mat on elastic foundations, Proportioning and structural design of footings subjected to combined vertical, moment and horizontal loads, Seismic design of shallow foundations, ductile detailing, Analysis and design of different type of pile foundations, piles subjected lateral load, moment and uplift, piles subjected to dynamic loads, design of pile group and pile cap, Seismic design of pile foundations and ductile detailing, Analysis and design of retaining walls, reinforced earth wall design, seismic design of retaining structure, Analysis and design of machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbo-generator, Computing static and dynamic stiffness of foundations, soil-structure interaction, Optimization and computer aided design of foundation, BIS, IRC, ACI, ASCE, AASTHO and Euro code provisions on structural and earthquake resistant design of foundations.

CE G641 Theory of Elasticity and Plasticity **3 2 5**

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

Chemical Engineering

CHE F211 Chemical Process Calculations **3 0 3**

Historical overview of Chemical Engineering, Principles of balancing with examples to illustrate differential and integral balances lumped and distributed balances, Material balances in simple systems involving physical changes and chemical reactions, Systems involving recycle, purge and bypass, Properties of substances: single component & multicomponent, single and multiphase systems. Ideal liquid and gaseous mixtures, Energy balance calculations in simple systems, Introduction to Computer aided calculations-steady state material and energy balances for chemical plants

CHE F212 Fluid Mechanics **3 0 3**

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non-Newtonian flow, Introduction to Fluid Statics, Dimensional Analysis (Buckingham PI theorem), Types of flows, Fluid Statics, Bernoulli equation, Differential and Integral analysis methods of analysis, Navier Stokes equation, Potential flows, Stream functions and velocity potential, Boundary Layer Theory, Flow measurement, Pipe flow analysis, Flow past immersed objects, Packed beds, Fluidized beds, Sedimentation, Pumps and compressors Agitation and Mixing, (Power consumption, mixing times, scale up), Introduction to Turbulent Flows (Reynolds equations), Compressible flows.

CHE F213 Chemical Engineering Thermodynamics **3 0 3**

Review of work, heat, reversible and irreversible processes, First Law applications to closed and open systems, Second law, Entropy, and applications related to power and refrigeration, Heat effects, Availability and Exergy analyses Equations of state and generalized correlations for PVT behaviour, Maxwell relations and fluid properties estimation; Residual and excess properties, Partial molar quantities; Gibbs-Duhem Equation, Fugacity and Activity Coefficient models, Vapour-liquid equilibria, Chemical Reaction Equilibrium.

CHE F214 Engineering Chemistry **3 0 3**

Organic chemistry – Important functional groups, their reactions and named reactions, Physical chemistry – thermo-physical and thermodynamic properties determination, phase rule, Adsorption equilibria, Electrochemistry, Chemical methods of analysis, Instrumental methods of analysis, Water and waste water chemistry and analysis, Corrosion, Engineering materials and inorganic chemicals, Metals and alloys, Polymers, Fuels and fuel analysis.

CHE F241 Heat Transfer **3 0 3**

Steady state and unsteady state conduction, Fourier's law, Concepts of resistance to heat transfer and the heat transfer coefficient. Heat transfer in Cartesian, cylindrical and spherical coordinate systems, Insulation, critical radius, Convective heat transfer in laminar and turbulent boundary layers, Theories of heat transfer and analogy between momentum and heat transfer, Heat transfer by natural convection, Boiling and condensation, Radiation, Heat exchangers: LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation.

CHE F242 Numerical Methods for Chemical Engineers **3 0 3**

Introduction to mathematical modelling and engineering problem solving, Use of software packages and programming, Errors and approximations including error propagation and Numerical error, Roots of equations: Linear algebraic equations, 1-D and multi-dimensional unconstrained optimization including gradient methods, Linear programming, Non-linear constrained Optimization, Optimization with packages, Least Squares Regression including quantification of error, Polynomial regression, Lagrange, inverse and spline interpolation and Fourier approximation, Engineering applications, Numerical differentiation and integration, Ordinary differential equations, Partial differential equations, Engineering applications

CHE F243 Material Science and Engineering **3 0 3**

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

CHE F244 Separation Processes I **3 0 3**

Molecular diffusion in fluids, Interphase mass transfer, mass transfer coefficient, Theories for interphase mass transfer, overall mass transfer coefficient and correlations, mass transfer with chemical reaction, analogy between momentum, heat and mass transfer, Absorption, Distillation including azeotropic and extractive distillation, Liquid-Liquid extraction, Leaching, Equipment for absorption, distillation, extraction and leaching.

CHE F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CHE F311 Kinetics and Reactor Design **3 0 3**

Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Kinetics of Solid Catalyzed Reactions; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models.

CHE F312 Chemical Engineering Lab I **0 3 3**

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Fluid Mechanics, Engineering Chemistry, Heat transfer and Separation Processes – 1. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F313 Separation Processes II **3 0 3**

Special equilibrium based separations like humidification and water cooling, Drying of wet solids, adsorption, crystallization etc., Mechanical separations like filtration, centrifugation, froth floatation etc., Solid separations based on size reduction including sieving operations and related equipment like crushers, mills, pulverizers etc., special separation processes like ion-exchange, membranes, chromatography etc.

CHE F314 Process Design Principles I **3 0 3**

Process invention using heuristics and analysis (The Design process, Process creation and heuristics for process synthesis, Molecular structure design, Role of process simulators Like Aspen, Chemcad, Hysys etc. in process creation), Detailed process synthesis using algorithmic methods with emphasis on reactor networks, separation trains, batch processes, heat integration etc.

CHE F341 Chemical Engineering Laboratory II **0 3 3**

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Kinetics and Reactor Design, Process Dynamics and Control and Separation Processes – 2. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F342 Process Dynamics and Control **3 0 3**

Introduction to process control, Theoretical models of chemical process, Laplace Transforms, Transfer functions and state space models, Dynamic response of first and second order processes, Effect of dead time, Dynamics response of more complicated systems, Development of empirical models from empirical data, Feedback control, Control system instrumentation, Overview of Control system design, Dynamic behavior and stability of closed loop system using root locus, frequency response using Bode and Nyquist plots, PID controller design and tuning, Control system design based on frequency response analysis, Feed forward, cascade and ratio control, Introduction to multivariable control system, identification of interaction, design of controllers in interactions, elimination of interactions, Control strategies for common industrial processes such distillation, heat exchangers, etc. Control strategies for Batch processes.

CHE F343 Process Design Principles II **3 0 3**

Review of process synthesis, Design and sizing of equipment of heat exchangers, separation towers, pumps etc. Cost accounting and capital cost estimation, Annual costs, earnings and profitability analysis, optimization of process flow sheets, Steps involved in designing configured industrial systems like solar desalinators, fuel cells, hand warmers etc.

CHE F366 Lab Project **3**

CHE F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHE F376 Design Project **3**

CHE F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHE F411 Environmental Pollution Control **3 0 3**

Air & water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies; associated laboratory.

CHE F412 Process Equipment Design **3 0 3**

Application of principles of Chem. Engg. to the selection and design of equipment for Chemical industries; design, cost estimation and selection of process equipment; piping, pressure vessels, heat exchangers, distillation columns etc. Use of computer software packages in the design; plant safety practices; use of codes.

CHE F413 Process Plant Safety **3 0 3**

Role of safety in society. Engineering aspects of process plant safety. Chemical hazards and worker safety. Hazardous properties of chemicals. Safety aspects in site selection and plant layout. Design and inspection of pressure vessels. Storage, handling and transportation of hazardous chemicals. Risk assessment methods. Toxic release, fire and explosions. Boiling liquid expanding vapor explosions. Safety audit. Emergency planning and disaster management. Case studies.

CHE F414 Transport Phenomena **3 0 3**

Analogy for momentum, heat and mass transport; shell balance approach for analysis of individual and simultaneous momentum, heat and mass transport; hydrodynamic and thermal boundary layers; velocity, temperature and concentration distributions in turbulent flow; interphase transport for isothermal and non-isothermal systems.

CHE F415 Molecular and Statistical Thermodynamics **3 0 3**

Fundamental of Statistical Mechanics, Quantum Mechanics, Postulates, Concept of Ensembles, Intermolecular Potential Energy functions; Distribution functions: Radial Distribution Function (RDF); Applications of Statistical Mechanics: Thermophysical property calculations in ensembles; Cooperative Phenomenon: Phase Equilibria: Ising model, Gibbs Ensemble (VLE), Thermodynamic Integration, Gibbs-Duhem Integration, Free Energy calculation; Virial EOS: second virial coefficient; Special Applications: From Surface Adsorption: Adsorption Isotherm. Molecular Simulation Techniques: Molecular Dynamics and Monte Carlo Simulation, Monte Carlo Simulation in various Ensemble.

CHE F416 Process Plant Design Project I **3**

This course aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be two major submissions: (i) Process selection and PFD, (ii) Material and Energy Balance. This part of the project in conjunction with Process Plant Design Project 2 is a Basic Process Package Report for a complete process plant.

CHE F417 Process Plant Design Project II **3**

This course is an extension of Process Plant Design Project 1 and aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be three major submissions in relation to the process selected in Process Plant Design Project 1: (i) Process Design, (ii) Mechanical design, (iii) Costing. This part of the project in conjunction with Process Plant Design Project 1 is part of detailed engineering and economics for a complete process plant.

CHE F418 Modelling and Simulation in Chemical Engineering **3 0 3**

Mathematical model and necessity, Introduction to modeling, Physical and Mathematical models, Modelling in Chemical Engineering, Formulation of dynamic models with case studies based on mass, component, momentum and energy balances, Modeling of selected fluid flow, heat transfer, mass transfer and reaction engineering phenomena, Role of Simulation and simulators, Sequential and modular approaches to Process Simulation, Equation solving approach, Decomposition of networks, Convergence promotion, Specific purpose simulation, Introduction to role of evolutionary computation in simulation.

CHE F419 Chemical Process Technology **3 0 3**

Process synthesis concepts for flow sheet generation - Unit operations and unit processes, General principles applied in studying a chemical industry; Chemical processes based on agricultural and sylvi-cultural raw materials - Sugar, starch, alcohol, cellulose, etc; Selected technologies for chemicals from inorganic chemical industry covering contact process, fertilizer, chloral-alkali, cement and lime; Natural product industry covering manufacture of oils, soaps, detergents, paper and pulp, Coal and various coal-chemicals, Petroleum and petrochemical products, Raw materials and principles involved in the production of olefins and aromatics, Acetylene, Butadiene and typical intermediates from olefins and aromatics such as ethylene glycol, ethyl benzene, phenol, cumene and DMT/PTA, Dyes and pharmaceuticals.

CHE F421 Bio-chemical Engineering **3 0 3**

Basics of Microbiology and Biochemistry; Introduction to Biochemical engineering, Mass and energy balance in microbial processes; Microbial growth, Substrate utilization and product formation kinetics; Medium and air sterilization; Enzyme kinetics and immobilized enzyme systems; Design of batch, continuous and fed-batch bioreactors; Transport Phenomena in biological reactors; Scale-up principles for biochemical processes; Instrumentation and control of bioprocesses, Bioseparations.

CHE F422 Petroleum Refining Technology **3 0 3**

Current world oil and gas scenario; History and development of refining; Petroleum industry in India; Origin, formation, and composition of petroleum; Classification and evaluation of crude oils; Petroleum products and test methods; Crude oil distillation; Thermal, catalytic and finishing processes; Product blending; Lube oil and bitumen (asphalt) manufacturing processes.

CHE F423 Membrane Science and Engineering **3 0 3**

Overview of membrane separation processes; Introduction to membranes; Polymeric membranes; Non-polymeric membranes; polymer synthesis; polymer characterization; Metallic membranes; Zeolites; Metal Organic Frameworks; Liquid membranes; Phase inversion; Thermodynamics of Phase inversion; Dip coating; Track etching; Chemical Vapor Deposition; Morphology of membranes; Hydrophilicity; Ultrafiltration; Microfiltration; Nanofiltration; Reverse Osmosis; Pervaporation; Membrane distillation; Gas separation; Biomedical engineering applications; Plate and Frame modules; Spiral wound modules; Hollow fiber membrane modules; Membrane contactors; Pore diffusion; Solution diffusion mechanism; Mathematical modeling of membrane separation processes; Membrane fouling; Concentration polarization; Cake layer formation; Gel layer formation; Membrane cleaning; Industrial membrane installations; Economics of membrane plants; Opportunities for membrane technology in start-up ecosystem.

CHE F424 Rheology of complex fluids **3 0 3**

Introduction to complex fluids, origins of non- Newtonian behaviour; fundamentals of rheology; rheological measurements and properties; linear and non-linear viscoelasticity; time-temperature

superposition, Boltzmann superposition principle, types of flow fields; various characterization techniques; techniques in oscillatory shear rheology; theoretical models for visco-elastic fluids; Maxwell model, Kelvin–Voigt model, Generalized Maxwell model, Oldroyd model; rheology of dilute polymer solutions, ideal chain conformations, real chain conformations, unentangled polymer dynamics, entangled polymer dynamics; rheology of two phase systems, rheology of soft glassy materials, physical aging and rejuvenation.

CHE F433 Corrosion Engineering **3 0 3**

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: materials selection, alternation of environment, design, cathodic and anodic protection, coatings.

CHE F471 Advanced Process Control **3 0 3**

Process identification and adaptive control; Model predictive control structures; Model-based control structures; State estimation; Synthesis of control systems-some case studies; intelligent control.

CHE F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

CHE F497 Atomic and Molecular Simulations **3**

Particle based simulations at atomic and molecular level. Molecular dynamics (MD), Lyapunov exponent, various algorithms for integrating the equation of motion, Verlet algorithm. Monte Carlo (MC) algorithm, Trial moves, MD and MC in various ensembles, thermostats, barostats etc. Hands-on simulations using GROMACS or LAMMPS or similar. Free energy calculations and phase equilibria. Various other applications of molecular mechanics calculations. State of the art development in the field, latest force fields, parameterization techniques etc. Introduction to density functional theory (DFT), Hands on simulations using any DFT packages such ADF or GAUSSIAN or GPAW or VASP or similar.

CHE F498 Colloids and Interface Engineering **3**

Colloids – Intermolecular forces and Properties of the colloids. Interface and Surface active agents – Thermodynamics of interfaces, interfacial rheology and transport process, surface free energy, surface tension, thermodynamics of micelle and mixed micellar formation, electrical phenomena at interfaces. Emulsion, Micro emulsion and Foam – Preparation, mechanism and stabilization, characterization and application of foams. Measurement techniques – Interfacial tension, contact angle, zeta potential and particles size. Industrial applications – Applications of various interfacial phenomena in the industries. Nanomaterials – Application of surface active agent through the surface modification for the synthesis of nanostructured material.

CHE G511 Fluidisation Engineering **3 1 4**

Fundamentals, industrial applications; study, design and operation of fluidisation units.

CHE G512 Petroleum Refining and Petro- Chemicals **3 1 4**

Origin, formation and composition of petroleum; history and development of refining; refinery products and test methods; classification and evaluation of oil stocks, fractionation of petroleum; thermal and catalytic processes; properties & production of petrochemicals.

CHE G513 Environmental Management Systems **3 2 5**

Introduction to air & water pollutants & solid wastes; sampling & analysis techniques; impact of these on environment; national & international regulations; ISO series; conventional & non-conventional energy resources; life cycle analysis; environmental audit; sustainable developments; case studies.

CHE G514 Evolutionary Computation **5**

Non-traditional optimization techniques; population based search algorithms; evolutionary strategies; evolutionary programming; simulated annealing; genetic algorithms; differential evolution; different strategies of differential evolution; Memetic algorithms; scatter search; ant colony optimization; self-organizing migrating algorithm; other emerging hybrid evolutionary computation techniques; engineering applications involving highly non-linear processes with many constraints and multi-objective optimization problems.

CHE G521 Chemical Engineering Analysis **2 2 4**

Mathematical analysis of chemical engineering problems; introduction to modelling and simulation techniques in the analysis of systems; emphasis on applying mathematical techniques to real Chemical Engineering processes and on physical and mathematical interpretation of results; use of computer software for analysis and solution of mass and energy balances problems for complex processes.

CHE G522 Polymer Technology **3 1 4**

Polymerisation techniques; classification of polymers; mechanism and kinetics of formation of polymers; different techniques for determination of different types of molecular weights; polymer structure; definition and measurement of glass transition and crystalline melting temperatures; viscoelasticity and rubber elasticity behaviour; degradation and stability; polymer processing; rheology and applications. The course will terminate with several design projects on real life problems.

CHE G523 Mathematical Methods in Chemical Engineering **3 2 5**

An introduction to mathematical modelling and simulation, Fundamentals of functional analysis, Linear algebraic equations and related numerical schemes, ODE's IVP and related numerical schemes, Partial differential equations and related numerical schemes, Optimization and related numerical schemes, Application of the above principles to solving problems in Chemical Engineering, Role of computer programming and packages in problem solving.

CHE G524 Introduction to Multiphase Flow **3 1 4**

Introduction to multiphase flow, Single particle motion, Bubble and droplet transition, Marangoni effects, Bubble growth and collapse, Cavitation, Flow patterns, Internal flow energy conversions, Homogenous flows, Flows with bubble and gas dynamics, Sprays, Granular flows, Drift flux models, System instabilities.

CHE G525 Chemical Process and Equipment Design **3 1 4**

The nature and function of process design, Flow sheet preparation and drawing, Process Planning Scheduling and Flow Sheet Design, P and I diagrams, Piping Design, Pump size selection. Design information and data, Specification and design of process equipment, Rules of THUMB for design of equipment, Software use in process design, Process design of equipment in heat and mass transfer, reactors, pumps, etc., Mechanical design of selected equipment.

CHE G526 Nuclear Engineering **3 1 4**

Review of Nuclear Physics, Mechanism of nuclear fission, Fission cross section, Fission products, Reactor Physics, Types of nuclear reactors, Construction and control of nuclear reactors, Heat transfer in nuclear reactors, Design and operation, Reactor shielding, Nuclear fuels, Moderators, Coolants, Reflectors and structural materials, Nuclear fuel cycle, Spent fuel characteristics, Reprocessing techniques role of solvent extraction in reprocessing, Reactor control and safety.

CHE G527 Energy Conservation and Management **3 1 4**

Energy conservation, Growth and demand of energy, Energy availability, Comparison of specific energy use in select industry, Potential and status of energy in India, Energy saving potential in industries, Potential of energy efficiency in India, Energy available for industrial use and the role of conservation, Energy management and policy, Comprehensive energy conservation planning (CECP), Definition and principles of energy conservation, Energy conservation technologies, Cogeneration concept and scope, Energy audit and management. Energy conservation in utilities.

CHE G528 Introduction to Nano Science and Technology **3 1 4**

Introduction to nano-science, Basic idea of solid state physics and quantum mechanics, Quantum wells, Wires and dots, Properties of nanomaterials, Carbon nanotubes, Nanosynthesis, Characterisation methods, Application of nano-materials to various fields like electronics, medical, MEMS, photonics, molecular switches and others, Special reference to Chemical Engineering as in catalysis, heat transfer and special additive and performance materials (nanofluids, nanocomposites), Future of nano science and technology, Large scale manufacture and technological issues.

CHE G529 Pulp and Paper Technology **3 1 4**

Selection of pulp and paper making raw materials, Wood Anatomy- identification, Preparation of wood chips, Chip screening, Storage and chip conveying, Chemical composition of fibrous raw materials, Chemical Pulping, Mechanical Pulping, Chemical thermo-mechanical (CTP) processes, Waste Paper Pulping, Bleaching and washing, Chemical Recovery, Description of various grades of pulp & paper, Mechanical and chemical properties of pulp, Paper making, cellulose derivatives- preparation & end use, Environmental aspects in pulp and paper industry.

CHE G531 Project Engineering **2 2 4**

Project feasibility studies and report; Project appraisal; Project solution and evaluation; Project planning; Economic decision making; Project preparation and management.

CHE G532 Alternate Energy Resources **3 1 4**

The scope and present day technology in utilization of solar energy, wind power, tidal power, geothermal power, M.H.D. and fuel cells.

CHE G533 Petroleum Product Characterization **3 2 5**

Methods of estimation of characterization parameters for pure hydrocarbons; methods of characterization of petroleum fractions and products; experimental methods on measurement of basic properties obtained from laboratory testing; methods of prediction of properties for defined mixtures from pure-component properties (normal boiling point, density, molecular weight, critical properties, etc.); methods of prediction of properties for undefined mixtures based on certain bulk properties; characterization methods for light and heavy as well as narrow and wide boiling range mixtures; predictive methods for some characteristics specifically applicable to petroleum fractions that affect the quality of a fuel; standard test methods recommended by ASTM for various properties; minimum laboratory data needed to characterize various fractions as well as analysis of laboratory data and criteria for development of a predictive method; introduction to characterization of crude oils and reservoir fluids; associated Petroleum Laboratory experiments.

CHE G541 Process Plant Simulation **2 2 4**

Computer aided analysis of chemical process systems; classification and development of mathematical models to various chemical engineering systems; decomposition of networks; tearing algorithms; numerical methods for convergence promotion and solving chemical engineering problems; traditional & non-traditional optimization techniques; specific purpose simulation; dynamic process plant simulation; case study problems using professional software packages.

CHE G542 Computational Transport Phenomena **3 2 5**

Concepts; partial differential equations: types, boundary conditions, finite difference scheme, error analysis, grid generation, stability criteria; conduction and convection : two-dimensional steady state problem, methods for solving coupled

algebraic equations, finite element method; fluid flow : governing equations, various approach of simulation (stream-vorticity, primitive variable), staggered grid, similarity solution, Newton-Raphson method, explicit and implicit formulation; solution of Navier-Stokes equations : solution of full and parabolized equations, unsteady flow, MAC, SIMPLE algorithm, RNS method; Mass Transfer : dynamic model, mass transfer with simultaneous convection and diffusion, transient multi-component diffusion; short projects on development of codes for various real life problems involving transport processes.

CHE G551 Advanced Separation Technology **3 2 5**

A brief overview of the existing separation technologies such as adsorption-based separation, membrane separation, cryogenic separation, and biotechnology-based separation. Recent advancements on the above areas and the new concepts such as simulated moving bed adsorption, thermally coupled pressure swing adsorption, reactive distillation, biofiltration, supercriticalfluid extraction etc. This course will terminate with several design projects on real life problems.

CHE G552 Advanced Transport Phenomena **5**

Viscosity, thermal conductivity and diffusivity, Shell momentum and energy balance, equations of change for isothermal and non-isothermal systems, Concentration distribution in solids and laminar flows, momentum, thermal and concentration boundary layers near walls, origin of turbulence, length scales in turbulent flows, Reynolds (RANS) equations, estimates of Reynolds stress (k-epsilon and k-omega type models), turbulent shear flow near a wall, turbulent flow in pipes and channels, turbulent heat transfer, Introduction to large eddy simulations models, rheology and material functions, non-Newtonian viscosity and generalized Newtonian models, Linear and non-linear visco-elasticity, radiation heat transfer, multi-component systems, Coupled heat and mass transfer, evaporation, boiling and condensation, chemical reactions, Special topics: Flow through porous media, compressible flows, multiphase flow, Transport phenomena in biochemical systems.

CHE G553 Statistical Thermodynamics **4**

Review: Classical thermodynamic and elementary Statistical Mechanics, Macroscopic and microscopic descriptions of the state of a system, Equilibrium ensembles, the partition function and thermodynamic properties; System of independent particles; Fluctuations and the compressibility equation; Chemical equilibrium in ideal gas mixtures; Molecular based equations of state, SAFT, Lattice statistics; Real gases, Virial equation; The liquid state: lattice models, distribution functions theories, perturbation theories; Liquid mixtures: solution theories and local composition models, Statistical thermodynamics of electrolytes.

CHE G554 Computational Fluid Dynamics **4**

Introduction to CFD, Equations of change for momentum, energy and mass transport, introduction to partial differential equations, Numerical analysis and discretization techniques, Managing uncertainties in CFD, grid generation, application of CFD to solve Chemical Engineering problems, Introduction to COMSOL, data analysis, validation and post processing.

CHE G556 Electrochemical Engineering **4**

Basic physics of galvanic cells, Electrochemical Energy conversion, Electrochemical Energy storage, Equivalent circuit dynamics, Impedance spectroscopy, Impedance of electrodes, Nernst equation, Fuel cells and batteries, Faradic equations in dilute solutions, Butler Volmer equation, Reactions in concentrated solutions, Ion absorption and intercalation, Concentration polarization, forced convection in fuel cells, Transient diffusion, Warburg impedance, Diffusion in concentrated solutions, Transport in bulk electrolytes, Ion concentration polarization, Double layer structure, Transport on porous media, Porous electrodes, Super capacitors, Electrostatic correlations.

CHE G557 Energy Systems Engineering **4**

Cradle to grave overview of major current and future energy conversion processes. Energy sources such as coal, natural gas, petroleum, biomass, uranium, wind, and solar. Fuel processing techniques such as Fischer-Tropsch synthesis, gasification, methane reforming, and CO_2 reforming. Power generation technologies including steam turbines, gas turbines, wind turbines, fuel cells, and solar panels. Sustainability impact factors including water consumption, smog formation, and CO_2 emissions. Advanced processing techniques such as combined cycles, turbine/fuel cell hybrids, and CO_2 capture technologies. Real world use and application.

CHE G558 Chemical Process Optimization **4**

Introduction to Process Modelling and simulation, Fundamentals of analytical optimization. Survey of one dimensional line-search methods, and multi-dimensional unconstrained and constrained numerical optimization algorithms. Applications of linear programming, nonlinear programming, mixed integer linear/ nonlinear programming, and parameter estimation in chemical engineering. Feasible-path and infeasible-path techniques for chemical process flowsheet optimization, Evolutionary computation in Chemical Engineering.

CHE G559 Reactor Physics and Engineering **5**

Nuclear Reactions, Binding Energy, Fission Reactions, Fissile and Fertile Materials, Radioactive Decay; Neutron Cross Sections, Nuclear Fuel Properties, Moderators, Energy Spectra, Infinite Medium Multiplication, Power Reactor Core & Kinetics, Neutron Balance & Diffusion Equation, Four-factor formula, Two-group analysis, criticality equation, Electrical power generation from nuclear fission, fundamental aspects of fission chain reaction, and reactor design. Reactor concepts & types, their static and dynamic characteristics Reactor operation and control, Startup and shut down of systems.

CHE G560 Nuclear Fuel Cycle and Waste Management **5**

Processing of nuclear fuel with descriptions of mining, milling, conversion, enrichment, fabrication, irradiation & properties of irradiated fuel, reprocessing, and waste disposal. In-core and out-of-core nuclear fuel management design, Nuclear power plant and fuel cycle economics, Management of spent fuel, high-level waste, uranium mill tailings, low-level waste and decommissioning wastes. Fundamental processes and governing equations for waste management systems, safety assessment of waste disposal facilities, Chemical Engineering operations in Nuclear fuel manufacture, waste reprocessing operations and waste management, Process Engineering for Nuclear Industry.

CHE G561 Nuclear Reactor Control and Instrumentation **4**

Fundamentals of process instrumentation and control, Open and closed loops, SCADA and DDC, PLC, Alarms and Safety interlocks for shutdown and emergency shutdown, special sensors and sensor specifications for Nuclear Industry, Nuclear reactor safety, Special control logic for Nuclear safety, reliability and redundancy, Nucleonics: application of Nuclear materials and radiation in measurement techniques, Nucleonics based instruments for analysis, Design, maintenance and operation of such instruments. Calorimetry, detection of alpha, beta and gamma rays including spectrometry, liquid scintillation counting.

CHE G562 Thermal Hydraulics and Heat Transfer **4**

Thermal-hydraulic core design and analysis of nuclear systems, Single and two-phase flow, Flow regimes, pressure drops, frictional losses, pumping power modeling of fluid systems. Design constraints imposed by thermal-hydraulics heat generation, temperature distribution, heat removal, reactor heat sources & coolants, departure from nucleate boiling, boiling heat transfer, critical heat flux conduction in reactor components and fuel elements, heat transfer in reactor fuel bundles and heat exchangers, application of CFD in thermo-hydraulics of core.

CHE G563 Nuclear Chemical Engineering **4**

Solvent Extraction, Ion Exchange, Decontamination, Isotope Separation, Unit operations and processes used in the Production of Heavy Water, Desalination, Thermo-chemical Cycle for Hydrogen Production, district heating, nuclear propulsion, waste processing including vitrification.

CHE G564 Nuclear Materials and Radiation Damage **4**

Nuclear Materials; fabrication and quality control, non – destructive evaluation and irradiation behavior of uranium, plutonium and thorium based ceramic, metallic and composite fuels; fuel failure, post irradiation examination and mitigation of fuel failure; fabrication, heat treatment, property evaluation and irradiation behavior of fuel cladding and core structural materials e.g. aluminum & alloys for research reactors, zirconium alloys for water cooled nuclear power reactors and stainless steels and oxide dispersion strengthened (ODS) steel for fast reactors; physical, chemical and instrumental methods of analysis of nuclear materials and real time accounting of nuclear materials, radiation damage of nuclear fuels, pressure vessel, pressure tubes and other structural materials including radiation-embrittlement, void swelling, irradiation growth and creep, fracture toughness etc.

CHE G565 Radiation and Radio Isotopes Applications **4**

Nuclear non-power research reactors, measurement of radiation and use of neutron radiography, neutron diffraction and activation analysis for materials characterization; Production of Radioisotopes and their applications in medicine and healthcare, food and agriculture including food irradiation & preservation, radiation induced mutation for seed and crop, sterilization and application of radioactive tracers in basic and applied research.

CHE G566 Nuclear Safety, Security and Safeguards **4**

Radiation interaction & safety, environmental aspects, internal and external dose evaluation, reactor effluents and release of radioactivity, Operational and maintenance safety, Hazop and Hazan analysis, HSE issues and systems management in Nuclear installations and Nuclear industry and Nuclear Laboratories, Design basis threat (DBT) and threat analysis and evaluation, Detection, delay and response technologies and evaluation, Incorporating insider threat/wrong operation in DBT, Security and safety in Nuclear Materials Transportation, Nuclear forensics and consequence management, Nuclear systems safety and security analysis, Technologies and techniques for securing nuclear materials, Nuclear materials safeguard systems from theft, spillage and other unforeseen incidents, Fuel facility safeguard systems, Design of safeguard systems, Intrinsic and Extrinsic safeguard and proliferation resistance of fissile and fertile materials, Technical issues associated with Nuclear Non Proliferation, Facility inspection, safety, security and safeguard audit, Elements of non-proliferation policies, treaties and enforcement technologies.

CHE G567 Natural Gas Processing **4**

Overview of Natural Gas industry; Overview of Gas Plant processing; Field operation and inlet receiving; Compression; Gas treating; Gas dehydration; Hydrocarbon recovery; Nitrogen rejection; Trace component recovery or removal; Liquids processing; Sulfur recovery; Transportation and storage; Liquefied Natural Gas; Capital cost of Gas processing facilities; Natural gas processing plants.

CHE G568 Modeling and Simulation in Petroleum Refining **4**

Introduction to modeling and simulation; Numerical methods and software; Modeling and simulation of multi-component distillation columns; Reactor modeling in the petroleum refining industry; Modeling of catalytic hydro-treating; Modeling of catalytic reforming; Modeling and simulation of fluidized-bed catalytic cracking converters.

CHE G569 Petroleum Production Economics **4**

Cash flow analysis in the petroleum industry (definition of cash flow, deriving net cash flow under tax/royalty systems and production sharing contracts, depreciation methods, inflation, sunk costs). Economic indicators (net present value, rate of return and other indicators). Fiscal analysis (the nature of petroleum fiscal regimes, the effects of fiscal regimes on exploration and field development decision making, economic analysis of fiscal regimes in India & abroad).

CHE G611 Computer Aided Analysis and Design **2 3 5**

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

CHE G613 Advanced Mass Transfer **3 2 5**

Use of stage and differential contact concepts in design of mass transfer equipment; methods of determining and interpretation of rate data; multicomponent distillation, absorption and extraction.

CHE G614 Advanced Heat Transfer **3 2 5**

Heat conduction with unsteady boundary conditions; recent advances in natural and forced convection; condensation and boiling phenomena; heat transfer in high speed flows; liquid metal heat transfer, radioactive metal heat-transfer between surfaces in absorbing media; complex problems involving simultaneous conduction, convection and radiation.

CHE G615 Advanced Separation Processes **3 2 5**

Shortcut and rigorous methods of conventional separation processes such as multicomponent distillation, absorption, stripping and extraction; Azeotropic and Extractive distillation; adsorption based separation, simulated moving bed adsorption, thermally coupled pressure swing adsorption; cryogenic separation, gas liquefaction; membrane based separation, pervaporation, liquid membrane; biotechnology based separation, modeling approach, design considerations, biofiltration; reactive distillation; super critical fluid extraction.

CHE G616 Petroleum Reservoir Engineering **3 2 5**

Origin and composition of petroleum; Geographic distribution of oil; Petroleum geology; Exploration, drilling and recovery; Drilling methods and drilling fluids; Lubricants and spotting fluids; Corrosion control; Analytical and test methods; Enhanced oil recovery; Injection fluids; Polymer and caustic flooding; Use of surfactants; Improvement of oil displacement efficiency; Environmental and economic aspects.

CHE G617 Petroleum Refinery Engineering **3 2 5**

History and development of refining; Indian petroleum industry; Composition of petroleum, laboratory tests, refinery products; Classification, characterization and evaluation of crude oil; Trends of petroleum products; Atmospheric and vacuum distillation; Design of crude distillation column; Catalytic cracking; Hydrotreating and Hydrocracking; Catalytic reforming; Delayed coking and visbreaking; Furnace design; Isomerization, alkylation and polymerization; Lube oil manufacturing; Energy conservation in petroleum refineries; Environmental aspects of refining.

CHE G618 Petroleum Downstream Processing **3 2 5**

Petrochemical feedstock; Pyrolysis of Naptha and light hydrocarbons; First generation petrochemicals: Ethylene, Propylene, Butylenes, Acetylene, Butadienes, Chloroprene, cyclohexane, BTX, Polymethyl Benzenes; Second generation petrochemicals: synthesis gas, methanol, ethanol, ethylene oxide, propylene oxide, acetone, allyl alcohol, glycerol, acrylonitrile, Acrylic acid and derivatives, phenol, aniline, nylon monomers, polyester monomers, styrene and other monomers; Third generation petrochemicals: plastics, rubbers, fibres, resins, detergents, pesticides, dyes, protein, explosives, petroleum coke and carbon black; Catalysts in petroleum refining and petrochemicals processes; Transportation of dangerous goods; Health and safety in petrochemical industries; Pollution and toxicity; Future of petrochemicals.

CHE G619 Process Intensification **3 2 5**

A brief review of the process intensification (PI), includes philosophy and principles of PI; equipments and methods for PI; few examples of their application on the commercial scale, such as multifunctional reactors, hybrid processes, monolithic reactors, high gravity reactors etc., industrial practice of PI- methodology and applications; PI by process synthesis; PI by plant safety. This course will terminate with several design projects on real life problems.

CHE G620 Energy Integration Analysis **3 2 5**

Importance and scope of application of Energy Integration; Pinch technology tools, targeting, design, synthesis and optimization of heat exchanger networks (HEN); Interfacing HEN synthesis with heat exchanger design, Retrofitting, energy integration of distillation and evaporation processes, mathematical programming approach, Artificial intelligence based approaches.

CHE G621 Fluid Dynamics **2 3 5**

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

CHE G622 Advanced Chemical Engineering Thermodynamics **3 2 5**

Review of fundamental principles; statistical foundations; thermodynamic properties of pure substances and mixtures, their estimation and correlation; stability and equilibrium criteria for homogeneous and heterogeneous systems; thermodynamics of irreversible processes.

CHE G641 Reaction Engineering **3 2 5**

Design of multi-phase reactors; analyses of gas-liquid and gas-liquid-solid reactions; intrinsic kinetics of catalytic reactions; residence time distribution models for micro-and macro-mixing; mathematical models for gas-liquid-solid reactors; laboratory reactors; dynamics and design of various multi-phase reactors such as trickle bed reactors, bubble column reactors, segmented-bed reactors, slurry reactors, spouted bed reactors, pulsating reactors, fluidized bed reactors, etc.; optimization of chemical reactors.

Chemistry

CHEM F110 Chemistry Laboratory **0 2 1**

This laboratory course consists of experiments based on fundamental principles and techniques of chemistry emphasizing on physical-chemical measurements, quantitative & qualitative analysis and preparations.

CHEM F111 General Chemistry **3 0 3**

Principles of thermodynamics, phase and chemical equilibrium, electrochemistry, kinetics; Atomic structure, chemical bonding, solid state and structural chemistry, molecular spectroscopy; organic compounds, functional groups, structure and isomerism, stereochemistry, reactions and mechanisms, aromaticity, coordination chemistry, chemistry of representative elements.

CHEM F211 Physical Chemistry I **3 0 3**

Kinetic - molecular theory of gases; perfect gas; pressure and temperature; Maxwell distribution; collisions, effusion, mean free path; Boltzmann distribution law and heat capacities; first law of thermodynamics; p-V work , internal energy, enthalpy; Joule-Thomson experiment; second law; heat engines, cycles; entropy; thermodynamic temperature scale; material equilibrium; Gibbs energy; chemical potential; phase equilibrium; reaction equilibrium; standard states, enthalpies; Temperature dependence of reaction heats; third law; estimation of thermodynamic properties; perfect gas reaction equilibrium; temperature dependence; one component phase equilibrium, Clapeyron equation; real gases, critical state, corresponding states; solutions, partial molar quantities, ideal and non-ideal solutions, activity coefficients, Debye-Huckel theory; standard state properties of solution components; Reaction equilibrium in non-ideal solutions, weak acids-buffers, coupled reactions; multi component phase equilibrium- colligative properties, two and three component systems, solubility; electrochemical systems- thermodynamics of electrochemical systems and galvanic cells, standard electrode potentials, concentration cells, liquid junction, ion selective electrodes, double layer, dipole moments and polarizations, applications in biology, concept of overvoltage.

CHEM F212 Organic Chemistry I **3 0 3**

Basic terminology and representation of organic reactions; thermodynamics and kinetics of reactions; reactive intermediates (carbocations, carbanions, free radicals, nitrenes carbenes); aromatic chemistry; properties, preparation and reactions of alkyl halides, alcohols, ethers, amines and nitro compounds; carbonyl compounds; carboxylic acid and derivatives; carbohydrates.

CHEM F213 Physical Chemistry II **3 0 3**

Origin of quantum theory - black body radiation, line spectra, photoelectric effect; wave particle duality; wave equation: normal modes, superposition; postulates of quantum mechanics, time dependence, Hermitian operators, commutator; Schrödinger equation - operators, observables, solution for particle in a box, normalization, variance, momentum; harmonic oscillator, vibrational spectroscopy; rigid rotor, angular momentum, rotational spectroscopy; Hydrogen atom - orbitals, effect of magnetic field; Variation method - variation theorem, secular determinants; Many electron atoms and molecules; Born Oppenheimer approximation, VB Theory, H2 in VB, Coulomb, exchange, overlap integrals states of H2; antisymmetric wavefunctions – two electron systems, Slater determinants, HF method; SCF method; term symbols and spectra - configuration, state, Hund's rules, atomic spectra, spin orbit interaction; basic MO theory, homonuclear diatomics - N2, O2, SCF-LCAO-MO, molecular term symbols; HMO theory - π electron approximation, conjugated, cyclic systems.

CHEM F214 Inorganic Chemistry I **3 0 3**

Structure of molecules: VSEPR model; ionic crystal structure, structure of complex solids; concepts of inorganic chemistry: electronegativity, acid-base chemistry, chemistry of aqueous and non-aqueous solvents; descriptive chemistry of some elements: periodicity, chemistry of transition metals, halogens and noble gases; inorganic chains, rings, cages and clusters.

CHEM F223 Colloid and Surface Chemistry **3 0 3**

Surface phenomena; intermolecular forces relevant to colloidal systems; forces in colloidal systems; experimental and theoretical studies of the structure, dynamics and phase transitions in micelles, membranes, monolayers, bilayers, vesicles and related systems; technical applications.

CHEM F241 Inorganic Chemistry II **3 0 3**

Coordination Chemistry: Bonding - Valence Bond, Crystal Field, and Molecular Orbital theories; Complexes - nomenclature, isomerism, coordination numbers, structure, electronic spectra, magnetic properties, chelate effect; Reactions - nucleophilic substitution reactions, kinetics, mechanisms; descriptive chemistry of Lanthanides and Actinides; Organometallic Chemistry: structure and reaction of metal carbonyls, nitrosyls, dinitrogens, alkyls, carbenes, carbynes, carbides, alkenes, alkynes, and metallocenes; catalysis by organometallic compounds; stereochemically non-rigid molecules.

CHEM F242 Chemical Experimentation I **0 3 3**

This course is based on laboratory experiments in the field of organic chemistry. Qualitative organic analysis including preliminary examination, detection of functional groups, preparation and recrystallization of derivatives, separation and identification of the two component mixtures using chemical and physical methods; quantitative analysis such as determination of the percentage/ number of hydroxyl groups in organic compounds by acetylation method, estimation of amines/ phenols using bromate-bromide solution/ acetylation method, determination of iodine and saponification values of an oil sample; single step synthesis such as benzaldehyde to cinnamic acid; multistep synthesis such as phthallic anhydride – phthallimide – anthranillic acid ; extraction of organic compounds from natural sources: isolation of caffeine from tea leaves, casein from milk, lactose from milk, lycopene from tomatoes, β- carotene from carrots etc.; demonstration on the use of software such as Chem Draw, Chem-Sketch or ISI-Draw.

CHEM F243 Organic Chemistry II **3 0 3**

Introduction to stereoisomers; symmetry elements; configuration; chirality in molecules devoid of chiral centers (allenes, alkylidenecycloalkanes, spiranes, biphenyl); atropisomerism; stereochemistry of alkenes; conformation of acyclic molecules; conformations of cyclic molecules; reaction mechanisms; asymmetric synthesis; photochemistry and pericyclic reactions.

CHEM F244 Physical Chemistry III **3 0 3**

Symmetry: symmetry operations, point groups, reducible and irreducible representations, character tables, SALC, degeneracy, vibrational modes IR-Raman activity identification; matrix evaluation of operators; stationary state perturbation theory; time dependent perturbation theory; virial and Hellmann-Feynmann theorems; polyatomic molecules: SCF MO treatment, basis sets, population analysis, molecular electrostatic potentials, localized MOs; VB method; configuration interaction, Moller Plesset perturbation theory; semi empirical methods-all valence electron methods: CNDO,INDO, NDDO; Density Functional Theory: Hohenberg-Kohn theorems, Kohn-Sham self consistent field approach, exchange correlation functional; molecular mechanics.

CHEM F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CHEM F311 Organic Chemistry III **3 0 3**

Applications of important reagents and reactions in organic synthesis and disconnection or synthon approach will be emphasized in this course. Basic principles of disconnection, order of events, chemioselectivity, regioselectivity etc. Common organic reagents, Organometallic reagents, Transition metal catalyzed reactions, introduction to reterosynthetic analysis using one group C-X and C-C disconnections, two group C-X and C-C disconnections, ring synthesis (saturated heterocycles), synthesis of heterocyclic compounds and complex molecules.

CHEM F312 Physical Chemistry IV **3 0 3**

Weak forces; surface chemistry: interphase region, thermodynamics, surface films on liquids, adsorption of gases on solids, colloids, micelles, and reverse micellar structures; transport processes: kinetics, thermal conductivity, viscosity, diffusion, sedimentation; electrical conductivity in metals and in solutions; reaction kinetics, measurement of rates; integrated rate laws; rate laws and equilibrium constants for elementary reactions; reaction mechanisms; temperature dependence of rate constants; rate constants and equilibrium constants; rate law in non ideal systems; uni, bi and tri molecular reactions, chain reactions, free-radical polymerizations; fast reactions; reactions in solutions; heterogeneous and enzyme catalysis; introduction to statistical thermodynamics; theories of reaction rates; molecular reaction dynamics.

CHEM F313 Instrumental Methods of Analysis **3 1 4**

Principles and practice of modern instrumental methods of chemical analysis. Emphasis on spectroscopic techniques such as UV-Visible, infrared, NMR (1H, 13C and other elements, NOE, correlation spectroscopies), ESR, atomic absorption and emission, photoelectron, Mössbauer, and fluorescence. Other topics will include mass spectrometry, separation techniques, light scattering, electroanalytical methods, thermal analysis, and diffraction methods.

CHEM F320 Introductory Computational Chemistry Laboratory **0 4 2**

In this course the major focus is on practical computation of electronic structure of atoms and molecules using open source and proprietary software; specific computational experiments will be in the areas of potential energy surfaces, geometry optimization, molecular geometry from symmetry and trigonometric relations without visualization software, molecular orbitals and bonding patterns, Hartree-Fock calculations, correlation energy and size-consistency, DFT based calculations, computing excited states using CIS, EOM-CCSD jobs for computing energies of excited, ionized and electron-attached states; methods to estimate activation energy, solvent effects etc.; molecular dynamics simulation, molecular mechanics

will also be explored; the actual experiments may vary and can have more specific learning outcomes so as to enhance the course with the latest developments in electronic structure theories of chemistry.

CHEM F323 Biophysical Chemistry **3 0 3**

The principles governing the molecular shapes, structures, structural transitions and dynamics in some important classes of biomolecules and biomolecular aggregates will be discussed. The topics will include: structure, conformational analysis, conformational transitions and equilibria in proteins and nucleic acids; protein folding; lipids - monolayers,bilayers and micelles; lipid-protein interactions in membranes.

CHEM F324 Numerical Methods in Chemistry **3 3 4**

Selected problems in chemistry from diverse areas such as chemical kinetics and dynamics, quantum mechanics, electronic structure of molecules, spectroscopy, molecular mechanics and conformational analysis, thermodynamics, and structure and properties of condensed phases will be discussed. The problems chosen will illustrate the application of various mathematical and numerical methods such as those used in the solution of systems of algebraic equations, differential equations, and minimization of multidimensional functions, Fourier transform and Monte Carlo methods.

CHEM F325 Polymer Chemistry **3 0 3**

Types of polymers; structures of polymers; molecular weight and molecular weight distributions; kinetics and mechanisms of major classes of polymerization reactions such as step growth, radical, ionic, heterogeneous, and copolymerization methods; polymer solutions- solubility, lattice model and the Flory- Huggins theory, solution viscosity; bulk properties-thermal and mechanical properties such as the melting and glass transitions, rubber elasticity, and viscous flow; polymerization reactions used in industry.

CHEM F326 Solid State Chemistry **3 0 3**

X-ray diffraction; point groups, space groups and crystal structure; descriptive crystal chemistry; factors which influence crystal structure; crystal defects and non-stoichiometry; solid solutions; interpretation of the phase diagrams; phase transitions; ionic conductivity and solid electrolytes; electronic properties and band theory; magnetic properties; optical properties; analysis of single crystal XRD data; preparation of solid state materials and the chemistry of device fabrication.

CHEM F327 Electrochemistry: Fundamentals and Applications **3 0 3**

Electrode Processes: Overpotential, Faradaic and non-Faradaic processes, the ideal polarized electrode, capacitance and charge of an electrode, electrical double layer; primary and secondary cells, variables in electrochemical cells, factors affecting electrode reaction, cell resistance; Mass transfer: steady-state mass transfer, semiempirical treatment of the transient response, coupled reversible and irreversible reactions, reference electrodes; Kinetics of electrode reactions: Arrhenius equation and potential energy surfaces, equilibrium conditions, Tafel Plots; rate determining electron transfer, Nernstian, quasireversible, and irreversible multistep processes; Marcus Theory; mass transfer by migration and diffusion; basic potential step methods; Ultramicroelectrodes (UME) potential sweep methods; polarography and pulse voltammetry; controlled current techniques; impedance; bulk and flow electrolysis; electrochemical instrumentation; scanning probe techniques, STM, AFM, Scanning Electrochemical Microscopy, approach curves, imaging surface topography and reactivity, potentiometric tips, applications.

CHEM F328 Supramolecular Chemistry **3 0 3**

Non-covalent interactions and their role in “supermolecules” and organized polymolecular systems; concepts of molecular recognition, information and complementarity; molecular receptors: design principles, binding and recognition of neutral molecules and anionic substrates, coreceptor molecules and multiple recognition, linear recognition of molecular lengths by ditopic coreceptors, heterotopic coreceptors, amphiphilic receptors, large molecular cages; supramolecular dynamics; supramolecular catalysis: reactive macrocyclic cation and anion receptor molecules, cyclophane type receptor, metallocatalysis, catalysis of synthetic reactions, biomolecular and abiotic catalysis, heterogeneous catalysis; transport processes and carrier design: cation and anion carriers, electron, proton and light coupled transport processes, transfer via transmembrane channels; supramolecular assemblies: heterogeneous molecular recognition, supramolecular solids, molecular recognition at surfaces, molecular and supramolecular morphogenesis; supramolecular photochemistry: photonic devices, light conversion and energy transfer devices, photosensitive molecular receptors, photoinduced electron transfer and reactions, non-linear optical properties; supramolecular electrochemistry: electronic devices, molecular wires, polarized molecular wires, switchable molecular wires, molecular magnetic devices; ionic devices, tubular mesophases, ion-responsive monolayers, molecular protonics, ion and molecular sensors, switching devices and signals, photoswitching and electroswitching devices, switching of ionic and molecular processes, mechanical switching processes; self-assembly: inorganic architectures, organic structures by hydrogen bonding; helical metal complexes, supramolecular arrays of metal ions – racks, ladders and grids, molecular recognition directed self-assembly of organized phases; supramolecular polymers; ordered solid-state structures; supramolecular synthesis, assistance, replication; supramolecular chirality; supramolecular materials.

CHEM F329 Analytical Chemistry **3 1 4**

Data handling; sample preparation; unit operations; volumetric and gravimetric analysis; chromatography; solvent and solid phase extraction; absorption and emission techniques; potentiometry, voltammetry; trace metal separation and estimation in biological and environmental samples with emphasis on green chemistry, sensors; laboratory training in some of these techniques.

CHEM F330 Photophysical Chemistry **3 1 4**

Absorption of the electromagnetic radiation; photophysical processes such as fluorescence, phosphorescence, non-radiative transitions, and delayed luminescence, excimer and exciplex formation; triplet state: radiative and non-radiative transitions; energy transfer, fluorescence resonance energy transfer (FRET), quenching of fluorescence; fluorescence decay; protein and DNA fluorescence; time-resolved emission spectra (TRES); time-dependent anisotropy decays; application of photophysics for the characterization of biological and bio-mimicking systems. In addition to the theory, through simple experiments, laboratory training will be imparted.

CHEM F333 Chemistry of Materials **3 0 3**

Solid state structure : unit cells, metallic crystal structures, polymorphism and allotropy, crystallographic direction and planes, closed packed crystal structures, polycrystalline materials, anisotropy; meso and micro porous materials: zeolites, composites, synthesis, characterization (XRD, SEM, TEM, AFM, FTIR, NMR, TGA, and DTA) and applications; ceramics and glass materials: crystalline and non-crystalline nature, glass-ceramics, processing; polymers: synthesis, structure, properties, inorganic polymers; mechanical properties: stress and strain, elastic and tensile properties, hardness, phase transformations, microstructure, alteration of mechanical properties; magnetic properties: atomic magnetism in solids, the exchange interaction, classification of magnetic materials, diamagnetism, pauli paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism, superparamagnetism, ferromagnetic domains, hysteresis loop, hard and soft ferrites, applications; electrical properties: conductivity, band theory, types of semiconductors, time dependence of conductivity, mobility of charge carriers, metal-metal junction, metal–semiconductor junction, n-type and p-type semiconductors; optical properties: refraction, reflection, absorption, transmission, luminescence, photoconductivity, opacity and translucency in insulators, optical fibers; thermal properties: heat capacity, thermal expansion, conductivity, thermal stresses; corrosion: electrochemistry of corrosion of metals, different forms, environmental effects, prevention.

CHEM F334 Magnetic Resonance **3 0 3**

Classical treatment of motion of isolated spins; quantum mechanical description of spin in static and alternating magnetic fields; Bloch equations; spin echoes; transient and steady state responses; absorption and dispersion; magnetic dipolar broadening; formal theory of chemical shifts; Knight shift; second order spin effects; spin-lattice relaxation; spin temperature; density matrix; Bloch-Wangsness-Redfield theory; adiabatic and sudden changes; saturation; spin locking; double resonance; Overhauser effect; ENDOR; pulsed magnetic resonance: Carr-Purcell sequence, phase alternation, spin-flip narrowing, real pulses; electric quadrupole effects; spin-spin coupling; 2D correlation spectroscopies: COSY, DQF, INADEQUATE experiments; CIDNP; electron paramagnetic resonance (EPR); nuclear quadrupolar resonance; muon spin resonance; magnetic resonance imaging.

CHEM F335 Organic Chemistry and Drug Design **3 0 3**

An introduction to organic chemistry principles and reactivities vital to drug design, drug development and drug action; the role of molecular size, shape, and charge, and in drug action; proteins and nucleic acids as drug targets; bioisosterism; ADME, QSAR and drug design; applied molecular modeling and combinatorial synthesis; Synthesis of some selected chemotherapeutic agents (e.g antifungal, antibacterial, antimalarial, anticancer etc.)

CHEM F336 Nanochemistry **3 1 4**

Nano and nature, importance of nanoscience, chemistry behind nano; instruments for characterizing nanomaterials; diversity in nanosystems: chemical aspects of metallic, magnetic and semiconducting nanomaterials, carbon nanotubes and fullerenes, self-assembled monolayers, monolayer protected metal nanomaterials, core-shell nanomaterials; applications of nano materials in nanobiology, nanosensors and nanomedicine; hands on experience in laboratory.

CHEM F337 Green Chemistry and Catalysis **3 0 3**

Definition and overview of the twelve principles of Green Chemistry, alternative starting materials; alternative synthesis and reagents; E factor and the concept of atom economy; the role of catalysis, alternate energy sources (microwave & ultrasound), catalysis by solid acids and bases, bio-catalysis, catalytic reduction, catalytic oxidation, catalytic C–C bond formation, cascade catalysis, enantioselective catalysis, alternative reaction media, renewable raw materials, industrial applications of catalysis.

CHEM F341 Chemical Experimentation II **0 4 4**

This course is based on laboratory experiments in the fields of inorganic, physical and analytical chemistry. Quantitative separation and determination of pairs of metal ions using gravimetric and volumetric methods; Ion exchange chromatography; Separation & estimation of metal ions using ion exchangers and solvent extraction techniques; Determination of Keq of M – L systems by colorimetry; Preparation, purification and structural studies (magnetic, electronic and IR) of inorganic complex compounds; Physical property measurements such as conductance, pH, viscosity, surface tension, refractive index, specific rotation etc. Experiments to illustrate the principles of thermodynamics, kinetics, chemical equilibrium, phase equilibrium, electrochemistry, adsorption, etc.

CHEM F342 Organic Chemistry IV **3 0 3**

The fundamental structural characteristics, synthesis and reaction of various heterocyclic compounds, natural products and biomolecules will be emphasized in this course. Structure, nomenclature and common reactions of heterocyclic compounds; synthesis, properties and reactions of three-, four-, five-, and six membered ring systems; condensed five and six membered ring systems, introduction to natural products; terpenoids, steroids, lipids, alkaloids, amino acids, peptides, proteins and vitamins.

CHEM F343 Inorganic Chemistry III **3 0 3**

Inorganic elements in biological systems: role of alkali and alkaline earth metal ions, iron, copper and molybdenum; metalloenzymes. Metals in medicine: metal deficiency and disease; toxicity of mercury, cadmium, lead, beryllium, selenium and arsenic; biological defence mechanisms and chelation therapy. Molecular magnetic materials: trinuclear and high nuclearity compounds; magnetic chain compounds; magnetic long-range ordering in molecular compounds; design of molecular magnets. Other emerging topics in inorganic chemistry.

CHEM F366 Lab Project **3**

CHEM F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHEM F376 Design Project **3**

CHEM F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CHEM F412 Photochemistry and Laser Spectroscopy **3 0 3**

Photochemical events : absorption, fluorescence and phosphorescence; Jablonski diagrams; physical properties of molecules after photoexcitation; photochemical tools and techniques: spectrophotometers, fluorescence decay time measurement and analysis, flash photolysis; fundamental properties of laser light; principles of laser operation ; description of some specific laser systems : Helium-Neon, Argon ion, CO2, Nd-YAG and ultrafast Titanium : Sapphire lasers.

CHEM F413 Electron Correlation in Atoms and Molecules **3 1 4**

Matrix algebra, Matrix representation of operators; mean-field approach: the Hartree-Fock method- formulation, coulomb and exchange integrals, Fock-operator, second quantization, Slater rules, self-consistency, correlation energy; Brillouin's theorem, Koopmans' theorem; basis-sets, restricted Hartree-Fock, Roothan-Hall equations; unrestricted Hartree-Fock method, spin-contamination; restricted open-shell Hartree-Fock method; Recovery of correlation energy time independent perturbation approach: Brillouin-Wigner and Rayleigh-Schrodinger perturbation theories; Møller Plesset and Epstein-Nesbeth partitioning of molecular Hamiltonion, many-body perturbation theory; Feynman diagrams, connected and disconnected terms, size-consistency; Recovery of correlation energy: configuration interaction and other non-perturbative approaches, variational and projection approaches for obtaining CI anasatz, truncated CI and size-consistency problem, Davidson correction, pair-coupled-pair theory, coupled-electron-pair method and coupled-cluster approach; Density functional theory, N-representability, V-representability, Kohn-Sham approach, natural orbitals, exchange-correlation functionals, Levy functional.

CHEM F414 Bio and Chemical Sensors **3 0 3**

Biological and chemical recognition: reaction kinetics, signals and noise, sensitivity, specificity, selectivity; IUPAC definition of biosensors, their classification based on receptors and transducers; analytical characteristics of various types of bio and chemical sensors, performance criteria of biosensors; electrochemical, optical, thermal, piezoelectric transducer selections for immunosensors and enzyme sensors; sufrace functionaliazaiton of transducers, novel self assembly techniques, coupling of biomolecules on different surfaces and their characterization; thermal biosensors, enzyme thermistor; miniaturization of sensors and flow injection techniques; applications in analysis such as urea, penicillin, pesticides, cholesterol; optical biosensor mechanisms: fluorescence and chemiluminescence techniques; electrochemical biosensors: impedimetric and amperometric biosensors; electrochemical quartz crystal micro balance, applications in chemical and biological analysis; flow injection systems vs. static measurements, protein-protein interaction and quantification; principle of inhibition based biosensor for enzyme and immunoassay, pretreatment techniques in bio-analysis.

CHEM F415 Frontiers in Organic Synthesis **3 0 3**

Traditional and classic organic synthesis; modern synthetic strategies; systematic approach in terms of progress in reaction methodologies in synthesizing complex natural molecules; metal-catalyzed C-C and C-X couplings; direct functionalization via C-H and C-C activation; development of organocatalysis: metal-free catalysis; direct functionalization of olefins including hydroamination, hydrogenation, hydrosilylation, hydroformylation and other C-C bond forming reactions; the potential of radical chemistry for C-C and C-X bond formation; metal-catalyzed carbocyclization: from Ru and Rh-mediated cycloadditions to Pt and Au chemistry; one-pot multi-steps reactions: avoiding time and resource-consuming isolation procedures; tracing the development from the first total synthesis to the state of the art for some complex molecules.

CHEM F422 Statistical Thermodynamics **3 0 3**

Review of classical thermodynamics, principles of statistical thermodynamics, ensemble averages; Boltzmann distribution; partition functions and thermodynamic quantities; ideal gases and crystals; thermodynamic properties from spectroscopic and structural data; dense gases and the second virial coefficient; statistical mechanics of solutions; Bose-Einstein and Fermi-Dirac statistics.

CHEM F430 Atmospheric Chemistry **3 0 3**

This course aims to describe the chemical and physical processes of atmosphere by different models. The specific topics will include, the measures of atmospheric compositions, atmospheric pressure, models to explain variation in concentration of chemical species in atmosphere, atmospheric transport, continuity equation to provide quantitative measures about the

variation of concentration, geochemical cycles, the green-house effect, aerosols, atmospheric chemical kinetics, stratospheric ozone, oxidation in troposphere, ozone air pollution, and acid rain.

CHEM F431 Sustainable Chemistry using Renewables **3 0 3**

mportance of the utilization of renewable resources as alternative feedstock for the chemicals and fuels industry; alternatives to current petro-based technology and processes such as biomass utilization; chemicals from renewables, bio-refinery concept, strategies for biomass utilization, Platform molecules, Degraded molecules, Biomass conversions by new catalytic/ synthetic routes, catalytic cascade reactions, one-pot multi-product synthesis; chemistry in lignocellulose conversions; bio-based oleochemicals; fine chemicals from renewables; thermo-chemical conversion to fuels and other chemicals; analyticals in thermal biomass conversions, kinetics based on tunable diode laser measurements, CFD modeling; bio-ethanol : production, upgradation and valorization; glycerol as feedstock; fatty acid epoxidation; hydrogen and carbon-di-oxide, hydrogen as a feedstock, electro-catalysis, solar-photo catalysis, fuel cells, Carbon-di-oxide capture and valorization.

CHEM F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

CHEM G511 Nuclear and Radio Chemistry **5**

Course description is to be developed.

CHEM G513 Advanced Nuclear and Radio-chemistry **5**

Nuclear stability, binding energy, properties of nucleons; Nuclear models (Shell Model, Liquid drop model), Radioactive decay characteristics, decay kinetics, α, β and γ decay, nuclear reactions, types, radiative capture, reaction cross section, theory of fission; Nuclear reactors – classification, Reactor power, Breeder reactors, Nuclear reactors in India, Reprocessing of spent fuel, Nuclear waste management (HLW, LLW and ILW); Detection and measurement of activity, GM counters, Gamma counters, Liquid Scintillation counting; Application of radioactivity, Szilard Chalmers reaction, Isotope dilution analysis, Neutron activation analysis, Diagnostic and therapeutic applications of radionucleides, interaction of radiation with matter.

CHEM G521 Environmental Chemistry **5**

Energy-flows and supplies, fossil fuels, nuclear energy, nuclear waste disposal, renewable energy, industrial ecology, green chemistry, ozone chemistry, effect of SO_x, NO_x as pollutants, reformulated gasoline, water pollution and treatment, organochlorine and organophosphate pesticides, eco-system effects, Toxic chemicals – Effect of dioxins, polychlorinated biphenyls (PCBs) and species of metals such as lead, mercury, cadmium etc.

CHEM G531 Recent Advances in Chemistry **5**

The course is aimed at providing an overview of recent developments in selected areas of chemistry. Topics to be covered may be drawn from: modern theories of structure, bonding and reactivity, spectroscopy, chemical dynamics, phase transitions, surface phenomena, solid state materials, and synthetic and mechanistic organic and inorganic chemistry, or such other topics as may emerge in the development of the subject.

CHEM G541 Chemical Applications of Group Theory **5**

Groups, subgroups and classes : definitions and theorems; molecular symmetry and symmetry groups; representation of groups; character tables; wave functions as bases for irreducible representations; direct product; symmetry adapted linear combinations; symmetry in molecular orbital theory; hybrid orbitals; molecular orbitals of metal sandwich compounds; ligand field theory; molecular vibrations; space groups.

CHEM G551 Advanced Organic Chemistry **5**

Recent advances in aromatic electrophilic and nucleophilic substitution reactions and nucleophilic addition reactions; oxidation and reduction; enolates in organic synthesis; retro synthetic analysis; multiple step synthesis; protecting groups.

CHEM G552 Advanced Inorganic Chemistry **5**

Advanced coordination chemistry, reactions, kinetics and mechanism; advanced organometalic chemistry, bonding models in inorganic chemistry, inorganic chains, rings, cages and clusters; group theory and its applications to crystal field theory, molecular orbital theory and spectroscopy (electronic and vibrational); inorganic chemistry in biological systems.

CHEM G553 Advanced Physical Chemistry **5**

Equilibrium: The laws of Thermodynamics, applications to phase equilibrium, reaction equilibrium, and electrochemistry; Structure: Principles and techniques of quantum mechanics, applications to atomic and molecular structure and spectroscopy, statistical thermodynamics, molecular interactions, macromolecules, solid state; Dynamics: Molecular motion in gases and liquids, reaction rate laws, mechanisms and rate theories of complex reactions, molecular reaction dynamics, surface processes, electron transfer dynamics.

CHEM G554 Physical Methods in Chemistry **5**

Advanced spectroscopic and non-spectroscopic techniques used in chemistry; Topics will include electronic absorption spectroscopy of organic and inorganic compounds, ORD, CD; vibrational rotational spectroscopy symmetry aspects; Dynamic and Fourier transform NMR, NOE, Multipulse methods, Two-Dimensional NMR; EPR; NQR; Mossbauer spectroscopy; Magnetism; Ionization Methods: Mass spectrometry, Ion Cyclotron Resonance; Photoelectron Spectroscopy; Microscopic techniques: TEM, STM, AFM; EXAFS, XANES; X-ray Crystallography.

CHEM G555 Chemistry of Life Processes **4**

Synthesis and structures of biopolymers such as proteins and nucleic acids; nucleic acid replication, transcription and translation; lipids and biomembranes; transport across membranes; neurotransmission; enzyme and enzyme inhibitors; citric acid cycle, pentose phosphate pathway and nucleic acid metabolisms; photosynthesis; electron transport systems in respiration and oxidative phosphorylation.

CHEM G556 Catalysis **4**

A comprehensive survey of the catalytic processes along with the fundamental aspects of the catalyst design and evaluation; several classes of heterogeneous industrial catalysts; their preparation, characterization and applications, recent developments in catalysis, application of nanomaterials in catalysis.

CHEM G557 Solid Phase Synthesis and Combinatorial Chemistry **4**

A comprehensive understanding of solid phase synthesis and combinatorial chemistry, basic principles of solid phase organic synthesis; solid phase organic synthesis strategies; introduction to combinatorial chemistry; analytical techniques in combinatorial chemistry; applications of the combinatorial approach in chemistry, drug development and biotechnology.

CHEM G558 Electronic Structure Theory **5**

Advanced methods in theoretical and computational chemistry based on Quantum Mechanics: Review of mathematical background, N-Dimension complex vector spaces, linear variational problem, many electron wave functions and operators, operators and matrix elements; Ab-initio methods: Hartree-Fock (H-F), Configuration Interaction (CI), Many Body Perturbation Theory (MBPT); Density Functional Theory: Thomas-Fermi model, Hohenberg-Kohn theorems, derivation of Kohn-Sham equations; Development and use of software for such models.

CHEM G559 Bioinorganic Chemistry **4**

Fundamentals of inorganic biochemistry; essential and non-essential elements in bio-systems, metalloproteins and metalloenzymes; role of metal ions in oxygen carriers, synthetic oxygen carriers, bioinorganic chips and biosensors; fixation of dinitrogen, environmental bioinorganic chemistry; transport and storage of metal ions *in vivo*, metal complexes as probes of structure and reactivity with metal substitution; fundamentals of toxicity and detoxification, chelating agents and metal chelates as medicines, nuclear medicines.

CHEM G561 Heterocyclic Chemistry **5**

The fundamental structural characteristics; synthesis and reactions of various heterocycles with nitrogen, oxygen and sulphur heteroatom in the ring; heterocyles such as pyrrole, thiophene, furan, imidazole, thiazole, oxazole, indole, benzofuran, pyridine and quinoline; advanced synthesis and reaction mechanism of heterocyclic compound.

CHEM G562 Solid State Chemistry **4**

Basics of solid state chemistry, comprehensive survey of different synthesis techniques, properties and their structural-property relationship of solid materials; introduction to special nanomaterials, ceramics, polymers, biopolymers and nanocomposites; thermal and mechanical properties of nanomaterials; nanocomposites in hydrophobic applications; recent advances in material science and technology.

CHEM G563 Advanced Statistical Mechanics **5**

Review of ensembles, fluctuations, Boltzmann statistics, quantum statistics, ideal gases and chemical equilibrium; imperfect gases; distribution function theories and perturbation theories of classical liquids; electrolyte solutions; kinetic theory of gases; continuum mechanics; Boltzmann equation; transport processes in gases and Brownian motion; introduction to time-correlation function formalism.

Computer Science

CS F111 Computer Programming **3 1 4**

Basic Model of a Computer; Problem Solving-Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

CS F211 Data Structures & Algorithms **3 1 4**

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Recursive Data Types, Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues); Searching and Order Queries. Sorting

– Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization), Lower Bound on Complexity of Sorting Algorithms. Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Probabilistic/Randomized Data Structures (such as Bloom Filters and Splay Trees). Generalized Trees – Traversals and applications. Text Processing – Basic Algorithms and Data Structures (e.g. Tries, Huffman Coding, String search / pattern matching). External Memory Data structures (B-Trees and variants). Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees).

CS F212 Database Systems **3 1 4**

Data modeling, database design theory, data definition and manipulation languages, relational data model, relational algebra and relational calculus, SQL, functional dependencies and normalization, storage and indexing techniques, query processing and optimization, transaction management - concurrency control and crash recovery; distributed databases.

CS F213 Object Oriented Programming **3 1 4**

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages. Object Oriented Design Patterns: Behavioral, Structural and Creational.

CS F214 Logic in Computer Science **3 0 3**

propositional logic – syntax, semantics, satisfiability & validity, predicate or first order logic – syntax, semantics, satisfiability & validity, completeness & compactness, Undecidability & incompleteness; Godel's incompleteness theorem; SAT solvers; verification by model checking, linear-time temporal logic (LTL), & computational tree logic (CTL). Program verification using Hoare logic & proofs of correctness; Modal logic & logic programming paradigm.

CS F215 Digital Design **3 1 4**

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

CS F222 Discrete structures for Computer Science **3 0 3**

Sets & operation on sets; relations & equivalence relations; number theory; weak & strong form of mathematical induction; principle of inclusion & exclusion, pigeonhole principle; recurrence relations & generating functions; digraphs & graphs, graph isomorphism & sub-graphs, spanning trees, Euler & Hamiltonian graphs, planar graphs, chromatic numbers & graph coloring; groups; Lagrange theorem finite groups; Rings & Fields.

CS F241 Microprocessors & Interfacing **3 1 4**

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system . This course will have laboratory component.

CS F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

CS F301 Principles of Programming Languages **2 0 2**

The course covers features of programming languages and introduces the main programming paradigms. It covers, in detail, the semantics of the features of programming languages –Control Abstraction, Data Types and Data Abstraction, Scope and Parameter passing and Concurrency related features. It covers various aspects of runtime environments like global and local data, code, function call stacks, dynamically allocated data, runtime features for exceptions and threads. Introduction to programming paradigms. Functional paradigm – formal elements of lambda calculus, introduction to syntax of common functional programming languages and programming exercises that explore the functional

paradigm. Logic programming paradigm - formal elements of logic programming and programming tasks that explore the logic paradigm. Scripting as a paradigm. Domain specific languages. Applications of the principles of programming languages –program verification, software testing and security.

CS F303 Computer Networks **3 1 4**

Introduction; Need for Computer Networks; Top-down vs. Bottom-up approaches; Network Services, and Protocols; Network Reference Models and Architectures, Architecture of the Internet, Types and Applications of contemporary and emerging Networks, Application-Layer Requirements, Concepts, Services and Protocols: Protocols for Web, Email, File transfer, Name Resolution, Address Assignment / Discovery, Remote Access Services, Voice/Video over IP, Webcasting, Video-Conferencing and Telepresence, Network Management Protocols and Overlay Networks; Transport Layer Requirements, Services, Concepts and Protocols; Network Layer Requirements, Concepts, Services and Protocols, Routing vs.

Layer-3 Switching; QoS; Link Layer and Physical Layer Requirements, Concepts, Services and Protocols, Logical Link and Medium Access Control concepts, Physical medium dependent function, Modes of Signaling and Communication at the lower layer; IEEE 802 architecture, Bridging versus Layer-2 Switching; VLANs, VPNs, Performance vs. Security, Emerging Trends and Best Practices related to design of computer networks and internetworks.

CS F314 Software Development for Portable Devices **2 1 3**

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

CS F320 Foundations of Data Science **3 0 3**

Introduction to Data Science, Review of Probability, Random Variables and Probability Distributions, Bayesian probabilities, Conditional Gaussian distributions, Marginal Gaussian distributions, Bayes' theorem for Gaussian variables, Maximum likelihood and Bayesian Inference for the Gaussian, Mixtures of Gaussians, Probability Bounds, Nonparametric Methods - Kernel density estimators, Nearest-neighbour methods, Bayesian Curve Fitting, Introduction to constrained and unconstrained optimization, High Dimensional Data & Curse of Dimensionality, Dimensionality Reduction, PCA & SVD, Data Visualization Techniques, OLAP and Multidimensional Data Analysis, Data Pre-processing, Big Data & Big Data Analytics, Social Media data.

CS F342 Computer Architecture **3 1 4**

Processor performance criteria, performance benchmarks, arithmetic circuits, CPU design - instruction set architecture, instruction execution, Single and Multicycle implementation, Pipeline design, Hazards, methods of overcoming hazards, Branch prediction, Memory subsystems including cache optimization, Instruction level Parallelism.

CS F351 Theory of Computation **3 0 3**

Review of Set Theory - Cardinality, Countable and Uncountable Infinite Sets, Relations and Functions, Equivalence Relations. Introduction to Languages and Operations Applicable to Languages. Regular Expressions. Finite State Automata - Deterministic and Non-Deterministic – Equivalence, FSAs and Regular Expressions – Closure Properties of Regular Languages – Equivalence Classes of a Language and Minimal Automata. Non-Regular Languages. Context Free Grammars and Push Down Automata – Equivalence and Closure Properties – Normal forms and Concepts in Parsing – Languages that are not Context Free. Turing Machines – Unrestricted Grammars – Equivalence – Various Forms of TMs and their Equivalence. Recursive functions. Universal Turing machine – Reductions – Decidability – Undecidable Languages. Complexity Classes – P, NP and NP-Completeness.

CS F363 Compiler Construction **2 1 3**

Introduction - Compilation and Execution Environments -Compilers and Interpreters – Requirements and Motivation; Front-end and Back-end of compilers/interpreters; Intermediate Representation and Intermediate Languages; Compile Time vs. Execution Time; Translators, and Assemblers; Virtual Machine -Just-in-Time Compilers. Structure of a Compiler – Phases and Passes. In-memory data - intermediate versions of code, symbol table. Lexical Analysis: error handling & tool construction, DFA, Defining tokens using regular expressions, Designing and implementing scanners / lexical analyzers. Parsers: Context Free Languages (introduction where needed)and Recognizing CFLs. Parsing techniques – LL , LR - LR (0),LR(1), LALR) . Intermediate Representation: Parse Trees and Abstract Syntax Trees; 3-address code. Semantic Analysis. Back End Phases: Machine Independent optimizations: Loop Optimization Techniques - Loop Unrolling, Induction variable based optimization, Loop-Invariant code elimination. Procedure Call Optimization, and Dead Code Elimination. Target Code Generation : Data Flow Analysis, Register Allocation, Instruction Selection & Scheduling. Memory Management : Memory allocation support, Memory- de-allocation – Garbage Collection Techniques. Advanced Topics :Issues in compiling Object Oriented Languages, Functional Languages, Concurrent Languages, Script & Query Languages.

CS F364 Design and Analysis of Algorithms **3 0 3**

Basic Design Techniques – Divide-and-Conquer, Greedy, Dynamic Programming (Examples, Analysis, General Structure of Solutions, Limitations and Applicability). Specialized Design Techniques: Network Flow, Randomization (Examples, Analysis, Limitations). Complexity Classes and Hardness of Problems – P, NP, Reductions, NP-hardness and NP-Completeness, Reduction Techniques, Basic NP-complete problems. Design Techniques for Hard Problems – Backtracking, Branch-and-Bound, and Approximation (General approaches and structure of solution, Analysis, and Limitations). Linear Programming – LP Problem and Simplex Algorithm, Approach for using LP for modeling and solving problems. Introduction to Design and Analysis of Parallel and Multi-threaded Algorithms.

CS F366 Lab Project **3**

CS F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CS F372 Operating Systems **3 0 3**

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms

; File systems: design and implementation of file systems; Input/Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

CS F376 Design Project **3**

CS F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

CS F401 Multimedia Computing **3 0 3**

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codecs, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

CS F402 Computational Geometry **3 0 3**

Introduction to Computational Geometry, degeneracies and robustness, convex hull in 2D, line-segment intersection, doubly-connected edge list, computing the overlay of two subdivisions, art gallery theorem, guarding and triangulation, monotone polygons, partitioning arbitrary polygon into monotone polygons, triangulating a monotone polygon, range search problem, Kd- trees, range trees, fractional cascading, point location problem, trapezoidal maps, randomized incremental algorithm to compute trapezoidal map, post-office problem, Voronoi diagram and its properties, Algorithm to compute Voronoi diagram, Delaunay triangulation and relation with Voronoi diagram, Computing Delaunay triangulation, line and point duality, arrangement of lines, application of computational geometry.

CS F404 Computer Crime and Forensics **2 0 2**

Introduction to Computer Forensics: collection, preservation, analysis, preparation and presentation of computer based evidence for the purposes of criminal law enforcement or civil litigation. Structure of Storage Media: Study of different file systems (FAT12, FAT16, FAT32, NTFS, EXT2/EXT3, etc). Study of digital forensic techniques: Disk forensics, Network forensics and Device forensics. Understanding Computer Crime, Data Acquisition, Forensic Analysis (Internet History files, Email files and major operating system files for different OS's). Study of Steganography: information hiding and retrieval. Live versus Dead forensics. Use of Forensic Tools for file system analysis, registry analysis, network analysis, etc. Introduction to computer crimes in India and abroad.

CS F406 Ethical Hacking **2 2 3**

Techniques and tools for ethical hacking and countermeasures; exploit approaches – social engineering, scanning, footprinting, enumeration, sniffers, buffer overflows, web-hacking including cross scripting, SQL injection, privilege escalation, root kits, search engine highjack, covert channel, binary auditing, services specific hacking like DNS, Email, Web servers, Proxy; techniques of bypassing security mechanisms and hardening systems and networks for countermeasures of security analysis, monitoring and analysis tools including network traffic and system logs.

CS F407 Artificial Intelligence **3 0 3**

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving.

The course also aims at understanding its implementation using LISP and PROLOG languages.

CS F413 Internetworking Technologies **3 0 3**

Introduction to internetworking concepts; the internet architecture; goals and key issues related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security; case studies.

CS F415 Data Mining **3 0 3**

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

CS F422 Parallel Computing **3 0 3**

Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix algebra, graphs, discrete optimization problems and computational geometry.

CS F424 Software for Embedded Systems **3 1 4**

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis – Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

CS F441 Selected Topics from Computer Science **3**

This course is primarily intended to introduce the students of computer science to topics, either in recent advances or of special interest. Topics may be taken from one or more of the areas like artificial intelligence, theory of computing, networking and distributed processing, digital control, information theory, super computers, special purpose architectures and language processors.

CS F444 Real–Time Systems **3 0 3**

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS F446 Data Storage Technologies and Networks **3 0 3**

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

CS F451 Combinatorial Mathematics **3 0 3**

Course description is to be developed.

CS F468 Information Security Project **0 3 3**

Malware and Malware Identification, Terminate-and-Stay-Resident programs, Identification of signatures/patterns of viruses, Developing Antivirus tools, Single system firewalls and rules, Rootkits and identification of rootkits, Virtual machines, Sandboxes and run-time monitors.

CS F469 Information Retrieval **3 0 3**

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

CS F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

CS G501 Mobile Computing **5***

Course description to be developed.

CS G511 Design and Analysis of Algorithms **3 2 5**

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

CS G512 Introduction to Authoring Systems **4**

Characteristics and principles of expert systems; construction and transfer of expertise; meta-knowledge; tools and formalisms for expert systems; application through programs in prolog; state of art characteristics and principles of authoring systems; implementation techniques.

CS G513 Network Security **3 1 4**

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, securitystandards, security system interoperation and case studies of the current major security systems.

CS G514 Object Oriented Analysis and Design **2 2 4**

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

CS G515 Queueing Systems Theory **3 2 5**

Resource sharing issues and theory of queueing systems; Review of Markov chains and baby queueing theory; Method of stages. M/Er/1. Er/M/1. Bulk arrival and bulk service systems. Series-parallel stages. Fundamentals of open and closed queueing networks. Intermediate queueing theory: M/G/1; G/M/m. Collective marks. Advanced queueing theory: G/G/1; Lindley integral equation; spectral solution. Inequalities, bounds, approximations.

CS G517 Network and System Security **4***

Course description is to be developed.

CS G520 Advanced Data Mining **3 1 4**

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

CS G521 Object Oriented Programming **2 2 4**

Basics of object oriented programming: objects, classes, instances; inheritance; polymorphism; operator overloading; static and dynamic binding; small talk, C++, cases from other object oriented languages like Ada, Loop, Flavors, Objective-C, etc.; object oriented software engineering.

CS G523 Software for Embedded Systems **3 2 5**

Real-time and embedded systems; software issues in embedded system; software development process; requirement analysis: use cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed design; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, test cases. The course will also consist of laboratory practices and development of software for embedded systems.

CS G524 Advanced Computer Architecture **3 0 5**

Basics of Parallelism, Instruction Level Parallelism, Simultaneous Multi-Threading, Design and Optimization Techniques for Cache and DRAM; Pipelining and Super-scalar Techniques, Multiprocessor and Multi-core architecture, Shared Memory and Cache Coherence Issues; Multi-vector and SIMD computers, Performance evaluation methods, Interconnect Design Techniques.

CS G525 Advanced Computer Networks **3 2 5**

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CS G526 Advanced Algorithms & Complexity **3 2 5**

Advanced Algorithm Design Strategies such as Randomization, Approximation and Game-Theoretic Techniques. Design of Parallel and Distributed Algorithms. Design of algorithms for application domains such as Internet / Web, and Computational Biology.

CS G527 Cloud Computing **5**

Review of Distributed computing - Concurrency, message passing, connectivity and failure models, replication. Computing Infrastructure - Processing Power, Storage aggregation, I/O & Communication, Clusters and Data Centers. Resource modeling and virtualization - CPU virtualization, memory and storage virtualization, virtualized networks. Services - Service models and service contracts; Programming on the cloud. Cloud Applications - Software on the Cloud and Infrastructure Services. Cloud infrastructure - Private vs. Public Clouds, Resource scaling and Resource provisioning. Quality of Service - Performance models, scalability, Performance measurement and enhancement techniques. Security issues - Data/ Storage Security, Resource Access Control, Process Isolation and Control, Service Policies and Privacy Issues.

CS G531 Testable Design & Fault Tolerant Computing **3 2 5**

Fault: types, modelling and simulation; testing methodologies, coverage, economics and quality; test vector generation: design for testability, built-in self tests; fault tolerant computing; fault tolerant software.

CS G541 Pervasive Computing **4***

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

CS G551 Advanced Compilation Techniques **5**

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

CS G553 Reconfigurable Computing **5**

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation. Systolic Architectures.

CS G554 Distributed Data Systems **3 2 5**

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques.

Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization.

Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

CS G555 System Specifications and Modelling **3 3 4**

Requirement analysis, specification formalisms, system modeling issues, system modeling languages, Hardware Specification and verification languages, EDA tools and its applications.

CS G557 Distributed Computing **5***

Course description is to be developed.

CS G559 Database Security **5***

Course description is to be developed.

CS G562 Advanced Architecture and Performance Evaluation **3 2 5**

Introduction to advanced architectures; parallel processing; pipelining and vector processing; array processing; SIMD computers and processor enhancement; performance evaluation methods, statistics and discrete math applications; modelling for evaluation of virtual memory; time sharing environments.

CS G564 Advanced Cryptography **5***

Course description is to be developed.

CS G566 Secure Software Engineering **5***

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

CS G568 Network Security Project **0 3 3**

Network Intrusion and Intrusion Detection Techniques and Tools; Denial-of-Service attacks and Techniques/Tools for handling them; Network Firewalls and Firewall policies/mechanisms; Network-wide authentication schemes for users/clients/servers; Network-wide storage and storage security models and implementations.

CS G611 Distributed Processing Systems **2 2 4**

Concepts of distributed processing, networkable architectures, inter process and processor communication algorithms, process migration and porting techniques etc.

CS G612 Fault Tolerant System Design **2 3 5**

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

CS G622 Local Area Networks: Design and Implementation **2 3 5**

Introduction to Local Networks; carrier sense networks; shared memory and device systems; protocol and token passing techniques & algorithms; security and integrity problems; algorithms and implementation; and selected current topics.

CS G623 Advanced Operating Systems **3 2 5**

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, aggrement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, thereads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

CS G631 Devices, Data Communications and Control **3 2 5**

Principles of operations of I/O devices; device handlers; master- slave control & controllers; Intelligent mode of operation; device handlers; most popular data communication methods; synchronisation and handshaking; design of controllers for selected devices.

CS G632 Application Driven System Design **0 4 4**

General principles of application driven systems, examples from space and high speed digital imaging systems, Bandwidth considerations, design aspects etc

CS G641 Microprocessor-Based Systems Design **2 3 5**

Small systems organisation; bus architectures; building blocks around a microprocessor; memory techniques; RAM disks; paged memory modules; communications and data transfers; monitors and operating systems; engineering applications of microprocessors as device controllers; concept of local and central control.

CS G642 Recent Advances in Computing **2 2 4**

Introduction to transputing and transputers, minimization algorithms, design aspects. Neural networks modelling, simulation and design. Optical computing and recent advances.

CS G651 Symbolic Computing & Computer Algebra **2 2 4**

Course description is to be developed.

CS G652 Digital Communications and Message Switching **3 2 5**

Signals & transmission types; noise; coding & decoding; modulation techniques; filters; time and frequency multiplexing; message switching; protocols; packet switching systems; remote networks; satellite linking communications.

CS G653 Software Architectures **3 2 5**

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

CS G671 Advanced Computer Graphics **3 2 5**

Overview of computer graphics and graphic devices; two dimensional & three dimensional curve representations, rotations and transformations; surfaces, generation, representation, rotation and transformations; modelling techniques; concepts in geometric design.

Design Engineering

DE G511 Advanced Methods in Applied A Mathematics **5**

Suitable topics from amongst the following: linear algebra; vector analysis; numerical methods to solve different types of equations; approximate numerical solutions of ordinary and partial differential equations; integral transform; linear and nonlinear optimization techniques; mathematical programming; mathematical modelling; calculus of variations; random variates and statistical techniques; decision models and analysis.

DE G512 Finite Element Analysis **5**

Element properties, Isoparametric elements, Finite element methods and analysis, Applications in design including continuum mechanics, Dynamic systems, Heat conduction and Electrical potentials, etc. will be taken up.

DE G513 Tribiology **3 2 5**

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

DE G514 Fracture Mechanics **3 2 5**

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

DE G521 Instrumentation and Applied Electronics **5**

Generalized instrumentation system for measurement and control; performance characteristics of instruments; analytical techniques - time and frequency domain analysis, Laplace and Fourier transform techniques; sensors and transducers; Feedback measurement system, ynalmg and digital signal conditioning and conversion techniques, telemetry techniques, improvement of signal-to-noise ratio, statistical instrumentation techniques; transducers interfacing; computer control instrumentation, electronic bench instruments, etc.

DE G522 Design Projects **3 2 5**

Practice in engineering design through projects emphasizing creative solutions to engineering design problem. Illustrative case studies of design will be taken up. The course will be conducted through selected group/individual projects.

DE G531 Product Design **3 2 5**

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

DE G532 Quality Assurance & Reliability **5**

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

DE G611 Dynamics & Vibrations **3 2 5**

Steady and transient Vibration of single and multi degree freedom systems. Systems with distributed mass and elasticity. Non-linear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

DE G621 Digital & Microprocessor Based Systems **5**

Digital system design using combinational and sequential circuits; processor architecture, assembly programming and system design using peripheral devices such as PPI, Interrupt controller, DMA controller, etc. Microcontroller architecture and typical applications; concept of bus based system design and PC based system design.

DE G631 Materials Technology & Testing **5**

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibres and other modern engineering materials and their application with particular reference to Railways. Destructive and non-destructive testing techniques and their applications in Railways.

Electronics and Communication Engineering

ECE F211 Electrical Machines **3 1 4**

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram.

Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machines- universal motors, Induction generators.

ECE F212 Electromagnetic Theory **3 0 3**

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

ECE F214 Electronic Devices **3 0 3**

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

ECE F215 Digital Design **3 1 4**

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

ECE F241 Microprocessors and interfacing **3 1 4**

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

ECE F242 Control Systems **3 0 3**

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

ECE F243 Signals and Systems **3 0 3**

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

ECE F244 Microelectronic Circuits **3 0 3**

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

ECE F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

ECE F311 Communication Systems **3 1 4**

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum.Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization.

ECE F312 EM Fields and Microwave Engineering Laboratory **0 1 1**

Experiments in Microwaves and antennas using Microwave benches and simulation softwares.

ECE F314 Electromagnetic Fields and Microwave Engineering **3 0 3**

Electromagnetic waves; Maxwell's equations; Poynting theorem and wave equations; propagation of EM waves; transmission lines; microstrip lines; wave guides; cavities and antennas; microwave generators, microwave amplifiers; measurement at microwave frequencies.

ECE F341 Analog Electronics **3 1 4**

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit performance . Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators,; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

ECE F343 Communication Networks **3 0 3**

Packet switching and circuit switching; layered network architecture (OSI model), point-to-point protocols and links: physical layer, error detection and correction, ARQ retransmission strategy, framing, X.25 standard, queueing theory and delay analysis: Little's theorem, analytical treatment of M/M/1 and M/M/m queuing systems, simulation of queueing systems, delay analysis for ARQ system, multi-access protocols and techniques: Aloha systems, CSMA, IEEE-802 standards, routing and flow control. TCP/ IP protocols, ISDN, ATM, network security, design of a LAN system with commercially available functional units. Wireless LAN: adhoc network, security issues.

ECE F344 Information Theory and Coding **3 0 3**

Random variables and random processes; Information sources and source coding theorem, Kraft inequality, Shannon-Fano codes, Huffman codes, Arithmatic Codes, Lempel-Ziv-Welch algorithm, universal source codes; channel capacity: channel capacity; noisy channel coding theorem for discrete memoryless channels; channel capacity with feedback; continuous and Gaussian channels; error control coding: linear block codes and their properties, hard-decision decoding, convolution codes and the Viterbi decoding algorithm, iterative decoding; turbo codes and lowdensity-parity-check codes; rate distortion theory: rate distortion function, random source codes; joint source-channel coding and the separation theorem; cryptography: basic concepts on cryptography and cryptoanalysis, security issues; private-key encryption algorithms-stream ciphers, block ciphers, Shannon's theory; introduction to number theory - modular arithmetic, exponentiation and discrete logarithms in Galois field; public-key encryption algorithms- Diffie-Hellman public-key distribution scheme, RSA public-key cryptosystem; Message authentication, hashing functions, digital signatures.

ECE F366 Lab Project **3**

ECE F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECE F376 Design Project **3**

ECE F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECE F414 Telecommunication Switching Systems and Networks **3 0 3**

Intoduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

ECE F416 Digital Communication **3 0 3**

Introduction, the modeling and characterization of information sources, algorithms for source coding and encoding of analog output sources; Information transmission through AWGN channels using digital modulation methods and BER estimation; Digital communication through band limited Gaussian noise channels; channel coding and decoding; Wireless communication channels: its characterization and modulation schemes for such channels; emerging trends in the above field.

ECE F418 Modern Communication Technologies **3 0 3**

Modern communication systems overview, Digital modulation techniques, Channel capacity and coding, Digital link improve techniques, Digital receiver design and performance analysis, Wireless communication systems: wireless channel models and link improvement techniques, multiple access schemes. Basic concept of mobile network, Optical Communication Systems: Transmitters, receivers and other optical Communication subsystem, Optical wireless systems.

ECE F431 Mobile Telecommunication Networks **3 0 3**

Fundamentals of mobile telecommunications, with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements/ architecture.

ECE F434 Digital Signal Processing **3 1 4**

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ECE F472 Satellite Communication **3 0 3**

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

ECE F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

Economics

ECON F211 Principles of Economics **3 0 3**

Nature and scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behaviour and of the firm: linear economic models; market structures; social accounting and basic elements of economic planning.

ECON F212 Fundamentals of Finance and Accounts **3 0 3**

Introduction to basic accounting principles for measuring and communicating financial data, single and double entry, ledgers, journals, trading, profit and loss and appropriation accounts, trial balance and balance sheet; cash flow statements, risk-return trade off notions, security analysis, structure of capital market, primary and secondary market, introduction to financial system and its components, financial market reforms.

ECON F213 Mathematical & Statistical Methods **3 0 3**

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like standard deviation, variance, Kurtosis, correlation coefficient; Sampling Methods - Simple random sampling, with and without replacement, stratified random sampling. Statistic and sample moments, Sampling Distributions - Properties of Student's – t, Chi-square and F-distributions. Theory of Estimation - Point estimation, method of moments; maximum likelihood; interval estimation. Testing of Hypothesis - Statistical hypothesis, simple and composite hypothesis,critical region, types and size of error, test of simple hypothesis versus simple alternative. Analysis of Variance - Analysis of one-way classified data, application in the study of relationships. Theory of Index Numbers - Calculation of Laspeyre's, Paasche's, Fisher's and Chain index numbers, criteria of a good index number, cost of living index numbers, base shifting, splicing and deflating of index numbers. Introduction to Regression Analysis - Specification of simple linear regression model, least square method of estimation, classical assumptions, general and confidence approach to hypothesis testing.

ECON F214 Economic Environment of Business **3 0 3**

Business and Economics, Government and business; market an the role of the Government, market failure, Government and the market, government and the firm, Fiscal policy and the environment, Macroeconomic environment; macroeconomic environment of business, Business activity, employment and inflation, monetary policy and economic environment, balance of payment accounting, Business in the international environment; World trade and international monetary system; international investing; investment decisions in multinational markets; country risk; multinational corporate strategy; multinational treasury management; currency risk; globalization and multinational business, FDI, FII, pricing strategy and business.

ECON F241 Econometric Methods **3 0 3**

Business environment and economy, industrial policy, industrial licensing, role of industry in economic development, monetary and fiscal policy, inflation, foreign trade and balance of payment, MRTP, FERA and FEMA Acts, business ethics and corporate governance, IPR, technology issues, liberalization, privatization and disinvestment, globalization, FDI, MNCs, international business environment.

ECON F242 Microeconomics **3 0 3**

Consumer behavior under risk, production function and linear programming applications, derivation of cost and supply functions, commodity pricing under imperfect market structures, factor pricing, multimarket equilibrium, optimization over time, welfare optimization, game theory applications.

ECON F243 Macroeconomics **3 0 3**

Systems of national accounts; input-output systems; flow of fund systems; monetary circulation and exchange; basic model of income determination; classical macroeconomic models; obstacles of full employment; Keynes model, derivation of IS-LM functions; three sector model; four sector model; inflation and Phillips curve; real business cycles and new Keynesian economics; monetary policy, fiscal stabilization policy; consumption hypothesis; absolute income hypothesis, permanent income hypothesis, life-cycle income hypothesis, relative income hypothesis, investment models; money supply and money demand.

ECON F244 Economics of Growth and Development **3 0 3**

Economic growth and development; models of economic growth; harrod domar model, solow model, neoclassical models of economic growth, the Feldman model, Cambridge model of growth,models of technical progress, the problem of economic development; causes of underdevelopment, human development index, theories of economic development, classical and neoclassical theory of economic development, Rostow stages theory, balanced and unbalanced growth, the lewis theory of economic development, Big-push theory, Critical Minimum effort Hypothesis theory.

ECON F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

ECON F311 International Economics **3 0 3**

The international economy; early trade theories; comparative advantage model; neo-classical trade theories; gains from trade; offer curves, terms of trade; Edge-worth box, factor endowments and the Heckscher-Ohlin model; alternative models of trade and intra-industry trade; the imitation-lag hypothesis; product cycle theory; international trade and economic growth; international trade policy; tariff, non-tariff trade barriers, economic integration, international trade and economic development, balance of payment accounting, foreign exchange markets and exchange rates, exchange rate determination, open economy macroeconomics; income and price adjustment mechanisms, adjustment policies, macroeconomic policy in open economy.

ECON F312 Money, Banking and Financial Markets **3 0 3**

Overview of the financial system, interest rate and their role in valuation, fluctuation in interest rate, risk and term structure of interest rate, rational expectation and efficient market hypothesis, central banking and the conduct of monetary policy,

money supply and credit creation, monetary transmission mechanisms, fundamentals of financial institutions, banking and management of financial institutions, commercial banking industry, risk management in financial institutions, credit risk, analysis of various financial and economic crisis.

ECON F313 Issues in Economic Development **3 0 3**

Income and Growth; Facets of Underdevelopment; Structural Features; contemporary models of development and underdevelopment, poverty, inequality and development, population and economic development, urbanization and rural-urban migration, education and health in economic development, environment and economic development, trade and economic development, FDI and economic development, infrastructure and economic development. Sustainable development.

ECON F314 Industrial Economics **3 0 3**

Economic analysis of the theory and practice of organization of firms and industries. Nature of competition among firms and their behaviour in various markets, with specific emphasis on imperfectly competitive markets. Tools for empirical and theoretical approaches to the analysis of industries. Issues related to price discrimination, vertical integration, advertising, research and development activities and entry and exit of firms. Government regulation of industries.

ECON F341 Public Finance Theory and Policy **3 0 3**

Role of Government in modern economy, Theory of Public good and public choice; public goods and externalities, equity in distribution, Public Expenditure and Macro-economy: Determining optimal size of government, financing of public expenditure, debt versus tax financing, impact of public expenditure on the level and composition of output and employment, Government budget and cost benefit analysis, Taxation; Direct and Indirect taxes, efficiency and equity, tax incidence, models of taxation incidence, theory of optimal taxation, recent developments in theory of taxation, evolution of tax structures, tax evasion and avoidance, designing of modern tax system, reforms in direct and indirect taxes, value added tax, fiscal federalism, designing optimal government expenditure policy; Fiscal Policy Issues: Budget deficit and public debt, interdependence of fiscal and monetary policies, theory of inter-governmental transfers, theory and policy of subsidies, theory of fiscal federalism, issues of equity and efficiency, role of planning and finance commission, goods and services tax in India, new direct tax code, role of central and state FRBMs.

ECON F342 Applied Econometrics **3 0 3**

This course provides a introduction to advanced estimation and econometric techniques of analysis, with particular emphasis on how these techniques can be used for the empirical testing of economic theories and/or policy prescriptions. Topics to be studied include specification, estimation, and inference in the context of models that include then extend beyond the standard linear multiple regression framework. Multiple regression analysis; analysis of generalized linear and nonlinear models; instrumental variables; maximum likelihood, generalized method of moments (GMM), and two step estimation methods; simultaneous equation models; time series processes; identification and estimation of time series models; techniques for assessing model fit; forecasting; time series analysis and models of expectations; univariate time series analysis, stationary vs. non-stationary series; ARIMA, GARCH, VAR, cointegration, granger causality, error correction and limited dependent variable models; auto regressive distributed lagged variable models multivariate time series analysis; dynamic models; analysis of panel data, balanced and unbalanced panel data, mixed, fixed and random effect models.

ECON F343 Economic Analysis of Public Policy **3 0 3**

This course deals with the contributions of economic analysis to public policy and governance. It focuses on evaluating the rationale for government intervention in the economy and evaluating the efficiency, incentive, and distributional effects of social and economic policies. Introduction to of economic analysis; economic tools in valuing outcomes; measuring outcomes in policies and programme; policy making; the market and the public policy, policy framework and regulation, market and government issues, distribution and policy analysis; applications in tax policies, welfare policies, government policies relating to contracting, health, education, labour and employment, energy policy, competition policy, gender, rural-urban development, food security, climate change, infrastructure policy, financial and trade policy.

ECON F344 Models in Operations Management **3 0 3**

Project Management Tools and Techniques, Forecasting Techniques, Quality Management Tools, Facility layout and location models, inventory management, aggregate planning, and scheduling.

ECON F345 Behavioral Economics **3 0 3**

Behavioral decision theory; perspective on psychology and economics; heuristics and biases; bounded rationality; classical expected utility model; choice under uncertainty (and certainty); probabilistic judgment; and inter-temporal choice; responses to games; analogous games.

ECON F351 Indian Economic Development **3 0 3**

Indian Economic Development; Understanding the Indian Economy, Growth of GDP and Per Capita Income, Planning for the economy; plan models, Five Year Plans, Sectoral Aspects; Regional Variations, Economic Reforms, Monetary Policy, Nationalization of Banks, Financial Sector Reforms; Role of Central Banking in India. External Sector; Growth and structure of India's international trade; Balance of Payments, Import and Export Policies, India ,World Bank and IMF. Agricultural Policy; Land Reform, Agricultural Growth and Productivity, Irrigation; Green Revolution and After, Price Policy; Subsidies; Impact of WTO. Industrial Policy; Industrial Controls and Licensing, Productivity and Growth, Industrial Credit Industrial Sickness-Foreign Investment, Industrial Reforms, Investment, Regional Variations, Impact of WTO, Social Sectors, Health and Education, Poverty and Inequality in India, Human Development Indicators.

ECON F352 Management of Banks and Financial Institutions **3 0 3**

Overview Of Banking Industry And Regulations; Critical Analysis Of Bank's Balance Sheet, Cost Of Funds Evaluation Of Bank Performance; Management Of Profit & Loss Accounts Of A Bank; Management Of Non-Interest & Non-Fund Income and Expenses; Assessment & Management of Risks; Interest Rate Risk, Credit Risk, Market Risk, Operational Risk, Liquidity Risk Etc., Basel Accords, Correspondent Banking; Mortgage And Asset-Backed Securities; Securitization, Innovation In Banking.

ECON F353 Energy Economics and Policy **3 0 3**

Global Energy and Climate Policy; population and energy, energy intensity, energy crisis and alternate sources; understanding cost-benefit analysis, life-cycle cost analysis and pricing developments, analysing and managing risks; energy and environment, energy security and governance ; economics of changing role of crude oil, natural gas, coal, nuclear power and renewable power; global energy markets and the challenge of mitigating global climate change. Geopolitical dimensions of energy supply and demand, regulatory approaches to cutting greenhouse gases and building a low-carbon economy; future of energy scenario.

ECON F354 Derivatives and Risk Management **3 0 3**

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk.

ECON F355 Business Analysis and Valuation **3 0 3**

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

ECON F356 Strategic Financial Management **3 0 3**

Company Value and the Manager's Mission: Introduction to Valuation, Why Value Value? The Value Manager, Cash Is King and Value-Based Management. Approach to Valuation - A Practitioner's Guide: Frameworks for Valuation. Valuation Methods: Discounted, Relative and Contingent Claim. Analyzing Historical Performance. Forecasting Performance. Estimation of Discount Rates. Estimation of Cash Flows. Estimation of Growth Rates. Valuation Models: Dividend-Discount Models, Free-Cash-Flow-To-Equity Discount Models, Free-Cash-Flow-to-firm Approach, Price / Earnings Ratio, Price/Book Value Ratio and Price/Sales Ratio. Measuring and Managing the Company Value: Company Value vs. Shareholders Wealth Maximization - TSR. Economic Value Added, Market Value Added and Cash Value Added. Wealth Creator by the Indian Corporates. Analyzing the Company Performance - Application of Balanced Scorecard (BSC). Applying Valuation: Multibusiness Valuation. Mergers, Acquisition , and Joint Ventures.

ECON F357 Management Control System **3 0 3**

The nature of management control system, management control environment; understanding strategies, revenue and expense centers, profit centers, transfer pricing, measuring and controlling assets employed, The management control process; strategic planning, budget preparation, analyzing financial performance, performance measurement, management compensation, Variation in management control; controls for differentiated strategies, service organizations, multinational organizations, management control projects.

ECON F366 Lab Project **3**

ECON F367 Lab Project

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECON F376 Design Project **3**

ECON F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ECON F411 Project Appraisal **3 0 3**

Criteria for selection of a project; factor intensity; commercial profitability; national economic-profitability; limitations of market prices; estimation of shadow prices; linkup project appraisal to national objectives; McGaughey and Thorbeck approach; Little-Mirrlees method; UNIDO guidelines approach; limitations of the conventional project appraisal; towards a new framework for project appraisal.

ECON F412 Security Analysis and Portfolio Management **3 0 3**

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives-options & futures.

ECON F413 Financial Engineering **3 0 3**

Introduction; Review of Markets, Players, and Conventions; Cash Flow Engineering with Forward Contracts; Engineering Simple Interest Rate Derivatives; Swap Engineering; Report Market Strategies; Dynamic Replication Methods and Synthetics; Mechanics of Options; Options Engineering with Applications; Pricing Tools; Applications of Fundamental Theorem of Finance; Fixed Income Engineering; Tools for Volatility Engineering: Volatility Swaps and Volatility Trading; Engineering of Equity Instruments: Pricing and Replication, computational methods such as Monte Carlo Simulation.

ECON F414 Creating and Leading Entrepreneurial Organizations **3 0 3**

Fundamentals of entrepreneurship; entrepreneurship development in emerging markets; entrepreneurial leadership; creativity and business ideas; identifying business opportunities; legal aspects of business; entrepreneurship and intellectual property rights; business plans; marketing plan; operation and production plan; venture team and organizational plan; insights from financial statements; issues in raising finance; venture capitalist evaluation of business plans; launching a venture; corporate strategies for growth; people skills, Public issue; revival, exit and end to a venture.

ECON F415 New Venture Creation **3 0 3**

Entrepreneurship as career option, idea to opportunity – market analysis and segmentation, presenting a pitch deck, building the startup team, industry and competition analysis, lean startups, product development, protection of intellectual property, sales and marketing, business models, financing options and strategies, launching a business, growth and exit strategy, social entrepreneurship, business plan presentation skills.

ECON F416 Regional Economics **3 0 3**

Concept of a region; scope and method of regional economics; criteria for location of economic activities; regional economic structure; measurement of regional economic activity; interregional theory of income and trade; regional economic growth and its impact on regional structure; public policy.

ECON F418 Quantitative Analysis of International Trade **3 0 3**

Global trade and empirical facts of International trade, Nature of Globalization process and benefits and costs associated with it, Theory and empirical testing of trade theories, Alternative trade theories and their empirical tests, Gains from trade and the impact of trade on income distribution, Instruments of trade policy and welfare effects, International factor movements and the impact and spillover effects of FDI and portfolio investments, Different forms of Economic integration and their benefits and costs, Technology and growth, International Technology Transfer, Exchange rate and balance of payments, Trade policy simulation using software, WTP Negotiations

ECON F422 Functions and Working of Stock Exchanges **3 0 3**

Overview of financial markets and instruments; stock exchanges in India; trading and settlement procedures; listing; risk management; primary markets; debt markets; indices; mutual funds; derivatives; exchange traded funds; corporate governance; SEBI and regulation of the markets; important events in the stock markets; market microstructure; empirical studies on the Indian markets.

ECON F471 Resources and Environmental Economics **3 0 3**

Introduction to Environmental Economics; Economy-Environment interaction; Environment vs. Development, Environmental Kuznet's curve, Economics of Exhaustible Resources; Solow-Harwick's Rule; Market structure and optimal extraction policy; Uncertainty and the rate of resource extraction; Resource scarcity, Economics of Renewable Resources ; Economics of Biodiversity, The Theory of Externality and Public Goods ; Concepts; Market Failure; Pigouvian Solution; Buchanan's Theory; Coase's theorem and its critique; Pigouvian vs. Coasian solution; Detrimental externality and non convexities in the production set; Property rights; Collective action, Techniques of Valuation; Physical linkage methods; Abatement cost methods; Behavior linkage methods; Social cost benefit analysis, Environmental impact assessment.

ECON F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

ECON G511 Dynamic Modeling and Control of National Economies **5**

ECON G521 Modern Cost Engineering **5**

Course description for the above courses are to be developed.

ECON G531 Theory of Macroeconomic Policy **5**

This course focuses on macroeconomic policy as the major application of the theoretical material and also considers the implications of macroeconomic events for asset price determination, management, decisions, social problems and personal employment and retirement planning.

Topics to be covered are: the foundations of aggregate supply and demand: use of AD-AS model; the business cycle; applications in the areas of asset market, management decisions, social problems, etc.

ECON G541 Economic Systems Analysis **5**

Course description is to be developed.

Electrical and Electronics Engineering

EEE F111 Electrical Sciences **3 0 3**

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors. Introduction to operational amplifiers and applications. Introduction to Digital Electronics.

EEE F211 Electrical Machines **3 1 4**

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram.

Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machines- universal motors, Induction generators.

EEE F212 Electromagnetic Theory **3 0 3**

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

EEE F214 Electronic Devices **3 0 3**

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

EEE F215 Digital Design **3 1 4**

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

EEE F241 Microprocessors and Interfacing **3 1 4**

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

EEE F242 Control Systems **3 0 3**

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

EEE F243 Signals & Systems **3 0 3**

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

EEE F244 Microelectronic Circuits **3 0 3**

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

EEE F245 Control System Laboratory **0 1 1**

Experiments and simulations on concepts related to conventional and advanced control systems.

EEE F246 Electrical and Electronic Circuits Laboratory **0 2 2**

Experiments in Electrical sciences, Electronic devices, motors, transformer windings, machine windings, electronic circuits and signals, systems etc.

EEE F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

EEE F311 Communication Systems **3 1 4**

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum.Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization.

EEE F312 Power Systems **3 0 3**

Review and importance of power system, Present power system scenario, Transmission line parameters and modeling, Characteristics and performance of lines, Load flow studies, Optimal system operation, Automatic Generation and voltage Control, Power system fault analysis, Power Systems stability, Introduction of power system protection, Introduction of HVDC Transmission.

EEE F313 Analog & Digital VLSI Design **3 0 3**

Moore's Law, Y chart, MOS device models including Deep Sub-Micron effects; an overview of fabrication of CMOS circuits, parasitic capacitances, MOS scaling techniques, latch up, matching issues, common centroid geometries in layout. Digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; timing issues (clock skew and jitter) and clock distribution techniques; estimation and minimization of energy consumption; Power delay trade-off, interconnect modelling; memory architectures, memory circuits design, sense amplifiers; an overview of testing of integrated circuits. Basic and cascaded NMOS/PMOS/CMOS gain stages, Differential amplifier and advanced OPAMP design , matching of devices, mismatch analysis, CMRR, PSRR and slew rate issues, offset voltage , advanced current mirrors; current and voltage references design, common mode feedback circuits, Frequency response, stabilty and noise issues in amplifiers; frequency compensation techniques.

EEE F341 Analog Electronics **3 1 4**

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit performance . Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators,; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

EEE F342 Power Electronics **3 1 4**

Need for power conversion; Power electronic converters: classifications and scope; Power semiconductor switches: diodes, SCR , GTO and transistors (BJT, MOSFET and IGBT): Ratings, static and dynamic characteristics, drive and switching aid circuits and cooling; DC to DC conversion: Buck, Boost and Buck-Boost converters: circuit configuration and analysis with different kinds of loads; Choppers: single quadrant and two quadrant operation with DC motor load and steady state analysis; Rectifiers: single phase and three phase operation, power factor, harmonics and effect of source inductance; Dual converters; Drive concept: Four quadrant drive and load characteristics, selection of motor, control and stability of electric drives, feed back control of drives; DC motor drive; Inverters: single phase and three phase bridge inverters and PWM inverters; Single phase AC voltage regulators and cycloconverter; Induction motor drive - Variable frequency operation of 3-phase induction motor, stator voltage control and V/f control methods; Non-drive application of power electronic converters: UPS, active power line conditioner, electronic ballast and induction.

EEE F345 Power Apparatus & Networks **3 0 3**

Essential fundamentals of power networks: overview of power systems and changing landscape; sources of electrical energy and environmental consequences; the Indian power industry; fundamental principles of power networks; magnetic prerequisites. Apparatus in power networks: transformers; synchronous generators; transmission lines, cables, HVDC; loads and power quality. Analysis and operation: power flow; rotor angle and voltage stability; control of large intercon-

nected power networks. Protection: fault calculations, relay co-ordination and circuit breakers; transient overvoltages, protection by surge arrestors, and insulation co-ordination. Management of vertical utilities, utility deregulation and open access: operational economics of the power industry, privatization; deregulation and energy markets.

EEE F346 Data Communication Networks **2 0 2**

Communication Concepts; Data and Voice Communications; Hardware Systems and Configurations; Network Topologies and Design Aspects; Protocols; Networking Software; Local Area Networks; Network Security and Management; Emerging Trends in Communications.

EEE F347 Communication Networks Laboratory **0 2 2**

Experiments on analytical studies of communication networks through network simulation, analysis of network performance, LANs, Cellular or Satellite networks, Wireless Adhoc or Sensor Networks, Wi-Fi and WIMAX networks, information theory and coding etc.

EEE F348 FPGA Based System Design Laboratory **0 2 2**

Introduction to Field Programmable Gate Arrays, Overview of FPGA design tools, Implementation of Data Flow Graph in FPGA, Analysis of performance tradeoffs (Pipelining, Retiming, Unfolding), Bus protocols (SPI, I2C), FPGA based DSP System Design , ADC/DAC interface, Real time signal processing system design.

EEE F366 Lab Project **3**

EEE F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

EEE F376 Design Project **3**

EEE F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

EEE F411 Internet of Things **3 1 4**

Introduction to IoT, Sensors and Actuators for IoT, Programming IoT end points, Communications and networking in IoT, Data management in IoT, Security issues in IoT, Emerging technologies.

EEE F414 Telecommunication Switching Systems & Networks **3 0 3**

Intoduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

EEE F416 Digital Communication **3 0 3**

Introduction, the modeling and characterization of information sources, algorithms for source coding and encoding of analog output sources; Information transmission through AWGN channels using digital modulation methods and BER estimation; Digital communication through band limited Gaussian noise channels; channel coding and decoding; Wireless communication channels: its characterization and modulation schemes for such channels; emerging trends in the above field.

EEE F417 Computer Based Control Systems **3 0 3**

Introduction to process control and Computer based control, elements of computer based control loop, digital sensors and their applications, field buses and specifications, types of digital and intelligent controllers, types of industrial control valves and their selections, PID vs Fuzzy and Neural Techniques of control, programmable logic controllers, SCADA and its applications, distributed ontrol systems comparison between PLC, DCS, Fuzzy. ANN, industrial network hierarchy, industrial standards for networking, application of PLC in power system and process industries.

EEE F418 Modern Communication Technologies **3 0 3**

Modern communication systems overview, Digital modulation techniques, Channel capacity and coding, Digital link improve techniques, Digital receiver design and performance analysis, Wireless communication systems: wireless channel models and link improvement techniques, multiple access schemes. Basic concept of mobile network, Optical Communication Systems: Transmitters, receivers and other optical Communication subsystem, Optical wireless systems.

EEE F422 Modern Control Systems **3 0 3**

State variable characterization of linear continuous - time and discrete - time systems, controllability, observability, stability; sampled data systems; Z transforms; non-linear systems; phase plane and describing function methods; calculus of variations; optimal control.

EEE F425 Power System Analysis and Control **3 0 3**

Course description is to be developed.

EEE F426 Fiber Optics & Optoelectronics **3 0 3**

Theory of optical fibres; image transmission by fibres; technology of fibre production; fibre testing; characterization of optical fibres; detectors and sources for fibre optic systems; active fibres; applications of optical fibres; optoelectronic devices and applications.

EEE F427 Electric Power Utilization and Illumination **3 0 3**

Introduction to industrial utilization of electric power, types of drives, its characteristics, insulation materials used, Industrial applications such as electric heating, welding etc.., traction systems, DC and AC systems of railway electrification, Train movement and factors effecting Energy Consumption, Speed-time curve, Tractive effort, Power of traction motors. Braking systems, Regenerative braking, Mechanical braking, control equipments. Illumination, laws of illumination, lighting calculation, interior and exterior illumination systems, design of various lighting schemes, types of lamps, high or low pressure lamps and discharge tubes.

EEE F431 Mobile Telecommunication Networks **3 0 3**

Fundamentals of mobile telecommunications, with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements/ architecture.

EEE F432 Medical Instrumentation **3 0 3**

Basic components of bio-medical instruments, bio-electric signals & recording electrodes, transducers, recording and display devices. Patient care and monitoring systems, cardiovascular measurements-blood pressure, blood flow, cardiac output, heart sounds etc.; instrumentation for respiratory and nervous systems, analysis of EEG, ECG, EMG, EOG and action potentials, non- invasive diagnostic measurements - temperature, ultrasonic diagnosis, CAT scan techniques, sensory measurements-motor response, analysis of behaviour etc. biotelemetry, biofeedback, clinical laboratory instruments, X-ray diagnosis. Recent advances in biomedical instrumentation- microprocessor based systems, lasers & optical fiber based systems.

EEE F433 Electromagnetic Fields & Waves **3 0 3**

Maxwell's equations; application of circuit theory and field theory; Maxwell's equations in free space and time varying fields; plane waves in dielectric and conducting media; solution of wave equations; the poynting vector; the poynting theorem; poynting vector in conducting media and circuit application; wave polarization; linear, elliptical and circular polarization; wave reflection, refraction and diffraction; transmission lines and resonators; Smith chart, and its applications in stub matching and impedance matching; discontinuties; antennas and radiation; halfwave dipole antenna; loop antenna; helical antenna; directive arrays; frequency independent antennas; reflector and lens antennas; horn antennas; antenna arrays; Friis formula; antenna practices and antenna measurements.

EEE F434 Digital Signal Processing **3 1 4**

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

EEE F435 Digital Image Processing **3 0 3**

Introduction to multidimensional signal processing-- 2-D convolution and filtering, discrete-time Fourier , filter design 2-D sampling and reconstruction transform, human visual system, Brightness perception , Temporal properties of vision, 2-D Block transforms-- Walsh-Hadamard, Karhunen Loeve, Discrete Hartley, Filter Banks and Wavelets etc. , Image Compression , Image Enhancement , Medical Image Processing , 3D techniques.

EEE F462 Advanced Power Systems **3 0 3**

Symmetrical components, sequence impedances; fault calculations; short circuit studies; circuit breakers and their selections; power system stability, power system protection--generators, transformers and lines; waves on transmission lines, protective devices -- grounded and ungrounded systems.

EEE F472 Satellite Communication **3 0 3**

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

EEE F473 Wind Electrical Systems **3 0 3**

Thermodynamics of wind energy, Types of Wind energy conversion devices, Aerodynamics of wind rotors, design of wind turbine rotor, Power -speed characteristics, torque-speed characteristics, Wind turbine control systems, Wind speed measurements , Wind speed statistics, Site and turbine selection, Induction Generators, Wound field synchronous Gener-

ator, Permanent Magnet synchronous machine, Doubly fed induction generator, Power Flow equations, Power Semiconductor devices, Converters, Inverters, power quality, Reactive power compensation, Wind diesel hybrid systems, Wind photovoltaic systems, Role of Govt. and policies for market development.

EEE F474 Antenna Theory and Design **3 1 4**

Introduction into antenna theory and practice, Radiation integrals and auxiliary potential functions; basic EM theorems in antenna problems, Antenna characteristics, Infinitesimal dipole; wire and loop radiating elements, Wire antennas – dipoles, monopoles, Arrays – analysis and design, Reflector antennas, Broadband antennas, Micro-strip patch antennas , Smith Chart Review in line with antenna theory and Design , Antenna measurements, Antenna design using commercial software, study of radiation pattern of various antennas.

EEE F475 Special Electrical Machines **3 1 4**

Construction, principle of operation and performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors, permanent magnet synchronous motors.

EEE F476 Switchgear and Protection **3 1 4**

Working applications of various switchgears and protective elements. Switches and fuses, Elementary principles of Circuit Breakers, Description and Operation of different types of circuit breakers, Electromagnetic and Static Relays, operation, construction and characteristics, Generator Protection, Transformer Protection, Feeder and Bus-Bar Protection, Neutral Grounding, Protection against over voltages.

EEE F477 Modeling of Field-Effect NanoDevices **3 0 3**

Physical principles and MOS transistor phenomena, developing models including effective mobility, temperatures effects, and source/drain resistances. small-dimensional effects, impact ionization, velocity saturation drain-induced barrier lowering (DIBL), ballistic operation, polysilicon depletion, quantum effects, gate-tunneling currents, gate-induced drain leakage (GIDL) , fundamentals of low-power (low-voltage) CMOS design issues; the threshold voltage shift (due to SCE) , increased leakage power, sources of power , SOI MOS, (PDSOI, FDSOI) , multigate (MG) MOSFET, electrostatic integrity and short channel control, quantum mechanical origin, basics of BSIM CMG, compact models for multigate MOSFETs , mobility in multiple gate devices, improvement of the mobility ,crystallographic orientations, strained Si channels.

EEE F478 Power Systems Laboratory **0 2 2**

Experiments on relays, circuit breakers, transmission lines, switch gear and protection , energy generation methods, and application of artificial intelligence techniques, electric energy utilization including illumination, electrical drives etc.

EEE F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

EEE G510 RF Microelectronics **5**

Introduction; application of RF electronics in modern systems; basic concepts in RF circuit design, active RF components: various RF diodes and transistors and their circuit models, matching and biasing networks, RF amplifier design: low power, low noise and broadband amplifiers, RF oscillator design; negative resistance oscillator; dielectric resonator oscillators, phase noise. RF Mixers: Balanced mixers; low noise mixers; noise in RF circuits, microwave transmitters and receivers.

EEE G511 Integrated Electronics **3 2 5**

Review of basic semiconductor devices and ICs, fabrication and design of integrated circuits, comparison of current bipolar and MOS technologies, VLSI design methodology and layout examples, etc. The main objective of this course is to enable the students to keep pace with the rapidly changing semiconductor technology.

EEE G512 Embedded System Design **3 1 4**

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

EEE G520 Wireless and Mobile Communication **3 2 5**

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

EEE G521 Optoelectronic Devices, Circuits &Systems **3 2 5**

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

EEE G522 Advanced Satellite Communication **5***

Radio wave propagation effects, low, medium and geo-synchronous earth orbits and their main characteristics. Various sub-systems of the satellite , the outer space and its impact on the design of spacecraft subsystems, LEO satellite network and its routing calls; Battery technology , propagation loss models, modulation and error correction techniques, Digital Video Applications, Satellite Mobile including NGEO, satellite access techniques, third generation satellite communication, remote sensing, bandwidth utilization and throughput capability, the Indian National Satellite System (INSAT), INTELSAT and other international satellite programs, VSAT, Mobile and Personal Satellite communication, principles of Global Positioning System (GPS), GPS receivers and its applications, regulatory and interference issues. Study and design of uplink transmitter, down link receiver, spacecraft transponder, satellite communication links.

EEE G531 Testable Design and Fault Tolerant Computing **3 2 5**

Fault: types, modelling and simulation; testing methodologies, coverage, economics and quality; test vector generation: design for testability, built-in self tests; fault tolerant computing; fault tolerant software.

EEE G541 Distribution Apparatus and Configurations **3 2 5**

Basic configuration of a distribution set-up at the consumer end. Transformer types, specifications, performance, protection, and sizing. Types of cables and insulation, cable parameters, ampacity and protection. Ratings of LV switchgear and their use in selection, switching transients and clearing time. Properties of fuses with reference to ampacity. Meters, instrument transformers, and their application. Voltage control at distribution levels. Elementary concepts of power quality: power factor, frequency, and harmonic content.

EEE G542 Power Electronic Converters **3 2 5**

The importance of the converter as an interface between source and load. DC-DC converters: Buck, boost, and buck-boost configurations. AC-DC converters: Diode and thyristor converters in single and three phase. Inversion in thyristorised converters and applications of line commutated inverters. DC-AC converters: Switch mode voltage source inverters in single and three phase, PWM operation of different types, VSI's operating in multi-levels, space vector modulation techniques. AC-AC converters: Thyristor fed AC loads, the cycloconverter. Matrix converter arrays and their operation as DC-DC and DC-AC converters.

EEE G543 Power Device Microelectronics and Selection **3 0 3**

Thermal features of power device packaging, the issues of $R_{\theta JC}$ and $R_{\theta CS}$, heat flow and effect on device temperature, heat sink design and selection. The two-layer junction behaviour, the concept of drift region, characterisation of power diodes. The base operation in a thick film BJT, steady state characteristics, turn ON and turn OFF times, the multistage power Darlington. The four-layer junction behaviour, two transistor model of a thyristor, dynamic model for a four layer junction device. GTO thyristors, the turn OFF mechanism in four layer junction devices, current technological problems. MOS operation and characteristics, characterisation and structure of the power MOSFET. Development of the MOSFET to IGBT, technological advantages, characterisation, and dynamic behaviour. Current technological problems in insulated gate technologies. Introduction to matrix converters.

EEE G544 Steady State and Dynamics of Electric Motors **3 2 5**

Direct current machines, dynamic characteristics of PM and shunt DC motors. The Reference Frame theory, balanced steady state phasor relations and voltage equations. Symmetrical induction machines: commonly used reference frames and per-unit system, analysis of steady state and dynamic operation and free acceleration characteristics from different reference frames. Synchronous machines: equations in different reference frames, per-unit system, steady state analysis, dynamic analysis for load changes and faults. Brushless DC machines: voltage and torque equations in machine variables, and rotor reference frame variables, analysis of steady state and dynamic performance. Operational impedances and time constants for synchronous machines. Linearised machine equations, and reduced order machine equations. Symmetrical and asymmetrical two-phase induction machines: conversion to stationary reference frame, analysis of steady state operation of the asymmetrical machine, single phase induction machine.

EEE G545 Control and Instrumentation for Power Electronic Systems **3 0 3**

The regulation and control problem with reference to power electronic converters. Converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models. Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications. Control design based on linearisation: transfer functions, compensation and filtering, compensated feedback control systems. Hysteresis control basics, and application to DC-DC converters and inverters. General boundary control: behaviour near a boundary, and choice of suitable boundaries. Basic ideas of fuzzy control techniques, and performance issues. Sensors for power electronic circuits, speed and torque transducers.

EEE G546 Systems Simulation Lab. **4**

Simulation tutorial problems on single- and three-phase AC-DC converters, DC-DC buck-, boost-, and buck-boost converters, DC-AC inverters in single and three phase with different levels of control complexity. Simulation of practical applications from utility and drives. May also include a small project.

EEE G547 Device Drivers **3 2 5**

Introduction to operating system, Introduction to Linux Basics, commands, file system , kernel and introduction to Android, Process Synchronization ,Semaphores, Message Passing, Mailboxes and debugging, Module programming/ Shell programming / Character Device Driver, Timing and Interrupts--, Device Driver Programming as applicable to Linux/ Android/ Windows, Parallel/ Serial Port Driver/ Block /USB /NETWORK/ PCI/ Drivers, tty Subsystem

EEE G552 Solid State Drives **3 2 5**

Introduction to the drive system: requirements, components and benchmarks; Review of motor theory; Power electronic control of motors: requirements and operational issues; Static speed control of induction motors: the AC power controller, slip energy recovery, VSI and CSI controlled induction motors; Speed control of synchronous motors and associated machines; The problem of DC motor speed control: rectifier and chopper controllers; Advanced induction motor drive control: vector control, current modulation, importance of microcontroller based systems; Organisation of microcontrollers: sensing and actuation of signals, interrupt handling and timing, priority of tasks in a microcontrolled drive system.

EEE G553 Utility Applications of Power Electronics **3 0 3**

Static excitation systems: converters as used in SES, control and the IEEE types, enhancement of stability. HVDC transmission: configurations of line-commutated converters, constant current and constant extinction angle control at device terminal level, individual phase and equidistant pulse firing control at device level, active and reactive power considerations. FACTS: impedance type and inverter type FACTS devices, the static var compensator, the thyristor controlled series reactor, the STATCOM and its developments in the form of UPFC and SSSC. Active filters: the power quality problems at distribution level, inverter control by transient p-q theory, configuration of active filters and their control, existing bottlenecks.

EEE G554 Soft Switching Converter Technologies **3 0 3**

Series, parallel, series-parallel resonant DC-DC converters, half and full bridge topologies, analysis and design. Sinusoidal analysis of resonant converters, soft switching, load resonant properties, exact characteristics. Soft switching mechanisms of semiconductor devices, zero current and zero voltage switching quasi resonant converters, resonant switch topologies, soft switching in PWM converters and inverters, multi resonant converters, control of resonant and soft switching converters, EMI suppression, snubbers, load resonant converters, passive components at high frequencies.

EEE G555 Transformer and Motor Design **3 0 3**

Course description for the above course is to be developed.

EEE G556 DSP Based Control of Electric Drives **3 0 3**

State space and transfer matrix representations, representation of nonlinear systems by update of parameters, output feedback and state feedback control, basic notion of state estimation. Sampling of signals, discrete representation of signals, *z*-transforms. Nature of discrete time poles and zeros. A/D and D/A converters as system elements. FIR and IIR behaviour, noise and its nature. AR, MA, and ARMA models of systems. The Fourier transform and what it conveys. Processing requirements of a DSP, floating point DSP's: the TMS320C3x family. Memory organisation, interrupt systems, and I/O interface with the TMS320C3x family. The TMS320C31 as an embedded controller, drive control features. Applica tions in vector and direct torque control of synchronous motors, vector and direct torque control of induction motors, torque control of SRM's.

EEE G557 Drives for Electronic Transaction **3 0 3**

Course description is to be developed.

EEE G558 DSP Based Implementation Drivers **3 0 3**

Course description is to be developed.

EEE G559 Advanced Power Electronics **5**

Qualitative, Quantitative, and Simulation studies of Power electronic circuits like AC to DC, DC to DC, DC to AC and AC to AC converter circuits for their theory, performance, design, testing and applications. Use of these circuits for industrial, motor control, FACTS, HVDC, PF improvement and energy conservation applications.

EEE G581 RF & Microwave Engineering **3 2 5**

Introduction to radio frequency engineering; advantages; various frequency bands; propagation; transmission lines; microwave waveguides and components; their characterizations; s-parameters and their use; microwave transistor; FETs, Gunn diode, IMPATT diodes; microwave tubes; Klystron; two cavity Klystron amplifier analysis; reflex Klystron; TWTs; high power tubes; cross field tubes; microstriplines; MMICs; microwave measurements; microwave antennas and microwave communication system; microwave applications; ISM applications; introduction to EMI and EMC; microwave hazards.

EEE G582 Telecom Network Management **5**

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

EEE G591 Optical Communication **3 2 5**

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques); beam forming; focussing and coupling schemes to optical repeators; optical amlifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; long haul communications; fibre optic networks.

EEE G592 Mobile & Personal Communication **3 2 5**

History of mobile radio; the mobile radio signal environment; review of statistical techniques; pathover flat as well as hilly terrain; effects of RF system design on propagation; received signal envelope and phase characteristics; modulation

schemes employed; functional design of mobile radio systems, diversity schemes-space; frequency and polarization diversity; mobile radio system functional design; signal error analysis versus performance criteria; multiple access schemes; classification of the concepts of sensitive topics; new concepts data transmission via cellular; spectrum and technology of WLL.

EEE G593 Power Quality **5**

Power Quality Introduction and terms and definitions, Voltage sags and interruptions, Transient Over Voltages, Fundamentals of harmonics, Harmonic Solutions, Long duration voltage variations, Distributed generation and power quality, Wiring and grounding, Power quality monitoring.

EEE G594 Advanced VLSI Devices **5**

Device physics of and engineering of advanced transistors, review of metal oxide semiconductor (MOS) with quasi-ballistic and ballistic transport, Short-channel effects (SCEs) in nanometer regime, scaled MOSFETs, Device physics and engineering of sub-100nm MOSFETs , Limits of the state-of-the-art silicon device technology, issues in the miniaturization, Alternative device structures ,non-conventional MOSFETs, and transport in novel nanodevices. Analytical expression (supported by TCAD simulation) for the one-dimensional transport and interpretation of novel device characteristics.

EEE G595 Nanoelectronics and Nanophotonics Technology 5

Semiconductor Fundamentals, Band Theory, Quantum Structures and Quantum Mechanics, Transport in Quantum Structures, Optical Properties of Semiconductor Quantum Structures, Strain Engineering, Electro- Optic Effects, Photonic / electronic Devices based on Nano structures.

EEE G611 Computer Aided Analysis and Design **3 2 5**

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

EEE G612 Coding Theory & Practice **3 2 5**

Codes for data-compression: instantaneous codes; Kraft inequality; Mcmillan theorem; Huffman codes; codes for error-detection and correction; binary symmetric channel; channel capacity, Shannon's fundamental theorem; linear codes; Macwilliam's identity; Reed-muller codes; cyclic codes; BCH codes; codes for secrecy and security; private-key cryptosystems; affine codes; twisted codes; one-time-pads; public-key cryptosystems based on large primes and discrete logarithms.

EEE G613 Advanced Digital Signal Processing **5**

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

EEE G621 Advanced Electronic Circuits **3 2 5**

Linear and non-linear operational circuitry, controlled sources, Active filters, power amplifiers, Power supplies, Analog switches and comparators, combinational and sequential logic circuitry. Data transmission and display, Electronic Controllers, Transducer interfacing and measurement circuits, etc.

EEE G622 Advanced Digital Communication **3 2 5**

Introduction to Digital communication, review of probability and statistic processes; review of source coding and characterization of signals; optimum receivers for additive white gaussian noise channel; carrier & symbol synchronization; channel capacity & coding; block & convolutional codes; communication through band – limited linear filter channels; adaptive equalization multicarrier systems; digital communication through fading multipath channel; future trends in digital communication.

EEE G625 Safety Critical Embedded Systems Design **4**

Course description is same as given under HTSL ZG631.

EEE G626 Hardware Software Co-Design **4**

Course description is same as given under HTSL ZG641.

EEE G627 Network Embedded Applications **3 1 4**

This course deals with the three main application areas of Network Embedded Systems – Wireless Sensor Networks, Automotive Networks, and Industrial Networks– Network Architecture , Deployment Issues, Network Protocol stack: Modular and Cross Layer Design. Network Node: Architectures, Operating System and Applications. Middleware Issues and Design. Security and Encryption.

EEE G641 Applied Estimation Theory **3 2 5**

Review of random processes, linear algebra and matrix theory, ML phase and timing estimation in digital communication, Scalar estimation, estimation in real and complex vector space, Study of performance degradation due to estimation errors, Frequency diversity and equalization, Study of MLSE for equalization, Estimation of Single Input-Single Output (SISO) channel to very complex Multi Input-Multi Output (MIMO) channels, study of different estimators such as MMSE, linear MMSE, orthogonal frequency division multiplexing (OFDM) basics, OFDM channel estimation, Channel quality estimation,

Impact of channel estimation errors on performance, Introduction to WLAN standards, IEEE 802.11n, channel estimation, MATLAB experiments and projects.

English

ENGL G511 Growth of the English Language **5**

The Origin and development; old English, middle English and modern English; foreign influences; changes in grammar and phonology; rise of standard English; English in the international context.

ENGL G512 Language and S & T **5**

Historical development of communication in science; communicative process in science and technology; language of science & technology; scientific literature; growth and role of scientific journals.

ENGL G513 Social Impact of S&T **5**

Elements of scientific thinking; role of science and technology in social change; impact of science on environment; technology and social growth; impact of science & technology in terms of developments in transportation and communication and innovations in sources of energy; impact on the quality of life.

ENGL G521 Principles of Language Teaching **5**

Teaching different language skills; grading; sequencing and presentation; teaching at different levels; remedial teaching; techniques of teaching comprehension, grammar, composition; lesson planning; syllabus design; testing.

ENGL G522 Aesthetics and Technology **5**

Aspects of aestheticism; emergence of aestheticism; influence of aesthetics on technology; impact of technological explosion on human sensibility and its expression in selected art forms.

ENGL G531 Applied Linguistics **5**

Linguistics and language teaching; contrastive linguistics and its applications; error analysis; a linguistic theory of translation; linguistic approach to literature.

ENGL G541 Interpretation of Literature **5**

Literary forms and conventions and their development; different critical approaches; practical criticism.

ENGL G551 Information Technology Lab I **5**

(This course is specially designed to prepare the stream of input, viz. traditional English graduates, in the use of technology in communication).

This course is built around the theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organisation. Consistent with this theme, assignments would be drawn from the student's work environment and from one or more areas of the following: Computerized text processing; use of utility software packages for information processing and production; desk top graphics; desk top video; computerized graphics packages; office automation equipment such as electric typewriters; photography; equipment for projection and preparation of projection material; reprography equipment; duplication equipment; audio visual technology involving equipment such as video systems, audio systems and audio-visual recording equipment; techniques for display and exhibition of formatted information, etc. The course will be unstructured in nature and assignments may require study of the principles of the above areas, or the actual use of equipment and techniques.

ENGL G561 Information Technology Lab II **5**

(This course is specially designed to prepare the stream of input, viz. traditional English graduates in the use of technology in communication)

This is a sequal to the first course of the same name. The theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organization would be further developed. However, assignments would invariably emphasize the integration between various technologies for totality of communication.

ENGL G571 Applied Communication I **5**

(This course is specially designed to prepare the stream of input, viz. engineering and hard science graduates in communication methods)

Process of communication; elements of speech; role of body language; dyadic communication; participation in different types of discussion groups, audio-visual aids.

ENGL G581 Applied Communication II **5**

(This course is specially designed to prepare the stream of input viz. engineering and hard science graduates, in communication methods)

Elements of effective writing; methods of written exposition; art of condensation; writing technical articles, research papers, proposals, reports, manuals and letters, preparation and use of graphic aids; mechanics of writing; technical editing.

ENGL G591 Project Formulation and Preparation **5**

This course is designed to inculcate principles of technical documentation as required within S&T organizations. Through this course, students are expected to acquire familiarity with several of the following: Proposals, feasibility reports, formal project reports, short reports, memos, negotiations, contracts, etc. In the process principles of project formulation and evaluation, such as technical considerations; performance specifications; preliminary block diagrams, types and analysis of contracts; cost estimation concepts, work breakdown structure; project data preparation, scheduling facilities etc., would

be introduced. The course would invariably include the preparation of a detailed report embodying as many of the above concepts as appropriate.

ENGL G611 Twentieth Century English Literature **5**

Margret Atwood, Tony Morrison, Samuel Beckett, Harold Pinter, Philip Larkin,Ted Hughes.

Finance

FIN F212 Fundamentals of Finance and Accounts **3 0 3**

This course is a broad introduction to finance and related areas. An introduction to basic accounting principles for measuring and communicating financial data about a business enterprise to external parties, single and double entry, ledgers, journal, trading, profit and loss and appropriation accounts, trial balance and balance sheet; cash flow statements; capital budgeting and risk management using risk return trade-off notions; introduction to working capital management; structure of capital market; primary and secondary markets; financial market reforms, source of investment information; portfolio selection.

FIN F213 Mathematical and Statistical Methods **3 0 3**

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like standard deviation, variance, Kurtosis, correlation coefficient; Sampling Methods - Simple random sampling, with and without replacement, stratified random sampling. Statistic and sample moments, Sampling Distributions - Properties of Student's – t, Chi-square and F-distributions. Theory of Estimation - Point estimation, method of moments; maximum likelihood; interval estimation. Testing of Hypothesis - Statistical hypothesis, simple and composite hypothesis,critical region, types and size of error, test of simple hypothesis versus simple alternative. Analysis of Variance - Analysis of one-way classified data, application in the study of relationships. Theory of Index Numbers - Calculation of Laspeyre's, Paasche's, Fisher's and Chain index numbers, criteria of a good index number, cost of living index numbers, base shifting, splicing and deflating of index numbers. Introduction to Regression Analysis - Specification of simple linear regression model, least square method of estimation, classical assumptions, general and confidence approach to hypothesis testing.

FIN F214 Economic Environment of Business **3 0 3**

Business and Economics, Government and business; market an the role of the Government, market failure, Government and the market, government and the firm, Fiscal policy and the environment, Macroeconomic environment; macroeconomic environment of business, Business activity, employment and inflation, monetary policy and economic environment, balance of payment accounting, Business in the international environment; World trade and international monetary system; international investing; investment decisions in multinational markets; country risk; multinational corporate strategy; multinational treasury management; currency risk; globalization and multinational business, FDI, FII, pricing strategy and business.

FIN F242 Introduction to Financial Mathematics **3 0 3**

Basic financial calculations; financial securities, time value of money, Annuties and equation of values; discounting and accumulations, flat rate and APRs, Capital Budgeting Techniques and compound interest problems; NPV, IRR, payback period. Arbitrage, Forward contracts, and term structure of interest; rationale of arbitrage assumptions; forward contracts, calculating the forward price, hedging, fixed cash income, spot rate and forward rate, term structure of interest rate, yield curves, yield to maturity, interest rate risk calculation, Stochastic interest models and investments; simple stochastic interest rate models, fixed and varying interest model, log normal distribution, fixed interest government borrowings, government bonds, tax, government bills, convertibles, property, derivatives, future, clearing house, margin, bond futures, short interest futures, stock index futures etc.

FIN F243 Functions and Working of Stock Exchanges **3 0 3**

Overview of financial markets and instruments; stock exchanges in India; trading and settlement procedures; listing; risk management; primary markets; debt markets; indices; mutual funds; derivatives; exchange traded funds; corporate governance; SEBI and regulation of the markets; important events in the stock markets; market microstructure; empirical studies on the Indian markets.

FIN F244 Indian Financial System **3 0 3**

Indian Financial System, financial markets, financial intermediaries and financial instruments. Components and structure of the financial system. Financial Assets & Financial Markets: Meaning of financial assets & types, role and structure of money market and capital market – Call money market, Treasury bill market, Commercial bill market including commercial paper and certificate of deposits, Discount market – Government securities market – Debt Market – Industrial Securities Market. Markets for derivatives; futures and options, and other derivatives. Definition and types of non-bank financial institutions, LIC, UTI, Mutual Funds, Venture Capital, bankassurance; their growth and impact on India's economic development. Organisational set up & functions of regulators: Reserve bank of India, SEBI, IRDA, Financial sector reforms.

FIN F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

FIN F311 Derivatives & Risk Management **3 0 3**

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk

FIN F312 Fundamental of Taxation & Audit **3 0 3**

Legal business entities and tax assessments; profit and gains of business or profession; capital gains; Tax planning for business entities; tax accounting principles; VAT , excise duty, custom duty etc.; computation of tax liability; appeal procedure; auditing procedure and taxation principles; auditing concepts; generally accepted auditing standards; audit documentation and evidence; role of internal N-131 control and concurrent audit; audit mechanism, valuation of assets, and auditing of depreciation, provisions, reserves, profits and dividends, etc.

FIN F313 Security Analysis and Portfolio Management **3 0 3**

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives-options & futures.

FIN F314 Investment Banking and Financial Services **3 0 3**

Merchant banking function- perspectives; organization of merchant banking function; managing new issues; negotiating terms with financial institutions, brokers, investors and under writers; pricing of further issues- SEBI guidelines; syndication of loans from banks; preparation of loan dossiers and application for financial assistance; negotiations; public deposits to finance working capital; agencies mobilizing public deposits; regulations governing raising of public deposits; cost of public deposits, factoring, forfeiting , structured finance, securitization and personal finance like house loan, personal loan and other individual loans, non-fund based services -credit rating, business advisory services, mergers, de-mergers and acquisition, asset management and insurance commodities services and wealth management.

FIN F315 Financial Management **3 0 3**

Concepts and techniques of financial management decision; concepts in valuation - time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

FIN F341 International Financial Markets and Services **3 0 3**

Currency futures, options and swaps; interest rate determination and asset pricing in face of volatile nominal and real exchange rates; international portfolio management; treasury risk management and performance measurement; major international stock exchanges: New York; ISE London; Tokyo; trading and settlement practices; listing of Indian derivatives on Brussles stock exchange; arranging foreign collaboration; floating India funds; syndication of Euro-dollar loans.

FIN F342 Project Finance **3 0 3**

Project identification, feasibility; appraisal of projects from technical, financial and economic view points; design of capital structure; factors influencing form of capital; instruments; shares, preference shares, debentures, convertible debentures; borrowing from development finance institutions.

FIN F366 Lab Project **3**

FIN F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

FIN F414 Financial Risk Analytics and Management **3 0 3**

Financial risk (which includes interest rate risk, credit risk, foreign exchange risk and portfolio risk), Application of Asset price Theory, CAPM and Modern Portfolio Theory, Multifactor models of risk and return, Capital adequacy, BASEL Norms; Comprehensive Capital Analysis and Review, Basel Committee on Banking Supervision guidelines, Value at Risk (VaR), VaR from regulator perspective, Responsive VaR Model, Addressing VaR weakness, Backtesting Concepts - Checking the Strength of VaR Model, Issues with the Standard VaR models, Risk Not in VaR (RNIV) to VaR migration of risk, Volatility Clustering, Quantifying and Modeling volatilities, Hedging techniques, Options Greeks, Managing Risk with Deriatives.

FIN F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

General Studies

GS F211 Modern Political Concepts **3 0 3**

Nature and scope of political science; emergence and basis of the state; rights and duties; forms of government; democracy, fascism, capitalism, socialism, anarchism, communism, Maoism, radicalism and Gandhism.

GS F212 Environment, Development & Climate Change **3 0 3**

Specific topics on environment, development and climate change; regional, national and international climate debates; review of international climate negotiations such as Kyoto, Copenhagen and other declarations; environment problems: causes, sustainability and policies; population, resources and sustainability; population dynamics, capacity and conservation; food security, poverty, impact and global solutions; energy resources: renewable, wind, oil, natural gas, nuclear energy; growth, technology and greenhouse gas emissions, carbon credit; regional impacts of climate change and adaptation strategies; techniques in modeling; water resources and pollution: monsoon, drought, rainwater harvesting, traditional practices in water conservation; case studies.

GS F213 Development Theories **3 0 3**

Course description is to be developed.

GS F221 Business Communication **3 0 3**

Managerial communication – national and international contexts, Interpersonal Communication, persuasive communication, communication technology, effective listening group communication, professional presentation.

GS F222 Language Lab Practice **0 3 3**

Writing: Grammar and usage, sentence completion, jumbled sentences, emphatic word order, vocabulary building, message organization, paragraph development techniques and note taking. Reading: Skimming, scanning, rapid reading, analytical reading, factual reading, and aesthetic reading. Listening: Content listening, critical listening, aesthetic listening, empathetic listening, listening to short conversations, stories, lectures.

GS F223 Introduction to Mass Communication **3 0 3**

Mass communication: an overview, history of media and media plan, cinema, radio, television, theatre, advertising, audience and media, public relations, writing for media, new information technology: software revolution, internet, social media, video conferencing.

GS F224 Print and Audio-Visual Advertising **3 0 3**

The Dimensions of Advertising; Advertising and Marketing; Creative strategy and Creative process; Creative Execution: Art and copy; Media strategy; Advertising research; Relationship Building: Public relation and Corporate advertising; Ethical issues.

GS F231 Dynamics of Social Change **3 0 3**

Nature of society, social institutions; concept and nature of socio-cultural change, obstacles, rate and direction of change; factors of social change-ideological, economic, technological and political demographies; agencies of social change-education, leadership, propaganda, legislative reforms; five-year plans and social change, peasant and land reform, bhoodan and gramdan; changing pattern of family, marriage, caste and religion.

GS F232 Introductory Psychology **3 0 3**

The development of psychology as a science -- individual and the environment; nature; kinds and determinants of perceptions; response mechanism and kinds of responses, motivations, modifications of behaviour through learning, memory and transfer of training; thought processes, problem solving and creative thinking; nature and characteristics of psychological tests; nature and evaluation techniques of intelligence and personality.

GS F233 Public Policy **3 0 3**

Public Policy-meaning nature and types; approaches and models of public policy; nature of public process-process in the executive; parliamentary processes; processes to manage the ruling party-government interfaces; strategic thinking on the process of policymaking, judicial policy making.

GS F234 Development Economics **3 0 3**

Concept of development; statistical foundation of decisions; nutrition, disease and climate as influences on growth; critical importance of population; importance of agriculture, international trade and industry; cost- benefit analysis and planning process.

GS F241 Creative Writing **2 1 3**

Principles of creative writing; stimulating creative activity; techniques of creating images; constructing events and creating characters, writing short stories, plays and poems, writing critical essays on works of art.

The course will require from the student a comprehensive report on the techniques learnt and include samples of his creative writings.

GS F242 Cultural Studies **3 0 3**

Introduction to Cultural studies, Importance of cultural studies, types of cultural studies, relation to Critical theory, relation to Literary Criticism. Introduction to theories such as Communication studies, Film studies, Feminist theory, Art history/Criticism, Societal impact, business relevance, introduction to myriad practices, institutions, beliefs and varied social structures within a given culture.

GS F243 Current Affairs **3 0 3**

Introduction, importance and scope; domains: political, social, religious, scientific, developmental, etc.; categories: controversial, non controversial, neutral; sources of information: newspapers, magazines, posters, pamphlets, manifestoes, etc.; reading skills: skimming, scanning, extensive and intensive reading; understanding, interpreting and analysing news, events and information; forming, balancing and expressing opinion.

GS F244 Reporting and Writing for Media **3 0 3**

Reporters and their functions; What makes news; Analysing the components; Getting the information and putting it together; Organizing a news story; Building colour into news stories; Fighting the formula story ; Writing Leads; Message molecules (Vocabulary, grammar, Spelling), Human Interest and Depth Report; Finding and using news sources; Basics of ethics in Journalism.

GS F245 Effective Public Speaking **2 1 3**

Principles of public speaking; importance of effective listening; use of body language; characteristics of voice; ways to control stage fright; measures to develop confidence; audience analysis; modes of delivery; organization of speech; speeches for special occasion: welcome, introduction, felicitation, farewell, valedictory, inaugural; impromptu and extemporaneous speeches; meetings, group discussions, professional presentations, interviews.

(This course is extensively practice-oriented. Theoretical guidelines also will be given to the students for achieving effectiveness in public speaking. Students would be asked to prepare and deliver a number of talks and presentations. Comments and discussions will follow each presentation so as to provide the students opportunity to correct themselves. Group discussions and presentations will be recorded and projected for them to observe their organization, body language and understand the nuances of the characteristics of their voice. Evaluation components will be designed to assess the students' ability to listen actively and speak effectively. The new language laboratory will be used to enable the students to listen to speeches by eminent leaders and renowned personalities who were/are able to attract the masses with their powerful speeches. The lab would also be used to conduct group discussions through computers).

GS F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

GS F311 Introduction to Conflict Management **3 0 3**

Characteristics and dynamics of conflict, reasons for conflict; the value of conflict in social change; the different approaches to addressing and managing conflict; Examining the history and impacts of a conflict; exploring stakeholder power and relationship; assessment of options to address conflict; tools for determining the best strategy; incentive sand methods in getting stakeholders to collaborate; active listening; skills in mediation and facilitation; roles of mediator and facilitator in conflict management; dealing with emotions and difficult situations; planning and preparing for negotiations; improving negotiation skills; joint problem solving approaches; building agreements; building conflict management mechanisms and consensus-building strategies.

GS F312 Applied Philosophy **3 0 3**

Content of Philosophical Perspectives – Ethical, Logical, Epistemological and Metaphysical; Ethics and Social Dilemmas; Social Justice and Equality; Freedom of Expression; Social and Value Dimensions of Technology; Impact of Information Technology on the Quality of Life; Computer and Inter net Crime; Democratic Values and the Internet.

GS F313 Marxian Thoughts **3 0 3**

Marx and his times; basic tenets; dialectical materialism; economic determinism; doctrine of surplus value; doctrine of class struggle; different schools of Marxism; Leninism; Stalinism; Maoism; future of Marxism.

GS F321 Mass Media Content & Design **3 0 3**

Types of Corporate Communication documents; Importance of corporate communication; communication documents for stakeholders; Data collection for documents- Sources, types, methods; Analyzing and Organizing the content – preparing the drafts; Design Concepts; Design Technologies – Overview; Specific Design tools – Dreamweaver, Macromedia Director, Adobe Premier, Photoshop, Flash; Integrating Content and Design.

GS F322 Critical Analysis of Literature and Cinema **3 0 3**

Creativity and Aesthetics; An overview of Major Movements in Literature and Cinema; Interpretation of Selected Works; Cinema & Art; Understanding Drama: Theme, Character, Plot, form; Understanding Poetry: Diction, Imagery, Symbolism,

Structure and Form, Personification, Apostrophe, Sound and Rhythm; Understanding fiction: Setting, Point of View, Plot and Character; Understanding Short Fiction: Meaning and message, Style and Coherence; Understanding Cinema: Plot; Character; Screenplay; Linguistic, Social, Musical codes; Cinematic Codes; Camera Work.

GS F325 Journalism **3 0 3**

Principles of reporting; the news media and public relations; ground rules for reporters; investigative reporting; specialised reporting of events, trends and activities; creating headlines; editing, copyediting; newspaper style; proof reading; the press and the law.

GS F326 Creative Thinking **2 1 3**

Creative thinking & its importance, Process of creative thinking, Road blocks to creative thinking, Developing creative thinking, Brainstorming, Bloom's Taxanomy, Assessment of creative thinking, Conceptual framework for Critical thinking, Aspects of critical thinking, Stages of critical thinking; Reasoning: Fountain head of critical thinking, Need & benefit of critical thinking, Critical thinking in decision making, Developing critical thinking in classroom, Assessment of critical thinking skills.

GS F327 Selected Reading **3 0 3**

The course is intended to nurture the students' critical thinking and to enhance their skills at information gathering and expressing. Selected readings from books in the areas of History, Science & Technology, Culture, Literature, Art, Philosophy, Psychology, Religion, Development Concepts and Trends etc. will be assigned to the students. A set of books will be identified in at least two broad areas for study and analysis. This course is designed only for students of M.Sc.(Tech.) General Studies Programme.

GS F331 Techniques in Social Research **3 0 3**

Principles of social research, research process, stages of social research, choosing the research problem, objectivity and subjectivity in social research, ethics in social research, ethical codes of practice, confidentiality and anonymity, privacy, Effects of Value in social research, constructing social explanations, descriptive studies, explanatory studies, designing a social research proposal, quantitative research, survey, sampling, SPSS, various statistical tests, qualitative research, observation: participant and non-participant, issues in conducting qualitative research studies, case studies of socio-economic, political, health, gender and developmental issues, interview as social interaction, ethnographic research, field study, hypothesis testing, analysis of data, report preparation and documentation, factors limiting application of social research, evaluation research and development of social indicators.

GS F332 Contemporary India **3 0 3**

Topics will include some or all of the following: economic process; contemporary Indian planning and industry; political processes; Contemporary Indian political scene and Indian administration: India and the contemporary world; social processes: contemporary Indian educational scene; religion and caste system; Indian science; Indian women; cultural processes; contemporary Indian art, music, dance, theatre, cinema and literature.

GS F333 Public Administration **3 0 3**

Definition, nature and scope of public administration; the chief executive; leadership qualities of an administrator; principles of organization; organization of Ministries of Home and Finance; personnel administration-bureaucracy; recruitment, promotion, conduct and discipline, employer-employee relations; administration at work-planning, policy formulation, decision making, supervision, coordination; integrity in administration; public corporations in India; financial administration in India; local administration in India.

GS F334 Global Business, Technology and Knowledge Sharing **3 0 3**

Changing corporate landscape, New knowledge industries, networking and interdependence, Technology: a fundamental driving force, WTO. Global Business Environment, Intellectual Property Rights (IPR), FDI, trends in India and comparison with China. Technology import and export, Technology transfer and adaptation. Need for technology intermediation, newly emerging techno-business opportunities, technology forecasting, technology assessment, technical actions. The role of small and medium enterprise's and the changing roles of enterprises. Leadership for the inter-networked business, Employment and Jobs, access and equity, quality of life, global knowledge innovation infrastructure.

GS F342 Computer Mediated Communication **3 0 3**

Course description is to be developed.

GS F343 Short Film and Video Production **2 1 3**

Introduction; communication media formats like audio, film, video, audio recording and editing; image composting; script writing : screenplay; equipment: video cameras, film cameras, the lens, the camera; the film stock: negatives, prints, aspect ratio, grain, gauge, speed, colour contrast, tone; handling the camera; image technology, sound technology; basic filming techniques: lights and lighting, shooting, sound recording, sound track, dubbing, voice over; visual effects, editing: familiarization with editing software, mixing and looping; final production.

GS F344 Copywriting **2 0 2**

Concept of Copywriter, Setting up as a Copywriter, Copywriting Audience, Copy Writing Process, Marriage of Visual and Copy, Copy Types-Email Marketing, Direct Mail Press Release, Press Ads, Writing Leaflets and Brochures, Newsworthy Newsletters, Radio Copy, Online Copywriting, Other Types of Copy.

GS F366 Lab Project **3**

GS F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

GS F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

Humanities and Social Sciences

HSS F221 Readings from Drama **3 0 3**

Oliver Goldsmith, John Galsworthy, T.S. Eliot, John Osborne.

HSS F222 Linguistics **3 0 3**

Linguistics as a field of study and its relationship with other disciplines; nature of language; its varieties and role in society; concepts of structure, system, unit and class; theories of linguistic analysis.

HSS F223 Appreciation of Indian Music **3 0 3**

The course is intended as an appreciation of Indian music; the emphasis will be upon exposing the students to musical performances, records, tapes, both vocal and instrumental; through these illustrations the consciousness in terms of the distinction between Raag and Taal etc., is expected to be derived; the course will pick up a certain number of Raags from the basic thaats and demonstrate the delineation of the Raag through Alap, through various improvisations based upon compositions; the appreciation of concepts both vocal and instrumental (Sitar and Violin) is expected to be obtained; Karnatik music will also be touched upon particularly in terms of Raags common to Hindustani Music.

HSS F226 Postmodernism **3 0 3**

Postmodernism, The Postmodern Condition, History of Postmodernism in brief, Pluralism, Eclecticism, Polysemy, Intertextuality, Metanarratives, Language Games, Parody, Pastiche, Simulation, Postcolonialism, Commodification, Deconstruction

and New Historicism, Creativity, Critical Judgment, Ethical and Social Understanding, analysis of postmodern cultural artifacts and practices from fine art, music, theology, literature, and film alongside primary texts by the leading theorists of postmodernism.

HSS F227 Cross Cultural Skills **3 0 3**

Overview of Intercultural Communication, Intercultural Communication in the Global Workplace, Technology as cultural Power and Its Social Impact, Critical Issues and challenges in Intercultural Communication, Understanding interrelatedness among Religion, Family, Culture, Gender and Race.

HSS F228 Phonetics and Spoken English **3 0 3**

Speech mechanism; the English phonemes; word accent; features of connected speech; phonetic transcriptions; varieties of spoken English; spoken English in India; problems of Indian speakers; oral reading of passages including conversation; speech training.

HSS F229 Introduction to Western Music **3 0 3**

A historical and cultural examination of music in Western culture from the Middle Ages to the 21st century; Listening to and understanding different genres of music; Fundamentals of Music: Rhythm, Meter and Measure; Melody and Harmony; Pitch names; Intervals; Key signatures; Chord progressions; Score reading; In-tune singing; Ear training; Making music on the electronic keyboard.

HSS F232 Introduction to Development Studies **3 0 3**

History of development; meanings of development; Key development thinkers: Smith, Marx, Liszt, Keynes, Prebisch, Friedman; 20th century perspectives on development: dependency, modernization, human development, post- and anti-development theories; Models of development: ISI and neoliberalism; Themes in comparative international development: environment, health, gender, foreign aid, social and human rights.

HSS F233 Main Trends in Indian History **3 0 3**

A panoramic view of the development of Indian thought and society; evaluation of Indian life and quality from earliest times through the so-called Hindu, Muslim and British periods; the present day analysis and discussion on the basic features of Indian society, its strength and its weakness; a glimpse into future in terms of the transformation of the Indian society.

HSS F234 Main Currents of Modern History **3 0 3**

Renaissance, the major revolutions of the world; rise of nationalism; growth of imperialism; world between the two world wars; super powers and the contemporary world; resurgence of Asia, protest movements in Africa and Latin America; problem of world peace.

HSS F235 Introductory Philosophy **3 0 3**

An overview of some philosophical theories and issues both from India and the western world; nature and purpose of philosophy; theories of cosmology, metaphysics and epistemology; skepticism and its philosophical value; contemporary philosophy.

HSS F236 Symbolic Logic **3 0 3**

A brief historical survey of the development of logic; nature and kinds of arguments; sentential connectives; symbolization of statements and arguments; truth tables, establishing validity of arguments by truth tables and different types of proofs, quantified statements; quantified arguments and their validity.

HSS F237 Contemporary Indian English Fiction **3 0 3**

Indian novel in English as a global phenomenon; pioneering publications; new approaches to the art of storytelling and reworking of language introduced in Indian English fiction. Developments in contemporary Indian fiction in English from the 2000 to the present; Analysis of selected novels set in their historical, political, social and cultural contexts, and alternate view-points on contemporary India.

HSS F238 Sports and Society **3 0 3**

The Sociology of Sport; Theories; Sports and Socialization; Sports and Culture; Deviance and Violence; Class, Gender, Race and Ethnicity; Sports and Education; Sports and Economy; Sports and Politics; Sports and Media; Sports and Globalization.

HSS F242 Introduction to Phonology **3 0 3**

Means of communication; language differences; human speech sounds; organization and structure; deployment; historical evolution; tools and theoretical framework; formal analysis of data; theories.

HSS F243 Introduction to Critical Pedagogy **3 0 3**

Critical pedagogy; ideology and education; oppressive vs. liberatory pedagogy; practice of freedom; democratic education; hidden curriculum; power in classroom; politics in classroom; class; religion; gender; sexuality; disability; examination and impact; mind as blank slate; awakening critical consciousness; humanistic teaching.

HSS F244 Crime and New Media **3 0 3**

Biological Theories: The 'Born Criminal', Social Darwinism, Detective Fiction and the Forensic Method, Monstrous Bodies; Psychoanalytic Theories: Trauma and Perversion, Trigger Warning, Voyeurism, Spectacle of Punishment; Social Disorganization Theories: Sociopath and Vigilante, Organized Crime, Cyber Bullying and Trolling, Panopticism; Feminist Theories: Female Offender, Female Victim, Law Enforcement, Social Rights Movements.

HSS F245 Gender, Science and Technology **3 0 3**

Introduction to science studies: Nature of science and technology, Modern Western science, Science study debates in Indian subcontinent; Gender, science and technology: Sex and gender, Representation of genders in science and technology, Access and retention; Feminism and science: Practice of science and gender, Feminist epistemology; Feminism and technology: Gender-technology debates, case studies.

HSS F246 Philosophy of Nāgārjuna **3 0 3**

Abhidharma notions; Rejection of aggregates, elements, and conditioned entity; Desire and the desirous, agent and action, and fire and fuel; Ontological independence, prior entity, initial and final limits, intrinsic nature, and compounded phenomena; Early-Buddhist views on suffering, bondage and freedom; Action and consequence; Self and entities within substance metaphysics; Time, origin and dissolution of existents, Tathāgata, assemblage, and conjunction; Four noble truths, nirvāṇa, and the twelve links of dependent origination.

HSS F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

HSS F311 Introduction to Videogame Studies **3 0 3**

Introduction to videogames- a brief history of videogames, game studies as a multidisciplinary academic field, play and game- deconstructing videogames: narrative structures of videogames, critiquing rules in videogames, immersion and materiality- puzzles, drama and socio-technical system of video games- Themes of videogames: violence, addiction, language, sexuality, gender, identity, communities, values and ethics- game genres: e-sports, indie games, serious games- gamification, game design; developing story, action and characters in videogames- Game market and economics, game journalism.

HSS F312 Bureaucracy **3 0 3**

Course description is to be developed.

HSS F313 Introduction to Contemporary Arts **3 0 3**

Methodologies of viewing contemporary art and its cultural, political, Philosophical and environmental underpinnings- the basic principles of Western and Eastern art - Indian art history at a glance - different mediums of artistic practice through the ages - modern art- connecting art and technology.

HSS F315 Society, Business and Politics **3 0 3**

Course description is to be developed.

HSS F316 Popular Literature and Culture of South Asia **3 0 3**

South Asia as a region; culture and its representation through literature and cinema; politics of representation, breaking the stereotypes; bringing in the marginalized voices; writings of women; identity formation; concept of majority and minority; commonality in spite of all the differences, violence, migration and dislocation.

HSS F317 Introduction to Globalization **3 0 3**

Main themes and concepts: Globalization, Globalism, Localization, Glocalization; Dimensions of Globalization: Social, cultural, economic, political and ideological; Processes related to Globalization: Internationalization, Westernization, Americanization, Neo- Colonialization; Relationship with issues of environment, city, consumption, media, inequality; Development; Impact and consequences of Globalization in India; Challenges and future of Globalization: Anti-Americanization and Anti-Globalization Movements.

HSS F318 Introduction to Anthropology **3 0 3**

Introduction to Social and Biological Anthropology: Human Nature, Race, Evolution; Sex, Gender, Family; Archaeology: Domestication, Agriculture, and Civilization; Cultural Anthropology: Nature of Culture, and Cultural Relativism; Nature of Language and Languages.

HSS F319 Lighting for Theatre and Films **2***

Design principles and elements of design; lighting instruments; lighting mechanics, rigging and focusing lights; color and color theory, psychology of color, color mixing; lighting paper works, lighting for play, opera, thrust, musical, proscenium, arena and films.

HSS F323 Organizational Psychology **3 0 3**

Industrial/Organizational Psychology, Hawthorne Studies, Leadership-Theories, Motivation-Concepts, Personality & Values: Strengths & Weaknesses, Employee Issues: Recruitment, Training & Development, Organizational Change & Development- Psychosocial Aspects, Organizational Culture & Climate, Work-Family Balance, Stress and its Management, Positive Organizational Psychology.

HSS F325 Cinematic Adaptation **3 0 3**

Course description is to be developed.

HSS F326 Humanities and Design **2 2 3**

Ideas and Designs, Thinking about New Designs, Perspectives to Design: Historical, Social, Technical and Creative Dimensions; Engineering Design and Problem Solving; Basic Concepts in Engineering Design; Design Skills, Abstraction, Identification of Patterns in Processes and Products, Application of Systematic Techniques to Problem Solving, Application and Adaptation of tools and technologies to new problems; Core Principles of Design; Elements of Design, Form and Functionality, Central Activity of Engineering Designs; Language and Interface Design, Design Thinking: Influence of Context Vs. Conflict with Context.

HSS F327 Contemporary Drama **3 0 3**

Course description is to be developed.

HSS F328 Human Resource Development **3 0 3**

The strategic role of human resources management; human resource development – concept, goal, mechanism, and design the system; manpower planning and policies; staffing process- recruitment & placement, job analysis, selection, managing employee separation, downsizing and outplacement; maintaining & developing people- training & development, developing managers, appraising performance, managing career, employee remuneration; governance- developing employee relations & communication, respective employee rights & managing discipline; trade union; managing safety & health.

HSS F329 Musicology – An Introduction **3 0 3**

Music and it's philosophy, history of music, different theories regarding the development of music, music as an exact science (mathematics), musical terminology, musical forms and their background, composers, artistes and their contributions, music of different cultures, music and film world, music therapy. Emphasis would be laid on research and knowledge gained through self-experience.

HSS F330 Appreciation of Art **3 0 3**

Visual perception and basic techniques used in art, compositional balance, space, movement form, light colour, texture, tensions, expressions lines; mainstreams of art; influence of Indian art abroad; various schools of art-Greecian, Medieval, Christian Renaissance, Baroque and Romanticism, impressionism and post impressionism, fauvism, futurism, expressionism, Dadaism and surrealism, metaphysical art, non-representational and abstract art; analysis of work of art and their evaluation.

HSS F331 Sankara's Thoughts **3 0 3**

Life and achievements of Adi Sankara; pre-Sankara Vedanta; basic concepts and theories of Advaita: Atman and Jeeva, nature, sources and validity of knowledge, Brahman and Isvara, Maya and World, Avidya, bondage and liberation; Sankara's contribution to Indian heritage.

HSS F332 Cinematic Art **3**

Cinema as an art form; elements of cinema; defining form, style types, rhyme as adopted in global cinema; new idiom in Indian cinema; experimental techniques; evolution of the language of cinema; analysis of Japanese, Swedish, American, French and Indian cinema ; theatre and cinema.

HSS F333 Comparative Religion **3 0 3**

A clear objective description of the great religions and their appeal to the spiritual aspirations of the different people of the world; a comparative non-sectarian approach to the understanding of Hinduism, Buddhism, Islam and Christianity; a final summing up bringing the unity of all religions of the world.

HSS F334 Srimad Bhagavad Gita **3 0 3**

The science of Soul; Reincarnation; Karma; Karma Yoga; Transcendental Knowledge; Action in Krishna consciousness; Dhyana Yoga; Knowledge of the Ablolute; Attaining the Supreme; The process of Transmigration; the most confidential knowledge; Bhakti Yoga – The process to go back home, back to Godhead.

HSS F335 Literary Criticism **3 0 3**

Aristotle, Dryden, Johnson, Coleridge, Arnold, Eliot.

HSS F336 Modern Fiction **3 0 3**

E.M. Forster, Virginia Woolf, Joseph Conrad, Aldous Huxley, D.H. Lawrence.

HSS F337 English Literary Forms and Movements **3 0 3**

This course is designed to provide a historical perspective on major forms and movements in English Literature and to develop an insight into various social, religious and other influences on their birth and growth. The course will cover the entire range of literature from renaissance and reformation to modern times.

HSS F338 Comparative Indian Literature **3 0 3**

This course is intended to acquaint the students with literary achievements in Indian Languages and their home-environment and to give integrated view of Indian literature, literary selections from the best writers in the Indian languages will be studied.

HSS F339 Theatre Art-Acting and Production **3 0 3**

General historical background of theatre; general knowledge of acting; its tools and exercises; voice training and practice; a study of stage; various systems of theatres; rehearsal techniques and stage management.

HSS F340 Post Colonial Literature **3 0 3**

Introduction to Post colonial discourses; Post Co-lonial Concepts: Colonization, De-colonization, Linguistic colonization, Politics of representation, Orientalism, Euro-centrism, Hybridization, Select Literary Texts.

HSS F341 Performance Design **3 0 3**

Study of a dramatic text and its genre, structure; plot, time, theme and its development, character;music and spectacles; conceiving scenography: basic principles of design; reading the hidden image in the text; performance and show; organizing performing space, conceiving light, music, and sound;staging the show: final production.

HSS F342 Advanced Communicative English **3 0 3**

Pronunciation, Accent, Intonation, Vocabulary, Active Listening, Conversation, Group Discussion,Dynamics of Writing, Art of condensation, Dictogloss, Critical Essays, Academic Essays, Term Paper, Book Review.

HSS F343 Professional Ethics **3 0 3**

Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.

HSS F344 Heritage of India **3 0 3**

Foundations of India; India and her ancient culture; life of the people; systems of Indian philosophy; art and archaeology; languages and literature; impact on world civilization; Western influence.

HSS F345 Gandhian Thoughts **3 0 3**

Sources of Gandhian thoughts, metaphysical convictions, ethical principles, ends and means; Gandhi and religion; theory of satyagraha; political thought; economic thought; social reforms; untouchability; Gandhi and Muslims; Gandhi and women; some items of constructive programme, Gandhi and Marx; his nonviolent state; Gandhism after Gandhi.

HSS F346 International Relations **3 0 3**

Rise of nationalism, World War I, Interregnum; World War II and after; bi-polar politics and detente; instruments for promotion of national interest; diplomacy; propaganda and political warfare; integration of Western Europe; West Asia and world politics; panchsheel and nonalignment; major national foreign policies--USA, USSR, UK and Pakistan; disarmament; UN and World peace.

HSS F347 Introduction to Carnatic Music **3 0 3**

Origins and History of Carnatic music; Basic concepts of svara, svaravalis, svarasthanas, aarohana, avarohana, sthayis; Concept of laya, tala, gati, nadai, different jaati's of taalams; Concept of raaga, Melakarta and janya; Ragalakshanam for some specific raagas; Notation of svaras, taalam; Brief biography of the Trinity, Purandaradasa, and other major composers; Concert formats and styles; Vocal or instrumental exercises including varisais, Saptataala alankaaras, Geetams, svarajati, keertanams; Listening practice.

HSS F348 Introduction to Hindustani Music **3 0 3**

Origins of Hindustani music and evolution of the style; Basic concepts of melody and rhythm: Naad, Dhwani, Sangeet, Swar, Laya, Raag, Taal, Shuddh- Vikrit, Chal-Achal, Mandra-Madhya-Taar, Poorvang – Uttarang, Saptak - Ashtak, Sthayee – Antara, Aroha- Avaroha, Raag-Jati, Tal Jati, Alap-Tan, Varn, Alankar, Pakad, Bandish, Vilambit-Madhya-Drut, Matra, Theka, Vibhag, Tali, Khali, Sam. Raaga, Thaat, raag vivara; Compositions: khayals, dhrupad, taraana etc; Vocal or instrumental exercises including ten alankars, Identification of svaras, Aroh, avaroh and pakad of simple raags viz. Yaman, Bhoop, Khamaj, Des, Kafi, Bhimpalasi, Bageshri, Durga; Sargam geets, lakshan geets and madhyalay khayals; Taals including Trital, kaharva, daadra; Listening, identification of raaga from simple phrases.

HSS F349 Ecocriticism **3 0 3**

Defining Ecocriticism; Interdisciplinarity; Ecosystem and Biodiversity; Ecology and Environment; Developmental Ecology; Ecocritical Concepts; Literary Ecocriticism; Application of Ecocritical Principles in Literature - tinai Criticism; Deep Ecology; Bioregionalism - Cultural Ecocriticism; Ecocinema - Debates on Anthropocentrism and Biocentrism/Ecocentrism; Food documentaries; Animal Studies; Ecophobia; Gaia Theory; Ecocriticism and Society; Ecopolitics and Activism; Ecospirituality and Ecosophy; Practical Ecocriticism.

HSS F350 Human Rights: History, Theory & Practice **3 0 3**

The meaning and history of human rights; Human rights debates and controversies; Political, civil, social and economic rights; Culture and human rights; Themes - Democracy, dictatorship, and human rights; Science, technology, and human rights; Ethnicity; Gender; Children's rights and others;Evaluating the progress made and challenges in practice of human rights.

HSS F351 Social and Political Ecology **3 0 3**

Environmental History and Social construction of nature; Theoretical perspectives on Natural Resource use; Ecological Development; Natural Resource Governance; Ecological Identity and Social Movement-Gender-based dimensions; Degradation and Marginalization; Conservation and Control; Ecotourism; Urban Ecology; Regional case studies.

HSS F352 Technology, Work and Society **3 0 3**

Work during and after Industrial Revolution; Major theoretical contributions to the study of Work; Technology and its impact on work in the 21st century; Work and self in the service industry; Work and self among professionals and managers; Changes in Culture of Work; Domestic labor and the politics of household work; Modern distinction between work and family.

HSS F353 Philosophy of Aesthetics **3 0 3**

Fundamental questions related to art, its purpose and manifestations as well as foundational problems such as, ideology, ontology, values attached, implicit/explicit meanings, connections with other disciplines, social manifestations and implications, historical contexts, mediums and representations. Important Indian and Western perspectives on aesthetics through music, literature, painting and cinema, contextualizing them in history.

HSS F354 Introduction to Islamic Economy **3 0 3**

Islamic Finance and Islamic digital economy, Halal industries, Halal tourism, Islamic art and design, Islamic economy standards and certification, and Islamic information and education.

HSS F355 Dictatorship, Democracy & Development **3 0 3**

Overview of the relationship between political regimes and development; how regimes matter: top-down interventions and bottom-up pressures; key concepts: democracy, dictatorship, civil society, social movements, social capital, human development; survey of academic literature to understand "democracy advantage"; country studies: Brazil, China, India; relevance and limitations of the relationship between political regime type and development.

HSS F356 Social Movements and Protest Politics **3 0 3**

Need for studying social movements ; origins, forms, trajectory, outcomes of social movements ; key participants; protestors objectives, their achievements / failures ; the Civil Rights Movement ; women's movements in the US and Europe; pro-democracy movements in Brazil; Islamic movements in the Middle East; The Christian Right in the US; the Hindu nationalist movement in India ; Maoism in India; anti-corruption protests.

HSS F361 Urban Policy and Governance **3 0 3**

Urban, urbanization, urbanism- the concepts; Major schools of thought in urban sociology; Patterns of urbanization- World urbanization, third world and India; Urban processes- assimilation, segregation, differentiation, suburbanization, Core-periphery, urban sprawl, primate city, right to city; Factors of urbanization- Natural growth, migration and re-classification; The constitutional and political dimensions of urbanization in India; Urban growth in post-liberalization era and informal economy in cities; Urban problems; Urban policy history in India and contemporary policy measures; Future of urbanization in India.

HSS F362 Local Governance and Participation **3 0 3**

Political role of Panchayat Raj - Decentralisation below state level, Decentralised planning, Panchayati Raj Bills, Acts and Constitutional amendments, Grassroots politics; Inclusiveness and Participation - Women in Panchayati Raj, Impact of reservation in local bodies, Democracy and social capital, Local democracy and clientelism; Functional and Financial Devolution - Fiscal decentralisation to the sub-state level governments, Functional devolution to local bodies, Federalism, urban decentralisation and citizen participation, Poverty alleviation and efforts of panchayats; Challenges and Prospects of Local Government and Participation- Neighbourhood associations and local democracy, Experiment with direct democracy, Law of two-child norm in Panchayat, Beyond feminine public altruism.

HSS F363 Disaster and Development **3 0 3**

Disaster and Development - Concepts and contemporary debates, How disasters impact development, How development can induce vulnerability, Role of Planning in Disaster Management; Disaster Risk Assessment - Risk and Uncertainty, Multi- hazard analysis, Vulnerability and Capacity analysis, Risk evaluation and decision making; Mainstreaming Disaster Risk Reduction into Development - Mainstreaming of Frameworks and tools, Policies, Plans and Regulations, Challenges: data and modelling limitation, political and economic consideration; Disaster Management Planning - Need and impact assessment, Business Continuity Plan (BCP), Response and recovery planning.

HSS F364 Political Economy of Gulf Cooperation Council States **3 0 3**

Overview of Gulf History and Society: History in a nutshell; Religion, Language, Identity and Culture, Rentier State, Citizenship; Political and Social Change in the Gulf: Nationalism, Rule of Law and Political Liberalization, Gender and Participation; Media, Bureaucracy and Civil Society Groups; Economic Reforms and Governing Structure: State-Business Relations, Islamic Finance Development, Oil based Economy to Knowledge Economy, Resource Curse, Labour Market & Migration Policies; Internationalization of the Gulf: Security and Strategic Trends, Foreign Policy with International Reach, Environment, Energy, Maritime and Sustainable Policies, Challenges in transition.

HSS F365 Science of Sustainable Happiness **3 0 3**

Introduction to Science of Happiness; What Determines Happiness; Happiness Model and Model of Sustainable Happiness; Power of Social Connection; Managing Stress, Hardship, and Trauma; Living in the Present, Committing to Your Goals; Compassion and Kindness; Cooperation and Reconciliation; Mindfulness; Gratitude; Mental Habits of Happiness; If You are Depressed; New Frontiers and Happiness "Fit"; Five Hows Behind Sustainable Happiness; Sustainability, Happiness and Education.

HSS F368 Asian Cinemas and Cultures **3 0 3**

Introduction; The ideas of Asia; Asia as method; India and her neighbors; BRICS and ASEAN; Look East Policy; Cinema, Culture and Diplomacy; Cinema as Soft Power; Asian diaspora cinema; Indian Diaspora in the East; Cinemas from the Middle East; Iranian Cinema after the Revolution; Cinemas of & on the Israel-Palestine conflict- New Asian Metros; Thai Cinema and the global auteur; South Korean history through their Cinema; Filipino New Wave, Taiwanese New Wave; Chinese Cinemas after the Cultural Revolution; Asianization of the West; India's Cine-Cultural Negotiations with her Asian Neighbors.

HSS F369 Caste and Gender in India **3 0 3**

Concepts - Caste and Gender; Materialist and religious theories; Caste Ideologies; Caste, class and gender intersections, Gender construction within castes; Graded Patriarchies; Colonial impact on caste and gender; Caste and Gender in contemporary period; Oppositional narratives to caste and gender construction; Legal interventions.

HSS F371 Cities-Life, Issues and Conflicts **3 0 3**

The origin and growth of city; Theories and paradigms of cities; Spatial, socio-economic, political and cultural perspectives of cities; Social psychology of cities; Conflicts and changes within a city; City and the environment; Globalization impact on urban development in the Indian context.

HSS F372 Introduction to Social Psychology **3 0 3**

Interaction between human and social situation; social environment and people and vice versa; fundamental theories; concepts; research methods in social psychology; past and present research related to social psychology; application of social psychological concepts to understand real life situation; social perception, social cognition; group dynamics; aggression; application of social psychology in law, health, and organizational sector; impact of social networking on life.

HSS F373 Shakespeare and Popular Culture **3 0 3**

Renaissance political exigencies of government and theater; Shakespeare as popular culture in renaissance England; Shakespeare adaptations; case study of hamlet; the prince's right to govern; use of political force; early modern cultural expectations of the governed; renaissance individual's reliance of fortune; Machiavelli's The Prince; Castiglione's the book of the courtier. Recent popular representations of Hamlet; cotemporary relevance; nature of artistic composition; the discursive nature of the relationship between the past the present.

HSS F374 Urban Modernity and the Renewal of Paris **3 0 3**

1850s – 1870s Street level reform; hygiene; circulation of capital; Modernity and Urban planning; theoretical background of urban planning; role of Baron Haussmann; notion of any modern city; political and artistic effects of urban planning; advertising and modern consumer culture in 1850s – 1870s.

HSS F399 Introduction to American Literature **3 0 3**

Socio-cultural and literary history of the United States since the landing of the Pilgrims from *The Mayflower* to the decisive American victory over the Axis powers in World War II. (1500-1700) Establishment of Plymouth Plantation and the establishment of early Puritanism. (1700-1800) Influence of Enlightenment thought on American life and letters and Consequences of the Revolutionary War on literature. (1800-1865): American Literary Nationalism, the westward expansion, and the American Civil War. (1865-1914): Reconstruction period, Mexican War, imperial expansion to the Southwest, building of transcontinental railroads, the American frontier issue, industrialization and transformation of American life and their effects on the literary marketplace. (1914-1945): the two world wars, the Great Depression, Modernism and Modernity in American life and letters, Harlem Renaissance, increasing presence of science and technology in everyday American life.

HSS G511 Philosophical Foundations of Liberal Studies **3 2 5**

Idea of being; modes of being; causation; metaphysical education; natural education; social education; refutation of metaphysics; concept of necessity; humanism; epistemology; search for the method of science; Reasoning – constructing Arguments- Standards for constructing and evaluating arguments; validity, truth, and soundness; Fallacies; Project

HSS G512 Theoretical Approaches to Liberal Studies **3 2 5**

Introduction to Ideologies in Social Sciences; Developmentalism, Political Culture, Sociological approaches; Psychoanalysis as bridging the fields of humanities, natural and social sciences; Institutions and institutionalism; Irrationalism; Environmentalism; Sociobiology; The present as post; Culture, Intellectuals and Media; Indigenous theories of change; Project

HSS N203T Basic Arabic **3 0 3**

Arabic of basic level, Recognition of Arabic alphabets with its different writing patterns, Phonetics and peculiar Arabic sounds, Familiarity with the basic vocabulary, Familiarity with profession specific words and phrases, Grammar, Sentence patterns and expressions for daily communication, Reading, writing, listening and speaking skills at initial level, Focus on modern standard Arabic and its comparison with colloquial and local dialect, exercises and practice.

HSS N301T Elements of Dance **1 1 2**

Introduction to elements of dance; dance sense; dance pathway; relationship of dance with culture, society, geography and arts; dance workout, salsa, ballet, folk, classical, contemporary, musical theatre

Humanities

HUM G511 Introduction to Health Systems **3 0 3**

Health facilities for SC/ST; Health Systems; Evolution of Medicine; Sociology, health and medicine; Primary health care; Health Development; Health education; Health policy in India; Issueslike euthanasia, consumer forums, child labor; Female infanticide; women's health; Role of hospitals; Advances in Public Health; Communications; Evaluation of National Health Systems; Demography; Family Planning; Psycho-social issues.

Instrumentation

INSTR F211 Electrical Machines **3 1 4**

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram. Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machinesuniversal motors, Induction generators.

INSTR F212 Electromagnetic Theory **3 0 3**

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell’s equations in free space.

INSTR F214 Electronic Devices **3 0 3**

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET),Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

INSTR F215 Digital Design **3 1 4**

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

INSTR F241 Microprocessors and Interfacing **3 1 4**

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

INSTR F242 Control Systems **3 0 3**

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

INSTR F243 Signals & Systems **3 0 3**

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

INSTR F244 Microelectronic Circuits **3 0 3**

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

INSTR F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

INSTR F311 Electronic Instrumentation & Instrumentation Technology **3 1 4**

Electronic indicating, display, recording and analysis instruments, signal generators, frequency synthesizer, counters, elements of design, grounding and shielding, electronic circuits manufacturing technology, metrology, standards in quality management, instrumentation in hazardous area, industrial communication techniques.

INSTR F312 Transducers and Measurement Systems **3 0 3**

Importance and types of measurement, generalized measurement system, functional elements, static & dynamic characteristics, primary sensing elements, passive transducers, active transducers, inverse transducers, fiber optic transducers, MEMS based transducers, measurement techniques for motion, seismic, pressure, flow, temperature, level, humidity, pH, viscosity; signal conditioning techniques using bridge, op-amp, instrumentation amplifier, carrier, chopper, charge, isolation amplifier, data converters, filters, modulators; data acquisition systems.

INSTR F313 Analog & Digital VLSI Design **3 0 3**

Moore's Law, Y chart, MOS device models including Deep Sub-Micron effects; an overview of fabrication of CMOS circuits, parasitic capacitances, MOS scaling techniques, latch up, matching issues, common centroid geometries in layout. Digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; timing issues (clock skew and jitter) and clock distribution techniques; estimation and minimization of energy consumption; Power delay tradeoff, interconnect modelling; memory architectures, memory circuits design, sense amplifiers; an overview of testing of integrated circuits. Basic and cascaded NMOS/PMOS/CMOS gain stages, Differential amplifier and advanced OPAMP design , matching of devices, mismatch analysis, CMRR, PSRR and slew rate issues, offset voltage , advanced current mirrors; current and voltage references design, common mode feedback circuits, Frequency response, stabilty and noise issues in amplifiers; frequency compensation techniques.

INSTR F341 Analog Electronics **3 1 4**

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit performance. Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

INSTR F342 Power Electronics **3 1 4**

Need for power conversion; Power electronic converters: classifications and scope; Power semiconductor switches: diodes, SCR , GTO and transistors (BJT, MOSFET and IGBT): Ratings, static and dynamic characteristics, drive and switching aid circuits and cooling; DC to DC conversion: Buck, Boost and Buck-Boost converters: circuit configuration and analysis with different kinds of loads; Choppers: single quadrant and two quadrant operation with DC motor load and steady

state analysis; Rectifiers: single phase and three phase operation, power factor, harmonics and effect of source inductance; Dual converters; Drive concept: Four quadrant drive and load characteristics, selection of motor, control and stability of electric drives, feed back control of drives; DC motor drive; Inverters: single phase and three phase bridge inverters and PWM inverters; Single phase AC voltage regulators and cycloconverter; Induction motor drive - Variable frequency operation of 3- phase induction motor, stator voltage control and V/f control methods; Non-drive application of power electronic converters: UPS, active power line conditioner, electronic ballast and induction.

INSTR F343 Industrial Instrumentation and Control **3 0 3**

Importance of process control, elements of process loop, mathematical modeling, dynamic closed loop characteristics, controller principles & tuning, direct digital loop, hydraulic controllers, pneumatic controllers, electronic controllers, complex & multivariable control schemes, final control elements, P& I diagrams, PLCs, Distributed Control Systems (DCS), AI techniques: expert systems, neural networks, fuzzy logic, genetic algorithms & applications.

INSTR F366 Lab Project **3**

INSTR F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

INSTR F376 Design Project **3**

INSTR F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

INSTR F411 Opto-Electronic Instruments **3 0 3**

Optical radiation-its emission, control and detection; optical signal processing; amplifiers and associated electronic equipments. Opto-electronic system design-calorimeters, spectrophotometers, flame photometers, fluorimeter and turbidimeters; project equipments; introduction to laser-based instruments.

INSTR F412 Analysis Instrumentation **3 0 3**

Generalized configuration of an analysis instrument. Off-line analysis instruments: emission spectrometers, UV/VIS/IR absorption spectrophotometers, flame emission and atomic absorption spectrophotometers, X-ray fluorescence spectrometer and diffractometer, NMR and mass spectrometers, pH-meters, gas chromatographs, electrochemical instruments, analytical electron microscopes. On line analyzers: Sampling systems for gases and liquids, fluid density monitors, consistency and viscosity analysers, thermal conductivity gas analysers, paramagnetic oxygen analysers, chemical composition analysers, on-line instruments for measuring standard parameters, e.g. vapour pressure, distillation characteristics, cloudpoint, pour point, flash point etc. Recent developments.

INSTR F413 Advanced Process Control **3 0 3**

Process identification and adaptive control; Model predictive control structures; Model-based control structures; State estimation; Synthesis of control systems-some case studies; intelligent control.

INSTR F414 Telecommunication Switching Systems & Networks **3 0 3**

Intoduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

INSTR F415 Digital Control **3 0 3**

Course Description is to be developed.

INSTR F419 Virtual Instrumentation **3 1 4**

Fundamentals of virtual instrumentation--- Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card. Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O., Analysis tools and simple applications :Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system.

INSTR F420 Design of Instrumentation Systems **3 0 3**

Design of transducers, signal conditioning circuits, instrument air system, control valve, control panel design, Human machine interface, Reliability, Electronic product design, Noise reduction, P&I diagrams, safety instrumentation systems, life cycle activities: requirement specifications, I&C system design and implementation, system integration, validation, operation maintenance, case studies of ISD in various sectors.

INSTR F422 Instrumentation for Petrochemical Industry **3 0 3**

Petroleum Processing: Petroleum exploration – Recovery techniques – Oil - Gas separation –Processing wet gases - refining of crude oil, Unit Operations in Petroleum Industry: Measurement in Petrochemical Industry: Parameter to be

measured in refinery and petrochemical industry – Selection and maintenance of measuring instruments – Intrinsic safety of instruments Control Loops in Petrochemical Industry: Process control in refinery and petrochemical industry – Control of distillation column control of catalytic crackers and pyrolysis , Automatic control of polyethylene production – Control on vinyl chloride and PVC production.

INSTR F432 Medical Instrumentation **3 0 3**

Basic components of bio-medical instruments, bio-electric signals & recording electrodes, transducers, recording and display devices. Patient care and monitoring systems, cardiovascular measurements-blood pressure, blood flow, cardiac output, heart sounds etc.; instrumentation for respiratory and nervous systems, analysis of EEG, ECG, EMG, EOG and action potentials, non- invasive diagnostic measurements - temperature, ultrasonic diagnosis, CAT scan techniques, sensory measurements-motor response, analysis of behaviour etc. biotelemetry, biofeedback, clinical laboratory instruments, X-ray diagnosis. Recent advances in biomedical instrumentation- microprocessor based systems, lasers & optical fiber based systems.

INSTR F473 Wind Electrical Systems **3 0 3**

Thermodynamics of wind energy, Types of Wind energy conversion devices, Aerodynamics of wind rotors, design of wind turbine rotor, Power -speed characteristics, torque-speed characteristics, Wind turbine control systems, Wind speed measurements , Wind speed statistics, Site and turbine selection, Induction Generators, Wound field synchronous Generator, Permanent Magnet synchronous machine, Doubly fed induction generator, Power Flow equations, Power Semiconductor devices, Converters, Inverters, power quality, Reactive power compensation, Wind diesel hybrid systems, Wind photovoltaic systems, Role of Govt. and policies for market development.

INSTR F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

INSTR G611 Advanced Control Systems **3 2 5**

Review of State variable modelling of linear continuous, linear discrete and non linear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

INSTR G612 Instrumentation Systems **2 2 5**

Generalized approach to measuring systems; performance characteristics of instruments; primary sensing elements and transducers; analog and digital signal conditioning operations; microprocessors in instrumentation; applied process control instrumentation; General purpose and analytical instruments covering spectroscopic, separation, atomic absorption instruments UV-VIS-IR,GLC, HPLC, etc; Instrumentation practices in typical R&D laboratories; instrumentation case studies covering selection, quality assurance, system design, etc; Hands on experience in operation of sophisticated instrumentation systems.

INSTR G621 Industrial Automation **3 2 5**

Computer control theory, sampling of continuous time signals, computer oriented mathematical models, discrete time systems, and analysis of the same, translation of analog design, state space design methods, pole-placement design based on input/output models. Adaptive control principles, implementation of digital controllers, model reference adaptive systems, self-tuning regulators, stochastic adaptive control, auto-tuning, expert controllers, learning systems and other applications.

Information Systems

IS F211 Data Structures & Algorithms **3 1 4**

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Recursive Data Types, Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues); Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization), Lower Bound on Complexity of Sorting Algorithms. Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Probabilistic/Randomized Data Structures (such as Bloom Filters and Splay Trees). Generalized Trees – Traversals and applications. Text Processing – Basic Algorithms and Data Structures (e.g. Tries, Huffman Coding, String search / pattern matching). External Memory Data structures (B-Trees and variants). Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees).

IS F213 Object Oriented Programming **3 1 4**

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages. Object Oriented Design Patterns: Behavioral, Structural and Creational.

IS F214 Logic in Computer Science **3 0 3**

propositional logic – syntax, semantics, satisfiability & validity, predicate or first order logic – syntax, semantics, satisfiability & validity, completeness & compactness, Undecidability & incompleteness; Godel's incompleteness theorem; SAT solvers; verification by model checking, linear-time temporal logic (LTL), & computational tree logic (CTL). Program verification using Hoare logic & proofs of correctness; Modal logic & logic programming paradigm.

IS F222 Discrete Structures for Computer Science **3 0 3**

Sets & operation on sets; relations & equivalence relations; number theory; weak & strong form of mathematical induction; principle of inclusion & exclusion, pigeonhole principle; recurrence relations & generating functions; digraphs & graphs, graph isomorphism & sub-graphs, spanning trees, Euler & Hamiltonian graphs, planar graphs, chromatic numbers & graph coloring; groups; Lagrange theorem finite groups; Rings & Fields.

IS F241 Digital Electronics and Microprocesors **3 1 4**

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing; examples of system design.

IS F242 Computer Organization **3 1 4**

This course covers the fundamentals of computer organization and architecture. Computer system components; Interconnection structures; Instruction set architecture; Computer arithmetic; Memory system; I/O systems; Control unit design; Instruction execution and scalar pipelining; Parallel processing and Super scalar pipelining; Introduction to parallel processing architecture including multi-core systems.

IS F243 Database Systems & Application **3 1 4**

Introduction to Database Management Systems; Data Independence in databases; DBMS architecture; Data Models; Relational Model; Query Languages: Relational Algebra and SQL, Database Design techniques; Normalization; Data Organization; File Systems and Indexing; Concepts of security and integrity in databases; Transaction Processing ; Query processing and optimization; DBMS based application development; internet applications XML data management; multimedia databases; Distributed Databases.

IS F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

IS F301 Principles of Programming Languages **2 0 2**

The course covers features of programming languages and introduces the main programming paradigms. It covers, in detail, the semantics of the features of programming languages –Control Abstraction, Data Types and Data Abstraction, Scope and Parameter passing and Concurrency related features. It covers various aspects of runtime environments like global and local data, code, function call stacks, dynamically allocated data, runtime features for exceptions and threads. Introduction to programming paradigms. Functional paradigm – formal elements of lambda calculus, introduction to syntax of common functional programming languages and programming exercises that explore the functional paradigm. Logic programming paradigm - formal elements of logic programming and programming tasks that explore the logic paradigm. Scripting as a paradigm. Domain specific languages. Applications of the principles of programming languages –program verification, software testing and security.

IS F303 Computer Networks **3 1 4**

Introduction; Need for Computer Networks; Top-down vs. Bottom-up approaches; Network Services, and Protocols; Network Reference Models and Architectures, Architecture of the Internet, Types and Applications of contemporary and emerging Networks, Application-Layer Requirements, Concepts, Services and Protocols: Protocols for Web, Email, File transfer, Name Resolution, Address Assignment / Discovery, Remote Access Services, Voice/Video over IP, Webcasting, Video-Conferencing and Telepresence, Network Management Protocols and Overlay Networks; Transport Layer Requirements, Services, Concepts and Protocols; Network Layer Requirements, Concepts, Services and Protocols, Routing vs. Layer-3 Switching; QoS; Link Layer and Physical Layer Requirements, Concepts, Services and Protocols, Logical Link and Medium Access Control concepts, Physical medium dependent function, Modes of Signaling and Communication at the lower layer; IEEE 802 architecture, Bridging versus Layer-2 Switching; VLANs, VPNs, Performance vs. Security, Emerging Trends and Best Practices related to design of computer networks and internetworks.

IS F311 Computer Graphics **3 0 3**

Graphics I/O hardware; Generation of dot, lines, conics, curves, surfaces & polygons; Filling closed regions, 2D & 3D Graphics & Transformations, Windowing, Viewing & Clipping, Efficient algorithms, Solid Modeling, Color Models & Dithering, Visible surface detection, Rendering, Animation Techniques, Advanced modeling and Future directions.

IS F322 Software Testing **2 1 3**

Brief description of importance of software, Life cycle model and process, Basic software testing, all definitions, Types of testing and techniques (CFG, CDG etc.), Black Box & white box Testing Methodologies, Finite State Machine Model, State based Testing, Static Testing and analysis, Test cases, Test Data Generation, Test selection, Minimizations and Prioritization, Test adequacy criteria, Software Testing on Web Engineering, Object based Software Testing, Architecture of Testing tool, Software Test Effort Estimation, Testing behavior and process model, Qualitative analysis, Quality factors in software testing, Selection of testing tools.

IS F341 Software Engineering **3 1 4**

Ethics of software Engineering (ACM/IEEE code of Ethics),Type of Software, Application of Software ,Software Life Cycle Model, Agile Modeling Requirement Engineering, Object Oriented Analysis and Design(using UML), Introduction of Web Engineering, Software Integration and Testing, Support Processes and Software Quality, Software change Management, Software Product and Process Metrics Measurement, Software Project Management ,Scheduling ,Staff Measurement, Risk Management, Componnet based Software Engineering, Quality and Reliability Model, Maturity Models , Software Reengineering, deployment models.

IS F342 Compiler Design **2 1 3**

Introduction - Compilation and Execution Environments -Compilers and Interpreters – Requirements and Motivation; Front-end and Back-end of compilers/interpreters; Intermediate Representation and Intermediate Languages; Compile Time vs. Execution Time; Translators, and Assemblers; Virtual Machine -Just-in-Time Compilers. Structure of a Compiler – Phases and Passes. In-memory data - intermediate versions of code, symbol table. Lexical Analysis: Regular expressions and DFA (introduction where needed), Defining tokens using regular expressions, Designing and implementing scanners / lexical analyzers. Parsers: Context Free Languages (introduction where needed)and Recognizing CFLs. Parsing techniques – LL , LR - LR (0),LR(1), LALR) . Intermediate Representation: Parse Trees and Abstract Syntax Trees; 3-address code. Semantic Analysis. Back End Phases: Machine Independent optimizations: Loop Optimization Techniques - Loop Unrolling, Induction variable based optimization, Loop-Invariant code elimination. Procedure Call Optimization, and Dead Code Elimination. Target Code Generation : Data Flow Analysis, Register Allocation, Instruction Selection & Scheduling. Memory Management : Memory allocation support, Memory- de-allocation – Garbage Collection Techniques. Advanced Topics :Issues in compiling Object Oriented Languages, Functional Languages, Concurrent Languages, Script & Query Languages.

IS F366 Lab Project **3**

IS F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

IS F376 Design Project **3**

IS F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

IS F372 Operating Systems **3 0 3**

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms ; File systems: design and implementation of file systems; Input /Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

IS F462 Network Programming **3 0 3**

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

IS F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

Internet Technology & e-Business

ITEB G621 Supply Chain Management **4**

Customer driven strategies in production and distribution systems; Integrated production & distribution networks; SCM in the context of JIT and MRP-II; Distribution Resource Planning; Management of dealer networks; Total Quality Control &

product innovation across the supply chain; Incoming logistics & supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; mathematical programming for SCM.

Mathematics

MATH F111 Mathematics I **3 0 3**

Functions and graphs; limit and continuity; applications of derivative and integral. Conics; polar coordinates; convergence of sequences and series. Maclaurin and Taylor series. Partial derivatives. Vector calculus in R^n; vector analysis; theorems of Green, Gauss and Stokes.

MATH F112 Mathematics II **3 0 3**

Complex numbers, analytic functions, Cauchy's theorems; elementary functions; series expansions; calculus of residues and applications.

Vector space; basis and dimension; linear transformation; range and kernel of a linear transformation; row reduction method and its application to linear system of equations.

MATH F113 Probability & Statistics **3 0 3**

Probability spaces; conditional probability and independence;random variables and probability distributions;marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions;sum of independent random variables; law of large numbers; central limit theorem (without proof);sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

MATH F211 Mathematics III **3 0 3**

Eigen-values and eigen-vectors. Inner product space and orthonormal bases. Elementary differential equations, Hypergeometric equations, Lengendre polynomials, Bessel functions; Fourier series; Sturm-Liouville problem, series solution for differential equation, systems of first order equations; Laplace transformation and application to differential equations; one dimensional wave equation, one dimensional heat equation & Laplace equation in rectangular form.

MATH F212 Optimization **3 0 3**

Introduction to optimization; linear programming; simplex methods; duality and sensitivity analysis; transportation model and its variants; integer linear programming nonlinear programming; multi-objective optimization;evolutionary computation techniques.

MATH F213 Discrete Mathematics **3 0 3**

Logic and methods of proof, Elementary Combinatorics, recurrence relations, Relations and digraphs, orderings, Boolean algebra and Boolean functions.

MATH F214 Elementary Real Analysis **3 0 3**

Countability and uncountability of sets; real numbers; limits and continuity; compactness and connectedness in a metric space; Riemann integration; uniform convergence.

MATH F215 Algebra-I **3 0 3**

Groups, subgroups, a counting principle, normal subgroups and quotient groups, Cayley's theorem, automprhisms, permutation groups, and Sylow's thorems.

Rings, ring of real quaternions, ideals and quotient rings, homorphisms, Eculidean rings, polynomial rings, and polynomials over the rational field.

MATH F231 Number Theory **3 0 3**

Primes and factorization; division algorithm; congruences and modular arithmetic; Chinese remainder theorem Euler phi-function and primitive roots of unity; Gauss's quadratic reciprocity law; applications to periodic decimals and periodic continued fractions.

MATH F241 Mathematical Methods **3 0 3**

Integral Transforms: Fourier, Fourier sine/cosine and their inverse transforms (properties, convolution theorem and application to solve differential equation), Discrete Fourier Series, Fast Fourier transform, Calculus of Variation: Introduction, Variational problem with functionals containing first order derivatives and Euler equations, Variational problem with moving boundaries. Integral equations: Classification of integral equations, Voltera equations, Fredholm equations, Greens functions.

MATH F242 Operations Research **3 0 3**

Introduction to Data Processing; Files and File Structures; Indexing Techniques; Sorting, Searching and Merging Techniques; Introduction to Database Management Systems; Design of Information Systems; Emerging trends in Data Processing.

MATH F243 Graphs and Networks **3 0 3**

Basic concepts of graphs and digraphs behind electrical communication and other networks behind social, economic and empirical structures; connectivity, reachability and vulnerability; trees, tournaments and matroids; planarity; routing and matching problems; representations; various algorithms; applications.

MATH F244 Measure and Integration **3 0 3**

Lebesgue measure and integration in real numbers, Convergence and Convergence theorems, absolutely continuous functions, differentiability and integrability, theory of square integrable functions, and abstract spaces.

MATH F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

MATH F311 Introduction to Topology **3 0 3**

Metric Spaces; Topological Spaces – subspaces, Continuity and homoeomorphism, Quotient spaces and product spaces; separation Axioms; Urysohn's Lemma and Tietze extension Theorem; Connectedness; Compactness, Tychonoff's Theorem, Locally Compact Spaces; Homotopy and the fundamental group.

MATH F312 Ordinary Differential Equations **3 0 3**

Existence and uniqueness theorems; properties of linear systems; behaviour of solutions of nth order equations; asymptotic behaviour of linear systems; stability of linear and weakly nonlinear systems; conditions for boundedness and the number of zeros of the nontrivial solutions of second order equations; stability by Liapunov's direct method; autonomous and nonautonomous systems.

MATH F313 Numerical Analysis **3 0 3**

Solution of non-linear algebraic equation; interpolation and approximation; numerical differentiation and quadrature; solution of ordinary differential equations; systems of linear equations; matrix inversion; eigenvalue and eigenvector problems; round off and conditioning.

MATH F314 Algebra II **3 0 3**

Dual spaces, modules, fields, finite fields, extension of fields: algebraic extension, separable and inseparable extension, normal extension, sptitting fields, Galois extension, and Galois group.

The algebra of linear transformations, characteristic roots and characteristic vectors, canonical forms: triangular form, nilpotent form, and Jordan form.

MATH F341 Introduction to Functional Analysis **3 0 3**

Banach spaces; fundamental theorems of functional analysis; Hilbert space; elementary operator theory; spectral theory for self-adjoint operators.

MATH F342 Differential Geometry **3 0 3**

Curve in the plane and 3D-space; Curvature of curves; Surfaces in 3D-space; First Fundamental form; Curvature of Surfaces; Gaussian and mean Curvatures; Theorema Egreguim; Geodesics; Gauss-Bonnet Theorem.

MATH F343 Partial Differential Equations **3 0 3**

Non linear equations of first order, Charpits Method, Method of Characteristics; Elliptic, parabolic and hyperbolic partial differential equations of order 2, maximum principle, Duhamels principle, Greens function, Laplace transform & fourier transform technique, solutions satisfying given conditions, partial differential equations in engineering & science.

MATH F344 Mathematical Fluid Dynamics **3 0 3**

Introduction to the Fluid Dynamics and Fundamental Concepts, Langrange and Eulerian Descriptions, Continuum hypothesis, Conservation of Mass based on different approaches, Equation of Continuity in different Coordinates,Potential Flow, Laplace Equation, one-,two- and three-dimensional flow, Conservation of Linear Momentum,Euler's Equation,Bernoulli's equation, Constitutive equations for Newtonian Fluid, Navier-Stokes Equations, First Law of Thermodynamics, Reynolds number, Exact Solution of Navier-Stocks Equation, Boundary Layer Approximations, Setting up the Boundary-Layer Equations, Limit Equation For the Flat Plate, Discussion of Blasius' Equation, Description of Flow Past a Circular Cylinder, Decay of a Laminar Shear Layer.

MATH F353 Statistical Inference and Applications **3 0 3**

Review of elements of probability and statistical methods, Classical Decision theory including parametric and non-parametric methods for testing of hypotheses, Analysis of Variance: One way and two way classifications, Design of experiments: Analysis of Completely randomized design, Randomized block design and Latin square design with one or more missing values, Statistical Quality control for variables and measurements.

MATH F354 Complex Analysis **3 0 3**

A rigorous treatment of the theory of analytic functions of complex variables including Cauchy's theorems; maximum modulus theorem; the principles of argument; Jensen's formula; Mittag Lefler theorem; Weierstrass canonical products and analytic continuation.

MATH F366 Lab Project **3**

MATH F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MATH F376 Design Project **3**

MATH F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MATH F378 Advanced Probability Theory **3 0 3**

Measure theoretic probability and probability space, Law of large numbers and independence, convergence, Central limit theorems, Higher dimensional limit theorems, Random walks and their properties, Martingale and their properties, Martingale convergence theorem, Radon-Nikodym derivative, Doob's inequality, Backward martingales, Markov chain and their properties, finite state ergodicity, recurrence and transience.

MATH F420 Mathematical Modeling **3 0 4**

Elementary mathematical models; Role of mathematics in problem solving; Concepts of mathematical modeling; Pitfalls in modelling; System approach; formulation, Analyses of models; Sensitivity analysis, Simulation approach. One or more of the interrelated topics will be covered from the following: optimal harvesting models, Environmental models, traffic flow models, bio-fluid flow models, socio-economic models, financial models, stochastic models, etc. providing a fertile ground for interdisciplinary courses. The selection of topics will depend upon the circumstances and mutual interest of the current students and faculty

MATH F421 Combinatorial Mathematics **3 0 3**

Advanced theory of permutations and combinations; elementary counting functions; theory of partitions; theorems on choice including Ramsey's theorem; the mobius function; permutation groups; Polya's theorem and Debrauijn's generalisation; graphical enumeration problems.

MATH F422 Numerical Methodology for Partial Differential Equations **3 1 4**

Classification of PDEs, nature of well-posed problems, interpretation of PDEs by characteristics and physical basis, appropriate boundary/initial conditions. Numerical methods for PDEs: Finite difference approximations to partial derivatives, Explicit and implicit schemes, Richardson Extrapolation Convergence, Stability and Consistency of Elliptic, Parabolic and Hyperbolic PDEs. Introduction to finite volume method, Computational experiments based on the algorithms

MATH F423 Introduction to Algebraic Topology **3 0 3**

Homotopy; Fundamental group and Computation; Covering Spaces; Universal Covering Spaces; Simplicial Complexes; Simplicial Homology and Computation.

MATH F424 Applied Stochastic Process **3 1 4**

Definition and examples of Stochastic Processes (SPs), classification of random processes according to state space and parameter space, types of SPs, elementary problems; Stationary Process: Weakly stationary and strongly stationary processes, moving average and autoregressive processes; Martingales: definition and examples of martingales; Markov Chains: Transition probability, classification of states and chains, stability of Markov chains, irreducibility, stationary distribution ergodic theorem; Continuous-time Markov Chains (CTMCs): Poisson process, birth-death process and their applications; Continuous time and continuous state space: Brownian motion, Wiener process and applications; Renewal processes in discrete and continuous time; Renewal reward process; Branching Processes; Galton-Watson branching process and its properties.

MATH F431 Distribution Theory **3 0 3**

C-infinity functions, distributions and their derivatives; support, convolution and regularization; distributions of finite order; multiplication of distributions; Fourier transforms of distributions; temperate distributions and their Fourier transforms; fundamental solutions.

MATH F432 Applied Statistical Methods **3 0 3**

Review of estimation and testing of hypotheses; Simple and multiple regression methodology through method of least squares, Multicollinearity and residual analysis, Categorical data handling through logistic regression; Multivariate data analysis by Hoteling T^2, Mahalanobis D^2, discriminant analysis, cluster analysis and factor analysis; Data handling and forecasting time series data by various components time series methodology; Statistical Quality Control of variables and attributes control charts; Non parametric data handling through Kruskal walls test, Mann Whitney and KS two sample test.

MATH F441 Discrete Mathematical Structures **3 0 3**

One or more of the interrelated topics will be covered from the following: graphs, designs, codes, shift register sequences, groups, fields, Boolean algebras, analysis of algorithms, Fast Fourier Transform etc. providing a fertile ground for interaction between mathematics and modern areas of computer science. The selection of the topics will depend upon the circumstance and current interest of faculty.

MATH F444 Numerical Solutions of Ordinary Differential Equations **3 0 3**

Introduction to ODEs, Numerical Techniques for One Step Methods, Convergence and Absolute Stability, Numerical techniques for Linear Multi-Step Methods, Zero Stability, Consistency, Convergence, Predictor-Corrector methods, Absolute Stability of Predictor-Corrector methods, Stiff ODEs and its numerical methods, Finite Difference Methods to Linear and Nonlinear Boundary Value Problems, Stability and Convergence Analysis, Differential Algebraic Equations, Numerical techniques for Differential Algebraic Equations, Introduction to One dimensional Finite Element Methods, Comparison

between Finite Difference Methods and Finite Element Methods, Variational formulation, Finite Element Approximation, Approximation Errors, Convergence of solution, Order of Convergence.

MATH F445 Mathematical Fluid Dynamics **3 0 3**

Introduction to the Fluid Dynamics and Fundamental Concepts, Lagrange and Eulerian Descriptions, Continuum hypothesis, Conservation of Mass based on different approaches, Equation of Continuity in different Coordinates, Potential Flow, Laplace Equation, one-, two- and three-dimensional flow, Conservation of Linear Momentum, Euler's Equation, Bernoulli's equation, Constitutive equations for Newtonian Fluid, Navier-Stokes Equations, First Law of Thermodynamics, Reynolds number, Exact Solution of Navier-Stokes Equation, Boundary Layer Approximations, Setting up the Boundary-Layer Equations, Limit Equation For the Flat Plate, Discussion of Blasius' Equation, Description of Flow Past a Circular Cylinder , Decay of a Laminar Shear Layer

MATH F456 Cosmology **3 0 3**

History of cosmological ideas, Observational overview of the universe, Expansion of the universe, Newtonian gravity, Friedman equation, the fluid and acceleration equations, Geometry of the universe, Infinite and observable universe, Big bang, Simple cosmological models, Hubble law, redshift, Observational parameters, the cosmological constant, the age of the universe, weighing the universe, dark matter, CMB, the early universe, Nucleosynthesis, Inflationary universe, Initial singularity, standard cosmological model, general relativistic cosmology, classic cosmology, neutrino cosmology, baryogensis, structure of the universe.

MATH F471 Nonlinear Optimization **3 0 3**

Introduction; convexity and cones; Kuhun Tucker theory; unconstrained and constrained optimization; gradient methods; polynomial optimization; penalty function; generalized convex functions; duality in nonlinear programming; optimality criterion for generalised convex functions; fractional programming.

MATH F481 Commutative Algebra **3 0 3**

Modules; direct sums and products; finitely generated modules, exact sequences; tensor product of modules; rings and modules of fractions; localization; Noetherian modules and primary decompositions; integral dependence and valuation theory; integrally discrete valuation rings and Dedekind domains; fractional ideals.

MATH F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

MATH F492 Wavelet analysis and applications **31 4**

Haar wavelet bases, Multiresolution analysis, Orthonormal wavelets from MRA, Orthonormal spline wavelets, Fast wavelet transforms, Biorthogonal wavelet bases, Compactly supported wavelets, The Daubechies scaling functions, Coding signals by wavelet transform, Filter banks, Condition number of a matrix , Wavelet Galerkin method.

MATH G511 Design and Analysis of Algorithms **5**

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

MATH G512 Selected Topics in Advanced Mathematics for Engineering Situations **5**

The topics may include mathematical theory of probability and stochastic processes, Graph theoretical techniques; information theory; pattern recognition; fuzzy sets.

MATH G521 Applied Functional Analysis **5**

MATH G531 Number Theory **5**

MATH G541 Advanced Methods in Discrete Mathematics **5**

Course description for the above courses are to be developed.

MATH G611 Algebraic Number Theory **5**

Localization, Galois extensions, Dedekind rings, discrete valuation rings; completion, unramified extensions, ramified extensions; the different and discriminant; cyclotomic fields, roots of unity, quadratic fields, relations in ideal classes; the unit theorem, Minkowski's constant, Zeta function.

MATH G612 Riemann Surfaces **5**

Compact Riemann surfaces, algebraic functions, analytic continuations, branched coverings, study of line bundles, Riemann- Roch theorem, Serre duality theorem.

MATH G621 Fibre Bundles **5**

Differential manifolds, tangent bundle, vector bundles, principal bundles, functorial properties, the Milnor construction, homotopy classification, Grassmannians, universal bundles, characteristic classes, introduction to K-theory.

MATH G622 Algebraic Geometry **5**

Study of varieties, introduction to complex varieties, some ideas on schemes, complete varieties, cohomology of coherent sheaves.

MATH G632 Lie Groups and Lie Algebras **5**

Lie groups: basic definitions, one parameter sub-groups, maximal tori, representation theory; Lie algebras: basic definitions, solvable and nilpotent lie algebras, cartan subalgebras, roots and weights, simple lie algebras, classification theorem universal enveloping algebras, PBW theorem.

MATH G642 Complex Manifolds **5**

Manifolds and vector bundles: manifolds, vector bundles, & operator & almost complex manifolds; sheaf theory: Sheaf cohomology & Cech cohomology; differential geometry: Hermitian differential geometry, canonical connection & curvature of Hermitian holomorphic bundles, Chern classes of bundles.

Master of Business Administration

MBA G501 Managerial Economics **3 0 3**

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation.

MBA G502 Business Structure & Processes **3***

Fundamental concepts, development of management theory, business forms, (proprietorship etc.); review of managerial functions (planning, organizing, staffing, leading and controlling); business processes, structure and systems, socio-economic interface.

MBA G503 Managerial Skills **2***

The role of manager, team building and goal setting, basics of supervision, leadership, decision making, negotiation skills and techniques, how managers communicate, how to interview, process of induction, training and development, delegation, how to appraise employees, how to manage time, use of committees, how to handle meetings, how to handle complaints.

MBA G504 Legal and Economic Environment of Business **4***

Indian contracts act, sale of goods act, negotiable instruments act, companies act, corporate tax laws, consumer protection and unfair trade practices act, FEMA, Industrial policy, macroeconomic environment, fiscal and monetary policy, overview of Indian economy, economic indicators.

MBA G505 Management Framework & Functions **2 0 2**

Overview of management, its role and range of applications, building blocks and interrelations, core concepts, functional and strategic areas, quantitative tools and techniques, issues and approaches to problem solving, developing professional perceptions and attitudes.

MBA G506 Negotiation Skills and Techniques **2 0 2**

Overview, Negotiation styles, Negotiation process, Tactics in Negotiation, Handling conflicts in negotiation, Best Alternative to a Negotiated Agreement, Communication - Key to Effective Negotiating, Non-verbal communication in Negotiations, Emotions: dealing with others and ourselves, International negotiations, Cross Cultural Issues in Negotiations, Power in negotiation, Workplace Negotiations, Turning Negotiation into a Corporate Capability, Do's and Don'ts of Negotiations, Negotiating over the telephone/ Electronic media, Ethics in negotiation, Negotiation-Exercise.

MBA G507 International Financial Markets & Services **3 0 3**

Currency futures, options and swaps; interest rate determination and asset pricing in face of volatile nominal and real exchange rates; international portfolio management; treasury risk management and performance measurement; major international stock exchanges: New York; ISE London; Tokyo; trading and settlement practices; listing of Indian derivatives on Brussles stock exchange; arranging foreign collaboration; floating India funds; syndication of Euro-dollar loans.

MBA G508 Functions and Working of Stock Exchanges **3 0 3**

Stock exchanges in India: regulations governing formation and working; trading and settlement procedures; review of the working of stock exchanges in India. National stock market system; OTCEI; listing requirements. requirements for membership of stock exchange; responsibilities of stock brokers in regard to contracts and accounts, duties and responsibilities to stock exchange, public and members interset; securitiescontracts act, by-laws and regulations; SEBI guidelines; trading in stock exchanges; insider trading: SEBI guidelines; dealings in debentures; rating of debentures; trading in government securities; potential for trading in derivatives.

MBA G509 Investment Banking and Financial Services **3 0 3**

Merchant banking function- perspectives; organization of merchant banking function; managing new issues; negotiating terms with financial institutions, brokers, investors and under writers; pricing of further issues- SEBI guidelines; syndication of loans from banks; preparation of loan dossiers and application for financial assistance; negotiations; public deposits to finance working capital; agencies mobilizing public deposits; regulations governing raising of public deposits; cost of public

deposits, factoring, forfeiting , structured finance, securitization and personal finance like house loan, personal loan and other individual loans, non-fund based services -credit rating, business advisory services, mergers, de-mergers and acquisition, asset management and insurance commodities services and wealth management.

MBA G510 Human Resource Management **4**

Strategic human resource management, manpower planning, job analysis, recruitment and selection, placement, induction, training and development, appraising and managing performance, compensation, employee discipline, workplace safety and health, collective bargaining, industrial relations, human resource accounting and audit.

MBA G511 Organisational Behaviour **4**

Evolution and relevance; perception emotions and learning in an organisational set up; attitudes and values, groups and group processes, leadership, power and politics, organizational change, resistance and development, managing conflict.

MBA G512 Manufacturing Strategy **4**

Corporate strategy; Missing links in manufacturing strategy; Audit approach; Restructuring; Manufacturing strategy process in practice; Formulation as a process; Operating strategies; Methodology framework; Lean production; Competitive priorities; Strategic value of response time and product variety; Flexibility in context of manufacturing strategy; Manufacturing focus; Business process reengineering; Theory of constraints; Link between strategy and organizational culture; Evolution of manufacturing systems; Operations management strategic perspective.

MBA G513 Quantitative Methods **4**

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

MBA G514 Technology Management **3 0 3**

Concept of technology, nature of technological change, economics of technology, corporate technology strategy, analysis for technology strategy, adoption and management of new technology, accounting for technology, appropriate technologies, transfer of technology, influence of government policies on technology, technology, management for sustainable development.

MBA G515 Financial and Management Accounting **4**

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

MBA G516 Corporate Finance and Taxation **4**

Role and environment of managerial finance, time value of money (NPV, IRR), project feasibility, budgeting, long term investment decisions, long term financing decisions (LT & ST), capital structure, dividend decisions, short term financing decisions, working capital management, principles of corporate taxation, income tax, capital gains tax, tax laws and provisions, financial engineering.

MBA G517 Business and Society **4**

Corporate social responsibility, business ethics, policies, codes, standards, ethics and decision making, environmental and social issues, workplace diversity, fostering ethics at work (whistle blower policy); business and social etiquette, internet and online behaviour, etiquette and office electronics.

MBA G518 Marketing **4**

Definition, marketing research and forecasting demand, creating customer value, satisfaction and loyalty, analysing consumer and business markets, market segmentation, brand equity, brand positioning, product and pricing strategies, managing services, managing value networks and channels, integrated marketing communications, international marketing.

MBA G519 Production and Operations Management **4**

Product & service design, plant location, aggregate planning, capacity, process, layout, sequencing & scheduling, line balancing, maintenance, quality (control, assurance, management), statistical quality control, queuing theory, project management. CPM, PERT.

MBA G520 Business Policy and Strategic Management **4**

Mission, vision, strategic intent, hierarchical levels of strategy, PEST analysis, SWOT analysis, industry analysis, organisational analysis, BCG matrix, GE matrix, core competencies, five force theory, value chain, competitive advantage, generic strategies, diversification, strategy implementation and control.

MBA G521 Supply Chain Management **4**

Purchase/procurement, stores, material handling systems, inventory analysis, inventory models, disposals, make or buy, outsourcing; vendor selection, development, and relations; Material requirements planning, manufacturing resources planning, ERP, JIT, inbound and outbound logistics, warehousing, transportation, packaging.

MBA G522 Total Quality Management **4**

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

MBA G523 Project Management **4**

Concepts and techniques of project formulation, evaluation and implemention; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MBA G524 International Business **3 0 3**

Global Trade Protection, Cultural Environment, Legal Aspects, International Monetary System, Overseas Business Options, MNCs, Regional Analysis, Screening and Segmentation, International Marketing Research, International Marketing Strategy, Export Policy and Institutional Infrastructure, Export Finance, Export Payments, Exchange Transactions, Product Planning; Positioning and Management, Distribution Policy; Management and Agreements, International Pricing and Promotion, Organizing for Overseas Markets.

MBA G525 R&D Management **3 0 3**

Distinctive need and particular structure for management of R&D systems; the close relationship between R&D objectives and innovation and precise time targets; micro considerations like economics and cost, science policy, criteria of choice, various issues connected with availability, transfer and marketing of technology; micro considerations in planning, organisation, project selection, formulation and management, R&D cost estimating and budgeting human resources availability, evaluation and measurement of performance, control problems; mission-oriented research; technology missions enunciated by Indian Government.

MBA G526 Database Management Systems **4**

Introduction to data bases and management; data files and structures; hierarchical, relational, network models; distributed data bases; query processing and query optimization, query languages; concepts of security and protection; case study of a data base system.

MBA G527 e-Business and Internet Marketing **4**

e-business evolution & opportunities; categories of e-business; e-business models; network infrastructure & web based tools for e-business; e-business risks & risks management; network security and firewall; cryptography and authentication; billing/payment systems; regulatory environment of e-business; ERP/SCM/CRM and web based marketing; business intelligence & intelligent systems; data warehousing and data mining; implementing e-business systems & change management. Case studies and projects in e-business areas; emerging e-business scenarios.

MBA G528 Internet Security and Cyber Laws **4**

Examination of issues related to network and information security, security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

MBA G529 Recent Advances in ETM **4**

Course description is to be developed.

MBA G530 Project Appraisal **3 0 3**

Criteria for selection of a project; factor intensity; commercial profitability; national economic-profitability; limitations of market prices; estimation of shadow prices; linkup project appraisal to national objectives; McGaughey and Thorbeck approach; Little-Mirrlees method; UNIDO guidelines approach; limitations of the conventional project appraisal; towards a new framework for project appraisal.

MBA G531 Managerial Communication **2***

Business communication basics; issue interpretation, reformulation and summation; interviews, questionnaires and forms; presentation techniques; technology and communication; business correspondence; business documents; group communication and meetings; employment communication.

MBA G532 Risk Management and Insurance **3 0 3**

Introduction to risk; types of risk; risk measurement; risk management techniques; risk avoidance, loss control, loss financing, risk retention, risk transfer, internal risk reduction through diversification etc.; insurance business and operations; insurance pricing; insurance v/s hedging; life, health and income risk; property and liability risk – commercial and personal; social insurance; insurance regulation.

MBA G533 Advertising and Sales Promotion **3 0 3**

The communication process and models of persuasive communication; advertising research; advertising campaign components; advertising campaign planning; advertising/media scene; media concepts; media planning & strategy; advertising campaign planning, execution and evaluation; advertising agencies; sales promotion types and techniques; sales promotion strategy; measuring the effectiveness of the promotional program; regulations of advertising and promotion; Extending marketing communication to social communication, personal selling, international advertising, interactive advertising, advertising laws, social, ethical and moral issues.

MBA G534 Introduction to Business Sustainabiligy **3 0 3**

Evolution of the Concept of sustainable development, Dimensions of sustainable development, Issues and Trends in business sustainability, Business Sustainability, Sustainable Consumption and Production, Industrial Environment Management, Finance of sustainability, Setting Goals and Measuring Progress towards sustainability

MBA G535 Cross Cultural Management **3 0 3**

The Critical Role of Culture in Management, The Various Dimensions of Culture, The Impact of Culture On Management Functions Like Communication, Negotiation, Motivation, Leadership and Human Resource Management, Formulating and Implementing Strategy for International and Global Operations, Managing Global Teams, International Assignment and Expatriate Management, Skills and Competencies for Global Managers, International Business Etiquette and Uniqueness of Indian Culture and Management.

MBA G536 Strategic Financial Management **3 0 3**

Company Value and the Manager's Mission: Introduction to Valuation, Why Value Value? The Value Manager, Cash Is King and Value-Based Management. Approach to Valuation - A Practitioner's Guide: Frameworks for Valuation. Valuation Methods: Discounted, Relative and Contingent Claim. Analyzing Historical Performance. Forecasting Performance. Estimation of Discount Rates. Estimation of Cash Flows. Estimation of Growth Rates. Valuation Models: Dividend-Discount Models, Free-Cash-Flow-To-Equity Discount Models, Free-Cash-Flow-to-firm Approach, Price / Earnings Ratio, Price/Book Value Ratio and Price/Sales Ratio. Measuring and Managing the Company Value: Company Value vs. Shareholders Wealth Maximization - TSR. Economic Value Added, Market Value Added and Cash Value Added. Wealth Creator by the Indian Corporates. Analyzing the Company Performance - Application of Balanced Scorecard (BSC). Applying Valuation: Multibusiness Valuation. Mergers, Acquisition , and Joint Ventures.

MBA G537 Security Analysis and Portfolio Management **3 0 3**

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives-options & futures.

MBA G538 Marketing Models **3 0 3**

Introduction to Marketing Models, Understanding the consumer behavior models, Developing models for optimal pricing decisions, Product definitions and classifications, Modeling the effects of Advertising, media selection and scheduling, Understanding Distribution problem, strategy, location, Learning New Product Planning, Innovation Diffusion process, Understanding Marketing planning Strategy Decision, Decision and Implementation.

MBA G539 Six Sigma **3 1 4**

Voice of business/customer, Basic concepts of quality management, Quality function deployment, Developing Six sigma project charter, Measurement system analysis, Gauge repeatability and reproducibility, (R & R), Measuring base line performance, sigma short term, sigma long-term, sigma goal and entitlement, Validating the measurement systems, Cause-effect(CE) diagrams, charts hypothesis testing, Pugh matrix, Design of experiments, Design of Experiments, Analysis of Variance (ANOVA), Evolutionary Operation (EVOP); Fractional, Full and Orthogonal Experiments, Regression model building, Taguchi methods for robust design, Six Sigma sustainability, Process capability analysis, Process Capability (Cp), Process Capability Index (Cpk), Process Performance (Pp), Process Performance Index (Ppk), Combing the power of lean and six sigma.

MBA G542 Consumer Behaviour **3 0 3**

Concepts and characteristics of modern consumer behaviour; marketers' and consumers' views of consumer behaviour; market segmentation of consumers; consumer motivation; personality, values and involvement; consumers' perception, learning and attitudes, external influences on consumer behaviour-social, cultural, and situational; influences of sales persons and advertising on consumer behaviour; consumer decision process.

MBA G551 Internetworking Technologies **3 0 3**

Introduction to internetworking concepts; the internet architecture; goals and key issues related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security; case studies.

MBA G552 Total Productive Maintenance **4**

Outline of TPM; TPM – Challenging limits; Maximizing equipment effectiveness; Organizing for TPM implementation; TPM implementation and stabilization; TPM small group activities; the PM prize for outstanding TPM plants.

MBA G553 Organizational Change and Development **3 0 3**

Business Organisation: The Domain of Change; Concept of Change; Perspectives on Organizational Change; Models of Change; Organizational Resistance to Change; Organizational Change and Change Agents; Strategic Management of Change; Organizational Diagnosis; Organizational Development (OD); Organizational Transformation (OT); Role of Change Agents and Leadership; Manager as Catalyst of Change; Implementing Organizational Change; Organizational Culture and Change; Learning Organization: The Ultimate Objective of Change Management.

MBA G554 Innovative Leadership **3 0 3**

Leadership for innovation, Stimulating Bottom-Up innovation, Steering innovation Top-down, Appointing an Innovation Conductor, Leadership Imperative for Innovation Strategy, Leading development of new products, Leading the creation of totally new product/service, Innovation leaders as pragmatic architect, Leading improved customer solutions, Building an innovative leadership environment, Attracting, developing and keeping Innovative Leaders.

MBA G555 International Human Resource Management **3 0 3**

Enduring context of International Human Resource Management (IHRM), Context of Cross-border Alliances and SMEs, Staffing International Operations for Sustained Global Growth, Recruiting and Selecting Staff for International Assignments, International Training and Development, International Compensation, Re-entry and Career Issues (Expatriation Issues), IHRM in the Host Country Context, International Industrial Relations ,Performance Management, IHRM Trends: Complexity, Challenges and Choices in the Future.

MBA G556 Performance Management **3 0 3**

Overview of Performance Appraisal & Management, Performance Management in the Organizational Context, systems & processes ; Goal Setting, Approaches to Performance Appraisal, Performance Appraisal Techniques, Data Gathering, Observing, and Documenting, The Performance Appraisal Meeting, Feedback, Performance Diagnosis and Improvement, Linkage to Rewards & Compensation, Training & Development Requirements, Potential Appraisal & Career Progression, issues: Problems, Role of HR, Training the appraisers, Performance Appraisal in India.

MBA G562 Services Marketing **3 0 3**

Distinctive elements, system: relationships with customers; positioning; managing customer portfolio, demand management, service delivery process, pricing; promotion; operating strategy; quality, productivity, human resource management; internationalization of services; services marketing in future.

MBA G563 Industrial Marketing **3 0 3**

Market/consumer orientation, marketing in industrial context, industrial market behaviour, organisational buying and buying behaviour, business forecasting and planning, product planning, new product development, pricing, distribution, management of communications, advertising & personal selling, management of sales force, corporate strategy and industrial marketing.

MBA G571 Management Information Systems **3 0 3**

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

MBA G574 Retail Management Systems **3 0 3**

Retailing history and theories, basic retail management process, retail industry in Indian and abroad, shopper behavior in retailing, retailing formats and location related issues, category management, supply chain management in retail, retail buying, store layout and design, point of purchase communication, retail pricing strategy, building store loyalty and technology in retailing. Case studies and projects in retailing, specially focusing on Indian scenarios.

MBA G575 Financial Engineering **3 0 3**

Introduction; Review of Markets, Players, and Conventions; Cash Flow Engineering with Forward Contracts; Engineering Simple Interest Rate Derivatives; Swap Engineering; Report Market Strategies; Dynamic Replication Methods and Synthetics; Mechanics of Options; Options Engineering with Applications; Pricing Tools; Applications of Fundamental Theorem of Finance; Fixed Income Engineering; Tools for Volatility Engineering: Volatility Swaps and Volatility Trading; Engineering of Equity Instruments: Pricing and Replication, computational methods such as Monte Carlo Simulation.

MBA G576 Digital Marketing **3 0 3**

Fundamentals of e-Business and Internet Marketing, e-Business Models and Frameworks, Digital Marketing Strategy, Online Public Relations, Search Engine Optimization and Marketing, Content Marketing, E-Mail Marketing, Social Media Marketing, Mobile Marketing, Optimizing Customer and User Experience, Web Analytics.

MBA G577 Supply Chain Analytics **3 1 4**

Introduction to supply chain analytics, Data understanding and data preparation, Supply chain performance , Descriptive analytics, Predictive analytics and setting up the problem, Supply chain forecasting, studying holt, winter and ARIMA models, Supply chain Network Planning, Multi echelon network optimization, Supply chain sales and operations planning, Supply chain segmentation, Vehicle routing problems, Supervised and Unsupervised learning, Use of Bayesian networks in supply chain, Simulation and SC models, Supply chain risk management.

MBA G578 Game Theory and Business Strategy **3 0 3**

Psychology and philosophy of games of strategy; Non-cooperative, One-time, Static Games with Complete Information; Finitely, Infinitely Repeated, Static Games with Complete Information; Mixed Pure Strategies; Games with imperfect competition; Games with perfect competition and monopoly; Strategic Trade Policy; Dynamic Games with Complete and Perfect Information; Bargaining; Pure Strategies with Uncertain Payoffs; Auctions.

MBA G581 Expert Systems **4**

The object of this course is to study in details the features of expert systems and their role in the scientific world of today and tomorrow. It concentrates on the tools available to the knowledge engineer, expert systems, building techniques, and the difficulties which may be encountered during the development of an expert system.

MBA G582 Creating & Leading Entrepreneurial Organizations **3 0 3**

Fundamentals of entrepreneurship; elements of leadership; identifying business opportunities; market study and research; business plans; finance, issues in raising finance; venture capitalist evaluation of business plans, technical aspects for the

project, corporate strategies for growth; legal aspect to entrepreneurship, people skills, marketing and branding; creativity and communication.

MBA G583 Marketing Research **3 0 3**

An examination of the concepts and practical methodology used in marketing research. An overview of marketing research process, with emphasis on research design; data instrument design; questionnaire formulation; sampling plans; data collection methods -interviewing, panels; data analysis and use of computer based information systems for marketing intelligence. Also Time-series & Regression based models of sales forecasting, control and evaluation of marketing function and survey methodology are covered.

Emphasis will be on cases and research projects.

MBA G586 Product and Brand Management **3 0 3**

Scope of product Policy Decisions; Product-Market strategy; Product Life Cycle and Strategy; Managing Product Deletion; Product Associations; Branding including aspects of brand name selection; Brand Equity and its utilization for marketing decision making; Brand Extension: use for brand names for launching new products; New product development process; Idea Generation and Screening; Concept Development and Evaluation; Product Design and Testing; Market planning; Testing the market plan; Marketing research process; Adoption and Diffusion of products; Organizing for new and existing product.

MBA G588 Services Management System **3 0 3**

Understanding Services, the Service Sector today, Designing the Service Enterprise, Technological Issues, Structuring Service Operations, Processes Management, Staffing for Services, Functions of Services Management System, Client Relationships, Measuring and Reporting Services.

MBA G589 Enterprise Resource Planning **3 0 3**

Introduction to ERP; Re-engineering and ERP systems; ERP planning, design, and implementation; ERP systems – sales and marketing; ERP systems – accounting and finance; ERP systems – production and materials management; ERP systems – human resources; Managing and ERP project; Supply chain management and e-Market place.

MBA G593 Business Analysis and Valuation **3 0 3**

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

MBA G622 Software Project Management **4**

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documention in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

Mechanical Engineering

ME F110 Workshop Practice **0 4 2**

Laboratory exercises for different manufacturing processes like machining on lathe, drilling, grinding, milling and shaper; sand moulding and casting; metal forming; joining processes like arc welding, gas welding, brazing and soldering; carpentry; fitting; use of metrology equipments in measurement; demonstrations on CNC machines and CNC part programming.

ME F211 Mechanics of Solids **3 0 3**

Fundamental Principles of mechanics; introduction of mechanics of deformable bodies; force and moment transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion of circular member, stress and deflection due to bending, stability of equilibrium. Static failure criteria, ductile & brittle material; Dynamic failure criteria.

ME F212 Fluid Mechanics **3 0 3**

Fluid Statics; fundamentals of mass, momentum and energy transfer, control volume approach and integral equations. Differential analysis of mass, momentum and energy transfer, solutions for one dimensional steady state situations. Viscous and in-viscid flow. Dimensional analysis. Introduction to computational fluid dynamics.

ME F213 Materials Science & Engineering **2 0 2**

Introduction, Structure of Materials (Metal and Ceramics), Dislocations, heat treatment of steel and strengthening Mechanisms of Metals, Phase diagrams, Iron-carbide phase diagram, Phase transformation in Metals, Mechanical and thermal properties of Metals, Polymers (Structure, processes and properties), powder metallurgy.

ME F214 Applied Thermodynamics **3 0 3**

Availability and irreversibility, thermodynamic relations, gas and vapor cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychometrics and heat load calculations, gas turbine cycles , compressors, boilers and accessories

ME F215 Mechanical Engineering Laboratory **0 2 2**

The course shall aim to train the student in the skill of operation of instruments and equipments. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing, basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

ME F241 Machine Design & Drawing **3 1 4**

Fundamentals and principles of Design. Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings & Gears. Fundamentals of Machine Drawing; practices for Orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

ME F242 IC Engines **2 0 2**

Working cycles and operation of two stroke, four stroke SI and CI engine cycles. Ignition, combustion, alternative fuels, emission and their control.

ME F243 Production Techniques I **2 1 3**

Metal casting methods, patterns and molding, different types of casting processes, injection molding, die casting and casting defects. Casting analysis. Metal forming, different bulk metal forming processes like rolling, extrusion, forging and wire drawing. Metal forming process analysis and forming defects. Welding, brazing and soldering, different techniques and welding defects. Welding analysis. Simple description of various machining operations, machine tools and cutting tool geometry. Limits & Fits and Metrology. Fabrication project.

ME F244 Kinematics & Dynamics of Machinery **3 0 3**

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, Synthesis of mechanisms (Planer), cam design, Kinematics of gears (spur, helical, bevel and worm), gear trains, Dynamics of machines: static force analysis, dynamic force analysis (planar),dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes.

ME F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

ME F311 Heat Transfer **3 1 4**

Fundamental concepts of heat transfer; steady state and unsteady- state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; associated laboratory.

ME F312 Advanced Mechanics of Solids **3 0 3**

Generalized Hooke's law; Energy methods; torsion of non-circular members; shear center and asymmetrical bending; curved beams; thick cylinders; plates and shells; contact stress.

ME F313 Production Techniques II **3 1 4**

Metal cutting theory. Analysis, economics and quality control of metal cutting, laboratory exercises in metal cutting and fabrication project. Different machine tools their description and operation. Non-traditional machining processes. Micromanufacturing technologies. Introduction to computer aided manufacturing (CAM), CNC machines and CNC part programming.

ME F340 Introduction to Sports Engineering **3 0 3**

The course essentially prepares engineering students to utilize their existing technical knowhow for sports applications. The specific topics will include, working with human and human movement patterns, qualitative and quantitative techniques for analysis of human movement. Sports performance measure and analysis. Anthropomorphy, Ergonomics and Task design. Computer application in sports, computerized performance measure. Sports surface and its impact on sports performance, surface testing methods. Sports and training equipment case study, business around sports.

ME F341 Prime Movers & Fluid Machines **2 1 3**

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems; model similitude for turbo-machines; Introduction to fluid power system, laboratory exercises in testing reciprocating machines, rotary machines and fluid power system.

ME F342 Computer Aided Design **3 1 4**

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Students will be required to do several assignments and one CAD project.

ME F343 Mechanical Vibrations **3 0 3**

Small oscillations of linear dynamical systems, free and forced vibrations of single and multi-degree-of-freedom systems, normal modes and orthogonality relations, generalized co-ordinates and Lagrange's equations, matrix formulation, eigen-value problem and numerical solutions, transient response of one-dimensional systems, approximate energy methods, continuous system, vibration of string, rods, bars and beams. Introduction to control systems.

ME F344 Engineering Optimization **2 0 2**

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

ME F366 Lab Project **3**

ME F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ME F376 Design Project **3**

ME F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

ME F411 Fluid Power Systems **3 1 4**

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

ME F412 Production Planning and Control **3 0 3**

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

ME F413 Nonlinear Vibrations **3 0 3**

Introduction, sources of nonlinearity, examples, qualitative analysis: phase plane, singular points, stability of singular points, Forced response, Perturbation methods: straightforward expansion, the method of multiple scales, harmonic balance, method of averaging, Nonlinear normal modes, Nonlinear Multiple-DOF Systems, Bifurcations, Centre manifold reduction, Flouquet Theory, Chaos Theory, Melnikov Criterion, Applications to vehicle dynamics, structures and microsystems etc. Use of softwares for simulations and numerical solutions.

ME F414 Fuel Cell Science and Technology **3***

Introduction to fuel cell, types, advantages and applications; Fuel cell thermodynamics, electrochemistry, charge transport, heat and mass transport; Fuel cell modelling and simulation. In-situ, ex-situ experimental characterization techniques viz. polarization curve, electrochemical impedance spectroscopy, current density mapping etc. Polymer electrolyte membrane fuel cell including direct liquid fuel cell; Other fuel cells viz. SOFC, AFC, MCFC, PAFC, biological fuel cells etc. and recent development.

ME F415 Gas Dynamics **3 0 3**

Introduction to Gas Dynamics, Basic equations of compressible flow, Wave propagation, Steady one-dimensional flow (Varying-area adiabatic flow), Normal shock waves, Oblique shock and expansion waves, Prandtl-Meyer Flow, Flow with Friction and Heat Transfer, Potential equation for compressible flow, Similarity rule.

ME F416 Reverse Engineering and Rapid Prototyping **3 0 3**

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering. Project work.

ME F417 Advanced Metal Forming **3 0 3**

The stress and strain tensors in macroscopic plasticity and failure criteria for metal forming, effective stress and effective strain, flow rules for plastic deformation and principle of normality. Work hardening, determination of work hardening exponent. Plastic instability and effect of inhomogeneity on uniform strain. Strain rate and temperature effects on plastic deformation and flow stress, super-plasticity, temperature rise during metal forming. Ideal work and redundant work. Slab, upper-bound, slip-line field and finite element methods of analysis of various bulk and sheet metal forming processes. Bulk and sheet metal formability tests and forming limit diagram. Sheet metal properties and plastic anisotropy.

ME F418 Rocket and Spacecraft Propulsion **3 0 3**

Thrust and specific impulse. Compressible flows. Detailed analysis of liquid, solid and hybrid propulsion systems. Includes propellants, injection systems, combustion and chemical equilibrium, thrust chambers, nozzles and plumes. Electro-thermal thrusters. Plasmas and electromagnetic thrusters.

ME F419 Total Product Integration Engineering **3 0 3**

Quality design across global supply chain. Robust product architecture for market variety and technology advances. Product development risk management.

ME F420 Power Plant Engineering **3 0 3**

Classification of power plants. Components and layout of; thermal, nuclear, hydro electric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

ME F423 Micro Fluidics and its Application **4***

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for microfluidic devices, microvalves, micropumps, microflow sensors, microfluidics for life sciences: micromixers, microneedles, microfilters, microseparators, microreactors, modeling and simulation on CAD tool.

ME F424 Energy Management **3 0 3**

World and Indian energy scenario; energy policy; energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in energy intensive industries; choice of fuels and stoichiometry, steam generation, distribution systems, and electrical systems; integrated resource planning; demand-side management; cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications.

ME F425 Additive Manufacturing **3 0 3**

Introduction to Additive Manufacturing (AM), generalized AM process and process chain, different materials used in AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate. Various AM processes and their mechanics of operation. Vat polymerization processes, stereolithography. Powder based AM processes involving sintering and melting, selective laser sintering, direct metal laser sintering, selective laser melting, other polymer, ceramic, metal and alloy K-4 powder based AM processes. Extrusion based AM processes, fused deposition modelling (FDM). Sheet lamination processes, laminated object manufacturing (LOM). Micro- and nano-additive manufacturing processes; Modelling in Additive Manufacturing Transport phenomena models: temperature and fluid flow, molten pool formation, Various case studies - modelling of fusion based AM process, powder bed melting based process, droplet based printing process; Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications.

ME F426 Industry 4.0 in Manufacturing **3 0 3**

Limitations of existing manufacturing systems, industrial revolution 4.0 for manufacturing, vision and strategy, organization and structure, models and standards, drivers and enablers, smart products, smart process, smart production, smart factories, smart networked industries, smart supply chain, lean and I4.0. I4.0 navigators: sensors, actuators, data analytics, connectivity, and AI. Economic evaluation of existing system for I4.0. Limitations of I4.0. Case studies.

ME F432 Computer Aided Manufacturing **2 1 3**

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

ME F433 Solar Thermal Process Engineering **3 1 4**

Fundamentals of solar energy, earth-sun angles, solar spectrum, solar radiation, measurement and estimation of solar energy on horizontal and tilted surface, conversion routes and technologies, Standards and Performance Testing, thermal utilization of solar energy, modes of heat transfer and equations for performance calculations of systems- conduction, convection and radiation of heat, Flat plate collectors, solar concentrator systems, geometric optics, tracking methods, thermal analysis, energy storage, materials and properties, solar process loads and system calculations for time dependent loads, Life cycle cost analysis and economic analysis for various applications of solar thermal processes, solar water heating, space heating and cooling in Buildings, Industrial process heating, solar air-conditioning and refrigeration, Use of Simulation tools for performance simulation and Project Assignments, solar thermal power generation, Role of Govt., policies and plans.

ME F441 Automotive Vehicles **3 0 3**

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

ME F443 Quality Control, Assurance and Reliability **3 0 3**

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process

control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ME F451 Mechanical Equipment Design **3 0 3**

Design analysis for additional machine elements; retainment of bearings and design of machine housing; introduction to techniques of optimisation reliability and value analysis; exercises in detail design; design solutions to meet specified functional requirements.

ME F452 Composite Materials & Design **3 0 3**

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micro-mechanical aspects of composites, manufacturing methods, composite production design methods-design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies.

ME F461 Refrigeration and Air conditioning **3 0 3**

Principles, thermodynamic analysis, load estimates and design of various refrigeration and air conditioning systems for comfort and industrial applications. Theoretical or experimental investigation of refrigeration and air-conditioning problems.

ME F472 Precision Engineering **3 0 3**

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

ME F481 Project Appraisal **3 0 3**

Course Description is to be developed.

ME F482 Combustion **3 0 3**

Fuels, Combustion, Adiabatic Flame Temperature, Chemical Kinetics, Chain Reactions, Conservation Equations for Reacting Flows, Laminar and Turbulent Premixed Flames, Diffusion Flames, Droplet and Particle Combustion, Emissions, Applications.

ME F483 Wind Energy **3 0 3**

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for estimating the wind energy potential of a prospective site, Constructional features of various systems and sub-systems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F484 Automotive Technology **3 0 3**

Automotive vehicle: layout, operating systems, components, materials and production processes; Power unit: IC engine, working principles, performance, systems and the associated parts; Mechanical unit: transmission, drive train, steering, chassis, suspension, brakes, wheels and tyres; Electric unit: battery, charging, starter and lighting; Electronic control unit: application of electronics and computers, sensors, actuators and on-board diagnostics; Latest Trends: advanced combustion systems and hybrid/fuel-cell/electrical power systems, alternate fuels and the emissions.

ME F485 Numerical Techniques for Fluid Flow and Heat Transfer **3 0 3**

Introduction to CFD, Partial Differential Equation (PDE): Physical classifications, Mathematical Classifications, Well posed problem. Basic of Discretization Methods: Finite difference method, Truncation error, consistency, error and stability analysis, convergence, various discretization schemes. Introduction commercial software: OpenFOAM or Fluent. Application of numerical methods to selected model equations: Wave equation, Heat equation, Laplace's equations. Solution of Navier-Stokes equation for incompressible flows.

ME F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

ME G511 Mechanisms & Robotics **2 3 5**

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

ME G512 Finite Element Methods **5**

Fundamental concepts, matrix algebra and gaussian limination, one-dimensional problems, trusses, two-dimensional problems using constant strain triangles, axisymmetric solids subjected to axisymmetric loading, two-dimensional isoparametric elements and numerical integration, beams and frames, three-dimensional problems in stress analysis, scalar field problems, dynamic considerations, pre-processing and post processing.

ME G513 Heating and Cooling of Buildings **3 2 5**

Introduction to HVAC design, basic scientific principles, climatic conditions, building heat transmission surfaces, infiltration and ventilation, heating loads, heat gains and cooling loads, HVAC psychometrics, codes and standards for HVAC systems design, acoustics and vibration, human comfort, air distribution, duct system design, fans and central air systems, air system heating and cooling, air cleaning and filtration, introduction to electrical systems, controls for air distribution systems.

ME G514 Turbomachinery **3 2 5**

Introduction, thermodynamics, gas turbine plants, steam turbine plants, fluid dynamics, dimensional analysis and performance parameters, flow through cascades, axial turbine stages, high temperature turbine stages, axial compressor stages, centrifugal compressor stages, radial turbine stages, axial fans and propellers, centrifugal fans and blowers, and wind turbines.

ME G515 Computational Fluid Dynamics **3 2 5**

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numerics : basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

ME G516 Energy Systems Engineering **5**

Basic concepts of energy conversion, generation of electrical and thermal energy, transmission and distribution of electrical energy, load management, detailed analysis of utilization of thermal energy in : boilers, furnaces, compressors, heat transfer equipments, and HVAC systems, energy audit, waste heat recovery systems, cogeneration, demand side management, and management and organization of energy saving projects.

ME G521 Mechanical System Design **3 2 5**

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

ME G532 Machine Tool Engineering **3 2 5**

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

ME G533 Conduction and Radiation Heat Transfer **5***

Conduction: Steady and unsteady problems and their solutions in cartesian, cylindrical and spherical coordinates. Separation of variables. Duhamel's theorem. Laplace transform. Problems involving change of phase. Inverse heat conduction, Microscale heat transfer, Radiation: Radiative exchange among black and grey and spectral surfaces, Shape factors. Applications to cavities and enclosures. Integral equations approach. Radiation from gases, vapours and flames.

ME G534 Convective Heat and Mass Transfer **5***

Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.

ME G535 Advanced Engineering Mathematics **3 2 5**

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

ME G536 Thermal Equipment Design **5**

Course description is to be developed.

ME G537 Cryogenic Engineering **5**

Introduction to cryogenics and its applications, properties of cryogenic fluids, properties of materials at cryogenic temperature, gas-Liquefaction and refrigeration systems, gas separation, cryocoolers, cryogenic insulations, vacuum technology, instrumentation in cryogenics, safety in cryogenics.

ME G538 Toyota Production System **3 2 5**

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time,jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

ME G539 Computer Integrated Manufacturing **3 2 5**

Computer Modeling for mass property analysis. Computer Numerical Control. Computer-aided Manufacturing, operation of CNC machine tools. Design of manufacturing work cells, Automated Manufacturing and Programmable Controller.

ME G611 Computer Aided Analysis and Design **2 3 5**

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

ME G612 Plastics Engineering **3 2 5**

General properties of Plastics, Mechanical Behavior of Plastics, Processing of Plastics like Extrusion, injection moulding, thermoforming, calendaring, rotational moulding, compression moulding, transfer moulding, analysis of polymer melt flow, rheological models for polymer melt flow, analysis of heat transfer during polymer processing, elastic behavior of polymer melts, testing methods of polymers like DSC, TGA, DMA, XRD etc. FRP composites, Properties of FRP composites in longitudinal and transverse directions, volume and weight fraction relationships of fibers, failure mechanisms, mechanical properties and fiber orientation effects, processing of composite materials, advancement of composite materials in applications like wind mill blades, bullet proof jackets, etc.

ME G621 Fluid Dynamics **2 3 5**

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

ME G631 Advanced Heat Transfer **3 2 5**

Heat conduction with unsteady boundary conditions; recent advances in natural and forced convection; condensation and boiling phenomena; heat transfer in high speed flows; liquid metal heat transfer, radioactive metal heat-transfer between surfaces in absorbing media; complex problems involving simultaneous conduction, convection and radiation.

ME G641 Theory of Elasticity and Plasticity **3 2 5**

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

Microelectronics

MEL G512 Optoelectronic Devices, Circuits and Systems **3 2 5**

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

MEL G531 Testable Design and Fault Tolerant Computing **3 2 5**

Fault: types, modelling and simulation; testing methodologies, coverage, economics and quality; test vector generation: design for testability, built-in self tests; fault tolerant computing; fault tolerant software.

MEL G532 Digital Signal Processing **3 2 5**

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

MEL G611 IC Fabrication Technology **3 2 5**

Material properties; crystal growth and doping; diffusion; oxidation; epitaxy; ion implantation; deposition of films using CVD, LPCVD and sputtering techniques; wet and dry etching and cleaning; lithographic process; device and circuit fabrication; process modeling and simulation.

MEL G612 Integrated Electronics Systems Design **2 2 4**

General architectural features of 8/16/32 bit microprocessors, programmers model of 8086, assembly language programming, hardware design around 8086, bus based systems design, system design around IBM PC, design of real-time systems, ASIC's development tools.

MEL G621 VLSI Design **3 2 5**

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; structured design and testing; symbolic layout systems; CMOS subsystem design; system case studies.

MEL G622 Introduction to Artificial Neural Networks **2 2 4**

Fundamentals and definitions; Perceptrons, backpropagation and counterpropagation Networks; Statistical methods for network training; Hopfield nets; Associative memories; Optical neural networks; Applications of neural networks in speech processing, computer networks and visual processing.

MEL G623 Advanced VLSI Design **5**

Deep submicron device behavior and models, Interconnect modeling for parasitic estimation, Clock signals and system timing--Digital phase locked loop design, memory and array structures, Input/output circuits design, ASIC technology, FPGA technology, High speed arithmetic circuits design,-Parallel prefix computation, Logical effort in circuit design, Low power VLSI circuits-Adiabatic logic circuits, Multi threshold circuits, Digital BICMOS circuits, Design of VLSI systems.

MEL G624 Advanced VLSI Architectures **5**

Instruction set design and architecture of programmable DSP architectures; dedicated DSP architectures for filters and FFTs; DSP transformation and their use in DSP architecture design; Application Specific Instruction set Processor; superscalar and VLIW architectures.

MEL G625 Advanced Analog and Mixed Signal Design **5***

Mixed signal blocks design issues,, design of high resolution, high speed Comparators,, design of Active Mixers-balanced/ unbalanced,, Data Converters Architectures, CMOS multipliers , dividers and modulators , filters-active/ passive/ switched capacitor, Signal Conditioning and sensor associated circuits, Frequency Synthesizers, Phase Locked Loop, Power Management Circuits, Integrated Voltage Regulators, Energy Harvesting Circuits,, Analog Testing, Analog layouts, noise issues, emerging trends.

MEL G626 VLSI Test and Testability **5**

Fault models and types; automated test generation for combinational logic; test generation for sequential logic; need for adding testability logic; design for testability; Adhoc DFT methods; structured DFT; test generation for delay fault; issues in analog circuit testing and testability.

MEL G631 Physics and Modelling of Microelectronic Devices **3 2 5**

Physics and properties of semiconductor - a review; pn junction diode; bipolar transistor; metal-semiconductor contacts; JFET and MESFET; MOSFET and scaling; CCD and photonic devices.

MEL G632 Analog IC Design **3 2 5**

Basic Analog IC Design Issues, Analog Layouts, MOS Switch-- Charge Injection, Current And Voltage Biasing and Reference Generation Circuits,Common Mode Feedback Circuit, Replica Bias, Design, Analysis and Synthesis of Single StageAmplifiers, Differential Amplifiers, Operational Amplifiers and Operational Transconductance Amplifier Design, Low Power OPAMP , OPAMP/ OTA design in Subthreshold Operation region, Frequency Compensation, Current Mode Analog Circuit Design, Noise- Analysis and Estimation In Amplifiers, emerging trends.

MEL G641 CAD for IC Design **3 2 5**

Introduction to VLSI design methodologies and supporting CAD tool environment; overview of `C', data structure, graphics and CIF; concepts, structures and algorithms of some of the following CAD tools; schematic editors; layout editors; module generators; silicon compilers; placement and routing tools; behavioural, functional, logic and circuit simulators; aids for test generation and testing.

MEL G642 VLSI Architectures **2 2 4**

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hard-ware flowcharts; RISC instruction set architecture; Pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

Manufacturing Engineering

MF F211 Mechanics of Solids **3 0 3**

Fundamental Principles of mechanics; introduction to mechanics of deformable bodies; force and moment transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion of circular member, stress and deflection due to bending, stability of equilibrium. Static failure criteria, ductile & brittle material; Dynamic failure criteria.

MF F212 Fluid Mechanics **3 0 3**

Fluid Statics; fundamentals of mass, momentum and energy transfer, control volume approach and integral equations. Differential analysis of mass, momentum and energy transfer, solutions for one dimensional steady state situations. Viscous and in-viscid flow. Dimensional analysis. Introduction to computational fluid dynamics.

MF F213 Materials Science & Engineering **2 0 2**

Lattice structure and dislocations, binary phase diagrams , iron-ironcarbide phase diagram, heat treatment of steel, Phase transformation in Metals, Metallurgical techniques for property enhancement, Mechanical and thermal properties of Metals, and polymers, powder metallurgy. Material standards.

MF F214 Applied Thermodynamics **3 0 3**

Availability and irreversibility, thermodynamic relations,Compressible flow, Ideal gas and vapour cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychrometrics and Introduction to heat load calculations, gas turbine cycles , compressors, boilers and accessories.

MF F215 Mechanical Engineering Laboratory **0 2 2**

The course shall aim to train the student in the skill of operation of instruments and equipments related to Mechanical Engineering. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing,

basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

MF F241 Machine Design & Drawing **3 1 4**

Fundamentals and principles of Design. Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings & Gears, Fundamentals of machine drawing; practices for orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

MF F242 Manufacturing Management **2 0 2**

Introduction, product planning, forecasting, facilities location, process planning and design, layout of facilities, performance measures and capacity planning, planning and scheduling, material requirements planning and Just-in-time systems, inventory control, human resource management, financial management, marketing management, customer relationship management.

MF F243 Manufacturing Processes **2 1 3**

Foundry practices and Metal casting methods, Plastic working of metals, Welding and cutting, Machining Processes and machine tools. Nonconventional manufacturing processes, Finishing and Cleaning processes, Limits & Fits. Production quality control, Manufacturing and environment.

MF F244 Kinematics & Dynamics of Machinery **3 0 3**

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, cam design, gear trains, synthesis of linkages. Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes, free and forced vibrations.

MF F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

MF F311 Mechatronics & Automation **2 1 3**

Mechatronics design approaches, interfacing, instrumentation and control systems, modeling of mechanical and electromechanical systems, sensors and actuators, introduction to automation, pneumatics and hydraulics in automation, pneumatic circuits for automation, PLC programming and interfacing with pneumatic and hydraulic systems, introduction to MEMS, modeling and simulation of MEMS, CNC machines, automated material handling, introduction to FMS.

MF F312 Tool and Fixture Design **3 0 3**

Tool-design methods, tool making practices, tooling materials and heat treatment, design of cutting tools, gages and gage design, locating and clamping methods, design of drill jigs, design of fixtures, design of sheet metal blanking and piercing dies, design of sheet metal bending, forming and drawing dies, using plastics as tooling materials, tool design for numerically controlled machine tools and automatic screw machines.

MF F313 Metal Forming and Machining **3 1 4**

Plastic deformation of metals and related properties, metal forming processes, Yield conditions and stress-strain relations, Theory of slip lines, upper and lower bound theorems, Analysis of various hot & cold metal forming processes, Mechanics of machining processes and analysis, thermal aspects and cutting fluids, grinding and finishing operations, non conventional machining processes.

MF F341 Design of Machine Tools **3 0 3**

Determination of machining forces and power in turning, milling, grinding, drilling and shaper. Kinematics of machine tools and design of gearboxes, step-less regulation. Design of machine tool guide ways, beds, tables and columns. Design of power screws, spindle units and built-in inspection units. Bearings and lubrication in machine tools. Electric and hydraulic systems of machine tools. Introduction to dynamic analysis and vibrations in machine tools. Micro-displacement in machine tools, Design of CNC machines.

MF F342 Computer Aided Design **3 1 4**

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Hands-on in assignments and CAD project.

MF F343 Casting and Welding **3 1 4**

Casting processes, Pattern and Mould design, metal melting and handling, metallurgical aspects of casting, Metal flow and heat transfer, analysis of casting defects. Injection moulding of plastics Gas cutting and welding processes including its physics, chemistry and metallurgy, power source characteristics, different welding techniques, selection of welding processes, destructive and non destructive testing of weldments welding standards and codes, analysis of welded joints, brazing and soldering.

MF F344 Engineering Optimization **2 0 2**

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

MF F366 Lab Project **3**

MF F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MF F376 Design Project **3**

MF F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

MF F411 Fluid Power Systems **3 1 4**

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

MF F412 Automotive Systems **3 0 3**

Frame, suspension, springs and wheels, clutch and gear box, propeller shaft, universal joint, final drive, differential and rear axle, front axle and steering mechanism, brakes, automotive air conditioning, electrical vehicles, automotive electrical systems, automotive electronics systems.

MF F413 Mechanical Vibrations and Acoustics **3 0 3**

Introduction, single degree-of-freedom systems: free and forced vibration problems, concept of resonance and damping, vibration isolation, multi-degree-of-freedom systems: modeling of multi-degree-of freedom systems, eigen value problem and calculation of normal modes of a system, forced response using modal superposition techniques, introduction to acoustics - terminology used in acoustics and definitive of fundamental quantities 1D wave, equation (plane waves) & 3D wave equation, formulation and fundamental solution to the equations, measurement of noise & vibration – vibration measurement principles.

MF F414 Manufacturing Excellence **3 0 3**

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

MF F415 Noise Engineering **3 0 3**

Fundamentals of vibrations, vibrations of strings and bars, vibrations of membranes and plates, acoustic wave equation, acoustic energy and sound intensity, propagation of sound, concept of acoustic impedance, sound power transmission, transmission loss, human response and ratings, various measures of sound, weighting filters, loudness, indices of loudness, acoustic radiation from spherical source and piston source, acoustic sensors, measuring techniques and instruments, octave filtering, sound intensity measurement, intensity mapping, different types of measurement environment and uses, response of beam subjected to an acoustic plane wave, transmission loss of panels, sound absorption coefficient, noise control measures in building, reverberation time and auditorium design, industrial noise control, noise in machinery, traffic noise, vehicle noise, design of silencers and mufflers, active noise control, duct noise control and cabin noise control, practicals on noise measurements in different situations.

MF F416 Work System Design **3 0 3**

Introduction to work systems design, productivity and work study, method study: process analysis, man-machine analysis, operation analysis and micro-motion study, introduction to ergonomics and principles of motion economy, work measurement: stop watch time study, work sampling, standard data and predetermined motion time systems, job enlargement and job enrichment, incentive schemes.

MF F418 Lean Manufacturing **3 0 3**

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement.

MF F421 Supply Chain Management **4**

Customer driven strategies in production and distribution systems; Integrated production & distribution networks; SCM in the context of JIT and MRP-II; Distribution Resource Planning; Management of dealer networks; Total Quality Control & product innovation across the supply chain; Incoming logistics & supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; mathematical programming for SCM.

MF F442 Advances in Materials Science **3 0 3**

Deformation of materials, deformation at high temperatures and creep, recovery, recrystallization and grain growth, fracture of materials and fatigue failure, deterioration of materials, corrosion and oxidation, surface properties, surface energy and tribology, polymers and fibre reinforced polymeric composites, mechanical testings, nondestructive testing techniques.

MF F453 Industrial Relations **3 0 3**

Introduction to human resources management; planning and organising human resources; leadership and motivation; job satisfaction and morale; employee communication; audit and control; procurement of personnel; performance appraisal; human resource development; wage and salary administration; job change; discipline; labour welfare; trade unions and collective bargaining; industrial disputes; worker participation in management.

MF F463 Maintenance and Safety **3 0 3**

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipments and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

MF F471 Instrumentation and Control **3 0 3**

Measurement systems, transducers, feedback control, components: electrical, hydraulic,pneumatic; Signal conditioning and processing, controllers, display, recording, direct digital control, programmable logic controllers, PC based instrumentation.

MF F472 Precision Engineering **3 0 3**

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

MF F473 Product Design and Development **3 0 3**

Introduction to product design and development, product development planning and process tools, technical and business concerns, understanding customer needs, function modeling, benchmarking and engineering specifications, product architecture, concept generation, concept selection, concept embodiment, modeling of product metrics, design for X, physical prototypes, physical models and experimentation, robust design.

MF F474 Product Design and Development Projects **3**

The course will essentially deal with the practice of product design and development. The student will involve in the design and development of different products. He will be guided by the instructor/resource person. The effort must culminate with a product along with the project report.

MF F485 Sustainable Manufacturing **3 0 3**

Overview of sustainable manufacturing, 6R, WEEE, triple bottom concept of environment, economy and society, driver for, barriers to and stakeholders of sustainable manufacturing and their modelling, performance measures of sustainable manufacturing, evaluation of manufacturing systems based on environmental factors, eco-innovation and design for environment, recycling, remanufacturing, reuse, strategic and operational evaluation of technologies using life cycle management, environmental impact assessment models, end-of-life strategies, reverse logistics, sustainable product service systems, green factories.

MF F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

Management

MGTS F211 Principles of Management **3 0 3**

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MGTS F351 Organisational Behaviour **3 0 3**

A new perspective of management; conceptual model of organization behavior; the individualprocesses- personality, work attitude, perception, attribution, motivation, learning and reinforcement, work stress and stress management; the dynamics of organizational behavior- group dynamics, power & politics, conflict & negotiation, leadership process & styles, communication; the organizational processes- decision making, job design; organizational theory and design, organizational culture, managing cultural diversity; organizational change & development.

MGTS F433 Advertising and Sales Promotion **3 0 3**

The communication process and models of persuasive communication; advertising research; advertising campaign components; advertising campaign planning; advertising/media scene; media concepts; media planning & strategy; advertising campaign planning, execution and evaluation; advertising agencies; sales promotion types and techniques; sales promotion strategy; measuring the effectiveness of the promotional program; regulations of advertising and promotion; Extending marketing communication to social communication, personal selling, international advertising, interactive advertising, advertising laws, social, ethical and moral issues.

MGTS G511 Advanced Marketing Theories and Advertisement **5**

Strategic planning, theory and methods with emphasis on customer, competitor industry and environmental analysis and its application to strategy development and choice. Marketing communication through advertising and related mass media and promotion campaigns and its influence on market and other organisation. Globalisation and marketing aspects.

MGTS G513 Public Programme Evaluation **5**

Value judgements & public choice, social welfare-Paretion Welfare Economics; market system, income distribution and government & the market. social cost benefit Analysis (SCBA):SCBA and public sector investment planning, efficiency pricing & the rational of new methodology, problems of pricing comparative advantage, social pricing; the application SCBA: economic pricing of factor of production, social pricing, distribution & public sector; management values of public sector undertakings.

MGTS G521 Business Policy-Structure and Organisation **5**

Frame-work of business dynamics; missions; objective and goals; social aspects of business policy; environmental analysis; the dynamic setting of business policy; internal analysis of resources - strength and weaknesses; strategic planning choice, implementation and evaluation; functional policies; orientation in special cases - MNC's high-tech companies, non-profit organisations etc.

MGTS G531 Recent Advances in Organisation Behaviour Theory **5**

Emerging challenges of human resource management- a futuristic perspective; unified global theory of management; empowerment; employeeship; entrepreneurship; organisation diagnosis and development; social system and organisational culture-both in the national and global context interpersonal and group dynamics; employee attitudes; leadership and decision making; motivating employees; quality of work life and socio - technical systems; dealing with subordinates, boss, peers, problem employees.

MGTS G541 Management Information and Decision Support Systems **5**

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

MGTS G551 Frontiers in Financial Management **5**

Course description to be developed.

MGTS G561 Institutional Finance and Project Appraisal **5**

Mobilization of funds internally, externally, financial institutions and international financial institutions, financial and monetary framework of international financial management, foreign exchange markets and negotiations, project definition, preparation of feasibility assessment and selection, project reporting, conventional project appraisal - limitations, towards a new framework.

Public Health

MPH G510 Biostatistics & Computers in Public Health **5**

Introduction to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization.

Introduction to computer and its component, operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc; principles of software creation; processing concepts, flow charting and algorithms, programming constructs, programming languages, program development sequence; information systems; need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

MPH G512 Environmental & Occupational Health **4**

Introduction to environmental health and its importance; pollution from water, air, automobile, chemicals used in agricultural sector and their implication on health and environment; techniques for studying, monitoring and controlling pollution; handling and disposal of domestic industrial and bio-medical refuse, incineration of waste materials; methods of vector control; effect of low frequency electromagnetic radiation and nuclear radiation on public health, occupational health hazards; disaster management.

MPH G513 Public Health & Diseases **4**

Tropical diseases – their geography, identification, treatment methods, medicines, design of standard protocols and immunization processes including planning and execution; infections due to ticks and mites; bacterial, parasitic and viral infections- types and their classification, host–parasite relationships, their mode of proliferation, mechanisms of infestation, carriers, preventive methods and processes; understanding the public health problems related TB, AIDS, leprosy, GI infections and other communicable diseases.

MPH G515 Communication in Health Care **4**

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; research papers, interpersonal communication; business correspondence; use of modern communication aids and mass media; behavioral change communication; design, management & evaluation of IEC.

MPH G521 Health Care Management **4**

Basis of organizational culture and management techniques for efficient administration of health delivery; general principles of HR, materials and operation management; understanding the organizational culture that exists in public, private and non-Govt. sector agencies; management information system.

MPH G522 Preventive Nutrition & Health Promotion **4**

Basic concepts; nutritional requirements of essential nutrients, proteins, fats, carbohydrates, vitamins and minerals; balanced diet; nutritional problems in public health; nutritional factors in selected diseases; assessment of nutritional status; nutritional surveillance; mal-nutrition; special nutritional programme.

MPH G523 Epidemic & Disaster Management **4**

Disaster management; impact and response; relief phase; disaster mitigation in health sector; disaster preparedness; policy development; man-made disasters; international agencies providing health based humanitarian assistance; and strategies for disaster management.

MPH G531 Health Economics & Financial Management **4**

Concepts & methods of economic analysis related to health system; organization and policy; demand and supply of scarce resource for health care; health financing & population coverage; determinants of cost & utilization; health insurance; cost-benefit analysis; costing for decision making; fundamentals of accounting; financial statement analysis; budget process & budgetary control; capital investment decision.

MPH G535 Family & Community Health Measures **4**

Community-level indicators (CLI) measure aspects of the physical, legal, social and economic environment that reflect and are likely to influence the attitudes and behavior of individuals and community members. They also measure an important step in community-based health promotion interventions, Topics like, rural health services and health sector reforms from community perspective.

MPH G537 Law & Ethics in Public Health **3**

Various Acts/ legislations/ rules pertaining to public health and related fields like, drug & pharmaceuticals, medical practice, PNDT, CPCSEA, IHEC, Regulations related to waste disposal.

MPH G538 Telemedicine **3**

Advancing the use of digital telecommunications technology for the purpose of improving health care delivery to rural and underserved remote populations. Service areas include clinical services, educational programs, and research and development to provide high quality specialty care in participating rural communities and evaluation of the clinical utility and cost impact of telemedicine. Topic included will be Introduction to Telemedicine, Telehealth, Telemedicine Services, Telemedicine Systems and Telecommunications, Telemedicine Applications, Benefits and Drawbacks of Telemedicine, Information Sources, Advancing Telemedicine, etc.

MPH G539 Inter-sectoral co-ordination in Health Services **3**

Roles of public, private, government, non-government sectors in providing health services, Public works department, Sanitation, Waste disposal and management, Water and air pollution monitoring and control, Deforestation, Urbanization and rural development, Employment and occupational health hazards, Training of administrators and enforcement agency staff, Public awareness programs, etc.

MPH G540 Role of Voluntary bodies/ NGO's in Public Health **3**

Civil society organizations, Red Cross, Red Crescent movement and nongovernmental organizations in fund raising, international and local humanitarian responses, partnerships and collaborations with civil society, Operations in remote areas and marginalized groups; Role of indigenous voluntary bodies, Functioning of NGOs, WHO in preparedness and response efforts and Needs-based deployment of available resources, Effective health services coordination, etc.

MPH G613 Health Systems and Society **2**

Introduction to health systems; functions of health systems; managing health systems; problems of health systems management; Major environmental health problems including quality of water, waste disposal food production and processing, vector control etc. Air pollution and its controlling, Hazards of radiation, municipal and other wastes, Occupational health hazards.

MPH G661 Research Methodology I **5**

Course description is same as given under SKILL G661.

MPH G665 Hospital Operations Management **3**

Operation Management aspects connected with outpatient ward, casualty, operation theatres, diagnostic laboratories, pathology laboratories, pharmacy diet and nutrition, blood bank, laundry, medical records, security, scheduling and deployment of doctors, nurses and other staff, accounts among others. The course will involve on site visits in a hospital, discussions and presentations on the practical aspects of hospital operations management.

MPH G681 Strategic Management **3**

Concepts of Strategic Planning; Environment Analysis; Internal and External; Resource Analysis; Organizational Structure and Linkage with Strategies, Formulation, Implementation and Control of Strategic Plan; Communicating Strategic Plan; Case studies.

MPH G692 Epidemiology **2**

Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

Manufacturing Systems Engineering

MSE G511 Mechatronics **3 2 5**

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

MSE G512 Manufacturing Planning and Control **4**

Introduction, operations and manufacturing strategy for competitive advantage, product design and planning, forecasting product demand, facilities location, process selection and design, capacity planning, layout of facilities, job design and work measurement, aggregate planning, master manufacturing schedules, material requirements planning for dependent demand, short-term schedules and shop floor control, independent demand inventory systems, logistics and supply chain management, just-in-time systems, maintenance and reliability, quality management, managing projects, strategies for manufacturing excellence.

MSE G513 Maintenance Engineering **3 1 4**

Introduction, maintenance systems, methods and tools of maintenance analysis, eliability and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

MSE G514 Leadership and Managing Change **3 1 4**

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change : organisational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MSE G521 World-Class Manufacturing **3 2 5**

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

MSE G531 Concurrent Engineering **3 2 5**

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

Materials Science and Technology

MST F331 Materials Characterization **3 1 4**

Thermal properties of Materials and Characterization, Electrical Characterization: Temperature dependent DC conductivity in materials, impedance spectroscopy, Characterization instruments like impedance analyzer, Optical Characterization: UV- Visible spectroscopy, FTIR spectroscopy, optical microscopy, Confocal microscopy, Mechanical Characterization: Time dependent and time independent mechanical behavior of materials, Dynamic Mechanical Analysis, Instruments:Universal testing machine, Fatigue machine, Izod and charpy impact testers, Hardness indenters, Abrasion tester, Physical Characterization: Microstructure Characterization, Characterization instruments: SEM, TEM, X-ray diffractometer, AFM, Rheological Characterization: Linear and non-linear visco-elastic behavior of materials. Magnetic Characterization: Basics of diamagnetism, ferromagnetism and paramagnetism, anti ferromagnetism and ferrimagnetism, hysteresis and anisotropy, AC susceptibility and SQUID magnetometer.

MST F332 Materials Processing **3 0 3**

Processing of metals: electrometallurgy, hydrometallurgy, pyrometallurgy, extraction, and refining, Powder processing of metals and ceramics: Powder handling, compaction and forming techniques. Drying, burnout, densification, sintering, and grain growth in powder compacts. Crystal growth, epitaxial growth, Deposition of thin films – Plasma Laser deposition, metal organic chemical vapour deposition, Production of carbon-based materials: Controlled pyrolysis, electro-spinning.

Processing of plastics and fiber reinforced plastics: Processing by using techniques such as extrusion, injection molding, compression molding, SMC, pultrusion and filament winding.

MST F333 Introduction to Biomaterials **3 0 3**

Proteins, polysaccharides, oils and fats, fibers and biopolymers, structure and characterization of biomaterials, isolation and processing of biomaterials, development of polymers and composites from biomaterials, structure-property relationships (thermal, mechanical, biocompatibility, biodegradation etc.). Value-added products developed by using biomaterials, adhesives, bioplastics, composites for insulation and construction applications, biomedical applications such as, dental implants, sutures etc.,

MST F334 Materials for Catalytic applications **3 0 3**

Classification of different industrial catalysis technology; Classification of solid catalysts; Synthesis of bulk and nanomaterials; Chemical properties of energy-relevant materials environmental catalytic materials at the nanoscale.; Metals and metallic alloys supported on oxide-based catalytic materials; Metal-support interaction; Structure sensitivity of catalytic reactions; Reaction mechanisms in catalysis on metal supported catalysts; Porous materials for catalyst supports; Oxide non-stoichiometry - structural defects; Semiconductor character - photocatalysts; Acidic and Basic oxide catalysts; Lewis and Brønsted acidity in oxides; Hydrotalcites - precursors for base oxides; Sulfide based catalysts.

MST F335 Coating and Thin film technology **3 0 3**

Coating composition, pigments, binders, solvents, additives, Industrial process of making coatings, Rheology and mechanical properties of coatings, coatings in building and automotive sector, Introduction and formation of thin films by processes such as CVD, PVD, electrochemical deposition, thermal sprays, etc. Characterization of thin films such as coating hardness, thickness, assessment of friction & wear, roughness using nano-scale tests. Applications such as in defense, solar energy, consumer goods and implant materials.

MST F336 Glass Technology **3 0 3**

Introduction to glass, glass transition, principles of glass formation and molecular structure of glass. Structural basis for glass formation. Characterization of properties of Glass. Glass making: Raw materials and mixing methods, batch wetting and compaction techniques. Glass batch melting reactions and principles. Glass technology and commercial glasses: Press and blow, Individual selection machines, molds, and container design. Surface treatments and chemical durability. Flat glass forming and fabrication. Fabrication processes: chemical strengthening, annealing, tempering, and laminating. Strengthening of glass by physical and chemical means. Gorilla glass. Fiber glass manufacturing methods and products for application in insulation, filtration, polymer reinforcement and textiles.

MST F337 Materials for Energy Applications **3 0 3**

Overview of conventional and non- conventional energy resources, Silicon based Photovoltaic Solar cells, Photovoltaic thin films, Lightweight composites for wind turbine blades, Metals and ceramics used in thermal power plants, Ceramics for Energy storage and conversion, Ceramics and Composites for Nuclear energy, Photoelectrochemical Cells for hydrogen generation, Functional materials for Hydrogen storage, Functional Materials for fuel cells, Membrane electrode assemblies for fuel cells including DMFC's, Novel materials for Solid oxide fuel cells (SOFC) systems.

MST F338 Metals and Alloys **3 0 3**

Introduction, classification of Ferrous metals, Non-ferrous metals such as Titanium, Aluminium, Magnesium, Copper and their alloys, Structure-property relationship, Phase diagrams and Phase kinetics, processing and applications of metals and alloys, degradation of metals, Applications in transportation, chemical and medical sectors.

MST F339 Polymer Materials **3 0 3**

Polymerization techniques; classification of polymers; mechanism and kinetics of formation of polymers; Theoretical and experimental techniques for determination of different types of molecular weights and molecular weight distributions; polymer solution viscosity; melting and glass transitions, rheology; polymerization techniques used in industry, polymer solution thermodynamics; viscoelastic behaviour; degradation and stability; polymer processing and applications. Engineering thermoplastics, additives, blends, polymer composites and Biopolymers. Applications in automobile, biomedical and electronic and other industries.

MST G511 Nondestructive Testing Techniques **3 2 5**

Ultrasonic testing, X-radiography, eddycurrent testing, magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

MST G512 Ceramics Technology **3 2 5**

Ceramic raw materials, their beneficiations and characterisations; crystal structure of important ceramic systems and structural defects; various types of ceramics; white wares, glasses, refractories, cements, abrasives, glass-ceramic, ceramic coatings, electronic ceramics; fabrication processes; grinding, pressing, slip casting, drying, sintering, glass blowing; development of ceramic microstructures; properties of ceramic materials; mechanical, thermal, electrical, optical, magnetic and chemical; ceramic composites, cermets.

MST G521 Materials Characterization Techniques **3 2 5**

Materials characterisation - definition; importance and application with case studies, principles and general methods of compositional, structural and defect characterisation, techniques of X-ray, electron and neutron diffraction, EDAX, thermal methods - DTA, TGA, DSC. TMA and DMA; microscopy-optical, electron (TEM & SEM) and spectroscopy -UV, visible, IR and Raman spectroscopy, ESCA and Auger spectroscopy, SIMS resonance method- NMR, ESR, Mossbauer techniques, particle size analysis, electrical and magnetic characterization techniques.

MST G522 Advanced Composites **3 2 5**

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture thoughness and fatigue; properties of fibre reinforcement and production technology of composites.

MST G531 Experimental Stress Analysis Techniques **3 2 5**

Strain gauges, photoelasticity, brittle lacquer, three dimensional photoelasticity, Moire methods.

MST G532 Electronic Materials **3 2 5**

Electrical conduction in glasses and ceramics, non-stoichiometry and valence controlled conduction, ceramic heating elements, fast ion conductors, superconducting materials and devices, dielectric ceramics, ceramics in micro electronics, voltage dependent resistors, positive and negative temperature coefficient resistors. Piezo electric, pyroelectric, ferroelectric and electrooptic ceramic materials and devices, ceramic sensors, magnetic and magneto-optic ceramic devices, ceramics for microwave applications, luminescent and photoconducting ceramics, light transmitting filters, IR transmitting glass, optical fibre technology.

Music

MUSIC N103T Indian Classical Music (Vocal) I **3***

MUSIC N104T Indian Classical Music (Vocal) II **3***

MUSIC N203T Indian Classical Music (Vocal) III **3***

MUSIC N204T Indian Classical Music (Vocal) IV **3***

MUSIC N113T Indian Classical Music (Instrumental) I **3***

MUSIC N114T Indian Classical Music (Instrumental) II **3***

MUSIC N213T Indian Classical Music (Instrumental) III **3***

MUSIC N214T Indian Classical Music (Instrumental) IV **3***

The eight courses given above – four in vocal and four in instrumental - are designed to give theoretical and practical knowledge of Indian Classical Music in Hindustani or Carnatic style.

In the Hindustani series, the student will be introduced to the Hindustani system, *swara gyan,* structure of *Raag*s and *Taal*s, the ten *Thaat*s, and practice in performing selected *raag*s through compositions with elaborations.

For the Carnatic style series, the syllabus includes basic *Swara gyana*, structure of *Raagas* and *Taalas*, renderings of graded compositions in the form of *Geetam, Swarajati, Varnam* and *Keertanam*, introduction to the *Melakarta* and *Janya Raaga* system with reference to the seventy two Melakartas, performance practice including compositions and elaborations.

These courses are not available for fulfilling the requirements of any programme in the institute and can be taken only as audit courses.

MUSIC N105T Western Classical Music I **3***

MUSIC N106T Western Classical Music II **3***

MUSIC N205T Western Classical Music III **3***

MUSIC N206T Western Classical Music IV **3***

The above four courses are designed to introduce and train the student in notation, rhythmic concepts and practice of western classical music.

The beginning level will develop the skills of reading and writing notations, supported by singing exercises. The objective of the theory part is to impart the required skills for reading music while either playing an instrument or plain vocal. The student will be trained further in keyboard or violin practice.

At the advanced level, the student will be trained in more complex notations, rhythms, concept of Harmony melody etc., and composing rhythms and melodies. Training syllabus and examination tests will be based on that of the Associated Board of the Royal Schools of Music, London, and/or the Trinity-Guildhall board of music examinations.

(These courses are not available for fulfilling the requirements of any programme in the institute and can be taken only on audit).

MUSIC N303T Advanced Indian Music Practice (Vocal) **0**

MUSIC N313T Advanced Indian Music Practice (Instrumental) **0**

These courses are designed to allow facilities for practice with minimum supervision for students who have satisfactorily completed MUSIC N204T or MUSIC N214T respectively. These courses carry zero units. A student who has met the prerequisite can take these courses as audit courses as many times as he needs.

Pharmacy

PHA F211 Pharmaceutical Analysis **2 1 3**

Basic techniques of pharmaceutical analysis, data handling and analysis, sources of error in analysis. The analytical methods would comprise of various titrimetric methods, such as acid-base, complexometric, non-aqueous, oxidation-reduction, precipitation, conductometric; physical and instrumental analysis such as gravimetric, polarography, nephelometry, amperometry, turbidometry, potentiometry; chromatographic separations such as TLC, coloumn, ion-exchange,

extraction methods such as gel-filtration, fractionation processes, analysis of metallic and non-metallic elements; water content, as well as evaluation of drug constituents in various pharmaceutical preparation.

PHA F212 Dispensing Pharmacy **2 1 3**

Prescriptions, principles involved in the dispensing of prescriptions; physical, chemical and therapeutic incompatibilities involved and their remedy in such prescriptions; techniques involved in dispensing of mixtures. ENT preparations, parenteral products, radiopharmaceuticals, etc.

PHA F213 Microbiology **2 1 3**

Introduction and classification of microbes; structure and physiology of microbial cell; infection and immunity; host parasite relationship; microbiology of milk, air, water and food; physical and chemical methods of controlling microbes; experiments for isolation, cultivation, physiological and biochemical characterization of microbes.

PHA F214 Anatomy Physiology & Hygiene **2 1 3**

Anatomical study of the important organs of human body; physiology of various functional systems of human body; general principles of personal and community hygiene and prevention of communicable diseases.

PHA F215 Introduction to Molecular Biology & Immunology **3 0 3**

Basic aspects of cell and molecular biology, DNA replication, transcription, translation and control mechanisms of protein synthesis. Post transcriptional modifications, DNA-protein interactions and regulation of gene expression. Basic aspects of immune system, cell-mediated and humoral immunity.

PHA F241 Pharmaceutical Chemistry **2 1 3**

This course deals with study of important classes of organic compounds such as alcohols, ethers, esters, aldehydes etc and their reactions. The mechanisms for various reactions will also be dealt with to comprehensively cover the basics of chemical reactions. Some important five and six member heterocycles with their reactions will also be part of the course. This course also emphasizes the use of inorganic compounds in pharmacy.

PHA F242 Biological Chemistry **2 1 3**

Chemistry and functions of constituents of cells and tissues; introduction to enzymes; metabolism of carbohydrates, lipids, aminoacids; nucleic acids and protein synthesis; vitamins and hormones.

PHA F243 Industrial Pharmacy **2 1 3**

Pharmaceutical processes and equipments commonly used in pharmaceutical industries; drug extraction and clarification; mixing and granulation; pharmaceutical preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions, etc.; galenical products like infusions, decoctions, tinctures, extracts, etc, glandular preparations and blood plasma substitutes.

PHA F244 Physical Pharmacy **2 1 3**

This course is designed to make the students conversant with the applications of physico-chemical principles to the study of the drug stability behaviour of drug powers and of other pharmaceutical systems; it includes the discussion of drug degradation, micromeritics, rheology and interactions of drugs.

PHA F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

PHA F311 Pharmacology I **2 1 3**

This course is intended to impart the knowledge regarding the sources, routes of drug administration, pharmacokinetics (ADME) and pharmacodynamics (mechanism of action) of various drugs. This course is also intended to impart the knowledge regarding the concepts of action of drugs on various systems of the human body including ANS, SNS and CNS. The course also deals with therapeutic uses, side effects and contraindications of the drugs, which are commonly prescribed for the treatment of various disease conditions.

PHA F312 Medicinal Chemistry I **2 1 3**

This course deals with the study of important classes of drugs predominantly acting on CNS, ANS, SNS. Various aspects like structure, properties, therapeutic and pharmaceutical importance and the uses of drug molecules both of natural and synthetic origin will be covered. Study of physiochemical properties, mechanism of action, S.A.R. and metabolism of drugs will also be emphasized. Special emphasis will be given on important topics such as Cholinergic drugs, Adrenergic drugs, Local anesthetics and volatile anesthetics, Sedative hypnotics and anti anxiety drugs, Antiepileptics, Antihistamines, NSAIDS etc.

PHA F313 Instrumental Methods of Analysis **2 1 4**

Principles, configuration, applications of instruments like mass spectrophotometer, NMR, UV, IR, X-ray apparatus, atomic spectrophotometer, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA, TGA, etc.

The course is specially designed for students in the first degree majoring in experimental sciences and would require groups of students to work with the above instruments in order to appreciate the potentiality of such modern instrumental methods of analysis.

PHA F314 Pharmaceutical Formulations and Biopharmaceutics **2 1 3**

Physical, chemical and biopharmaceutical considerations in formulations, absorption, distribution and elimination of drugs; pharmaceutical additives; formulation and stability aspects of solid dosage forms, semi-solid dosage forms and liquids dosage forms; sustained release medication; aerosol products and packaging.

PHA F341 Pharmacology II **2 1 3**

This course is intended to impart the knowledge regarding the concepts of actions of drugs on various systems of the human body including cardiovascular system, urinogenital system, respiratory system, gastrointestinal and endocrine system etc. The course also imparts the knowledge regarding the mechanisms of action of various antimicrobial agents in the treatment and prevention of various diseases caused by the bacteria, fungi viruses and parasites. The course also deals with the drug-drug interactions, therapeutic uses, side effects and contraindications of the drugs, which are commonly prescribed for the treatment of various disease conditions.

PHA F342 Medicinal Chemistry II **2 1 3**

This course deals with the study of important classes of drugs. Various aspects like structure, properties, therapeutic and pharmaceutical importance and the uses of drug molecules both of natural and synthetic origin will be covered. Study of physico-chemical properties, mechanism of action, S.A.R. and metabolism of drugs dealt will also be emphasized. Special emphasis will be given on Important topics such as Anti hypertensive drugs, Drugs affecting sugar metabolism, Antimalarial drugs, Anticancer agents, Antiviral agents etc.

PHA F343 Forensic Pharmacy **2 - 2**

A study of the professional pharmacist's relation to the public and to other professions; a critical survey of statutory regulations governing the practice of pharmacy and drug industry in all its aspects; history and ethics of the profession of pharmacy.

PHA F344 Natural Drugs **2 1 3**

The course imparts a knowledge of the crude drugs of natural origin used in pharmaceutical and medical practice. Study will include the different systems of classifications of crude drugs; cell contents; general principles of cultivation, collection, drying, storage and commerce of natural products of current medical and pharmaceutical importance; their morphologial and microscopical study: use and knowledge of common substitutes and adulterants.

PHA F366 Lab Project **3**

PHA F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHA F376 Design Project **3**

PHA F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHA F413 Pharmaceutical Management and Quality Control **3 0 3**

Concepts of Pharmaceutical management, Managing of pharmaceutical industry, planning, layouts, designs, current good manufacturing practices, pharmaceutical process validation, documentation, pilot plant scale up technique optimization, pharmaceutical marketing, quality aspects and quality control, managing hospital pharmacy and its importance.

PHA F414 Biopharmaceutics **3 0 3**

Biopharmaceutics and Biopoharmaceutical aspects of drug delivery covering absorptions, distribution, metabolism and elimination (ADME) characters of drugs. Compartment model, pharmacokinetics of drugs and their applications, bioavailability, bioequivalence and their studies, drug-drug interactions and other related matters.

PHA F415 Pathophysiology **3 0 3**

Cellular pathology, inflammatory, genetic and immunological disorders, infectious diseases- their expression and cause, targets for therapy, diseases of the organ systems, environmental and nutritional pathology.

PHA F416 Chemistry of Synthetic Drugs **3 0 3**

Heterocyclic drugs; methods of heterocyclic drug synthesis; mechanisms of important heterocyclic compounds; mechanism based optimization of lead compounds on target sites; biological properties of heterocyclic durgs; synthesis of other special organic compounds of biological importance like steroids, prostaglandins etc.

PHA F417 Pharmacoeconomics **3 0 3**

Economic aspects of health care and its applications in the health sector are broadly emphasized. Cost-benefit, cost-effectiveness, cost-minimization, and cost-utility analyses to compare the different pharmaceutical products, drug therapy and treatments are focused. Economic concepts such as supply, demand, efficiency, equity, health policy, market failures, health insurance, pharmaceutical market, measurement of direct and indirect costs to a health care program, economic issues, pharmaceutical regulations, pricing policy and related topics will be covered.

PHA F422 Cosmetic Science **2 1 3**

Principles of formulation of typical cosmetic preparations such as cosmetic creams, powders, lipsticks, rouges, hair preparations, dentrifices, aerosol cosmetics, perfumes for cosmetic, their blending and mixing techniques. Some recent and new trends.

PHA F432 Hospital Pharmacy **3 0 3**

Definition and function, location, organisation, staff, space, equipment. Pharmaceutical services, Medical stores, objectives, procedures for procurement and suplies, Distribution & control, inspection of stocks, Licensing procedures for stocking of alcohol, narcotics, Maintenance ofrecords of stocks, issue and use. Pharmaceutical services for out - patient and in - patient department.

PHA F441 Biochemical Engineering **3 0 3**

Principles of Chemical Engineering applied to Bioprocesses; Kinetic Models for growth, substrate utilization and product formation; Biological reaction kinetics and applied enzyme catalysis; immobilized biocatalysts; Bioreactor Design and Operation; Fermentation, Upstream & Downstream processing; Novel Bioreactor Configurations; Transport phenomena in Bioprocesses; Instrumentation and control; Bioprocess Optimization and Scale up; Industrial Protein Purification Techniques; Commercial Enzymes & Biopharmaceuticals; Bioprocess Patenting, Economics & Feasibility Studies.

PHA F442 Applied Pharmaceutical Chemistry **3 0 3**

The course comprises of structure, reactions and synthesis of selected carbocyclic and heterocyclic ring systems. Their application for drug design, structure activity relationship, pharmacological action, methods of assay.

PHA F461 Phytochemistry **2 1 3**

This course is intended to impart knowledge to the students in the isolation, characterization and chemistry of the natural products derived from various sources, which are of pharmaceutical importance. Intriguing chemistry involved in their invivo production and their importance as structural materials, biologically active molecules like toxins, hormones, life process substrates and drugs will be covered in this course, the evaluation of these substances using qualitative and quantitative methods will also be covered; specail emphasis will be given to newer techniques in the biogenesis of these molecules.

PHA F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

PHA G510 Application of Statistics and Computer in Pharmacy **5**

to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization. Introduction to computer and its components; operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc.; principles of software creation; processing concepts, flow charting and algorithms, programming constructs, programming languages, program development sequence; information systems: need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

PHA G511 Fermentation & Biotechnology **2 3 5**

Industrial scale production by fermentation processes of antibiotics, vitamins, alcohol and other selected products, development, selection, isolation and preservation of mutants, media sterilisation, accretion and air sterlisation, continuous fermentation, recent advances in fermentation biotechnology, enzymes, their large scale extraction and purification, principles of immobilisation of enzymes and its applications.

PHA G512 Chemistry of Natural Drugs **3 1 4**

Study of recent methods of phytochemical investigations with reference to alkaloids like rauwolfia,vinca, cantharanthus etc.; some selected steroids, terpenes & flavoring agents, their chemistry, structure activity relationship, pharmacological actions and synthetic routes.

PHA G521 Molecular Biology & Immunology **3 1 4**

General principles governing the structures and functions of various molecules of the immune system, acquired immune responses, immunological tolerance, genetic control of immunity, hypersensitivity reactions, protein structure, functions, RNA and DNA cloning, principles of Genetic Engineering and its future in drug production.

PHA G522 Chemistry of Macromolecules **2 2 4**

Physical, Chemical and Biological properties of biopolymers like proteins, nucleic acids, poly saccharides. Synthetic polymers, biomedical and pharmaceutical polymers with emphasis on recent development.

PHA G523 Total Quality Management and Regulatory Affairs **(5*)**

Quality control, quality assurance, total quality management, various parameters for achieving quality products, application of statistics in quality assurance, statistical process control, current good manufacturing practice (cGMP), introduction to process validation, drug regulatory affairs, clinical research protocols, new drug applications, intellectual property rights.

PHA G531 Disinfection and Sterilization **2 2 4**

Theories and kinetics of the disinfection reaction, study of the principles involved in vivo and in vitro evaluation of disinfectants and antiseptics, structure activity relationships of the representative groups of disinfectants, sterilisation, heat, ionizing and ultraviolet radiations, ultrasonic waves, filtration, gaseous sterilisation and cellular dessication methods, controls used and special problems involved.

PHA G532 Quality Assurance & Regulatory Affairs **3 2 5**

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

PHA G541 Computer Aided Drug Design **3 2 5**

3D structure and function of bio-molecules; targets of drugs and design principles; molkecular modeling methodologies; quantitative structure-activity relationships; chemical compound databases and search tools; interactive graphics in drug design; molecular surfaces and algorithm of automated docking of durgs into receptor sites; receptor mapping; introduction to molecular modeling and docking software.

PHA G542 Advanced Physical Pharmaceutics **3 2 5**

Preliminary evaluations and molecular optimization, Drug substance considerations including protein, peptide and biological products, Bulk characterization, Solubility analysis, Rheology and dispersed systems, Micromeritics and shape factor analysis, Compression and compaction, Principles of dissolution, Dissolution test design and release kinetics evaluation, Compatibility testing, Stability analysis and test design according to international standard, Studies of broad category of polymers used in drug delivery, Rationale basis of formulation recommendation.

PHA G543 Clinical Research **5***

Fundamentals of clinical trials including design, conduct, analysis and interpretation, randomization and blinding methods, sample size determination, recruitment methods, choice of controls, ethical, regulatory and research clearance including GCP, trial requirements-multi-centric/collaborative and related operational issues, data collection, processing, protocol management and quality control issues, interim analysis and critical review of intervention and therapies, design and results, statistical techniques in analysis and interpretation of results, documentation and reporting, pharmacovigilance.

PHA G544 Advanced Pharmaceutical Chemistry **3 2 5**

Stereochemical aspects of drugs and biological molecules; effect of stereochemistry on drug action and isomerism in various drugs; rearrangements and name reactions useful in synthesis of bioactive molecules; example applications of rearrangements and name reactions in synthesis of existing drugs.

PHA G545 Intellectual property rights and Pharmaceuticals **3 0 3**

Key aspects of intellectual property law and their impact on Pharmaceutical industry; concept of property with respect to intellectual creativity; emerging debates, policy issues and law reforms related to IPR with respect to pharmaceuticals; Issues of Intellectual Property such as Patents, Copyright, Trademarks, and Design; rules and regulations of marketing and competition; Patent processing, infringement of patents, ethics and economic issues related to IPR;

PHA G546 Pharmaceutical Biostatistics **3 0 3**

Different types of data; methods for data collection; organization and summarization of data; probability distributions; descriptive measures (measures of central tendency and measures of dispersion); sampling and estimation of parameters (point estimates and interval estimates); tests of hypothesis using parametric (t-test and ANOVA) and various non-parametric tests; correlation and linear regression; determination of sample size for a study; estimating bio-equivalence of pharmaceutical products

PHA G547 Quality-by-Design in Pharmaceutical Product Development **3 2 5**

Principles and tools of Quality-by-Design (QbD) for pharmaceutical product development and manufacturing; essential elements of QbD approach including basic risk analysis techniques; constructing the quality target product profile (QTPP); identification of critical quality attributes (CQAs); critical process parameters (CPPs); design of experiments (DoE); identifying design space and control strategy; selection of critical factors using various screening designs; optimization of factors using various experimental designs; introduction to process analytical technologies (PAT)

PHA G611 Advanced Pharmacology **2 3 5**

Biochemical pharmacology; pharmacologically active polypeptides; general pharmacological principles involving immunological processes, pharmacogenetics, teratology, pharmacokinetics, drug resistance and related phenomena, drug-interaction; recent advances in the therapy of neoplastic diseases, viral diseases, atherosclerosis and hypertension; topics of recent interest like contraception; use of gases and ions in therapy etc.

PHA G612 Pharmacokinetics & Clinical Pharmacy **3 2 5**

The study of pharmacokinetics and its clinical applications in the development, evaluation and use of drugs; the time course of drug and metabolite levels in different fluids, tissues and excreta of the body, mathematical relationship required to develop models to interpret the data for single and multiple dosing, study of bio- availability, dosage regimen adjustment in renal impairment, application of the pharmacokinetic principles to the therapeutic management of patients.

PHA G613 Pharmaceutical Biotechnology **3 2 5**

Molecular biology, immunology, recombinant DNA technology and principles of biochemical engineering. Application of biotechnology in diagnosis, therapeutics and production of products of fermentation. Bioinformatic tools required to store, analyze and use biological information for therapeutic utility, immense potentiality and application f decoding the human genome.

PHA G614 Clinical Pharmacy and Therapeutics **3 2 5**

Basic concepts of Clinical pharmacy and its applications, analysis of patient data interpretation of clinical laboratory tests, drug information queries, their sources and interpretation of the information. Clinical pharmacokinetics, therapeutic drug monitoring, drug-drug interactions.

PHA G615 Pharmacy Practice **3 2 5**

Overview of health care systems, providing drug information, physical examination, diagnostic procedures, drug administration, selection of alternate therapies, clinical alert, nutrition and electrolyte therapy, documentation of pharmacy services, patient counseling, paediatric pharmacy practice, evaluation of drug related problems, environmental, and health care management.

PHA G616 Pharmaceutical Administration and Management **3 2 5**

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

PHA G617 Advanced Drug Delivery Systems **3 2 5**

A study of physicochemical and biopharmaceutical factors involved in the design of novel drug delivery systems like mucosal, particulate systems for systemic delivery of bioactive molecules. Special considerations for delivery of protein, peptide and other biological products. In vitro and in vivo evaluation of novel drug delivery systems.

PHA G618 Reterosynthetic Analysis **3 2 5**

Methods and techniques to transform target molecule to precursors, functional group, stereo-chemical, structural, transform based and topological strategies involving organic reactions, functional group inter-conversions, reconnection and disconnection approaches, acyclic, ring structure synthesis, rearrangement reactions pertaining to the synthesis of selected medicinally important compounds.

PHA G619 Screening Methods and Techniques In Pharmacology **5***

Biochemical assays, qualitative and quantitative estimation of receptor specific drugs, animal handling, breeding, nutrition and diet manipulation for testing, methods and techniques involved, therein. Design and development of new animal models and evaluation techniques for co-morbid illnesses and their standardization, toxicological, teratogenic, carcinogenic studies, data analysis, normalization in tabular and graphical formats.

PHA G621 Advanced Medicinal Chemistry **2 3 5**

Methods of synthesis; properties, uses, methods of assay and structure-activity relationship of non-mercurial diuretics, psychopharmacologicals, anticancer agents; chemistry of prostaglandins; some concepts of receptor theories, dose response curves, introduction to QSAR.

PHA G622 Chemistry of Natural Drugs & Macromolecules **3 2 5**

Size and shape of macromolecules, biomedical polymers, their structure, synthesis and function, chemistry of newer oral contraceptive agents, terpenes used as flavouring agents, newer phytochemical investigations in glycosides, alkaloids, etc.

PHA G632 Dosage Form Design **2 3 5**

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; microencapsulation; radio pharmaceuticals.

PHA G642 Laboratory Project **6**

Exercises illustrating principles discussed in theory courses.

PHA G645 Molecular Pharmacology **3 0 3**

Molecular basis of the action of drugs; the characteristics of interactions between drug molecules and substrates of drug action in the cell; molecular, biochemical and cell biological techniques; response of cells to pharmacologic agents.

Physics

PHY F110 Physics Laboratory **0 2 1**

An introductory experimental course covering experiments in Mechanics, Oscillations and Waves. In addition to performing classic experiments in physics, the course aims at strengthening experimental skills and ability to take proper measurements. The course should motivate students to enter the exciting world of experimental physics.

PHY F111 Mechanics, Oscillations and Waves **3 0 3**

Conservation Principles, Rotational Dynamics, Oscillations, Wave Motion, Reflection and Refraction, Interference, Diffraction, Polarisation.

PHY F112 General Physics **3 0 3**

Philosophy of Science; Newton's laws of motion; Work Energy, Impulse and Momentum; Equilibrium; Moment of a force; Rotation; Periodic motion; First law of thermodynamics; Second law of thermodynamics; Electromagnetic waves; Interference and diffraction; Polarization; Relativistic mechanics; Photons, Electrons and Atoms; Quantum Mechanics; Atoms, Molecules and Solids; Nuclear Physics.

PHY F211 Classical Mechanics **3 1 4**

Review of Newtonian mechanics, constraints and generalized coordinates, Lagrange's equation of motion, calculus of variation and principle of least action, central force motion, kinematics of rigid body motion, rigid body equations of motion, heavy symmetrical top, Hamilton's equations of motion, canonical transformations.

PHY F212 Electromagnetic Theory I **3 0 3**

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

PHY F213 Optics **3 0 3**

Geometrical optics - light as rays, Fermat's principle, matrix methods in ray tracing; scalar wave theory of light, spatial and temporal coherence, theory of diffraction - Fresnel & Fraunhoffer diffraction, diffraction at rectangular and circular aperture, diffraction around opaque objects; crystal optics - electromagnetic wave propagation in anisotropic media, birefringence, e-m waves in nonlinear media, elements of nonlinear optics; scattering of light – Thomson and Rayleigh scattering; elements of modern optics - lasers and applications, holography, fiber optics, Fourier optics.

PHY F214 Electricity, Magnetism, and Optics Lab **0 2 2**

This lab will consist of experiments on electromagnetism, optics and lasers.

PHY F215 Introduction to Astronomy and Astrophysics **3 0 3**

Introduction and scope, telescopes, distance and size measurements of astronomical objects, celestial mechanics, the Sun, planets, planet formation, interstellar medium, star formation, stellar structure, stellar evolution, star clusters - open clusters, globular clusters, the Milky-Way galaxy, nature of galaxies - normal and active galaxies, Newtonian cosmology, cosmic microwave background radiation, the early universe.

PHY F241 Electromagnetic Theory II **3 1 4**

Maxwell's equations in matter, boundary conditions on electric and magnetic fields; energy of e-m fields and Poynting's theorem, linear momentum and angular momentum of e-m fields, Maxwell's stress tensor; electromagnetic waves in dielectric media – reflection, refraction and transmission at interfaces; wave propagation in metals – absorption and dispersion; guided waves; potential formulation of e-m fields, retarded potentials & Jefimenko's equations, Lienard-Weichert potentials and fields of a moving point charge; dipole radiation & radiation due to point charges; special theory of relativity, relativistic mechanics, relativistic electrodynamics.

PHY F242 Quantum Mechanics I **3 0 3**

Origin of the quantum theory - black body radiation, photoelectric effect, Compton scattering, electron diffraction, Bohr model of hydrogen atom, Frank-Hertz experiment, Bohr-Sommerfeld quantization condition; notion of wave function, statistical interpretation of the wave function, issues of normalization, the Heisenberg uncertainty relation; Schrodinger equation, stationary states and time independent Schrodinger equation, energy eigenvalues and eigenfunctions, one-dimensional problems – potential wells, potential barriers, the harmonic oscillator; Hilbert space formalism – state vectors, Dirac's bra-ket notation, observables as Hermitian operators, eigenvalues and eigenstates of Hermitian operators, the measurement postulate.

PHY F243 Mathematical Methods of Physics **3 0 3**

Tensor analysis in Cartesian and curvilinear coordinates; linear vector spaces, linear transformations and theory of matrices; functions of a complex variable, contour integration and applications; elements of calculus of variation; series solution

of ordinary differential equations, special functions, Sturm-Liouville theory; Fourier integral; partial differential equations of physics, solution of partial differential equations by separation of variables method, the Green function method.

PHY F244 Modern Physics Lab **0 2 2**

This lab will consist of experiments on modern physics and electromagnetism.

PHY F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

PHY F311 Quantum Mechanics II **3 0 3**

Hilbert space formalism (continued from QM-I) - operators and their matrix representations, change of basis, position and momentum representations, commuting and non-commuting observables, the generalized uncertainty relation; the time evolution operator and Schrodinger equation, Schrodinger and Heisenberg picture, simple harmonic oscillator using operator method; angular momentum operators and their commutation relations, eigenvalues and eigenvectors of angular momentum, spherically symmetric potentials, the hydrogen atom; time independent perturbation theory, WKB approximation, variational method; time dependent perturbation theory, interaction of atom with classical radiation field; identical particles.

PHY F312 Statistical Mechanics **3 0 3**

Review of Thermodynamics - First and the second law of thermodynamics, reversible and irreversible processes, entropy, absolute temperature, thermodynamic potentials ; Statistical description of macroscopic systems - micro and macro states, phase space distribution, Liouville theorem, microcanonical ensemble, statistical definition of temperature, pressure and entropy; Canonical ensembles, probability distribution in canonical ensemble, partition function and calculation of thermodynamic quantities, equipartition and virial theorems, Maxwell velocity distribution, paramgnetism, harmonic oscillators, polyatomic molecules; Grand canonical ensembles - probability distribution in grand canonical ensemble, grand partition function, calculation of thermodynamic quantities; Quantum statistics - indistinguishable particles, Bose-Einstein and Fermi-Dirac distribution, classical limit, photon statistics, Planck distribution; Ideal Fermi gas - equation of state of ideal Fermi gas, free electron gas in metals, Pauli paramagnetism, Landau diamagnetism, statistical equilibrium of white dwarf stars; Ideal Bose Gas - equation of state, Bose-Einstein condensation.

PHY F313 Computational Physics **3 0 3**

Review of programming language - C/C++, Matlab and Mathematica; Functions and roots - Newton-Raphson method, rate of convergence, system of algebraic equations; Numerical integration - Romberg integration, Gaussian quadrature; Ordinary differential equations - Euler Method, Runge-Kutta method, predictor-corrector method, system of equations; Partial differential equations - boundary value problems, finite difference method, finite element method; discrete and fast Fourier transform; Eigen-value problems; Monte-Carlo method - random numbers, sampling rules, metropolis algorithm.

PHY F315 Theory of Relativity **3 0 3**

Special theory of relativity : Experimental background and postulates of the special theory, Lorentz transformation equations and their implications, space-time diagrams, Four vectors, tensors in flat space-time, relativistic kinematics and dynamics, relativistic electromagnetism. General theory of relativity : Principle of equivalence, gravitational red shift, geometry of curved space-time, Einstein field equation, spherically symmetric solution of field equation.

PHY F316 Musical Acoustics **3 0 3**

Mathematical description of sound waves; physical

sound production by vibrations in different dimensions; perception of music by the human ear and brain, the scientific meaning of psycho-acoustic concepts of pitch, loudness and timbre; Fourier analysis as a tool for characterizing timbre; musical scales, harmonics and tones; musical instruments with plucked, bowed and struck strings, wood-wind instruments, reed instruments and the human voice, percussions instruments such as tympani, and drums; engineering for sound reproduction in transducers, mikes, amplifiers and loudspeakers; sound spectrum analysis; basics of signal processing for electronic music production, filtration and enhancement; rudiments of room and auditorium acoustics ; hands-on work and projects.

PHY F317 Introduction to Radio Astronomy **3 0 3**

Overview of Astronomy, Stellar and Galactic Astrophysics, Bremsstrahlung, Synchrotron radiation, free-free radiation, and Compton scattering, Radiative- transitions/line-emission, The radio sky and sources of radio signals, Theory of statistical random signals, Radio telescopes and Radio observations. Techniques of Line and continuum observations, Pulsar observations. Radio telescopes, antennas and receivers. Single dish and interferometric observations, Beam patterns, aperture synthesis and deconvolution, Phased arrays, Flux and Phase Calibration techniques. Study some radio telescopes GMRT, VLA, OWFA.

PHY F341 Solid State Physics **3 0 3**

Crystal structure - direct and reciprocal lattice, Brillouin zone, X-ray diffraction and crystal structure; free electron theory of metals; periodic potential and band theory of solids, the tight-binding approximation; lattice vibration and thermal properties; semiconductors - energy band gap in semiconductors, carrier density of intrinsic and extrinsic semiconductors, the p-n junction; magnetism - paramagnetism and diamagnetism, spontaneous magnetism, magnetic ordering; super conductivity-basic properties, the London equation, elements of BCS theory.

PHY F342 Atomic and Molecular Physics **3 0 3**

Interaction of electromagnetic field with atoms - transition rates, dipole approximation, Einstein coefficients, selection rules and spectrum of one electron atom, line intensities and shapes, line widths and lifetimes; one electron atoms - fine and hyperfine structure, interaction with external electric and magnetic fields; two electron atoms - para and ortho states, level scheme, ground and exited states of two electron atoms; many electron atoms - central field approximation, Thomas – Fermi model, Hartree- Fock method, L-S coupling and j-j coupling; Molecular structure - Born-Oppenheimer approximation, rotation and vibration of diatomic and polyatomic molecules, electronic structure and spin, rotational-vibrational and electronic spectra of diatomic molecules, nuclear spin.

PHY F343 Nuclear and Particle Physics **3 0 3**

Bethe-Weizsacker mass formula, nuclear size, mirror nuclei, electric multipole moments, Spherically and axially symmetric charge distribution, electric quadrupole moment, nuclear magnetic moment, nuclear decay, alpha and beta decay processes, nuclear fission, Bohr-Wheeler theory, two-body problem, deuteron wave function with central and non-central potential, electric quadrupole moment & magnetic moment, exchange forces, low energy nucleon-nucleon scattering, scattering length, effective range theory, spin dependence of n-p scattering, magic numbers, independent particle model, collective model. Mesons and baryons, antiparticles, neutrinos, strange particles, eightfold way, quark model, intermediate vector bosons, four fundamental forces, basic vertices and charactesitics of quantum electrodynamics, quantum flavordyamics and quantum chromo dynamics, decays and conservations laws, basic ideas of standard model of particle physics, qualitative discussion of current issues in particle physics.

PHY F344 Advanced Physics Lab **0 3 3**

This lab will consist of experiments on solid state physics, spectroscopy and nuclear physics.

PHY F345 Quantum Mechanics for Engineers **3 0 3**

Wave particle duality, Schrödinger wave equation, probability and current densities, position and momentum operators and state space, expectation values of operators, normalization, particle in a box, particle in finite height barrier and finite well, reflection and transmission, Harmonic oscillator, particle in linearly varying potential, Infinite potential well, delta function potential. Time dependent Schrödinger equation, time evolution of stationary states: Infinite well and harmonic oscillator, wave packets and time evolution with example, group velocity.

Crystals, one electron approximation, Bloch theorem, density of states in k space, effective mass theory, effective mass approximation in semiconductor heterostructures, density of states in energy, density of states in quantum well, K.P model for two-band semi conductor. Band structure calculations for cubic crystals, Nanostructures: quantum wire, quantum well, quantum dots

PHY F366 Lab Project **3**

PHY F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHY F376 Design Project **3**

PHY F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

PHY F378 Plasma Physics and its Applications **3 0 3**

Introduction to plasma physics. Motion of single charged particles in Electric and Magnetic fields. Fluid description of plasma and study of waves in plasmas, Theory of instabilities in plasma, A Kinetic theory description of plasma and some basic plasma phenomenon, Applications of plasma physics to plasma based accelerators, plasma based energy radiation sources, magnetic confinement fusion, laser-plasma interaction, astrophysical plasma, and studying plasma physics using computer simulation.

PHY F379 Thin Film Technology **3 0 3**

Overview of thin film technology, Structure and bonding of materials, Defects in thin film, Thermodynamics and phase diagram, Kinetics and diffusion mechanism, Surface nucleation and film growth, Epitaxy and growth modes, Basics of vacuum science and technology, Thin film growth technology, Epitaxial growth techniques, Structure and morphology of thin films, Surface reconstruction and surface chemistry, Electrical and magnetic properties, Special topics on thin film application, Laboratory based experiments or assignments related to thin films.

PHY F412 Introduction to Quantum Field Theory **3 1 4**

Klein-Gordan equation, SU(2) and rotation group, SL(2,C) and Lorentz Group, antiparticles, construction of Dirac Spinors, algebra of gamma matrices, Maxwell and Proca equations, Maxwell's equations and differential geometry; Lagrangian Formulation of particle mechanics, real scalar field and Noether's theorem, real and complex scalar fields, Yang-Mills field, geometry of gauge fields, cannonical quantization of Klein-Gordan, Dirac and Electromagnetic field, spontaneously broken gauge symmetries, Goldstone theorem, superconductivity.

PHY F413 Particle Physics **3 1 4**

Klein-Gordan equation, time-dependent non-relativistic perturbation theory, spinless electron-muon scattering and electron-positron scattering, crossing symmetry, Dirac equation, standard examples of scattering, parity violation and V-A interaction, beta decay, muon decay, weak neutral currents, Cabibo angle, weak mixing angles, CP violation, Weak isospin and hypercharge, basic electroweak interaction, Lagrangian and single particle wave-equation, U(1) local gauge invariance and QED, non-abelian gauge invariance and QCD, spontaneous symmetry breaking, Higgs mechanism, spontaneous breaking of local SU(2) gauge symmetry.

PHY F414 Physics of Advanced Materials **3 1 4**

Review of fundamentals of crystallography, structural properties of crystals, polymers and glasses, processes involved in materials preparation, viz., diffusion, phase diagrams, advanced techniques to prepare low dimensional systems and thin films, kinetics of phase transformations, Mechanical, structural, thermal and electrical characterization of advanced materials, e.g., high Tc superconductors, superionic conductors, conducting polymers, dielectrics, ferroelectric materials, polycrystalline semiconducting materials, magnetic semiconductors, magneto resistance and GMR materials, shape memory alloys.

PHY F415 General Theory of Relativity and Cosmology **3 1 4**

Review of relativistic mechanics, gravity as geometry, descriptions of curved space-time, tensor analysis, geodesic equations, affine connections, parallel transport, Riemann and Ricci tensors, Einstein's equations, Schwarzschild solution, classic tests of general theory of relativity, mapping the universe, Friedmann-Robertson-Walker (FRW) cosmological model, Friedmann equation and the evolution of the universe, thermal history of the early universe, shortcomings of standard model of cosmology, theory of inflation, cosmic microwave background radiations (CMBR), baryogenesis, dark matter & dark energy.

PHY F416 Soft Condensed Matter Physics **3 1 4**

Forces, energies, timescale and dimensionality in soft condensed matter, phase transition, mean field theory and its breakdown, simulation of Ising spin using Monte Carlo and molecular dynamics, colloidal dispersion, polymer physics, molecular order in soft condensed matter – i) liquid crystals ii) polymer, supramolecular self assembly.

PHY F417 Experimental Methods of Physics **3 1 4**

Vacuum techniques, sample preparation techniques, X-ray diffraction, scanning probe microscopy, scanning electron microscopy, low temperature techniques, magnetic measurements, Mossbauer and positron annihilation spectroscopy, neutron diffraction, Rutherford backscattering, techniques in nuclear experimentation, high energy accelerators.

PHY F418 Lasers and Applications **3 1 4**

Properties of laser light, theories of some simple optical processes, basic principles of lasers, solid-state lasers, gas lasers, semiconductor lasers, free electron lasers, liquid, dye and chemical lasers, dynamics of laser processes, advances in laser physics, Q-switching, modelocking (active and passive), saturable absorbers, Kerr lens mode locking, non-linear optics, laser spectroscopy, time resolved spectroscopy, multi-photon spectroscopy.

PHY F419 Advanced Solid State Physics **3 1 4**

Schrodinger field theory (second quantized formalism), Bose and Fermi fields, equivalence with many body quantum mechanics, particles and holes, single particle Green functions and propagators, diagrammatic techniques, application to Fermi systems (electrons in a metal, electron – phonon interaction) and Bose systems (superconductivity, superfluidity).

PHY F420 Quantum Optics **3 1 4**

Quantization of the electromagnetic field, single mode and multimode fields, vacuum fluctuations and zero-point energy, coherent states, atom - field interaction - semiclassical and quantum, the Rabi model, Jaynes-Cummings model, beam splitters and interferometry, squeezed states, lasers.

PHY F421 Advanced Quantum Mechanics **3 1 4**

Symmetries, conservation laws and degeneracies; Discrete symmetries - parity, lattice translations and time reversal; Identical particles, permutation symmetry, symmetrization postulate, two-electron system, the helium atom; Scattering theory - Lippman-Schwinger equation, Born approximation, optical theorem, eikonal approximation, method of partial waves; Quantum theory of radiation - quantization of electromagnetic field, interaction of electromagnetic radiation with atoms; relativistic quantum mechanics.

PHY F422 Group Theory and Applications **3 1 4**

Basic concepts – group axioms and examples of groups, subgroups, cosets, invariant subgroups; group representation – unitary representation, irreducible representation, character table, Schur's lemmas; the point symmetry group and applications to molecular and crystal structure; Continuous groups – Lie groups, infinitesimal transformation, structure constants; Lie algebras, irreducible representations of Lie groups and Lie algebras; linear groups, rotation groups, groups of the standard model of particle physics.

PHY F423 Special Topics in Statistical Mechanics **3 1 4**

The Ising Model – Definition, equivalence to other models, spontaneous magnetization, Bragg- William approximation, Bethe-Peierls Approximation, one dimensional Ising model, exact solution in one and two dimensions; Landau's mean field theory for phase transition – the order parameter, correlation function and fluctuation-dissipation theorem, critical exponents, calculation of critical exponents, scale invariance, field driven transitions, temperature driven condition, Landau-Ginzberg theory, two-point correlation function, Ginzberg criterion, Gaussian approximation; Scaling hypothesis –

universality and universality classes, renormalization group; Elements of nonequilibrium statistical mechanics – Brownian motion, diffusion and Langevin equation, relation between dissipation and fluctuating force, Fokker-Planck equation.

PHY F424 Advanced Electrodynamics **3 1 4**

Review of Maxwell's equations – Maxwell's equations, scalar and vector potentials, gauge transformations of the potentials, the electromagnetic wave equation, retarded and advanced Green's functions for the wave equation and their interpretation, transformation properties of electromagnetic fields; Radiating systems – multipole expansion of radiation fields, energy and angular momentum of multipole radiation, multipole radiation in atoms and nuclei, multipole radiation from a linear, centre-fed antenna; Scattering and diffraction – perturbation theory of scattering, scattering by gases and liquids, scattering of EM waves by a sphere, scalar and vector diffraction theory, diffraction by a circular aperture; Dynamics of relativistic particles and EM fields – Lagrangian of a relativistic charged particle in an EM field, motion in uniform, static electromagnetic fields, Lagrangian of the EM fields, solution of wave equation in covariant form, invariant Green's functions; Collisions, energy loss and scattering of a charged particle, Cherenkov radiation, the Bremsstrahlung; Radiation by moving charges – Lienard-Wiechert potentials and fields, Larmor's formula and its relativistic generalization; Radiation damping – radiative reaction force from conservation of energy, Abraham-Lorentz model.

PHYF425 Advanced Mathematical Methods of Physics **3 1 4**

Course description is to be developed.

PHY F426 Physics of Semiconductor Devices **3 1 4**

Course description is to be developed.

PHY F427 Atmospheric Physics **3 0 3**

Course description is to be developed.

PHY F428 Quantum Information Theory **3 0 3**

Classical Information, probability and information measures, methods of open quantum systems using density operator formalism, quantum operations, Kraus operators. Measurement and information, Entropy and information, data compression, channel capacity, Resource theory of quantum correlations and coherence, and some current issues.

PHY F431 Geometrical Methods in Physics **3 0 3**

Manifolds, tensors, differential forms and examples from Physics, Riemannian geometry, relevance of topology to Physics, integration on a manifold, Gauss theorem and Stokes' theorem using integrals of differential forms, fibre bundles and connections, applications of geometrical methods in Classical and Quantum Mechanics, Electrodynamics, Gravitation, and Quantum field theory.

PHY F432 Classical Theory of Fields: A Symmetry Perspective **4***

Rotations in real complex and Minkowski spaces laying group theoretical basis of 3-tensors and 4 tensors and spinors, transition from a discrete to continuous system, stress energy tensor, relativistic field theory, Noether's theorem, tensor and spinor fields as representation of Lorentz group, action for spin-0 and spin-1/2, and super-symmetric multiplet, introduction of spin-1, spin-2 and spin-3/2 through appropriate local symmetries of spin-0 and spin-1/2 actions.

PHY F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

PHY G511 Theoretical Physics **5**

Calculus of Variations and its applications to Lagrangian and Hamiltonian Dynamics, Thermodynamics and Geometric Optics and Electrodynamics. Geometric and Group theoretic foundations of Hamiltonian Dynamics, Hamilton-Jacobi Theory, Integrability and Action-Angle Variables, Adiabatic Invariants, Transformation (Lie) Groups and Classical Mechanics. Modern Theory of Phase Transitions and Critical Phenomenon: Thermodynamics and Statistical Mechanics of Phase Transitions, General Properties (eg Scaling, Universality, Critical exponents) and Order of Phase Transitions; Introduction to Landau-Ginzburg (Mean Field Theory) theory for Second Order Phase Transitions, the Ising Model and some Examples, Phase Transitions as a *symmetry-breaking* phenomenon.

PHY G512 Advanced Quantum Field Theory **3 0 3**

Diagrammatics : Feynman diagrams & rules, Loop diagrams, S-matrix, Path integrals, Gauge theories, QED and QCD Lagrangians, Renormalization group, Non-perturbative states.

PHY G513 Classical Electrodynamics **4**

Review of Electrostatics, Magnetostatics, and solution of Boundary Value Problems. Method of Images. Maxwell equations for time dependent fields, Propagation of electromagnetic waves in unbounded media. Waveguides & Cavity Resonators. Absorption, Scattering and Diffraction, Special Relativity, Covariant formulation of Classical Electrodynamics. Dynamics of charged particles in electromagnetic fields. Radiation by moving charges and Cerenkov Radiation.

PHY G514 Quantum Theory and Applications **4**

Mathematics of linear vector spaces, Postulates of Quantum Mechanics, Review of exactly solvable bound state problems, WKB methods, Angular momentum, Spin, Addition of angular momenta, Systems with many degrees of freedom, Perturbation theory, Scattering theory, Dirac equation.

PHY G515 Condensed Matter Physics I **4**

Free electron models, Reciprocal lattice, Electrons in weak periodic potential, Tight-binding method, Semiclassical model of electron dynamics, Theory of conduction in metals, Theory of harmonic crystals, Anharmonic effects, Semiconductors, Diamagnetism and paramagnetism, Superconductivity.

PHY G516 Statistical Physics & Applications **4**

Liouville's theorem, Boltzmann transport equation, H-Theorem; Postulate of statistical Mechanics; Temperature; Entropy; Micro-canonical, Canonical, Grand-canonical ensembles - Derivation, calculation of macroscopic quantities, fluctuations, equivalence of ensembles, Applications, Ideal gases, Gibbs Paradox; Quantum mechanical ensemble theory; Bose-Einstein statistics –derivation, Bose Einstein condensation, applications; Fermi-Dirac Statistics – derivation, applications - Equation of state of ideal Fermi gas, Landau Diamagnetism, etc; Radiation; Maxwell-Boltzmann statistics; Interacting systems – cluster expansion, Ising model in 1-d & 2-d; Liquid Helium, phase transitions and renormalization group.

PHY G517 Topics in Mathematical Physics **4**

Functions of complex variables, special functions, fourier analysis, sturm-Liuoville theory, partial differential equation with examples, Greens functions, Group theory, differential forms, approximation methods in solutions of PDE's, vector valued PDE's.

PHY G521 Nuclear and Particle Physics **5**

Course description for the above course is to be developed.

PHY G531 Selected Topics in Solid State Physics 5

Schrodinger Field Theory (2nd Quantized formalism), Bose and Fermi fields, equivalence with many body quantum mechanics, particles and holes, Single particle Green functions and propagators, Diagrammatic techniques, Application to Fermi systems electrons in a metal, electron-phonon interaction) and Bose systems (superconductivity, superfluidity).

PHY G541 Physics of Semiconductor Devices **5**

Electrons and Phonons in Crystals; Carrier dynamics in semiconductors; Junctions in semiconductors (including metals and insulators); Heterostructures; Quantum wells and Low-dimensional systems; Tunnelling transport; Optoelectronics properties; Electric and magnetic fields; The 2d Electron gas; Semiconductor spintronic devices

M.E. Sanitation Science, Technology and Management

SAN G511 Sanitation Technology **3 2 5**

This course aims to give the participants a review of the fundamentals as well as the latest technological developments applied in the field of sanitation. Urban Drainage and Sewerage, Carbon, nitrogen and phosphorus removal & recovery; sludge treatment, Site evaluation; toilets; onsite sanitation systems; emptying and transport; established and transferring technologies for dewatering, stabilization, pathogen inactivation and nutrient management, urban low cost drainage, Innovation processes, Intro & Exercise technology selection tool / decision support system; discuss outcomes

SAN G512 Sanitation and Public Health **3 2 5**

This course will have four modules – Introduction to Sanitation, Sanitation system and services, Public Health and Analysis of sanitation flow. Background on urban sanitation, Material flow analysis, Monitoring frameworks, Shit Flow Diagrams, Human Health Hazards and Waste, Review and Assessment of Transmission Routes, Review and Assessment of Transmission Routes, Disease Cycles – Lifecycles & Vectors, Control Measures, Risk Evaluation Tools, Urban development trends, demography, Urban sanitation planning & programming

SAN G513 Sanitation Governance, Behaviour Change and Advocacy **5***

This particular course will have two modules – Sanitation Governance and Behaviour change & Advocacy. Water & sanitation governance: definitions, debates, controversies, Power relations among actors in the local and global levels: Gender, class & race relations and power asymmetries, Practices of coordination & decision, making around contested water distribution, Case studies on regulatory frameworks around the world – how is sanitation managed: where, how and why, Everyday sanitation from different perspectives. Behaviour with reference to Societal and cultural aspects, Types: Knowledge, motivations and reactions, Reinforcements: Norms and behaviour Settings

SAN G514 Sanitation Financing and Project Management **5***

This course will have two modules – Sanitation Financing and Project Management. Introduction to financial viability, CAPEX, OPEX, business models and PPP of sanitation project, Calculating CAPEX and OPEX of a sanitation project and developing a business model, Local authority/municipal budgeting and public/government financing, Key aspects of project management including stakeholders' relationship, people management, risk management, budget management, reporting, Objective Oriented Project Planning.

SAN G515 Emergency Sanitation and Leadership **5***

This course will have two modules – Emergency Sanitation and Leadership. The evolution of humanitarian aid: historical events and the humanitarian system as it stands today. Overview of the international legal framework (Refugee law, Inter-

national Humanitarian Law-IHL, International Disaster Relief Law-IDRL), code of conduct and guiding principles of humanitarian action. Standards applied by relief agencies and global cluster, Sphere, WASH cluster. Disaster cycle, risk reduction/ response/ recovery/ development, emergency response phases. Overview of relief organizations, their mandates, their commitments and priorities in emergencies.

Sanskrit

SANS F111 Sanskrit **3 0 3**

Simple pieces of Sanskrit prose and poetry to be used for teaching the basic construction of Sanskrit words and sentences. The course will aim at making the student read elementary Sanskrit like a Subhashita Sloka or a Sloka from Ramayana or Mahabharata and be able to understand it with the help of a dictionary.

Skill Area

SKILL G611 Computer Operation and Software Development I **5**

SKILL G612 Computer Operation and Software Development II **5**

These two courses to be offered in two successive semesters will aim to develop the computer skills for running program packages and writing and developing software programmes for as wide areas as possible. Areas would include both the developmental processes involved in innovative education and of academic and applied research.

The operation of and evaluation in the courses would be done through seminars, group discussions, log books and programme outputs. One component of the evaluation will invariably consist of a lengthy involvement on an intricate task.

SKILL G621 Computer Maintenance I **5**

SKILL G622 Computer Maintenance II **5**

These two courses, to be offered in two successive semesters, will aim to develop the skill for maintenance of computer systems. Through these courses the student would be required to acquire a competence of planned and preventive maintenance, trouble shooting safety procedures etc. If required the student may be asked to undergo part of his training in established computer maintenance organisations. The operation and the evaluation of this course would be achieved through practicals, log books, seminars, quizzes etc. One component of the evaluation will invariably consist of a lengthy involvement on an intricate task.

SKILL G631 Professional Communication I **5**

SKILL G632 Professional Communication II **5**

These two courses, to be offered in two successive semesters, will aim at imparting communicative competence and demand training in the art of teaching and development of subject matter pertaining to the overall goal of the programme. The courses will operate on unstructured basis and would be monitored by a team of teachers identified for the purpose. Professional Communication II will be a project Course and must coterminate with a project report.

SKILL G641 Modern Experimental Methods I **5**

SKILL G642 Modern Experimental Methods II **5**

These two courses to be offered in two successive semesters will impart experimental skills in modern areas of interest to the Institute. Emphasis will be laid on operation and use of sophisticated instruments. The organisation and evaluation of these courses would be achieved through practicals, demonstrations, discussion on significance of results, seminars, quizzes etc. One component of evaluation will invariably be full finding of lengthy assignments. These courses will be conducted by a team of teachers who will incorporate professional competence into experimental method taken up for study.

SKILL G651 Techniques in Development Management I **5**

SKILL G652 Techniques in Development Management II **5**

These two courses, to be offered in two successive semesters, will aim to lead a student into the theory and practice of activities connected with innovation, institutional change and development of teaching and research. Actual cases would be included from BITS. New cases are to be developed. The power of analysis design of models would be the main thread of treatment in these courses. These courses will be operated by a team of teachers. The organisation and evaluation would be achieved through practicals, log books, seminars, quizzes etc. One component shall invariably be a full finding of a lengthy assignment on a particular instrument (Technique) or their use in a larger context of teaching and research.

SKILL G661 Research Methodology I

SKILL G662 Research Methodology II **5**

These two courses, to be offered in two consecutive semesters, are designed to impart training in methodology of research such as analysis of research problems, mathematical and statistical analysis of data, computer simulation methods, experimental techniques etc. The actual contents of these courses will depend upon the needs and research goals of a particular student. A project report has to be submitted by each student at the end of each course.

The organisation and evaluation of these courses would be achieved through seminars, group discussions, project reports etc. The courses will be conducted by a team of teachers.

Note: All the above mentioned Skill courses will be 'Unstructured' in the sense that they would be completely of 'non-lecture, type but would require committed involvement in the concerned professional engagement. Each course is a combination of two course numbers I & II running in two successive semesters where grades would be awarded for the two components separately. While normally a student will be required to take I & II, in rare occasions he may be asked to take

only Course No. I depending on his prior preparation and the ultimate goal to be achieved through the programme. No student can register I and II of the same course concurrently in a semester. Where there is sufficient academic justification to meet the goals of these courses, the Dean Instruction may permit delayed registration in course No. II or in the pair of courses.

Software Systems

SS G511 Design and Analysis of Algorithms **5**

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SS G512 Object Oriented Programming **4**

Basics of object oriented programming: objects, classes, instances; inheritance; polymorphism; operator overloading; static and dynamic binding; small talk, C++, cases from other object oriented languages like Ada, Loop, Flavors, Objective-C, etc.; object oriented software engineering.

SS G513 Network Security **3 1 4**

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, securitystandards, security system interoperation and case studies of the current major security systems.

SS G514 Object Oriented Analysis and Design **2 2 4**

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SS G515 Data Warehousing **3 2 5**

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SS G516 Computer Organization & Software Systems **5**

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

SS G517 Data Structures & Algorithm Analysis **5**

Abstract data types; Linear data structures; Hash functions, Binary and other trees, traversal algorithms; Heaps and balanced trees; Sorting and searching techniques; Divide and conquer, recursion, backtracking, branch and bound; Computational complexity and bounds.

SS G518 Database Design & Applications **5**

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SS G520 Advanced Data Mining **3 1 4**

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SS G521 Fourth Generation Languages and Applications **4**

Nature of 4GLs; application generators; RDBMS and 4GLs; SQL based 4GLs; 4GLs and development of information systems and decision support systems; other types of 4GLs; case studies.

SS G522 Software Development Standards **4**

Standards and their role in software development; Institutions involved in formulating and promoting standards; operating environment standards; POSIX; software design standards; diagramming standards; coding standards; language design, code generation and usage standards; software portability and standards; standards in software development tools; standards in compilers and interpreters; open systems; OSI; user interface standards.

SS G523 Software for Embedded Systems **3 2 5**

Real-time and embedded systems; software issues in embedded system; software development process; requirement analysis: use cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed design; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, test cases. The course will also consist of laboratory practices and development of software for embedded systems.

SS G527 Cloud Computing **5**

Review of Distributed computing - Concurrency, message passing, connectivity and failure models, replication. Computing Infrastructure - Processing Power, Storage aggregation, I/O & Communication, Clusters and Data Centers. Resource modeling and virtualization - CPU virtualization, memory and storage virtualization, virtualized networks. Services - Service models and service contracts; Programming on the cloud. Cloud Applications - Software on the Cloud and Infrastructure Services. Cloud infrastructure - Private vs. Public Clouds, Resource scaling and Resource provisioning. Quality of Service - Performance models, scalability, Performance measurement and enhancement techniques. Security issues - Data/ Storage Security, Resource Access Control, Process Isolation and Control, Service Policies and Privacy Issues.

SS G531 Pervasive Computing **4***

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SS G532 Information Theory **4**

Course description is same as given under BITS G532.

SS G541 User Interfaces **4**

Emerging importance of user interfaces; user interface management systems; designing UIMS toolkits; hardware and OS aids in user interface development; human & psychological factors in user interface design; theories, principles and guidelines; emerging interaction styles; menu selection systems, command languages, direct manipulation; interaction device; hypertext; standards in user interface design and implementation; case studies from Domain Dialog; Apple's user interface; Open Look; OSF/Motif.

SS G542 Knowledge Management **3**

Increasing knowledge work in organizations; technologies to support growth of knowledge work in organizations; scope, cost, efficiency and reliability of technologies to support knowledge work; role of knowledge in an enterprise; knowledge management process; knowledge management strategies; human aspects of knowledge management; knowledge management technologies; applications of technologies to be covered through cases; reading assignments and use of appropriate software.

SS G551 Advanced Compilation Techniques **5**

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

SS G552 Software Testing Methodologies **4**

Concepts and principles of software testing and quality assurance; software testing tools, functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SS G554 Distributed Data Systems **3 2 5**

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques.

Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization.

Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

SS G562 Software Engineering & Management **5**

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SS G624 Computer Based Simulation and Modlling **5**

Discrete event simulation on computers; Systems simulation & simulation languages; GASP & GPSS; Continuous simulation - languages and modelling techniques; Forrester's models; case studies.

SS G641 Management Information and Decision Support Systems **5**

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

SS G651 Project Formulation and Preparation **5**

This course is designed to inculcate principles of technical documentation as required within S&T organizations. Through this course, students are expected to acquire familiarity with several of the following: Proposals, feasibility reports, formal project reports, short reports, memos, negotiations, contracts, etc. In the process principles of project formulation and evaluation, such as technical considerations; performance specifications; preliminary block diagrams, types and analysis of contracts; cost estimation concepts, work breakdown structure; project data preparation, scheduling facilities etc., would be introduced. The course would invariably include the preparation of a detailed report embodying as many of the above concepts as appropriate.

SS G653 Software Architectures **3 2 5**

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.



PART VII

COURSE DESCRIPTIONS (Off-Campus)





AAOC ZC111Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal ES* ZGand student's t-distribution; test of hypothesis; correlation and linear regression.

AAOC ZC221 Graphs and Networks 3

Basic concepts of graphs and digraphs behind electrical communication and other networks behind social, economic and empirical structures; connectivity, reachability and vulnerability; trees, tournaments and matroids; planarity; routing and matching problem; representations; various algorithms; applications.

AAOC ZC222Optimization 3

Optimization of functions of one and many variables with and without constraints; Kuhn-Tucker conditions; gradient methods; linear programming; simplex based and integer programming methods; duality theory; transportation and assignment problems; dynamic programming; branch and bound methods; models of linear production systems, sequencing and scheduling, PERT, CPM.

AE* ZG510 Automotive Control Systems 5

Introduction to vehicle electronics, semiconductor diodes, FETs, rectifiers, small signal amplifiers, circuit models, automotive applications and case studies, automotive micro controllers, auto sensors and actuators, vehicle electronics, feedback control, control strategy, analog and digital controllers, expert systems and neural networks, advanced topics in EMC, vehicle communication networks, automotive control system design, transmission and powertrain, brake, traction, suspension, active safety and supplementary restraint systems, intelligent vehicle systems and ADAS.

AE* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

AE* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

AE* ZG513 Maintenance Engineering 5

Introduction, maintenance systems, methods and tools of maintenance analysis, eligibility and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

AE* ZG514 Advanced Automotive Systems 4

Frame, suspension, springs and wheels, clutch and gear box, propeller shaft, universal joint, final drive, differential and rear axle, front axle and steering mechanism, brakes, automotive air conditioning, electrical vehicles, automotive electrical systems, automotive electronics systems.

AE* ZG515 Non-Destructive Testing 5

Ultrasonic testing, X-radiography, eddy current testing, magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

AE* ZG516 Advances in Internal Combustion Engines 4

Air standard cycles, fuel air cycles, actual cycles and their analysis, fuels, alternative fuels, carburetion, mechanical and electronic injection systems, ignition, combustion and combustion chambers, engine friction and lubrication, heat rejection and cooling, engine emissions and their control, measurements and testing, performance parameters and characteristics, engine electronics, supercharging, two-stroke engines. Power-train auxiliary systems integration, newer engine technologies such as hybrid engines.

AE* ZG517 Automotive Systems Engineering 4

Automotive systems development and testing, compatibility issues, performance prediction,

design requirements and engineering metrics, systems engineering process, life cycle standards and management, concurrent engineering, systems analysis applications, and advanced model based development.

AE* ZG518 Electric and Hybrid Vehicles 4

Electric motors, drives, control, batteries, architectures, energy storage, recovery, and management, characteristics of autonomous vehicles, modelling, simulation, analysis and comparison of relations among multiple parameters for electric, hybrid and autonomous vehicles, insights into regulations and norms with respect to electric, hybrid and autonomous vehicles, hybrid vehicle propulsion systems, sustainable automotive power technology.

AE* ZG519 Automotive Security 4

Security concepts, security attacks and risks, architectures, policy management, mechanisms, understanding the risks and advantages of vehicle to internet (V2I), vehicle to vehicle (V2V), vehicle to IoT (V2IoT) connectivity, issues concerning the security of intelligent transport systems that communicate with the vehicle, telematics, cryptography, security standards, security system interoperation and case studies of the automotive security systems and connectivity technologies, automotive cyber security and autonomous vehicles, connected vehicle driver responsibility, issues around liabilities related to automotive cyber security incidents.

AE* ZG521 World Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee involvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

AE* ZG522 Advanced Vehicle Acoustics 4

Fundamentals of noise sources, transfer paths, principles of noise and vibrations control, assessment and control of engine noise and vibration, road / tyre noise, vehicle body noise and vibration, evaluating the vibration and acoustic characteristics of future vehicle systems.

AE* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

AE* ZG524 Vehicle Dynamics 4

Fundamentals of vehicle dynamics, steering, single and two degree-of-freedom systems, vibration isolation, absorbers, anti- vibration mounts, exhaust mount, tire properties, influence on vehicle dynamics, tire forces/moments & kinematics, modified SAE tire axes & terminology, introduction to tire modeling ,suspension and steering effects , basic tire modeling consideration, brush tire model, steady state lateral/longitudinal slip force generation, interaction between lateral slip and longitudinal slip, transient tire forces, steady state cornering stability analysis, handling diagram, quasi steady state cornering, straight line braking stability analysis, transient cornering dynamic cornering, principles of anti-lock braking system (ABS), steady state cornering of single unit heavy trucks, effect of tandem axles and dual tires, equivalent wheelbase handling diagram of complex vehicles, vehicle parameters and states estimation, road and basic driver models principles, basic powertrain, modeling, brake system modeling, electronic stability control (ESC), vibration mounts, construction and heavy engineering equipment.

AE* ZG531 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

AE* ZG532 Computer Aided Engineering 5

Mathematics and computer implementation methodologies of parametric geometric modeling for computer aided design including modeling of curves, surfaces, solids and NURBS, geometric transformations, concepts of elasticity and material behavior, theories of failure, finite element analysis (FEA) of one-, two- and three-dimensional problems with special emphasis on the application areas of noise and noise, vibration and harshness (NVH), durability, crash, occupant safety, computational fluid dynamics (CFD) and heat transfer, FEA of mechanical vibrations and

fracture. In all implementation work and assignments, suitable commercial CAE software packages such as ABAQUS is required to be used.

AE* ZG535 Advanced Engineering Mathematics 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

AE* ZG542 Just-in-time Manufacturing 4

Introduction; Toyota production system; JIT implementation surveys; Design, development and implementation of JIT manufacturing systems; Supply management for JIT; Framework for implementation of JIT; Theoretical research in JIT systems; Various case studies.

AE* ZG611 Computational Fluid Dynamics and Heat Transfer 4

Integral and differential conservation laws for mass, momentum, and energy, solution of Navier-Stokes equations, theory of potential flow, boundary layer theory, hydrodynamic stability turbulent flow, compressible flow quasi-one-dimensional nozzle flows numerical solution of a two-dimensional supersonic flow, incompressible Couette flow. supersonic flow over a flat plate, experimental techniques and uncertainty analysis, integral and differential forms of energy conservation law for heat transfer, heat transfer in internal laminar and turbulent flow, heat transfer in external laminar and turbulent flow, natural convection heat transfer, mixed convection heat transfer, convective heat transfer in porous media flow, condensation, evaporation, and boiling. radiation heat transfers in non-participating and participating media. radiation transport equation, heat transfer of engine cooling, exhaust manifold and HVAC for automobiles, computational analysis of fluid flow, heat transfer and multi-phase flow problems with special emphasis on problems relevant to automotive applications.

AE* ZG612 Advances in Materials, Composites & Plastics 4

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fiber reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibers, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fibre reinforcement and production technology of composites. Plastics and their processing technology including injection moulding, blow moulding etc. Mathematical modeling and simple computational techniques for the mechanics of composites and plastics. Applications of plastics and composite in automotive and aerospace structures. Advanced metals and alloys including titanium, aluminum and magnesium, Ceramic and metal alloys (CERMETS) including Aluminum based alloys and other ceramic components.

AE* ZG613 Tribology 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

AE* ZG614 Fracture Mechanics 5

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

AE* ZG615 Advanced Engine Technology 5

Engine Design & Development: Design and development of various engine components viz. cylinder block, head, combustion chamber, pistons, crank shaft, connecting rod, cam shaft, valves, intake and exhaust systems, fuel supply systems, Engine balance and vibration; Engine Combustion: Process, analysis and diagnostics; Engine Emissions & Controls: Analysis of gas emissions and control; Alternate Fuels: Alternative Fuels for Land, Rail, Marine and Aviation Transportation, Utilization of Alternative Fuels in Internal Combustion Engines; Engine Testing & Certification: Test facilities and methods, Instrumentation, Engine tests and quality standards; Vehicle Component Testing: Test facilities and methods for interior and exterior parts of an automotive vehicle.

AE* ZG621 Durability, Crash and Safety Engineering 4

Classical failure theory ,creep, fatigue, buckling, low and high cycle fatigue test, crack initiation and fracture mechanics, Effect of surface and metallurgical parameters on fatigue, EN-SN curves, plasticity corrections, Road load acquisition methods/instruments, Proving ground events & duty cycle preparation accordance with vehicle GVW, Joint Design, bolt slippage & torque relaxation methods in FEM. Durability of plastics - material failure criteria, Rattle & squeeze issues in automotive trims, IP panels. Optimization techniques/algorithms - Influence of space, size, weight etc., on form design, aesthetic and ergonomic considerations, Fundamentals of Crash Analysis, Transient Dynamic solutions, Lagarangian and Eulerian codes of solution, explicit and implicit methods of solving crash problems, crash worthiness, Contact theory and algorithms, Quasi-static and dynamic events for crash analysis, time-step computation and mass scaling of models, different element types, formulations and application, Material representations for Crash analysis, Human modeling and biomechanics, Human injuries and remedies, Impact sensor, types and developments, Active and Passive safety, Regulations for Automotive safety, Crash Worthiness Ratings, Model building and integration, Quasi-static load cases – Roof Strength, side door intrusion, Seating load cases, Internal head impacts, Whiplash, Airbag – types, modeling and applications.

AE* ZG622 Advanced Manufacturing Processes 4

High strength material forming, tooling for high strength materials, Cold and hot stamping, hydro forming, vacuum forming, high speed stamping, Aluminum forming & tooling technology including progressive and transfer dies for sheet metal forming, Advanced Automotive BIW assembly/welding technology, laser welding technology, robotic hemming. Tooling for lightweight composites, Carbon fibre moulds & advanced plastic moulding technology, High speed machining, precision machining technology, Resistance welding. Aluminum part manufacturing technique including die casting, tailor-made blanking etc. Mathematical modelling and analytical and numerical computations for sheet metal forming processes using Auto Form. Newer sheet metal forming techniques.

AE* ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

AE* ZG633 Advances in Vehicle Body Structures 4

Light Weight design of Vehicle Structure i.e. Front-End, Under Body etc; Materials Selection in Automotive Design; Material Matching and gauge Optimization; Lightweight Automotive Alloys; Mechanical Behaviour of Structural Polymers; Designing and Manufacturing with Lightweight Automotive Materials; Design and Manufacturing for Environment – Light Weight material perspective; Vehicle Crashworthiness - Light Weight material perspective; Advanced Light Weight Steels for Automobiles; Fuel Cell Materials and Manufacturing; Automotive Assembly Processes - Light Weight material perspective; Analysis of Lightweight Automotive Structures; Light Weight Power-train Materials and Design; Environmental Degradation of Materials - Light Weight material perspective; Application of Hybrid material and Joining methods.

AEL* ZC441 Automotive Vehicles 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

AEL* ZC442 Advanced Driver Assistance Systems 4

Automotive safety systems, assist and autonomous systems, automotive sensors and actuators for ADAS (stereo and mono cameras ultrasonic sensors, LIDAR, RADAR), fundamentals of machine vision, data fusion for ADAS,

mechatronics for ADAS, human – machine interface for ADAS, telematics and infotainment, ADAS system, legal and ethical aspects of ADAS, real time systems and development, advanced driver assistance systems, advanced computer systems, automated driving applications and systems.

AEL* ZC443 Connected Cars 4

Fundamentals of IOT - Architecture, Sensors, Cloud and the trade-off between polling and storage requirements, Structure and implementation of CAN networks, CAN message, priority & arbitration and the control hardware involved in the network, data analytics by creating a simple data model using OBD tools, ethical and legal aspects of connected car applications including data theft, privacy and security vulnerabilities, building of predictive analytic model based on in-vehicle data.

AEL* ZG510 Automotive Control Systems 5

Introduction to vehicle electronics, semiconductor diodes, FETs, rectifiers, small signal amplifiers, circuit models, automotive applications and case studies, automotive micro controllers, auto sensors and actuators, vehicle electronics, feedback control, control strategy, analog and digital controllers, expert systems and neural networks, advanced topics in EMC, vehicle communication networks, automotive control system design, transmission and powertrain, brake, traction, suspension, active safety and supplementary restraint systems, intelligent vehicle systems and ADAS.

AEL* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

AEL* ZG513 Automotive Communication Systems 5

Introduction to communication engineering; automotive communication systems: basic, current and future generation automotive communication protocols and telematics, advanced communication, intersystem communication and multiplex systems, wireless and photonics systems engineering, communications and networking, signal propagation in a mobile environment, modulation, coding, equalization, multiple access techniques, spread spectrum systems, second and third generation systems, UMTS, IMT-2000; Intra Vehicular Buses - CAN, TTCAN, FTTCAN, RT and FT Ethernet, TTP/A, TTP/C, Flexray, LIN, MOST; Clock Synchronization and Diagnostic Services in Intra Vehicular Buses.

AEL* ZG514 Robust and Intelligent Systems Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects, intelligent transport systems, neural networks and fuzzy logic, reconfigurable hardware system design, energy aware computing systems.

AEL* ZG517 Automotive Systems Engineering 4

Automotive systems development and testing, compatibility issues, performance prediction, design requirements and engineering metrics, systems engineering process, life cycle standards and management, concurrent engineering, systems analysis applications, and advanced model based development.

AEL* ZG518 Electric and Hybrid vehicles 4

Electric motors, drives, control, batteries, architectures, energy storage, recovery, and management, characteristics of autonomous vehicles, modelling, simulation, analysis and comparison of relations among multiple parameters for electric, hybrid and autonomous vehicles, insights into regulations and norms with respect to electric, hybrid and autonomous vehicles, hybrid vehicle propulsion systems, sustainable automotive power technology.

AEL* ZG519 Automotive Security 4

Security concepts, security attacks and risks, architectures, policy management, mechanisms, understanding the risks and advantages of vehicle to internet (V2I), vehicle to vehicle (V2V), vehicle to IoT (V2IoT) connectivity, issues concerning the security of intelligent transport systems that communicate with the vehicle, telematics, cryptography, security standards, security system interoperation and case studies of the automotive security systems and connectivity technologies, automotive cyber security and autonomous vehicles, connected vehicle driver responsibility, issues around liabilities related to automotive cyber security incidents.

AEL* ZG531 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications,

Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

AEL* ZG533 Autotronics 5

Fundamentals of automotive EMC, control concepts, control design with the help of sensors and signal conditioning. Understanding of autotronics and vehicle intelligence, sensor technologies, intelligent systems and mechatronic modelling. Introduction, electricity and electronic fundamentals, sensors, sensor types, signal conditioning, system modelling, dynamic response of systems, feedback/closed loop controllers, electronic fuel control systems, actuators: fuel injectors, exhaust gas recirculation, motors and ignition systems, hydraulics.

AEL* ZG534 Automotive Networking 4

Overview of TCP/IP systems, Disturbed and Networked Embedded systems, Embedded Internet, Real Time Networks and Fault Tolerant Networks – Issues and Design, Intelligent Transport Systems and IoT for Automotive Systems; Fault and Error Containment, Intra and Interworking in Vehicular Systems: Intra Vehicular Buses - an overview, Time Triggered and Event Triggered Networks in Intra Vehicular Systems, Automotive Network Domains – Power Train, Chassis, Body Domains – Network Characteristics and Domain Requirements, V2I/V2R, V2V , VANETS - MANETS vs VANETS, Safety Applications vs Comfort Applications of VANETS, Network Architecture, Protocols, Network Stack, MAC protocols, IEEE Wave and DSRC, Routing Protocols, Network Security – Attacks and Solutions. Emerging and advanced automotive networks – Aerial Networks; Interconnection between various networks in ITS – Interconnection between Intra and Inter Vehicular Systems, Network Models in Automotive Systems – Publisher Subscriber Model, Producer Consumer Models, Device Interoperability Issues in Interconnected Vehicles, Middleware in Automotive Systems, Network Management Function, Objects and Device Management - AutoSar and Networked OS; Protocol-independent design methodology for distributed real-time networks in vehicles – Volcano.

AEL* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation; Systolic Architectures.

AEL* ZG557 Artificial and Computational Intelligence 5

Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Backpropagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

AEL* ZG621 Safety Critical Advanced Automotive Systems 4

Functional safety, safety in electrical engineering, architecture / design practices for safety critical systems, ISO 26262: Road vehicles – functional safety, IEC 1508 standards; Methodology of certification and qualification for IEC 1508, modelling real time systems (UML-RT, and the tools), reliable, common system bus – VME, ASCB, safeBus, multiBus II etc. Real time and

safety standard and certifications, FPGA and ASIC based design, low-power techniques in RT embedded systems on-chip networking; Hardware software partitioning and scheduling, co-simulation, synthesis and verifications, architecture mapping, HW-SW interfaces.

AEL* ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

AEL* ZG631 Automotive Diagnostics and Interfaces 5

Sensors used in today's vehicles, such as temperature, pressure, position, distance, velocity, torque and flow; Designing and building analogue interfaces, regulation and control problem with reference to power electronic converters; converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models, On board diagnostics II (OBD II); Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications; Control design based on linearization: transfer functions, compensation and filtering, compensated feedback control systems; Hysteresis control basics, and application to DC-DC converters and inverters; Automotive diagnostics, electronic interfaces, sensors and interfacing, introduction to microsystems packaging, microcomputer control systems, reliability, diagnostics, and testing of vehicles.

AEL* ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

BA* ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

BA* ZC412 Models and Applications in Operations Research 4

This course provides a survey of selected topics in operations research (OR). Emphasis is placed on the practical application of OR tools rather than on the mathematical properties. Application areas include: financial planning and portfolio selection, production, priority planning and marketing. Topics include linear programming and its applications; programming to achieve a set of goals or targets with applications in finance and production; capital budgeting and project selection; transportation and network models; and portfolio models.

BA* ZC413 Introduction to Statistical Methods 3

Different types of data; Data Visualization; Data summarization methods; Tables, Graphs, Charts, Histograms, Frequency distributions, Relative frequency measures of central tendency and dispersion; Box Plot; Chebychev's Inequality on relationship between the mean and the standard deviation of a probability distribution. Basic probability concepts, Conditional probability, Bayes Theorem, Probability distributions, Continuous and discrete distributions, Transformation of random variables, Moments, Correlation and Covariance, Parameter Estimation, Hypothesis Testing.

BA* ZC414 Optimization Methods for Analytics 4

This course will focus on development of analytical models using optimization (and simulation) techniques to analyze and recommend appropriate solutions for complex business problems across various functional areas including finance, economics, operations, and marketing. Key topics covered in this course are as follows: solving various problems related to planning, production, transportation, microeconomics, etc. using LP models. Decision making in the context of multi stage LP models. Application of Goal Programming (GP) and Analytic Hierarchy Process (AHP) for

decisions relating to large teams and complex problems with long term implications. We will use various tools including spreadsheets and other software for the experiential components of this course to illustrate the application of these techniques to various industries.

BA* ZC415 Analytics for Competitive Advantage 4

In today's competitive business environment, high performing companies are doing more than just collecting data, storing it and generating reports. They are developing competitive strategies using Business Analytics. In this course we will look at how to use data-driven insights to differentiate a firm's business/ product strategy from other companies that are making the same product or delivering the same service. This course is designed for analysts in any function: marketing, operations, quality, customer service, IT, finance/accounting or human resources. We will use case studies and other experiential components to study the application of data-driven insights in the context of various industries.

BA* ZC416 Investment Banking Analytics 4

Modern portfolio theory, Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), and efficient market theory; Passive investing: indexing; Introduction to behavioral finance; Active investing: security analysis – fundamental analysis (strategic, financial, marketing tools) and technical analysis; Portfolio management including allocation, rebalancing and risk management; Transaction cost analysis; Fixed-Income and Credit Sensitive Instruments.

BA* ZC417 Financial Risk Analytics 4

The course will first cover the basics of Financial Risk and then focus on applications such as: currency, interest rate derivatives, equity markets and products, and commodity markets and products. Major topics include methodologies for measuring and analyzing volatility (a key metric of risk) including EWMA, ARCH & GARCH processes, volatility clusters and the issue of time varying volatility; Extreme value theory; Measuring risk using Value-at-Risk, including computation of VaR by various methods, and stress testing; Monte Carlo simulation, address issues in generating price process (such as Brownian Motion, Ito Process), Cholesky decomposition in computing multi-asset VaR; Currency risk analysis in global investing, interest rate parity (covered and uncovered); Value at risk for fixed income portfolios; Credit Risk Analytics. The topics covered in this course will have inbuilt case studies in financial risk management so as to understand the practical implications of the methodologies covered in the course.

BA* ZC418 Advanced Financial Modeling 4

Valuation of equity securities, fixed income securities, and derivatives. Topics include Introduction to Financial Modelling and Spreadsheet Essentials, Measuring Risk (Testing market efficiency with regression analysis & pivot tables), Portfolio optimization (Mean-variance portfolio selection, Bond portfolio selection, Term structure estimation, Capital budgeting), Advanced risk analysis (Monte-Carlo simulation, Risk analysis of discounted cash flow models, Spreadsheet features using @Risk for Monte-Carlo simulation and combining macros with @Risk), Business and equity valuation modeling , LBO Analysis Model , Stock Merger Model, etc.

BA* ZC420 Data Visualization 3

Information overload and issues in decision making. Design of visual encoding schemes to improve comprehension of data and their use in decision making; presentation and visualization of data for effective communication. elementary graphics programming, charts, graphs, animations, user interactivity, hierarchical layouts, and techniques for visualization of high dimensional data & discovered patterns.

BA* ZC421 Marketing Models 4

The primary purpose of this course is to enhance your ability to develop and critically evaluate marketing models. The course will examine a variety of models, including models of consumer behavior, industrial buying and firm behavior, (aggregate) market models (e.g., competition, market entry), strategic marketing models, forecasting methods, new product models, marketing response models (e.g., channels, pricing, advertising, promotion), forecasting models and decision support systems.

BA* ZC422 Marketing Analytics 4

This course discusses in detail how analytics can play a vital role in the various elements of the marketing research process viz. Problem Definition, Development of an approach to the problem, Research Design formulation, Fieldwork or Data collection, Data preparation & Analysis and finally Report preparation and Presentation. The emphasis of the course is proportionately focused

on Concepts, Techniques & Methodology, and Marketing Research Applications.

BA* ZC423 Retail Analytics 4

RFM (recency, frequency, monetary) analysis, chum modeling, retention modeling, shopper analytics, market basket association analysis, customer segmentation and profiling, propensity scoring models to identify prospective customers, best customers, lifetime value modeling, marketing campaign response modeling, cross sell modeling, etc.

BA* ZC424 Supply Chain Analytics 4

Demand Management and Forecasting: static, adaptive and rolling plans. Supply chain Network design: Mathematical Programming Models for Selecting the right number, location, territory, and size of warehouses, plants, and production lines; and optimizing the flow of all products through the supply chain. Space Determination and Layout Methods. Inventory Management: Inventory aggregation Models, Dynamic Lot sizing Methods, Multi-Echelon Inventory models. Transportation Network Models and scheduling algorithms: Efficient and responsive supply chains. Maximal Flow Problems, Multistage Transshipment. Supply chain dynamics and integration: Cost analysis of supplier selection, order fulfillment process, levers for improved supply chain performance, pricing and revenue management and coordination in supply chain. Application of Analytic Hierarchy Process (AHP) to supply chain analytics.

BA* ZC425 HR Analytics 4

In this course students will learn how to leverage analytic techniques in the context of the challenges faced by the HR and Talent Acquisition and Management functions. The primary goal is to leverage analytical techniques to deliver meaningful insights for effectively managing employees for achieving the goals of the organization. Applications include attracting right talent, forecasting future staffing needs, managing attrition and improving employee satisfaction levels. We will be extensively leveraging experiential components such as case studies to understand how various organizations have applied these concepts in practice.

BA* ZC426 Real-time Analytics 4

Motivation and challenges of real-time, distributed, fault-tolerant data processing, distributed messaging architecture (Apache Kafka), Real time data processing platform: Storm, Storm basic programming skills, linking Spouts, and connecting to the live Twitter API to process real-time tweets, multi-language capability of storm (with Python scripts), Case study: Networking fault prediction. This course also helps a student to analyze and understand Big-data using visuals. Topics include, Design principles, Perception, color, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.

BA* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

BA* ZG512 Predictive Analytics 4

Basic concepts in predictive analytics / predictive modeling. Two core paradigms for predictive modeling: classification and regression. Identification of important variables and their relation to each another. Basic modeling techniques such as k-nearest neighbors, classification and regression trees (CART), and Bayesian classifiers. Ensemble techniques. Model selection techniques.

BA* ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

BA* ZG522 Business Data Mining 4

Principles and current practices of data mining; data analytics tools and applications; acquiring and cleaning data, role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of

data mining in KDD; algorithms for classification, association rules, and clustering; Time series analysis.

BA* ZG523 Introduction to Data Science 3

Context and use of Data Science. High-dimensional data, graphs, vectors in high dimensional space and large matrices; Algorithms for massive data problems, sampling techniques. Techniques for extracting information/patterns from data.

BA* ZG524 Advanced Statistical Methods 4

Point and interval estimation and hypothesis testing, chi-square tests, non- parametric statistics, analysis of variance, regression; linear and multiple linear, correlation, factor models, decision theory, Bayesian statistics and autocorrelation, multivariate regression, randomization and sampling processes, Markov processes with discrete/continuous state space, statistical simulation and pattern recognition, Time Series Analysis.

BA* ZG525 Big Data Analytics 4

Big Data and its applications in various domains such as banking and finance, social media, e-commerce, and healthcare. Five V's of big data, namely Volume, Variety, Velocity, Veracity, and Value. Analysis of structured and unstructured data in various forms, including web logs, videos, e-mails, photographs, tweets etc. Uncovering hidden patterns and unknown correlations for better business decisions. Key technologies used in storing, manipulating, and analyzing big data. Tools for statistical analysis and key methods used in machine learning as applied to Big Data. Distributed computing techniques used in Big Data Analytics. Open source frameworks for data analysis including tools, languages, and platforms such as Hadoop, Pig, Hive, R, Spark, Mahout Etc.

BA* ZG537 Text Analytics 4

Emerging methods of organizing, summarizing, and analyzing collections of unstructured and lightly-structured text. Basics of text processing and natural language processing. Applications of text analysis such as sentiment analysis and opinion mining. Text processing techniques stop word removal, text parsing, and other relevant tree processing steps; text preprocessing, feature selection, text classification, text clustering, and summarization. Natural language processing techniques/steps – Syntactic Analysis, Semantic analysis, and Pragmatic analysis. Case studies with focus on business processes.

BA* ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

BITS ZC411 Object Oriented Programming 3

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism; classes and objects; static and dynamic binding; class utilities; meta classes; object oriented software engineering; programming and problem solving using one or more of the popular object-oriented programming languages like C++ or Java.

BITS ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

BITS ZC424T Project Work 10

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project. At the beginning of the semester, the student should select an area of work that is considered vital to the

sponsoring organization, and prepare a detailed project outline, in consultation with his/her Mentor. The student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, and taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar and viva-voce.

BITS ZC461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BITS ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

BITS ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

BITS ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

BITS ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

BITS ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

BITS ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

BITS ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

BSDC* ZC151 - Writing Practice 3

The course aims to develop students' writing ability. It is assumed that students who will be part of this course have not received explicit and extensive training in academic writing. Therefore, the course begins with paragraph writing and goes on to cover areas such as elements of writing, language issues and vocabulary related to writing and ends with different models of writing. Effort has been made to provide students with a comprehensive background in writing so that they can write their assignments, examinations, letters, reports and essays more effectively.

BSDC* ZC236 - Symbolic Logic

3A brief historical survey of the development of logic; nature and kinds of arguments; sentential connectives; symbolization of statements and arguments; truth tables, establishing validity of arguments by truth tables and different types of proofs, quantified statements; quantified arguments and their validity.

BSDC* ZC225 – Environmental Studies 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, overview of natural resources, environmental pollution, social issues and the environment, and environmental impact assessment.

BSDC* ZC226 – Creative Thinking 3

Creative thinking & its importance, Process of creative thinking, Road blocks to creative thinking, Developing creative thinking, Brainstorming, Bloom's Taxanomy, Assessment of creative thinking, Conceptual framework for Critical thinking, Aspects of critical thinking, Stages of critical thinking; Reasoning: Fountain head of critical thinking, Need & benefit of critical thinking, Critical thinking in decision making, Developing critical thinking in classroom, Assessment of critical thinking skills.

BSDC* ZC111 – Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal ES* ZGand student's t-distribution; test of hypothesis; correlation and linear regression.

BSDC* ZC112 – Electrical Sciences 3

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors. Introduction to operational amplifiers and applications. Introduction to Digital Electronics.

BSDC* ZC142 – Computer Programming 4

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

BSDC* ZC222 – Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

BSDC* ZC242 – Cultural Studies 3

Introduction to Cultural studies, Importance of cultural studies, types of cultural studies, relation to Critical theory, relation to Literary Criticism. Introduction to theories such as Communication studies, Film studies, Feminist theory, Art history/Criticism, Societal impact, business relevance, introduction to myriad practices,

institutions, beliefs and varied social structures within a given culture.

BSDC* ZC215 – Digital Design 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

BSDC* ZC356 - Data Structures 4

Elementary data structures; Linked lists, stacks, queues; Searching and Sorting. A selection of sorting algorithms and their usage and context; Non-linear data structures: Trees, binary trees, and heaps – applications, construction and operations, traversals, implementation techniques. Dictionaries - Hash tables, Binary Search Trees, and Balanced Binary Search Trees; Introduction to analysis of algorithms and complexity.

BSDC* ZC234 – Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

BSDC* ZC312 - Evolution of Design 3

Intellectual nature of design - two thousand years of design - three forms in which the design appears -mechanism, structure and systems – energy and design-materials and design- the aesthetic basis of design- evolution and design- economy, form and beauty- production and design in nature-The relation between manufacturing and design- verbal and visual thoughts-some aids to design- evolution of design in decorative arts. [*Design as an activity will be an integral part of teaching and learning as well as evaluation for this course.*]

BSDC* ZC353 – Computer Organization and Architecture 4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

BSDC* ZC313 – Object Oriented Programming and Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

BSDC* ZC328 – Humanities and Design 3

Ideas and Designs, Thinking about New Designs, Perspectives to Design: Historical, Social, Technical and Creative Dimensions; Engineering Design and Problem Solving; Basic Concepts in Engineering Design; Design Skills, Abstraction, Identification of Patterns in Processes and Products, Application of Systematic Techniques to Problem Solving, Application and Adaptation of tools and technologies to new problems; Core Principles of Design; Elements of Design, Form and Functionality, Central Activity of Engineering Designs; Language and Interface Design, Design Thinking: Influence of Context Vs. Conflict with Context.

BSDC* ZC231 – Dynamics of Social Change 3

Nature of society, social institutions; concept and nature of socio-cultural change, obstacles, rate and direction of change; factors of social change-ideological, economic, technological and political demographies; agencies of social change-education, leadership, propaganda, legislative reforms; five-year plans and social change, peasant and land reform, bhoodan and gramdan; changing pattern of family, marriage, caste and religion.

BSDC* ZC317 - Algorithm Design 3

Effective construction and analysis of algorithms. Understanding, application, and implementation of algorithm design techniques like divide-and-conquer, greedy, dynamic programming, and back-tracking. Worst case and average case analysis of algorithms. Basic notions of complexity classes – P, NP, and NP-complete and Reduction.

BSDC* ZC365 – Human Computer Interaction 3

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

BSDC* ZC322 – Critical Analysis of Literature and Cinema 3

Creativity and Aesthetics; An overview of Major Movements in Literature and Cinema; Interpretation of Selected Works; Cinema & Art; Understanding Drama: Theme, Character, Plot, form; Understanding Poetry: Diction, Imagery, Symbolism, Structure and Form, Personification, Apostrophe, Sound and Rhythm; Understanding fiction: Setting, Point of View, Plot and Character; Understanding Short Fiction: Meaning and message, Style and Coherence; Understanding Cinema: Plot; Character; Screenplay; Linguistic, Social, Musical codes; Cinematic Codes; Camera Work.

BSDC* ZC412 - Software Design Principles 4

Software Development lifecycle; Role of high level and low level design in lifecycle. Object-Oriented Abstraction and Object Oriented Design. Design for Reuse and Design for Change – Refactoring. Design Patterns - History of Patterns in Building Architecture and Relevance to Software Design, Evolution of Software Design Patterns and Impact of Using Design Patterns in Lifecycle. Crosscutting Concerns and Aspects – Aspect Oriented Design. High-level design vs. Low-level design. Basic Architectural Elements and Styles – Layered Architectures and Event-Driven Architectures, MVC architecture in User Interfaces.

BSDC* ZC316 - Computing and Design 3

Design Principles - Separation of Concerns, Abstraction, and Modularity. Application of these principles in the design of Computers. Hardware and Components - Modularity. Instruction Set Architecture - Abstraction and Modularity. Computing Systems - Hardware, Operating Systems, and Communication. Highlights of Operating System Design: Abstraction and Interfaces in Operating Systems - Processes, System Calls; Modularity in Operating Systems - Kernels vs. external modules such as device drivers. Abstraction in Programming: Data Abstraction and Control Abstraction. Modularity and Reuse in Programming. Design Principle - Virtualization. Virtualization at the Architecture and OS level. Virtualization in Software.

BSDC* ZC344 - Professional Ethics 3

Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.

BSDC* ZC351 - Organizational Behaviour 3

Course Description same as SE* ZC351

BSDC* ZC211 - Principles of Economics 3

Nature and scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behaviour and of the firm: linear economic models; market structures; social accounting and basic elements of economic planning.

BSDC* ZC330 - Appreciation of Art 3

Visual perception and basic techniques used in art, compositional balance, space, movement form, light colour, texture, tensions, expressions lines; mainstreams of art; influence of Indian art abroad; various schools of art-Greecian, Medieval, Christian Renaissance, Baroque and Romanticism, impressionism and post impressionism, fauvism, futurism, expressionism, Dadaism and surrealism, metaphysical art, non-representational and abstract art; analysis of work of art and their evaluation.

BSDC* ZC350 - Human Rights: History, Theory and Practice 3

The meaning and history of human rights; Human rights debates and controversies; Political, civil, social and economic rights; Culture and human rights; Themes - Democracy, dictatorship, and human rights; Science, technology, and human rights; Ethnicity; Gender; Children's rights and others;Evaluating the progress made and challenges in practice of human rights.

BSDC* ZC352 - Advanced Writing Course 3

This course includes components related to development of creative content and writing skills required for professional communication and documentation purposes. In addition, the course also tries to enable students to become independent and effective writers by exposing them to citation and referencing conventions, document formatting, use of web platforms for writing, international laws related to plagiarism, etc.

BSDC* ZC214 - Science, Technology and Modernity 3

Interrelationship between science, technology and modern society; forms in which beliefs and values of a modern society shape sciences and technologies; forms in which scientific discoveries and technological developments influence and shape modern societies. Scientific Revolution and the emergence of modernity as a social condition; Enlightenment promise of progress within the economic system of capitalism. Some critiques of the received view; recent phase of capitalism and the role of technology in globalization.

BSDC* ZC354 - Introduction to Architecture 3

Course Description to be developed

BSDC* ZC342 - Computer Mediated Communication 3

Course Description to be developed

BSDC* ZC432 - Applied Statistical Methods 3

Course Description to be developed

BSDC* ZC364 - Operating Systems 3

C Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

BSDC* ZC481 - Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

BSDC* ZC315 - Web Programming 3

Technologies related to web development and associated technologies that make the web work. Scripting languages like HTML, CSS and JavaScript; Design of dynamic websites; on both client-side and server-side scripting technologies; full-stack web development. Design and development of web applications, web applications that could query database and fetch information over the network; development and testing of web applications.

BSDC* ZC413 - Database Design 4

Introduction to database systems; DBMS Three-schema architecture; Conceptual data modelling-ER modelling and Extended ER modelling and use of UML in modelling databases; Relational query languages- Relational algebra and SQL; Database design- functional dependencies, normalization, normal forms and decomposition; Query processing and Optimization; Database tuning; Introduction to - Indexing, Transaction processing, Concurrency control and Recovery.

BSDC* ZC314 - Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

BSDC* ZC343 - Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BSDC* ZC327 - Systems Programming 3

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming;

multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific Programming including shell-scripting via online laboratory facility.

BSDC* ZC329 Design for Social Media 3

Course Description to be developed

BSDC* ZC229T - Design Project 5

Operate, maintain, design and develop software in innovative areas and activities of the industry; the student's actual day-to-day task involvement would constitute the central thread of the learning process. The evaluation will recognize this aspect by demanding day-to-day engagement and productivity of the student.

BSDC* ZC499T - Capstone Project 15

Real life problems encompassing computing and design problems/requirements obtained from organizations/third party vendors; Jointly mentored by the industry experts and faculty; Presentation of the progress and results in appropriate forms; Periodic review of progress of the project.

CBDA ZG511 The Hadoop Framework 1

Distributed computing environments for Big Data; Distributed storage and processing of Big Data using the MapReduce programming model; High-level programming for the environment.

CBDA ZG521 ETL & Batch Processing with Hadoop 2

Fundamentals of Data Warehousing and ETL, ETL vs. ELT, Data Lakes; Data Ingestion – Data Ingestion for structured and unstructured data, Data ingestion in the context of distributed and map-reduce execution platforms; Event processing – flows, tools and technologies for event processing, complex event processing applications; Workflow Management - workflow specifications and processing, tools, and interfaces with distributed platforms.

CBDA ZG531 Big Data Analytics using Spark 3

Introduction to Streaming Data – characteristics and sources, Processing of Streaming Data – components and architecture of a typical real-time / streaming processing system; Analytics Tasks – Regression, Classification, and Clustering; Tools and Platforms for implementing Analytics Tasks; Regression – definition, use-case and example, using a tool to implement regression; Classification – definition and use-cases; representing classes using a tree; Overcoming tree limitations with Random Forest; using a tool to implement a classifier; Clustering – definition and use-cases, notion of similarity, k-means clustering and hierarchical clustering, using a tool to implement a clustering solution; Case studies of Analytics.

CBDA ZG541 Capstone Project 2

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project that demonstrates application of knowledge and skills acquired through the program. This is an unstructured open-ended course where under the supervision of a mentor, the student will carry out the project and must submit a project report and an artifact (such as a design, system, or software) as a culmination of his / her endeavor and investigation.

CBDE ZG511 Foundations of Big Data Systems 2

Understanding Big Data – Big Data Sources and Applications, Characteristics, Processing Requirements and Constraints; Structured and Unstructured Data. Storing and Exchanging Big Data – Review of Data Structure Design, Data Structures for exchanging large volumes of data, Search trees and Queries including range search. Algorithm Design for Big Data – Review of Divide-and-Conquer, Design of Distributed Algorithms using Divide-and-Conquer, Select Design Patterns for Distributed Algorithms including Map and Reduce.

CBDE ZG521 Platforms for Big Data 2

Distributed Computing Environments for Big Data – Clusters and Map-Reduce Execution, In-memory vs. Persistent Data Stores, Distributed File Systems for Map-Reduce based processing, NoSQL databases, and high- level programming using parallel data flows. Programming environment and constructs for distributed in-memory processing. Data Store on the Cloud - introduction to Cloud as a platform for storage and execution, concept of virtualization and its usage in the context of deploying storage and applications on the cloud, simple object store and databases on cloud.

CBDE ZG531 Processing Big Data - ETL & Batch Processing 2

Data Warehousing – fundamentals of Data Warehousing and ETL, ETL vs. ELT, Data Lakes, Batch Processing. Data Ingestion – Data Ingestion

for structured and unstructured data, Data ingestion in the context of distributed and map-reduce execution platforms. Event processing – flows, tools and technologies for event processing, complex event processing applications. Workflow Management - workflow specifications and processing, tools, and interfaces with distributed platforms. Batch processing on the Cloud – elastic processing and models.

CBDE ZG541 Processing of Real-Time Data and Streaming Data 1

Introduction to Streaming Data – characteristics and sources. Processing of Streaming Data – components and architecture of a typical real-time / streaming processing system. Stream Processing – sourcing and modeling, abstractions, platforms, and programming interfaces used for processing streams, windowing / micro-batching techniques. Case studies and applications.

CBDE ZG551 Big Data Analytics 1

Analytics Tasks and Cases – Regression, Classification, and Clustering. Tools and Platforms for implementing Analytics Tasks. Regression – definition, use-case and example, using a tool to implement a solution based on regression, visualizing and interpreting the results. Classification – definition and use-cases; classifier models - line, curve, and plane separating classes; representing classes using a tree; probabilistic representation of classes; classifier performance; using a tool to implement a classifier; visualizing results. Clustering – definition and use-cases, notion of similarity, unsupervised grouping, k-means clustering and deciding k, using a tool to implement a clustering solution, visualizing and interpreting results. Case studies of Analytics.

CBDE ZG571 Capstone Project 3

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project that demonstrates application of knowledge and skills acquired through the program. This is an unstructured open-ended course where under the supervision of a mentor, the student will carry out the project and must submit a project report and an artifact (such as a design, system, or software) as a culmination of his / her endeavor and investigation

CGM* ZC411 Marketing 3

Definition and scope, fundamentals of consumer behaviour, competitive behaviour, demand estimation, new product introduction, channels of distribution, advertising and other sales promotion, positioning, marketing regulation, market research, basics of industrial marketing.

CGM* ZC421 Financial and Management Accounting 3

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, fundamentals of financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, basics of cost accounting.

CGM* ZC431 Quantitative Methods 3

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, fundamentals of time series analysis, index numbers, decision theory, applications of various statistical software and spreadsheets.

CGM* ZC414 Managerial Economics 3

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production costs (theory of firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, fundamentals of money and banking, employment, interest, inflation; basic concepts relating to economics of information, adverse selection, moral hazard problem, market failure, externalities, public goods.

CIOT ZG511 IoT Technology and Applications 3

Introduction to IoT and Cyber-Physical Systems; IoT Enabling Technologies; Different Levels of IoT Systems; IoT Design Methodology; Introduction to IoT Platforms and End Devices, Introduction to IoT Network and Cloud Services; IoT Applications - Design Challenges; Basic Architecture and Components.

CIOT ZG521 Hardware Architectures for IoT 4

This course covers the concepts necessary for designing IoT device hardware and developing optimal firmware to meet the demands of IoT applications which include time critical response, low power consumption, fault tolerance etc. Topics include - Low power processor and microcontrollers – architecture, programming & interfacing; IoT platforms; Memory architectures-Cache, Memory Management and Memory

protection, Speed Vs power optimizations; On-board / On-chip buses and I/O interfaces.

CIOT ZG531 Communication and Networking Technologies in IoT 3

Wireless Communication & Network protocols – 802.11, BLE, NFC, LORA, Zigbee; Wireless Sensor and Ad hoc networks, Cross-Layer protocol optimization; Industrial and Automotive Networks, VANETS, Security issues and QoS in IoT Systems.

CIOT ZG541 Sensors, Actuators, and Signal Processing 3

Sensing Technologies for remote data gathering; Sensors and actuators of varied complexity; Signal Acquisition, Processing and Conditioning; Sensor fusion, Smart Sensors and interface to the internet; Introduction to advanced Sensing technologies-HCI in IoT, BCI in IoT; Control of actuators via Internet.

CIOT ZG551 Software and Programming in IoT 4

Operating Systems for IoT applications; Building Android applications; Web server implementation and deployment; Commonly used software tools and technologies for IoT

CIOT ZG561 Data Management in IoT 2

This courses covers topics in management of data in the context of the Internet of Things. Specific topics include Data sources in IoT and Data Types in IoT, Data-centric IoT products, Flow of Data, Challenges in managing IoT Data; Data Models and Data acquisition in Wireless Sensor Networks (WSNs), Query Processing and Query Optimization in WSNs, Sensor Data Cleaning and Storage, Embedded Database Systems; Data Acquisition in RFID Networks – RFID data cleaning and data preparation; Stream Processing – Event Processing, Event Processing in RFID, Mining Data Streams – Clustering, Classification, Frequent Pattern Mining, Change Detection, Dimensionality Reduction, Forecasting; Big Data Management in IoT – Big Data Storage and Processing, Distributed Processing – Issues and solutions. Case studies.

CIOT ZG571 Capstone Project 3

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project that demonstrates application of knowledge and skills acquired through the program. This is an unstructured open-ended course where under the supervision of a mentor, the student will carry out the project and must submit a project report and an artifact (such as a design, system, or software) as a culmination of his / her endeavour and investigation.

CM ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

CM ZC473 International Business 3

International business - an overview, general international environment - political, legal, socio-cultural and economic factors, international operational framework, tax aspects, marketing factors, labor factors and economic integration. BOP analysis, foreign exchange control, governmental policies, international finance, economic community, IMF, managing multinationals/globalization of operations.

CM ZC483 Marketing Research 3

An examination of the concepts and practical methodology used in marketing research. An overview of marketing research process, with emphasis on research design; data instrument design; questionnaire formulation; sampling plans; data collection methods -interviewing, panels; data analysis and use of computer based information systems for marketing intelligence. Also Time-series & Regression based models of sales forecasting, control and evaluation of marketing function and survey methodology are covered. Emphasis will be on cases and research projects.

CM ZC489 Enterprise Resource Planning 3

Introduction to ERP; Re-engineering and ERP systems; ERP planning, design, and implementation; ERP systems – sales and marketing; ERP systems – accounting and finance; ERP systems – production and materials management; ERP systems – human resources; Managing and ERP project; Supply chain management and e-Market place.

CM ZG511 Consultancy Practice 4

Strategic planning and marketing of consultancy services, client consultant relationships, technology transfers, negotiations, agreements,

guarantees, organizing and executing consultancy services, quality in consultancy services, technical audit, government policies such as industrial policy, trade policy, technology policy, patent and trademarks etc.

CM ZG512 Consulting & People Skills 4

Facilitation skills, Communication skills, Presentation and Interviewing skills, Analytical Skills, Creativity, Partnership and networking skills, Critical thinking skills, Emotional Intelligence Development, Stress Management, Ethics and respect for the client, Vision and Framing of issues, Synthesizing Skills, Leadership skills.

CM ZG513 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

CM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

CM ZG516 Consulting & People Skills 4

Facilitation skills, Communication skills, Presentation and Interviewing skills, Analytical Skills, Creativity, Partnership and networking skills, Critical thinking skills, Emotional Intelligence Development, Stress Management, Ethics and respect for the client, Vision and Framing of issues, Synthesizing Skills, Leadership skills.

CM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

CM ZG524 Business Process Analysis 4

Course description to be developed.

CM ZG532 Total Quality Management 4

Nature of quality, dimensions, determinants, costs of quality, traditional quality management, emerging quality standards, ISO 9000, Malcom Baldridge Award, Top management commitment and involvement, customer involvement, quality function deployment, designing and controlling production processes and improving process capability, reliability concepts, developing supplier partnerships, building teams of empowered employees, quality circles, benchmarking and continuous improvement, TQM in services.

CM ZG542 Knowledge Management 3

Increasing knowledge work in organizations; technologies to support growth of knowledge work in organizations; scope, cost, efficiency and reliability of technologies to support knowledge work; role of knowledge in an enterprise; knowledge management process; knowledge management strategies; human aspects of knowledge management; knowledge management technologies; applications of technologies to be covered through cases, reading assignments and use of appropriate software.

CM ZG561 Management of Technology 4

Technology Forecasting and its application in decision making, study of different industrial profiles, choice of technologies considering impact on people and environment, Promotion of Indigenous technology, technology transfer, foreign collaborations, process licensing, equipment selection and purchase, training and retraining of manpower.

CM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

CM ZG619 Professional Practice 4

This course will aim to achieve a professional development of the student in the context of the overall goal of his/her programme. Depending upon the profession, this course will be conducted in terms of actual participation in professional activities such as teaching laboratory organization, course development, organizational development, R&D work, design, production, data organization, data preparation or management of institutions/ hospitals/voluntary organizations etc. The course will also deal with communication aspects such as teaching a course, presenting a paper in the seminar/conference, articulating ideas and concepts to professional audience/customers etc. This course will also deal with the laws and ethics concerned with the profession of an individual.

CM ZG621 Supply Chain Management4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

CM ZG631 Strategic Change Management 4

Results-based management, managing for outcomes–objectives and targets; strategy; indicator, performance information; environmental scan and SWOT analysis; planning, budgeting, implementation, review - the (strategic) management cycle Models and theories of planned change, Strategic management: transformational leadership or change management (or learning), Strategic management in a context of joint action and networks, Participation and Empowerment, Teams and Teamwork, Parallel learning structures, OD Interventions, Team Interventions, Intergroup and third party interventions, Structural and Comprehensive interventions, Action research, Socio-clinical and Socio-technical Approaches, Issues in Consultant-Client Relationships, Power Politics and Organization Development.

CM ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

CM ZG631 Strategic Change Management 4

Results-based management, managing for outcomes –objectives and targets; strategy; indicator, performance information; environmental scan and SWOT analysis; planning, budgeting, implementation, review - the (strategic) management cycle Models and theories of planned change, Strategic management: transformational leadership or change management (or learning), Strategic management in a context of joint action and networks, Participation and Empowerment, Teams and Teamwork, Parallel learning structures, OD Interventions, Team Interventions, Intergroup and third party interventions, Structural and Comprehensive interventions, Action research, Socio- clinical and Socio-technical Approaches, Issues in Consultant-Client Relationships, Power Politics and Organization Development.

CMP* ZC411 Managing People & Organizations 3

Fundamental concepts and principles of management as applied to a variety of organizations; elementary study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; basic concepts relating to planning activities, manpower development; basic concepts relating to organizational behaviour.

CMP* ZC426 Operations Management 3

Fundamentals of production systems; product and process design; facility location & layout; operations scheduling and control; productivity of operations; fundamentals of inventory planning & independent demand systems; MRP; basic concepts relating to quality management; Japanese approach to operations management (JIT, TPM, continuous improvement).

CMP* ZC437 Lean Manufacturing 4

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, basics of production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production.

CMP* ZC422 Total Quality Management 3

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment.

CS ZC444 Real-Time Systems 3

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CS ZG551 Advanced Compilation Techniques 5

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

CS ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

CSI ZC132 Linear Algebra & Optimization 3**

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

CSI ZC163 Computer Programming 4**

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

CSI ZC213 Probability & Statistics 3**

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

CSI ZC252 Discrete Structures for Computer Science 3**

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

CSI ZC263 Digital Electronics &Microprocessors 4**

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

CSI ZC311 Information Security 3**

Program security, Web security, Database security, Protection in operating systems, Cloud security fundamentals; Privacy and Anonymity in computing; Legal and ethical issues in security, Secure programming and Trusted systems design; policy, administration and procedures; auditing; physical security; content protection.

CSI ZC313 Object Oriented Programming & Design 4**

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

CSI ZC327 Systems Programming 4**

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific Programming including shell-scripting via online laboratory facility.

CSI ZC337 Database Systems & Applications 4**

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

CSI ZC353 Computer Organization & Architecture 4**

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

CSI ZC363 Data Structures & Algorithms 4**

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

CSI ZC364 Operating Systems 4**

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output

systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

CSI ZC424Software Development for Portable Devices 3**

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

CSI ZC446 Data Storage Technologies & Networks 3**

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

CSI ZC462 Network Programming 3**

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

CSI ZC463 Cryptography 3**

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

CSI ZC467Computer Networks 4**

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols, Laboratory experiments / assignments related to simulation of network protocols, programming simple network applications, implementing select routing algorithms via online laboratory facility.

CSI ZG511 IT Infrastructure Projects & Processes 3**

Course description to be developed

CSI ZG513 Network Security 4**

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

CSI ZG514 Data Warehousing 5**

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

CSI ZG515 Introduction to DevOps 4**

Continual Service - continuous integration and continuous delivery; Scaling: automating infrastructure and infrastructure-as-code; DevOps and Cloud: platform-as-a service and DevOps, use of virtual machines and containers for deployment, Micro-services; application lifecycle management: deployment pipeline and application deployment, continuous deployment pipeline; stack

management - life cycle of stack and events, resource and event monitoring, auto healing; Security: security of deployment pipeline, policy-as-code.

CSI ZG518 Database Design & Applications 5**

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

CSI ZG520 Wireless & Mobile Communication 5**

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

CSI ZG522 Design and Operation of Data Centers 5**

Data Center Design: Principles (Scalability, Reliability, and Elasticity), Components - Computing Infrastructure (Processing, Storage, and Networking) and Physical Infrastructure (Power, Cooling, and Physical Security); Servers – Server Hardening, Server Optimization, Server Deployment and Consolidation, Converged and Hyper-Converged Infrastructure. Application monitoring and maintenance. Networking for data centers – device hardening, bandwidth aggregation, traffic management, redundancy, network isolation, deployment of internal security and peripheral security; Contingency Planning & Disaster Recovery: Backup, recovery, and redundancy/replication technologies and approaches. Data Center Architecture: Private, Public, and Hybrid models; Distributed Data Centers; Introduction to Software Defined Data Centers. Costing and Pricing– Costing and Cost Optimization, Pricing and Economics of Data Center Operation.

CSI ZG523 Introduction to Data Science 3**

Context and use of Data Science. High-dimensional data, graphs, vectors in high dimensional space and large matrices; Algorithms for massive data problems, sampling techniques. Techniques for extracting information/patterns from data

CSI ZG524 Middleware Technologies 4**

Evolution of Middleware Technologies: Transaction Processing, Remote Procedure Calls, Message-Oriented-Middleware, Object Request Brokers, Web services and REST; Forms of Middleware: Enterprise Middleware, Web Middleware, and Cloud / Services Middleware; Middleware Elements: communication protocols, middleware protocols, data representation, server process control, naming and directory services, security, system management; Select case studies such as MS .NET, J2EE. Service Oriented Architecture: Loosely Coupled Systems, Business processes, Tiers, Architectural Choices; Resiliency in Middleware: resiliency techniques, hardware failures, communication failures, software failures; Performance and scalability in Middleware; Security in Middleware; Implementation Aspects: business process implementation, enterprise integration, web and database middleware (e.g. NoSQL middleware) change management. Case studies of Enterprise application architecture (EAI) - Eg. Tibco, Websphere.

CSI ZG525 Advanced Computer Networks 5**

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CSI ZG526 Web Technologies 4**

Introduction to the World Wide Web. Web Application Architecture –2-tier and 3-tier architectures, RESTful applications, Web Services, and mash-ups; Hyper-Text Transfer Protocol (HTTP) and Web Servers – Case studies e.g. Apache and IIS; Deploying and tuning web servers. Web Application Front Ends: Markup (HTML and XML), Styling (CSS), and Scripting (Client Side and Serve Side Scripts, Objects and Document Object Models – APIs for parsing documents, Event Handling and Asynchronous Scripting). Application Deployment on the Web: Dynamic Back-ends, Database Connectivity, Unstructured Data and NoSQL. Web Security – Typical Security Solutions for the Web.

CSI ZG527 Cloud Computing 5**

Concurrency and distributed computing, message passing over the network, connectivity and failure

models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

CSI ZG528 Cyber Physical Systems 4**

Course description to be developed.

CSI ZG533 Service Oriented Computing 4**

Course description to be developed.

CSI ZG538 Infrastructure Management 4**

Course description to be developed.

CSI ZG582 Telecom Network Management 5**

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

CSI ZG656 Networked Embedded Applications 4**

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

DE* ZC415 Introduction to MEMS 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermos fluid engineering; scaling law; micro actuators, micro sensors and micro electromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micro manufacturing; micro fludidics; micro robotics; case studies.

DE* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

DE* ZG512 Finite Element Methods 5

Element properties, Isoparametric elements, Finite element methods and analysis, Applications in design including continuum mechanics, Dynamic systems, Heat conduction and Electrical potentials, etc. will be taken up.

DE* ZG613 Tribology 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

DE* ZG514 Fracture Mechanics 5

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

DE* ZG515 Computational Fluid Dynamics 5

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numeric: basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

DE* ZG521 World-Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-

total quality - the first steps, getting people involved, monitoring world-class performance.

DE* G522 Advanced Composites 5

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture thoughness and fatigue; properties of fibre reinforcement and production technology of composites.

DE* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

DE* ZG525 Mechanical System Design 5

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

DE* ZG531 Concurrent Engineering 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

DE* ZG532 Quality Assurance and Reliability 5

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

DE* ZG535 Advanced Engineering Mathematics 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

DE* ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

DE* ZG542 Machine Tool Engineering 5

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

DE* ZG561 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

DE* ZG611 Dynamics & Vibrations 5

Steady and transient Vibration of single and multi-degree freedom systems. Systems with distributed mass and elasticity. Non-linear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

DE* G621 Computer Aided Analysis and Design 5

The course aims at developing complete self-reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including

system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

DE* ZG631 Materials Technology & Testing 5

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibres and other modern engineering materials and their application with particular reference to Railways. Destructive and non-destructive testing techniques and their applications in Railways.

DE*ZG641 Theory of Elasticity and Plasticity 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

DM ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

DM ZG521 Design for Additive Manufacturing 5

Fundamentals of computer aided design, part modeling and analysis using contemporary tools, design for manufacturing & assembly particularly in additive manufacturing, design considerations for additive manufacturing, support structures in metal-based systems and lightweight structures.

DM ZG531 High Precision Manufacturing 4

Introduction to high precision manufacturing processes. Process and design considerations of both conventional and non-conventional processes in micro and nano manufacturing. Applications of high precision manufacturing in the fields such as semiconductor devices, medical devices. Common quality defects in high precision manufacturing. Emerging trends in the field.

DM ZC472 Precision Engineering 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

DM ZG612 Advances in Materials, Composites & Plastics 4

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fiber reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibers, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fibre reinforcement and production technology of composites. Plastics and their processing technology including injection moulding, blow moulding etc. Mathematical modeling and simple computational techniques for the mechanics of composites and plastics. Applications of plastics and composite in automotive and aerospace structures. Advanced metals and alloys including titanium, aluminum and magnesium, Ceramic and metal alloys (CERMETS) including Aluminum based alloys and other ceramic components.

DM ZC622 Industrial IoT 4

Workplace safety, industrial revolution 4.0, connected factories, smart industrial devices and products, cyber physical system in manufacturing, connecting industrial devices and equipment with each other and with internet, data acquiring and collection, communication technologies, RFID, QR codes and cellular technologies, protocols, hardware in IoT, software (IDE), cloud platform, connectivity and networking in IIoT, smart eyes on shop floor, integrating smart into existing equipment, programming using IoT, case study and implementation.

DM ZG6631 Additive Manufacturing Process 5

Overview of additive manufacturing process, its importance to industries and its rapid development. Process, development and optimization for group of additive manufacturing technologies with special focus on metal based systems. Application of additive manufacturing technology in different

settings for a given application. Additive manufacturing process from CAD file import till post processing and finishing. Emerging trends in additive manufacturing.

DM ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

DM ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

DM ZG522 Behavioral Operations 4

Human behavior & cognition and their impacts on operating systems and processes. Heuristics used by operations managers to make spot decisions, their analysis using behavioral decision making literature with their potential implications for OM settings. The traditional operational issues (rational anomalies) such as bullwhip effect, explanation using behavioral operations theories. The impact of cognitive biases and methods of dealing with them in factory settings. Cognitive overload, decision making under uncertainty and ethical blindness in profession, which are relevant for modern digital factories.

DM ZG532 Big Data Analytics in Manufacturing 4

Big Data and its applications in manufacturing. Five V's of big data, analysis of structured and unstructured data in various forms, uncovering hidden patterns and unknown correlations for better operational decisions. Key technologies used in storing, manipulating, and analyzing big data. Tools for statistical analysis and data visualization. Open source frameworks for data analysis.

DM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

DM ZG534 Sustainable Manufacturing 5

Introduction to sustainable manufacturing, sustainable manufacturing design, practice and matrices, life cycle management and assessment, end of life (EOL) strategies, implementation framework, sustainable business models, waste minimization, case studies.

DM ZG535 Cyber Security in Manufacturing 4

Overview of cyber security for industry 4.0 landscapes with an emphasis on design and manufacturing application. Technological foundation of cyber security within manufacturing domain, existing threats faced by industry 4.0 sectors along with the existing solutions. Implementation of risk mitigation measures in industry.

DM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychol giccl, physiological considerations in design decision making; legal factors, engineering ethics and society.

DM ZG561 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

DM ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and

submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

DSE* ZC413 Introduction to Statistical Methods 3

Different types of data; Data Visualization; Data summarization methods; Tables, Graphs, Charts, Histograms, Frequency distributions, Relative frequency measures of central tendency and dispersion; Box Plot; Chebychev's Inequality on relationship between the mean and the standard deviation of a probability distribution. Basic probability concepts, Conditional probability, Bayes Theorem, Probability distributions, Continuous and discrete distributions, Transformation of random variables, Moments, Correlation and Covariance, Parameter Estimation, Hypothesis Testing.

DSE* ZC414 Optimization Methods for Analytics 5

This course will focus on development of analytical models using optimization (and simulation) techniques to analyze and recommend appropriate solutions for complex business problems across various functional areas including finance, economics, operations, and marketing. Key topics covered in this course are as follows: solving various problems related to planning, production, transportation, microeconomics, etc. using LP models. Decision making in the context of multi stage LP models. Application of Goal Programming (GP) and Analytic Hierarchy Process (AHP) for decisions relating to large teams and complex problems with long term implications. We will use various tools including spreadsheets and other software for the experiential components of this course to illustrate the application of these techniques to various industries.

DSE* ZC415 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

DSE* ZC416 Mathematical Foundations for Data Science 4

Vector and matrix algebra, systems of linear algebraic equations and their solutions; Eigenvalues, eigenvectors and diagonalization of matrices, Sets and relations; Graphs and digraphs; Trees, lists and their uses; Partially ordered sets and lattices.

DSE* ZC420 Data Visualization 3

Information overload and issues in decision making. Design of visual encoding schemes to improve comprehension of data and their use in decision making; presentation and visualization of data for effective communication. elementary graphics programming, charts, graphs, animations, user interactivity, hierarchical layouts, and techniques for visualization of high dimensional data & discovered patterns.

DSE* ZC421 Ethics for Data Science 3

Introduction to data ethics, perils of big data, foundations of data privacy, challenges of privacy in the digital age, data policies, consent and fair usage.

DSE* ZC426 Real Time Analytics 4

Motivation and challenges of real-time, distributed, fault-tolerant data processing, distributed messaging architecture (Apache Kafka), Real time data processing platform: Storm, Storm basic programming skills, linking Spouts, and connecting to the live Twitter API to process real-time tweets, multi-language capability of storm (with Python scripts), Case study: Networking fault prediction. This course also helps a student to analyze and understand Big-data using visuals. Topics include, Design principles, Perception, color, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.

DSE* ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its

implementation using LISP and PROLOG languages.

DSE* ZC465 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

DSE* ZG515 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

DSE* ZG516 Computer Organization & Software Systems 5

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

DSE* ZG517 Systems for Data Analytics 5

Fundamentals of data engineering - data engineering vs data science; Data processing concepts - partitioning, replication, grouping and sorting, data locality; Flynn's taxonomy; Task vs Data Parallelism; Databases, parallel vs distributed databases, architecture – performance; Distributed computing architecture; Processing frameworks - batch, map-reduce, stream processing, parallel processing, real time processing; Cloud fundamentals - virtualization, batch-transactional-continuous workloads, execution models and examples- AWS , Azure etc..

DSE* ZG519 Data Structures and Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization). Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

DSE* ZG521 Graphs - Algorithms and Mining 5

Basic concepts of graphs and digraphs connectivity, reachability and vulnerability; Trees, tournaments and matroids; Planarity; Routing and matching problems; Representations; Various algorithms; applications, introduction to graph mining, Graph Pattern Mining, Graph Classification, Graph Compression, graph model, graph dynamics, social network analysis, visualization, summarization, graph clustering, link analysis, applications of graph patterns.

DSE* ZG522 Big Data Systems 5

What is big data - are existing systems sufficient?; Data Warehouse v/s Data Lakes; Hadoop – Components; Storage - Relational DBs/ NoSQL dbs / HDFS / HBase / Object Data stores - S3; Serialization; Interfaces - Hive/ Pig; Stream Processing; Spark; Mahout.

DSE* ZG523 Introduction to Data Science 3

Context and use of Data Science. High-dimensional data, graphs, vectors in high dimensional space and large matrices; Algorithms for massive data problems, sampling techniques. Techniques for extracting information/patterns from data.

DSE* ZG524 Deep Learning 4

Common Architectural Principles of Deep Networks; Building Blocks of Deep Networks; Convolutional Neural Networks (CNNs); Recurrent Neural Networks; Recursive Neural Networks; Building Deep Networks with ND4J; Applications to Sequence Data, Anomaly Detection; Tuning Deep Networks; Vectorization.

DSE* ZG525 Natural Language Processing 3

Language modelling with N-gram, Spelling correction, Neural networks and neural language models, Parts-of-Speech tagging, Syntactic parsing, Language semantics, Computational symantics.

DSE* ZG526 Probabilistic Graphical Models 4

HMM, Markov Random Field, Bayesian networks, Representation, Learning, Inference; Dynamic Bayesian Networks and Temporal Bayesian networks, applications.

DSE* ZG537 Information Retrieval 4

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

DSE* ZG554 Distributed Data Systems 4

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques. Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization. Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

DSE ZG555 Data visualization and Interpretation 5**

Visualisation as a Discovery tool, Visualisation skills for the masses, The Visualisation methodology, Visualisation design objectives, Exploratory vs. explanatory analysis, Understanding the context for data presentations, 3 minute story, Effective Visuals, Gestalt principles of visual perception, Visual Ordering, Decluttering, Story Telling, Visualiztion Design; Taxonomy of Data Visualisation Methods: Exploring Tableau, Dashboard and Stories, Bullet graphs, Pareto charts, Custom background images; Dashboard : Dashboard categorization and typical data, Characteristics of a Well-Designed Dashboard, Key Goals in the Visual Design Process; Power of Visual Perception: Visually Encoding Data for Rapid Perception, Applying the Principles of Visual Perception to Dashboard Design.

DSE ZG556 Stream Processing and Analytics 5**

Real Time , Streaming Data & Sources, Real time streaming system architecture , Characteristics of a Real Time Architecture and Processing ; Configuration and Coordination Systems: Distributed State and Issues, Coordination and Configuration using Apache ZooKeeper; Data Flow Management : Distributed Data Flows , Various Data Delivery and Processing Requirements, N+1 Problem, Apache Kafka (High-Throughput Distributed Messaging); Processing Stream Data with Storm; Overview of Data Storage – Requirements: Need for long-term storage for a real time processing framework, In-memory Storage, No-Sql Storage Systems, Choosing a right storage solution; Visualizing Data :Requirements, Principles and tools; Bounds of Random variables, Poisson Processors, Maintaining Simple Statistics from Data Streams, Sliding Windows and computing statistics over sliding windows, Data Synopsis (Sampling, Histograms, Wavelets, DFT), Exact Aggregation, Timed Counting and Summation, Multi Resolution Time Series Aggregation, Stochastic Optimization; Statistical Approximation to Streaming Data: Probabilities and Distributions,Sampling Procedures for Streaming Data, Approximating Streaming Data with Sketching, Registers and

Hash Functions, Working with Sets, The Bloom Filter, Distinct Value Sketches, The Count-Min Sketch; Clustering techniques for Streaming Data; Classification methods : Decision Tree (VFDT); Evaluating stream processing algorithms; Case Studies in Designing solutions to streaming data

DSE ZG557 Artificial and Computational Intelligence 5**

Agents and environments, Task Environments, Working of agents; Uninformed Search Algorithms: Informed Search. Local Search Algorithms & Optimization Problems: Genetic Algorithm; Searching with Non-Deterministic Actions, Partial Information and Online search agents, Game Playing, Constraint Satisfaction Problem, Knowledge Representation using Logics: TT-Entail for inference from truth table, Proof by resolution, Forward Chaining and Backward Chaining, Inference in FOL, Unification & Lifting, Forward chaining, Backward Chaining, Resolution; Probabilistic Representation and Reasoning : Inference using full joint distribution, Representation of Conditional Independence using BN, Reinforcement Learning; Difference between crisp and fuzzy logic, shapes of membership function, Fuzzification and defuzzification, fuzzy logic reasoning; Decision making with fuzzy information, Fuzzy Classification; Connectionist Models: Introduction to Neural Networks, Hopfield Networks, Perceptron Learning, Backpropagation & Competitive Learning, Applications of Neural Net: Speech, Vision, Traveling Salesman; Genetic Algorithms - Chromosomes, fitness functions, and selection mechanisms, Genetic algorithms: crossover and mutation, Genetic programming.

EA ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

EA ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

EA ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

EBCT ZG511Overview of e-Business 3

E-Business Environment and Opportunities: Background; E-Business evolution; E-Business environment; Diverse opportunities in E-Business; E-Businesses on the Internet. Categories of E-Business - B2B/E2EI, B2C, C2C; Overview of E-Business implementation technologies. E-Business Models - Enterprise portal, CRM, ERP, Supply Chain Planning (SCP), Transport Management System (TMS), Warehouse Management System (WMS), Content Management. E-Business Products- Development products; integration products; generic tools; performance analyzer tools; content management tools; component generator tools. Electronic Transaction and Security – Online payment system and security issues; Secure Transport Protocols, Secure Transactions, Secure Electronic Payment Protocol (SEPP), Secure Electronic Transaction (SET); Security features – certificates for authentication (SSL, third party certifications); security on Web servers and Enterprise Network. Emerging E-Businesses Scenario- Changing economic considerations; Emerging business opportunities and revenue models; emerging technologies; Social aspects.

ED* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive

Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

ED* ZC211 Electrical & Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single-phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, poly phase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ED* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

ED* ZC232 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ED* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

ED* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

ED* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

ED* ZC245 Fluid Mechanics and Machines 4

Introduction and fundamental concepts, fluid statics, kinematics and dynamics of fluid flow, inviscid flows, pipe flow and network design, open channel flow, incompressible viscous flow, laminar boundary layers, turbulent flows, essentials of compressible flow, dimensional and model analysis, orifice, venturi, notches and weirs, hydraulic turbines, centrifugal and reciprocating pumps, fluid couplings and torque convertors, compressors.

ED* ZC251 Engineering Measurements 4

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

ED* ZC261 Mechanical Technology 4

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ED* ZC311 Manufacturing Process 4

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ED* ZC321 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ED* ZC322 Kinematics & Dynamics of Machines 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, cam design, gear trains, synthesis of linkages. Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes, free and forced vibrations.

ED* ZC324 Mechatronics & Automation 4

Mechatronics design approaches, interfacing, instrumentation and control systems, modeling of mechanical and electromechanical systems, sensors and actuators, introduction to automation, pneumatics and hydraulics in automation, pneumatic circuits for automation, PLC programming and interfacing with pneumatic and hydraulic systems, introduction to MEMS, modeling and simulation of MEMS, CNC machines, automated material handling, introduction to FMS.

ED* ZC325 Fluid Power Systems 4

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

ED* ZC332 Mechanical Engineering Design I 4

Introduction to mechanical engineering design, stress and strain, deflection and stiffness, introduction to materials and manufacturing, failures resulting from static loading, failures resulting from variable loading, design of mechanical elements: screws, fasteners, permanent joints, nonpermanent joints and mechanical springs. Practice of machine part and assembly drawings using Pro/Engineer or similar solid modeling environment.

ED* ZC342Mechanical Engineering Design-II 4

Lubrication and journal bearings, rolling contact bearings, introduction to gearing, spur helical, bevel and worm gears, clutches, brakes, couplings, flywheels, belts, chains, wire rope, shafts and axles. Practice of machine part and assembly drawings using Pro/Engineer or similar solid modeling environment.

ED* ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

ED* ZC433Mechanical Vibrations & Acoustics 4

Introduction, single degree-of-freedom systems: free and forced vibration problems, concept of resonance and damping, vibration isolation, multi-degree-of-freedom systems: modeling of multi-degree-of freedom systems, eigen value problem and calculation of normal modes of a system, forced response using modal superposition techniques, introduction to acoustics - terminology used in acoustics and definitive of fundamental quantities 1D wave, equation (plane waves) & 3D wave equation, formulation and fundamental solution to the equations, measurement of noise & vibration – vibration measurement principles.

ED* ZC434, Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance,

various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

ED* ZC436Computer Aided Design 4

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Hands-on in assignments and CAD project.

ED* ZC441 Automotive Vehicles 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

ED*ZC452 Composite Materials and Design 4

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micromechanical aspects of composites, manufacturing methods, composite production design methods design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies. Simulation of mechanics of composite materials using suitable software tools.

ED* ZC453 Product Design & Development 4

Introduction to product design and development, product development planning and process tools, technical and business concerns, understanding customer needs, function modeling, product teardown and experimentation, benchmarking and engineering specifications, product architecture, concept generation, concept selection, concept embodiment, modeling of product metrics, design for X, physical prototypes, physical models and experimentation, robust design, case studies.

ED* ZC454 Reverse Engineering and Rapid Prototyping 4

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering. Practice of virtual and physical rapid prototyping of simple models.

ED* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

EE* ZG511 Environmental Chemistry 5

Fundamentals of Physical Chemistry, Water Chemistry, Water pollution, Green Chemistry, Fundamentals of Analytical Chemistry, Atmospheric Chemistry and air pollution, Energy and climate change, Toxic compounds, Metals, soils, sediments and waste disposal, Case studies

EE* ZG512 Environmental Biotechnology 5

Principles, concepts and applications of Biotechnology to the management of environmental problems, Microbial technologies for waste management, Bioremediation of toxicants, Microbial systems for detoxification, Microbial technologies for waste management, Biochemical kinetics and engineering, Concept of rDNA technology, Regulation and ethics

EE* ZG513 Applied Transport Phenomena 5

Introduction to fluid, heat and mass transport, Newton's laws of viscosity, Fourier's laws of heat conduction, Fick's laws of diffusion, Continuity equation, Concept of laminar and turbulent flow, Convective heat and mass transfer, Introduction to transport equations for fluid, heat and mass transport, Sedimentation, Packed beds, Fluidization, Pumps and compressors, piping networks, Heat and mass transfer equipment

related to environmental systems, Dimensionless numbers and their significance

EE* ZG514 Environmental Sampling and analytical methods 5

Principles of sample collection and data analysis / interpretation, Gravimetric methods, titrimetric methods, electrochemical methods, Spectrometric methods of analysis, Chromatographic methods of analysis, Sampling techniques for air and water pollution, Biological methods of analysis, Interpretation of data in environmental monitoring

EE* ZG515 Environmental Management Systems 5

Study of environmental policies, Environmental laws, Environmental regulations and permit procedures; ISO series; Life Cycle analysis; Environmental audit; Environmental impact assessment, Risk assessment, Hazardous waste management, Integrating environmental and safety management; Case studies.

EE* ZG521 Physico – Chemical treatment principles & design for wastewater systems 4

Pollutant classification, Source selection process, Selection of treatment chain, Plant siting, Physical treatment methods like screening, sedimentation, filteration, etc., Chemical treatment principles like precipitation, coagulation, ozonation etc., adsorption, Novel processes like membranes, electrodialysis, etc., Design of physico-chemical systems for wastewater treatment, Case studies.

EE* ZG522 Biological treatment principles & design for wastewater systems 4

Fundamentals of biological treatment, Biochemistry and kinetics of biochemical processes like oxidation, nitrification & denitirification, Dephosphatization, Acedogensis and methogenasis, Aerobic and anaerobic treatment processes, Basic description of equipment and design methodologies, Design of reactors and configurations; Case studies for industrial and wastewater treatment.

EE* ZG523 Environmental Statistics 4

Introduction to probability and Statistics, Probability concepts and probability distributions, Fundamentals of data analysis, Uncertainty in Measurement, Precision and accuracy, Reproducibility/repeatability, Types of errors, Error propagation, Confidence intervals, Hypothesis testing for equality of mean and standard deviation: t-test, chi-square test and F-test, Errors in hypothesis testing, Experiment design and analysis of variances, Autocorrelation, cross-correlation and sensitivity analysis in data sets, Linear least-squares regression. Precision of parameter estimates, Coefficient of determination; Interpreting statistical results, documentation and recommendations, Theory of attributes, Time series analysis, Case studies

EE* ZG532 Pumps and Automation Systems 4

Pumps and Pumping stations: Need of pumping, classification and type of pumps, Pumping power, Head and capacity of pump, site selection pump specification and selection; Distribution system: Type of distribution system, different layout of distribution system, methods of supplying water, pressures in distribution system, distribution resources and its capacity, type of reservoirs & accessories; Valves and Fittings: Different type of valves, hydrants, meters, stop cock & water tap, pipe fittings, leakage & waste of water factors, affecting losses & wastes. Introduction to Automation: Sensors and actuators for pumping, basic control concepts, micro controllers and PLC's, Introduction to SCADA and HMI interface; Pump Drivers: Basics of AC motors, Types, starting methods, types coupling, motor and coupling selection; Water Automation systems: Automatic switching systems, control of Submersible Pumps, timer based control, level based control, Tank to Tank Flow Automation System.

EE* ZG533 Industrial Pollution Abatement 4

Different types of wastes generated in an industry, their effects on living and non-living things; environmental regulatory legislations and standards and climate changes; quantification and analysis of wastewater and treatment; different unit operations and unit processes involved in conversion of highly polluted water to potable standards; atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices; analysis and quantification of hazardous and non-hazardous solid wastes, treatment and disposal.

EE* ZG534 Urban Water Management 4

The urban water cycle (description, social imperatives, environmental considerations, and economic challenges); water supply (availability, service levels, and technical options); free basic water, demand management, loss control, use of recycled water; sewage (public health considerations, service levels and technical options, the dry-versus-wet sanitation debate,

social acceptance, and grey water management); drainage (service levels and technical options, sustainable urban drainage systems (SUDS), urban litter management, urban rivers, risk management, and groundwater issues); management (water sensitive urban design, introduction to asset management, GIS as a water management tool, and sustainability indicators).

EE* ZG611 Energy generation and management in waste treatment Plants 4

Energy audit and minimization in waste treatment facilities; Novel energy conservation technologies, Estimation of energy potential of waste; Selection of energy generation technologies coupled with waste treatment, e.g. incinerators, pyrolysis units, bio-digesters and purification and enrichment of off gases from these units; Utilization of fuel & fertilizer value of gases & liquids from bio-digesters and pyrolysis units; Energy generation from waste sludge.

EE* ZG612 Environmental remote sensing and GIS 4

Principles of remote sensing, Components of GIS: Hardware, Software and Organization Context, Types of Maps; Spatial and Non Spatial, Types of Projections, Editing the Raster and Vector data structures, Analysis using raster and Vector Data, Data Retrieval, Data Reclassification, Data Overlaying and Buffering; Data Output; Pollution data gathering in GIS area under consideration through terrestrial and aerial stations, unmanned aerial vehicles (UAV) equipped with imaging and spectroscopic probes; Pollution mapping coupled to GIS through wireless network; Water body pollution monitoring instruments coupled to GIS through wireless network, Thermal and microwave remote sensing, Space imaging, Case studies on various applications of GIS for environmental management.

EE* ZG613 Environmental systems modeling 4

Introduction to air quality models, Atmospheric stability and turbulence, Gaussian dispersion models, single source and multisource models, Transport and fate of pollutant in aquatic systems, Introduction to modeling of river, lake and estuarine hydrodynamics, Stratification and eutrophication of water bodies, Dissolved oxygen model for water streams, Computational methods in environmental modeling and simulation, Transport and fate of pollutants in soils and ground water, Applications of public domain models and software; Case studies.

EE* ZG614 Air Pollution Control Technologies 4

Introduction to air pollution, Atmospheric diffusion of air pollutants, Particulate control, Gaseous pollutant control, Methods for monitoring and control, Selection and design of control equipments, Meteorological aspects of air pollution, Applications and case studies

EE* ZG621 Solid Waste Management 4

Introduction to solid waste management: Sources and classification, Composition and Properties of Solid Waste and emerging e-waste, Onsite handling, storage and processing including segregation, Collection of solid waste, Transfer and transport, Recycling, Incineration pyrolysis and composting, Processing technique and equipment, Recovery of resources, conversion products, and energy, Biomedical and hazardous waste, Electronic waste, Regulatory framework, categorization, generation, collection, transport, treatment and disposal, Leacheate collection and treatment, Bioleaching and bioremediation; Case studies.

EE* ZG622 Environmental Process Engineering 4

Origin, Nature and composition of solid, liquid and gaseous emissions from various processes in Industries, institutions and human habitats, Assessment of pollution potential through study of process chemistry and process engineering, Understanding block flow diagrams (BFD), Process Flow Diagrams (PFD) and Piping and Instrumentation Diagram (P&ID) and Process Pollution Flow Diagram (PPFD), Maximum Attainable Control Technologies (MACT) and Best Available Control Technologies (BACT), Reasonably Available Control Technology (RACT) and Lowest Attainable Emission Rate (LAER), List of equipment and processes for BACT/RACT/LAER and their description, Estimating thermo-physical and thermodynamic data for pollutants, Use of software in Environmental Process Engineering Equipment design and datasheet generation, Technical audit of Existing process technology, Environmental carrying capacity calculations; Interpretation of field/on-site and laboratory data, Case studies.

EE* ZG623 Environmental Impact and Risk Assessment 4

Introduction to Environmental Impact Assessment (EIA), Environmental assessment framework, Impact assessment methodologies; Air and water

quality Impact analysis (AQIA / WQIA), Energy and noise impact analysis (EnIA / NIA), Vegetation, wild life and socio-impact analysis, Environment risk assessment, Environmental Impact statement.

EE* ZG624 Advanced Water Treatment Technology and Water Supply Systems 4

The course will cover estimation of water demand, characterization of water quality (physical, chemical and biological), different unit operations for treatment of water (screening, sedimentation, coagulation, filtration, disinfection etc.), nature of emerging contaminants (types of contaminants and sources, physical & chemical characteristics and their health hazard), advanced techniques for water purification (includes advanced process such as reverse osmosis, desalinization process, membrane filtration etc., and advanced material such as nanomaterial, composite material etc.), water distribution system, pumping at the mains, water leakage and their detection, water auditing.

EE* ZG625 Advanced Wastewater Engineering 4

The course will cover design of sewer system (including pumping of swage, sewer hydraulic, layout and construction), Characterization of waste (physical, chemical and biological characteristics), Natural attenuation, Wastewater unit operation (preliminary treatment, secondary or biological treatment), Sludge disposal, Industrial waste and their characterization (physical, chemical characteristics, health hazard), Advanced wastewater treatment (nature of waste, application of nanotechnology, biotechnology, and other advanced material etc.), Solid waste management (source and nature of waste, disposal method, recycle and reuse, guideline and legislation); Water and wastewater sampling and laboratory analysis.

EEE ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

EEE ZG571 Optical Communication 4

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques); beam forming; focusing and coupling schemes to optical repeators; optical amplifiers; optical field reception; coherent and non-coherent light wave systems; fibre optic communication system design and performance; multichannel light wave systems; long haul communications; fibre optic networks.

EEE ZG572 Satellite Communication 5

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

EEE ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

EEE ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

ENGG ZC111 Electrical & Electronics Technology 4

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single-phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, poly phase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ENGG ZC232 Engineering Materials 4

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement;

corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ENGG ZC241Mechanical Technology 4

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ENGG ZC242 Maintenance & Safety 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipment's and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

ES ZC263 Digital Electronics and Microprocessors 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

ES ZC343 Microprocessors & Microcontollers 3

Introduction to microprocessors and microcontrollers. Architecture of 8086 microprocessors; Assembly directives, Assembly language programs with algorithms, Memory interfacing and timing diagrams; Architecture of 8-bit microcontrollers; Assembly language programming for microcontrollers; Interfacing I/O devices; System design examples.

ES*ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ES* ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

ES* ZC441 Robotics 3

The objective of this course is to make the students familiar with Robotics, the main components of kinematics, sensors, transmission and drives, control systems, intelligence and vision, geometric modelling and reasoning, assembly planning, grasping, collision avoidance, mobile robots, force strategies, uncertainty analysis, and representation of visual world.

ES* ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

ES* ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms,

congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

ES* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

ES* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

ES* ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

ES* ZG514 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

ES* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

ES* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

ES* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

ES* ZG525 Avionics Systems 5

Civil avionics systems, fly-by-wire technology, flight control systems, engine control systems, fuel systems, hydraulic systems, electrical systems, pneumatic systems, environmental control systems, navigational systems, emergency systems, rotary wing systems, advanced systems, system design and development, avionics technology, environmental conditions, flight management systems, vehicle health management systems, communication protocols, hardware certification process, software certification process, certification considerations for highly integrated / complex aircraft systems.

ES* ZG526 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

ES* ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

ES* ZG532 Testability for VLSI 5

BIST, boundary sean, stuck-at faults, test generation algorithms for combinatorial logic circuits and sequential circuits, logic simulation and fault simulation, synthesis for test, built in self-test,

pseudo-random test techniques, other test methods - IDDQ testing, boundary scan etc.

ES* ZG545 Control & Instrumentation for Systems 5

The regulation and control problem with reference to power electronic converters. Converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models. Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications. Control design based on linearisation: transfer functions, compensation and filtering, compensated feedback control systems. Hysteresis control basics, and application to DC-DC converters and inverters. General boundary control: behaviour near a boundary, and choice of suitable boundaries. Basic ideas of fuzzy control techniques, and performance issues. Sensors for power electronic circuits, speed and torque transducers.

ES* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

ES* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation; Systolic Architectures.

ES* ZG556 DSP Based Control of Electric Drives 3

State space and transfer matrix representations, representation of nonlinear systems by update of parameters, output feedback and state feedback control, basic notion of state estimation. Sampling of signals, discrete representation of signals, z-transforms. Nature of discrete time poles and zeros. A/D and D/A converters as system elements. FIR and IIR behaviour, noise and its nature. AR, MA, and ARMA models of systems. The Fourier transform and what it conveys. Processing requirements of a DSP, floating point DSP's: the TMS320C3x family. Memory organization, interrupt systems, and I/O interface with the TMS320C3x family. The TMS320C31 as an embedded controller, drive control features. Applications in vector and direct torque control of synchronous motors, vector and direct torque control of induction motors, torque control of SRM's.

ES* ZG571 Optical Communication 5

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques; beam forming; focusing and coupling schemes to optical repeaters; optical amplifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; long haul communications; fibre optic networks.

ES* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ES* ZG611 Advanced Control Systems 5

Review of State variable modelling of linear continuous, linear discrete and nonlinear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

ES* ZG612 Fault Tolerant System Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

ES* ZG613 Advanced Digital Signal Processing 5

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

ES* ZG621 VLSI Design 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; Structured design and testing; Symbolic layout systems; CMOS subsystem design; System case studies.

ES* ZG625 Safety Critical Embedded System Design 4

Architecture / Design practices for Safety critical systems; DO178B standards. Methodology of Certification and Qualification for DO178B, Modelling real time systems (UML-RT, and the tools), Reliable, common system bus – VME, ASCB, SafeBus, MultiBus II etc. Safety critical system busses & protocols, ARINC 429, 629, Mil-1553B & 1773, Ethernet based switched network for safety critical applications, Real time and safety standard and certifications, Reliability Maintainability & Safety of Embedded Systems. FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ES* ZG641 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ES* ZG642 VLSI Architecture 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hardware flowcharts; RISC instruction set architecture; pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

ES* ZG651 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

ET ZC234 Manufacturing Processes 4

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ET ZC323 Mechatronics and Automation 4

Introduction to mechatronics, sensors and transducers, pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, features of numerical control machine tools, numerical control part programming, control loops for numerical control systems, computerized numerical control, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems.

ET ZC341 Instrumentation & Control 3

Measurement systems, transducers, feedback control, components: electrical, hydraulic, pneumatic; Signal conditioning and processing, controllers, display, recording, direct digital control,

programmable logic controllers, PC based instrumentation.

ET ZC342 Materials Management 4

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; appraisal and control; just in time (JIT); automation in materials management.

ET ZC344 Instrumentation & Control 4

Generalized measurement system and performance characteristics, Transducers - principles and applications, Signal conditioning circuits – bridges, amplifiers, data converters, filters; Process control – control schemes, controllers, multi-loop control configuration, Control valves; Programmable Logic Controllers, DCS and SCADA, Simulation, Case Studies.

ET ZC352 Energy Management 4

Energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in energy intensive industries; steam generation, distribution systems, and electrical systems; integrated resource planning; demand-side. management; cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications.

ET ZC362 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

ET ZC348 ADDITIVE MANUFACTURING 4

Introduction to Additive Manufacturing, CAD for Additive Manufacturing; Material Science Aspects in Additive Manufacturing, Different materials used in AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate; Various Additive Manufacturing Processes Powder-based AM processes involving sintering and melting, Printing processes (droplet based 3D printing), Fused deposition modelling (FDM), Laminated object manufacturing, Stereolithography, Micro- and nano-additive manufacturing processes; Modelling in Additive Manufacturing Transport phenomena models: temperature and fluid flow, molten pool formation, Various case studies - modelling of fusion based AM process, powder bed melting based process, droplet based printing process; Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications

ET ZC349 IoT in MANUFACTURING 4

Safe work practices and workplace safety, Industrial revolution 4.0, Forces behind Industry 4.0 (IoT, big data and cloud computing, robotics and artificial intelligence), Connected factories (what is connected factory and criteria for connected factory), Smart devices and smart products, cyberphysical system, definition; cps in manufacturing, Connecting devices with each other and with internet, Data acquiring and collection, Communication technologies (WIFI, IEEE 802.15.41), RFID, QR codes and cellular technologies, Protocols, Hardware in IoT, Software (IDE), Cloud platform, Smart devices and control system, Connectivity and networking in IoT, Smart eyes on shop floor, Integrating smart into existing, Programming using IoT, Case study and implementation.

ET ZC412 Production Planning & Control 4

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

ET ZC413 Engineering Design 4

The Engineering Design Process, Current Practices in Engineering Design, Establishing Need, Design Proposal, Formulating the Problem, Structuring the Search for a Solution: Design Goals and Specifications; Applying and Protecting Technical Knowledge, Abstraction and Modeling, Synthesis in Engineering Design, Ethics and Product Liability Issues, Hazard Analysis and Failure Analysis, Design Analysis - Alternative Designs, Prioritizing the Design Goals, Decision Matrix and Economic Analysis, Implementation - Transforming a Design Concept into Reality, Materials Selection in Design, Common Fabrication Materials, Materials Testing, Manufacturing Processes, Communicating the Design, Case Studies.

ET ZC414 Project Appraisal 3

Overview of project and project phases; project formulation aspects in terms of market studies, technical studies, financial studies, economic

studies, environmental studies, etc.; project evaluation aspects in terms of commercial profitability prospects, national economic profitability prospects; issues of project preparation in project implementation.

ET ZC415 Manufacturing Excellence 4

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

ET ZC423 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

ET ZC426 Plant Layout & Design 4

Factors affecting plant layout, Types of layout, procedure for plant layout, techniques and tools for planning layout, quantitative layout analysis, material handling equipment, improving and revising existing layout, evaluation of layout, plant location, evaluation of location, design of layout, computer applications in layout design.

ET ZC434 Quality Control, Assurance & Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

FIN ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

FIN ZG512 Global Financial Markets and Products 4

Capital markets; stock markets, bond markets, derivative markets; operations of these markets from a global perspective; Overview and features of key financial products, equities, fixed income securities and derivatives; bond features, indenture, coupon, maturity, YTM, zero coupon, valuation, duration, convexity; Equities, product features, basic valuation concepts; derivatives, forwards, futures, options, swaps, commodity derivatives, cost of carry, concepts, basic features, payoff, put call parity, basic option strategies; relevant case studies, simulations, modeling.

FIN ZG513 Management of Banks & Financial Institutions 4

Overview and operation of financial institutions and banks; Commercial banking, Investment banking; Define, quantify, and manage various types of risks faced by financial institutions; asset liability management - overview, strategies; off balance sheet activities of banks; sovereign risk; deposit insurance; capital adequacy; study current best practices using selected case studies; bank management failures; insights from collapse of Lehman Brothers; introduction to bank regulation; international considerations; relevant case studies, simulations, modeling.

FIN ZG514 Derivatives and Risk Management 4

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to

various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk.

FIN ZG518 Multinational Finance 4

Effective financial decision making in a multinational corporation; issues in global financial management, international monetary system, balance of payments, foreign exchange markets, international parity conditions, foreign currency options, transaction exposure, operating exposure, translation exposure, sourcing capital globally, foreign investment decisions, basics of multinational taxation, transfer pricing, principles of multinational capital budgeting, and managing multinational operations . Extensive use of case studies and simulations to connect theory with practice.

FIN ZG519 Business Analysis and Valuation 4

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

FIN ZG520 Security Analysis and Portfolio Management 4

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives, options & futures.

FIN ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

FIN ZG522 Mergers, Acquisitions, and Corporate Restructuring 4

Basics of M&A (corporate finance, strategy, economics), merger types, trends; theories underlying M&A; legal aspects; evaluating an acquisition target; valuation of mergers and acquisitions, MVA, relative valuation, multiples, DCF, FCFF, FCFE; M&A deal structuring; synergy analysis; break-up valuation; sensitivity analysis; terms of merger; financing considerations; capital structure decisions; structuring and valuing of Leveraged Buy-out (LBO) transaction; financing considerations; exit strategies; extensive use of relevant case studies, simulations, modeling.

FIN ZG523 Market Risk Management 4

Market risk measurement and management in foreign exchange markets, debt markets, equity markets, commodities markets; application of Value-at-Risk (VaR) to market risk management, VaR methods, VaR mapping, stress testing, multi factor VaR, limitations of VaR, alternative metrics to VaR, expected shortfall; market risk in bank trading strategies; market risk management in fixed income securities, duration, convexity, advanced term structure models, mortgage backed securities, pre-payment risk, burnout, modeling pre-payment risk; volatility smiles, exotic options; measuring and managing corporate risk, cash flow exposures; extensive use of relevant case studies, simulations, modeling.

FIN ZG524 Credit Risk Management 4

Default, charge-off, bankruptcy; loan restructuring, loan moratorium; counterparty credit risk, measurement, management; credit risk modeling, quantitative models, Probability of Default, Exposure at Default, Loss Given Default, Expected and Unexpected losses; qualitative framework, five Cs of credit; application of Value-at-Risk (VaR) to credit risk management, i.e. Credit VaR, default risk measurement and management in Fixed Income securities, and securitization; extensive use of relevant case studies, simulations, modeling.

FIN ZG525 Operational Risk Management 4

Topics covered include: operational risk measurement, management framework; internal loss data, external loss data; key risk indicators; scenario analysis, stress testing; risk appetite; reputational risk and operational risk; application of

value-at-risk (VaR) to operational risk management; liquidity risk, definition, measurement and management; liquidity adjusted VaR; liquidity and leverage; legal risk, compliance risk; fraud risk (internal and external); model risk; enterprise risk management; extensive use of relevant case studies, simulations, modeling.

FIN ZG526 Advanced Risk Models 4

Advanced VaR models, expected shortfall, stressed VaR, historical simulation, delta/ gamma models, full revaluation, risk factor selection, volatility clustering, structured Monte Carlo analysis, stress testing, scenario analysis, back testing; country and sovereign risk models; management of country and sovereign risks, external and internal credit ratings methodology and framework; expected and unexpected loss framework and related metrics; extensive use of relevant case studies, simulations, modeling.

FIN ZG527 International Regulatory Framework for Banks 4

Three pillars of the Basel II framework; key elements of risk management in banks; various methodologies used to calculate capital and provision requirements under Basel III framework, capital conservation buffer, counter cyclical capital buffer; liquidity coverage ratio, NSFR, leverage ratio; implications for the management of credit risk, market risk and operational risk; basic approach, standardized approach, advanced approach, etc.; extensive use of relevant case studies relating to bank failures and 2008 financial crisis.

FIN ZG528 Venture Capital & Private Equity 4

This course will lay a strong foundation in core concepts, features and characteristics of the venture capital and private equity markets; specialized services provided by VC's and PE funds; stages in VC investing; deal flow; deal sourcing, evaluation; risk return tradeoff of VC/ PE investments; valuation of VC/ PE transactions; structuring and execution of deals; exit options, distributions; Course will make extensive use of case studies to understand industry best practices and current trends.

HHSM ZG513 Biostatistics & Epidemiology 4

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

HHSM ZG516Epidemic & Disaster Management 4

Disaster management; impact and response; relief phase; disaster mitigation in health sector; disaster preparedness; policy development; man-made disasters; international agencies providing health based humanitarian assistance; and strategies for disaster management.

HHSM ZG517Health Care Management 4

Basis of organizational culture and management techniques for efficient administration of health delivery; general principles of HR, materials and operation management; understanding the organizational culture that exists in public, private and non-Govt. sector agencies; management information system.

HHSM ZG614 Hospital Operations Management 4

Operations Management aspects connected with outpatient ward, casualty, operation theatres, diagnostic laboratories, pathology laboratories, pharmacy, diet and nutrition, blood bank, laundry, medical records, security, scheduling and deployment of doctors, nurses and other staff, accounts among others; Equipment planning and management, Materials management, Management of human resources in hospitals, Hospital Management Information Systems, Licensing and legal compliance, Quality and accreditation of hospitals and healthcare organizations. The course will involve onsite visits in a hospital, discussions and presentations on the practical aspects of hospital operations management.

HHSM ZG615 Service Quality Excellence in Healthcare 4

Quality in healthcare, Leadership for Quality, Customer satisfaction in healthcare, Continual improvement, cost of quality, Benchmarking, Performance measures, Statistical process control, Experimental design, Quality tools, Lean tools applied in healthcare, Case study in healthcare.

HHSM ZG617 Strategic Management of Healthcare Organizations 4

Strategic management function within contemporary health services organization with focus on organizational strategic planning processes including principles and methods of strategic assessment, strategy formulation, evaluation, implementation, and control, Case studies in healthcare systems.

HHSM ZG631 Introduction to Health Systems & Environmental Health 4

Introduction to health systems; functions of health systems; managing health systems; problems of health systems management; Major environmental health problems including quality of water, waste disposal food production and processing, vector control etc. Air pollution and its controlling, Hazards of radiation, municipal and other wastes, Occupational health hazards.

IS ZC313 Object Oriented Programming & Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

IS ZC314 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

IS ZC323 Systems Programming 3

Batch processing Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

IS ZC327 Systems Programming 4

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific Programming including shell-scripting via online laboratory facility.

IS ZC328 Software Testing 3

Brief description of importance of software, Life cycle model and process, Basic software testing, all definitions, Types of testing and techniques (CFG, CDG etc.), Black Box & white box Testing Methodologies, Finite State Machine Model, State based Testing, Static Testing and analysis, Test cases, Test Data Generation ,Test selection ,Minimizations and Prioritization, Test adequacy criteria, Software Testing on Web Engineering, Object based Software Testing, Architecture of Testing tool, Software Test Effort Estimation, Testing behavior and process model, Qualitative analysis, Quality factors in software testing, Selection of testing tools.

IS ZC332 Database System & Application 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

IS ZC337 Database Systems & Applications 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

IS ZC343 Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

IS ZC353 Computer Organization & Architecture **4**

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

IS ZC362 Operating Systems **3**

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

IS ZC363 Data Structures & Algorithms **4**

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; Analysis of algorithms; Linear data structures – stacks, arrays, lists, queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees; Implementation techniques for different data structures including trees, graphs and search structures; Performance evaluation of data structures and algorithms; Implementation issues in large data structures.

IS ZC364 Operating Systems **4**

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, inter process communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

IS ZC365 Human Computer Interaction **3**

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

IS ZC373 Complier Design **4**

Introduction to Programming Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime.

IS ZC415 Data Mining **3**

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

IS ZC422 Parallel Computing **3**

Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix

algebra, graphs, discrete optimization problems and computational geometry.

IS ZC423 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

IS ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

IS ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

IS ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

IS ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

IS ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

IS ZC464 Machine Learning 3

Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical / probabilistic methods, genetic algorithms; inductive / analytic / reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

IS ZC465 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

IS ZC467 Computer Networks 4

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode

(ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols, Laboratory experiments / assignments related to simulation of network protocols, programming simple network applications, implementing select routing algorithms via online laboratory facility.

IS ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

IS ZC472 Computer Graphics 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

IS ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

MATH ZC161 Engineering Mathematics I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

MATH ZC222 Discrete Structure for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

MATH ZC232 Engineering Mathematics II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

MATH ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

MATH ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

MBA ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

MBA ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

MBA ZC416 Managerial Economics 4

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking,

employment, interest, inflation, economics of information, problem of adverse selection, moral hazard problem, market failure, externalities, public goods.

MBA ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

MBA ZG511 Managing People & Organizations 4

Concepts and principles of management as applied to a variety of organizations; study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; planning activities, leadership & control; manpower development; organizational behavior and theory.

MBA ZG513 Enterprise Resource Planning 4

Course description to be developed.

MBA ZG514 Leadership & Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MBA ZG515 Consulting & People Skills 4

Facilitation skills, Communication skills, Presentation and Interviewing skills, Analytical Skills, Creativity, Partnership and networking skills, Critical thinking skills, Emotional Intelligence Development, Stress Management, Ethics and respect for the client, Vision and Framing of issues, Synthesizing Skills, Leadership skills.

MBA ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation- time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

MBA ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

MBA ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MBA ZG525 Business Process Analysis 4

Course description to be developed.

MBA ZG524 Quality Management System 5

Quality system & quality management, evolution of quality post world war II era i.e. Quality control, quality assurance, total quality control & total quality management; ISO 9000 series of standards, formation of ISO (1947), background & development of ISO 9000. ISO 9000 family of standards, selection & use of appropriate model of ISO 9000. Requirements of ISO 9001; System demonstration & documentation, how to organize formal quality assurance system, pyramid of quality system documentation structure, two tier, three tier & four tier documentation, preparation of quality manual & quality procedures, quality records; Implementing documented quality system, how to proceed, how to implement change, obtaining top management commitment, assessing current company position, developing the implementation plan, initiating people (employees) to own the system, system development; System audit & review, objective of system audit, types of quality audit, product Vs system audit, internal quality audit, management review; System certification, benefits of third party certification, choice of certification body, route to certification, surveillance

& renewal; Other quality system standards, relating ISO 9000 with QS 9000 and ISO 14000.

MBA ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

MBA ZG531 Statistical Quality Control 5

Sources of Variation: Common and Assignable Causes, Descriptive Statistics, Statistical Process Control Methods, Control Charts for Variables, Control Charts for Attributes, C-Charts, Process Capability, Acceptance Sampling, Operating characteristic curve, Statistical Quality Control in Services.

MBA ZG535 Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

MBA ZG537 Lean Manufacturing 5

Course description to be developed.

MBA ZG541 Consultancy Practice 4

Strategic planning and marketing of consultancy services, client consultant relationships, technology transfers, negotiations, agreements, guarantees, organizing and executing consultancy services, quality in consultancy services, technical audit, government policies such as industrial policy, trade policy, technology policy, patent and trademarks etc.

MBA ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

MBA ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

MBA ZG634 Strategic Change Management 4

Results-based management, managing for outcomes–objectives and targets; strategy; indicator, performance information; environmental scan and SWOT analysis; planning, budgeting, implementation, review - the (strategic) management cycle Models and theories of planned change, Strategic management: transformational leadership or change management (or learning), Strategic management in a context of joint action and networks, Participation and Empowerment, Teams and Teamwork, Parallel learning structures, OD Interventions, Team Interventions, Intergroup and third party interventions, Structural and Comprehensive interventions, Action research, Socio-clinical and Socio-technical Approaches, Issues in Consultant-Client Relationships, Power Politics and Organization Development.

MBA ZG641 Management Information & Decision Support Systems 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

MBA ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews,

critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

MBA ZG623TProject 12

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work in Engineering / Management aspects that are considered vital to the sponsoring organization. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar & viva-voce.

ME* ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, poly phase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ME* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

ME* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

ME* ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

ME* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

ME* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

ME* ZC234 Maintenance & Safety 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipments and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

ME* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of

matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

ME* ZC236 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ME* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

ME* ZC242 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ME* ZC251 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ME* ZC261 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ME* ZC271 Manufacturing Excellence 3

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

ME* ZC311 Automobile Technology –I 3

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development.

ME* ZC312 Automobile Technology-II 3

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box-arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law.

ME* ZC323 Design of Machine Elements 4

Fundamentals and principles of design; properties of engineering materials; design of simple machine parts; shafts, keys and couplings; power screws; threaded joints, welded and riveted joints, bearings and seals, gears, cams and followers; design of mechanisms.

ME* ZC324 Mechatronics and Automation 4

Introduction to mechatronics, sensors and transducers, Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related signal conditioning techniques , pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic

controllers; Introduction to automation, control loops for numerical control systems, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems, System design concepts through case studies.

ME* ZC331 Production Planning & Control 3

Types of production systems and problems of planning and control, product planning, forecasting, product demand, process planning, project management, capacities location and layout of facilities, aggregate planning and scheduling, materials requirement, planning, inventory management, systems and recent trends in production management.

ME* ZC332 Operations Research 3

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems.

ME* ZC343 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; stores management; material planning, make or buy decisions; scheduling, strategic sourcing, JIT, Kanban system; inventory costing principle; concept of MRP II; vendor development; central excise, customs, importing, sales tax.

ME* ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

ME*ZC418 Lean Manufacturing 3

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement.

ME* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

ME* ZC432 Quality Control, Assurance & Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ME* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

MEL* ZC415 Introduction to MEMS 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; micro actuators, microsensors and micro electromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micro manufacturing; micro fludidics; micro robotics; case studies.

MEL* ZG510 RF Microelectronics 5

Introduction; application of RF electronics in modern systems; basic concepts in RF circuit design, active RF components: various RF diodes and transistors and their circuit models, matching and biasing networks, RF amplifier design: low power, low noise and broadband amplifiers, RF oscillator design; negative resistance oscillator; dielectric resonator oscillators, phase noise. RF Mixers: Balanced mixers; low noise mixers; noise in RF circuits, microwave transmitters and receivers.

MEL* ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

MEL* ZG512 Optoelectronic Devices, Circuit & Systems 5

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

MEL* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

MEL* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

MEL* ZG526 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

MEL* ZG531 Testability for VLSI 5

BIST, boundary sean, stuck-at faults, test generation algorithms for combinatorial logic circuits and sequential circuits, logic simulation and fault simulation, synthesis for test, built in self-test, pseudo-random test techniques, other test methods - IDDQ testing, boundary scan etc.

MEL* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

MEL* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation. Systolic Architectures.

MEL* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

MEL* ZG611 IC Fabrication Technology 5

Material properties; Crystal growth and doping; diffusion; oxidation; epitaxy; Ion implantation; Deposition of films using CVD, LPCVD and

sputtering techniques; Wet and dry etching and cleaning; Lithographic process; Device and circuit fabrication; Process modeling and simulation.

MEL* ZG613 Advanced Digital Signal Processing 4

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalmanfilter, non-linear identification, quasi linearization, numerical identification methods.

MEL* ZG621 VLSI Design 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; Structured design and testing; Symbolic layout systems; CMOS subsystem design; System case studies.

MEL* ZG623 Advanced VLSI Design 5

Deep submicron device behavior and models, interconnect modeling for parasitic estimation, Clock signals and system timing--Digital phase locked loop design, memory and array structures, Input/output circuits design, ASIC technology, FPGA technology, High speed arithmetic circuits design, -Parallel prefix computation, Logical effort in circuit design, Low power VLSI Circuits-Adiabatic logic circuits, Multi threshold circuits, Digital BICMOS circuits, Design of VLSI systems.

MEL* ZG625 Advanced Analog and Mixed Signal Design 5

Design of high speed compartors and Op-amps; analog buffers; different architectures of A/D and D/A converters; analog multipliers and dividers; design of PLLS; design methods for switched capacitor filters sample and hold circuits; mixed signal design issues; noise coupling from substrate and its reduction; cross talk and shielding; analog layout techniques for mixed signal designs.

MEL* ZG631 Physics & Modelling of Microelectronic Devices 5

Physics and properties of semiconductor - a review; pn junction diode; bipolar transistor; metalsemiconductor contacts; JFET and MESFET; MOSFET and scaling; CCD and photonic devices.

MEL* ZG632 Analog IC Design 5

Basic concepts; BICMOS process and technology; current and voltage sources; Differential and Operational Amplifiers; Multipliers and modulators; phase-lock techniques; D-to-A and A- to-D converters; Micropower circuits; High voltage circuits; Radiation Resistant Circuits; Filter design considerations.

MEL* ZG641 CAD for IC Design 5

Introduction to VLSI design methodologies and supporting CAD tool environment; Overview of `C', Data structure, Graphics and CIF; Concepts, structures and algorithms of some of the following CAD tools; Schematic editors; Layout editors; Module generators; Silicon compilers; Placement and routing tools; Behavioral, functional, logic and circuit simulators; Aids for test generation and testing.

MEL* ZG642 VLSI Architecture 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hardware flowcharts; RISC instruction set architecture; pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

MEL* ZG651 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

MEL* ZG652 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

MGTS ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MM ZC348 ADDITIVE MANUFACTURING 4

Introduction to Additive Manufacturing, CAD for Additive Manufacturing; Material Science Aspects in Additive Manufacturing, Different materials used in AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate; Various Additive Manufacturing Processes Powder-based AM processes involving sintering and melting, Printing processes (droplet based 3D printing), Fused deposition modelling (FDM), Laminated object manufacturing, Stereolithography, Micro- and nano-additive manufacturing processes; Modelling in Additive Manufacturing Transport phenomena models: temperature and fluid flow, molten pool formation, Various case studies - modelling of fusion based AM process, powder bed melting based process, droplet based printing process; Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications

MM ZC349 IoT in MANUFACTURING 4

Safe work practices and workplace safety, Industrial revolution 4.0, Forces behind Industry 4.0 (IoT, big data and cloud computing, robotics and artificial intelligence), Connected factories (what is connected factory and criteria for connected factory), Smart devices and smart products, cyberphysical system, definition; cps in manufacturing, Connecting devices with each other and with internet, Data acquiring and collection, Communication technologies (WIFI, IEEE 802.15.41), RFID, QR codes and cellular technologies, Protocols, Hardware in IoT, Software (IDE), Cloud platform, Smart devices and control system, Connectivity and networking in IoT, Smart eyes on shop floor, Integrating smart into existing, Programming using IoT, Case study and implementation.

MM ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

MM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

MM* ZC472 Precision Engineering 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

MM ZG512 Manufacturing Strategy 4

Corporate strategy; Missing links in manufacturing strategy; Audit approach; Restructuring; Manufacturing strategy process in practice; Formulation as a process; Operating strategies; Methodology framework; Lean production; Competitive priorities; Strategic value of response time and product variety; Flexibility in context of manufacturing strategy; Manufacturing focus; Business process reengineering; Theory of constraints; Link between strategy and organizational culture; Evolution of manufacturing systems; Operations management strategic perspective.

MM ZG513 Maintenance Engineering 5

Introduction, maintenance systems, methods and tools of maintenance analysis, reliability and safety, maintainability, supportability, design for maintenance, maintenance integration computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

MM ZG514 Leadership and Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

MM ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability

MM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

MM ZG534 Sustainable Manufacturing 4

Introduction to sustainable manufacturing, sustainable manufacturing design, practice and matrices, life cycle management and assessment, end of life (EOL) strategies, implementation framework, sustainable business models, waste minimization, case studies.

MM ZG535 Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

MM ZG537 Lean Manufacturing 5

Course description to be developed.

MM ZG539 Six Sigma 4

History of Six Sigma, Implementing Six Sigma, Becoming a Customer and Market-Driven Enterprise, Customer Expectations and Needs, Linking Six Sigma Projects to Strategies, Attributes of Good Metrics, Using resources wisely, Project Management Using the DMAIC and DMADV Models, The Define Phase, The Measure Phase, Measurement System Analysis, Analyzing Data: Value Streams and Dealing with Variations, Designing Experiments, The Improve Phase, The Control Phase.

MM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychol giccl, physiological considerations in design decision making; legal factors, engineering ethics and society.

MM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic

management of MNCs, management style and behavior, corporate style, behavior and culture.

MM ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

MM ZG627 Managerial Corporate Finance 4

Introduction to corporate finance; financial statements -analysis and interpretation; value creation – ways and means; time value of money; risk and return; understanding and analyzing various cost concepts and behaviour; analysis and impact of leverage; cost of capital; project appraisal and management - emphasis on technology projects (Diamond framework: NTPC - Novelty, Technology, Pace and Complexity); dimensions of adaptive technology project management; measuring and controlling assets employed in a project; project risk analysis; management control of projects; project financing – leasing and hire purchase; management control system - budget preparation; analyzing financial performance reports (variance analysis) and performance measurement system; working capital management – managing operating capital.

MM ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

MT* ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

MT* ZC213 Engineering Measurements 4

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

MT* ZC221 Computer Programming 4

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

MT* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MT* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

MT* ZC234 Maintenance & Safety 3

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety;

maintenance of components and equipments; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

MT* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

MT* ZC236 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

MT* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

MT* ZC245 Fluid Mechanics and Machines 4

Introduction and fundamental concepts, fluid statics, kinematics and dynamics of fluid flow, inviscid flows, pipe flow and network design, open channel flow, incompressible viscous flow, laminar boundary layers, turbulent flows, essentials of compressible flow, dimensional and model analysis, orifice, venturi, notches and weirs, hydraulic turbines, centrifugal and reciprocating pumps, fluid couplings and torque convertors, compressors.

MT* ZC251 Mechanical Technology 4

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

MT* ZC261 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

MT* ZC311 Automobile Technology-I 4

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development. Virtual demonstration of automobile parts and assemblies may be demonstrated. Some amount of Pro/Engineer (CREO) modeling of automobile structures may be practiced.

MT* ZC312 Automobile Technology-II 4

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law. Virtual demonstration of automobile parts and assemblies may be demonstrated. Some amount of Pro/Engineer (CREO) modeling of automobile structures may be practiced.

MT* ZC315 Casting and Welding 4

Casting: fundamentals of casting processes, design of castings, furnaces, foundry mechanization, special casting processes, economics of casting, inspection and defects of casting. Powder metallurgy: introduction, methods of powder production, characteristics and properties of powder, manufacturing methods, furnaces, finishing processes, economics of

powder metallurgy. Welding: various welding processes, design for welding, safe practices in welding, inspection and defects of welding, economics of welding, brazing and soldering. Virtual simulation of casting and welding processes.

MT* ZC316 Transport Phenomena 4

Fundamental concepts of fluid flow, concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, concept of pressure drop and drag; Heat transfer: steady state and unsteady state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; Elements of mass transfer; one dimensional compressible flow; associated laboratory on condenser, boiler, economizer, super heater etc.

MT* ZC324 Mechatronics & Automation 4

Introduction to mechatronics, sensors and transducers, Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related signal conditioning techniques , pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, control loops for numerical control systems, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems, System design concepts through case studies. Virtual demonstration of mechatronics elements, their assembly to obtain devices and products etc.

MT* ZC331 Production Planning & Control 4

Types of production systems and problems of planning and control, product planning, forecasting, product demand, process planning, project management, capacities location and layout of facilities, aggregate planning and scheduling, materials requirement, planning, inventory management, systems and recent trends in production management. Simulations using software tools such as FlexSim or Quest may be conducted.

MT* ZC332 Operations Research 4

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems. FlexSim and Lingo/Lindo based virtual simulations.

MT* ZC342 Machine Design 4

Fundamentals and principles of design, design and selection of machine elements such as shafts, spindle supports, gears, bearings; etc.; design of mechanism; design of machine tool structure; dynamics of machine tools; introduction to CAD, CAM, CIM; Design of jigs and fixtures; press tools for blanking; punching; drawing; combination tools and progressive tools. Machine Drawing of part and assembly drawing using Pro/Engineer (CREO) or similar software tools are to be conducted.

MT* ZC343 Materials Management 4

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; stores management; material planning, make or buy decisions; scheduling, strategic sourcing, JIT, Kanban system; inventory costing principle; concept of MRP II; vendor development; central excise, customs, importing, sales tax. FlexSim/Quest based simulations.

MT* ZC344 Metal Forming and Machining 4

Metal forming: introduction, metal forming machines, metal forming process analysis and design. Machining: introduction, metal cutting machine tools, mechanics of metal cutting, other aspects of machining processes, grinding and finishing operations, non-conventional machining processes and processing of plastics. It may consist of virtual practical work using software tool CNC Simulator-Pro (http://cncsimulator.info/). Similarly, we need to get metal forming process animations in 3DS-Max, Maya or similar software tools. Virtual simulation of metal forming and machining processes.

MT* ZC348 ADDITIVE MANUFACTURING 4

Introduction to Additive Manufacturing, CAD for Additive Manufacturing; Material Science Aspects in Additive Manufacturing, Different materials used in AM, Use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate; Various Additive Manufacturing Processes Powder-based AM processes involving sintering and melting, Printing processes (droplet based 3D printing), Fused deposition modelling (FDM), Laminated object manufacturing, Stereolithography, Micro- and nano-additive manufacturing processes; Modelling in Additive

Manufacturing Transport phenomena models: temperature and fluid flow, molten pool formation, Various case studies - modelling of fusion based AM process, powder bed melting based process, droplet based printing process; Applications of Additive Manufacturing in Aerospace, Automotive, Electronics industries and Biomedical applications

MT* ZC349 IoT in MANUFACTURING 4

Safe work practices and workplace safety, Industrial revolution 4.0, Forces behind Industry 4.0 (IoT, big data and cloud computing, robotics and artificial intelligence), Connected factories (what is connected factory and criteria for connected factory), Smart devices and smart products, cyberphysical system, definition; cps in manufacturing, Connecting devices with each other and with internet, Data acquiring and collection, Communication technologies (WIFI, IEEE 802.15.41), RFID, QR codes and cellular technologies, Protocols, Hardware in IoT, Software (IDE), Cloud platform, Smart devices and control system, Connectivity and networking in IoT, Smart eyes on shop floor, Integrating smart into existing, Programming using IoT, Case study and implementation.

MT* ZC411 Tool and Fixture Design 3

Tool-design methods, tool making practices, tooling materials and heat treatment, design of cutting tools, gages and gage design, locating and clamping methods, design of drill jigs, design of fixtures, design of sheet metal blanking and piercing dies, design of sheet metal bending, forming and drawing dies, using plastics as tooling materials, tool design for numerically controlled machine tools and automatic screw machines.

MT* ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS. FlexSim/Quest based simulations.

MT* ZC418 Lean Manufacturing 4

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement. Logistics case studies using software tools such as FlexSim may be conducted.

MT* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

MT* ZC432 Computer Aided Manufacturing 3

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

MT* ZC434 Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

MT* ZC452 Composite Materials and Design 4

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous

reinforcements, matrix materials, micromechanical aspects of composites, manufacturing methods, composite production design methods design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies. Simulation of mechanics of composite materials using suitable software tools.

MT* ZC471 Manufacturing Excellence 4

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility. FlexSim/Quest based simulations.

PCAM* ZC211 Regression 2

Regression as a type of supervised learning technique where the target attribute is a continuous variable; regression models from theoretical and implementation perspectives. Model selection and performance measures; Issues with regression models such as overfitting and the ways of combatting overfitting like ridge and lasso regression; Interpretability/explicability of the models;

PCAM* ZC111 Feature Engineering 1

Feature Engineering as a step to develop and improve performance of Machine Learning models; Data wrangling techniques that help transforming the raw data to an appropriate form for learning algorithms; Data preprocessing techniques such as normalization, discretization, feature subset selection etc. and dimension reduction techniques such as PCA. Different ways of visualizing the data such as Box plots, Contour plots, Heat maps etc.

PCAM* ZC311 Classification 3

Classification is a type of supervised learning techniques where the target attribute takes discrete values; Three types of techniques to solve classification problems – discriminant function, generative, and probabilistic discriminative approaches. Algorithmic perspective of popular classification algorithms - k-NN, Naïve Bayes, Decision Tree, Logistic Regression and SVM. Implementation details of these models along with tuning of parameters. Ensemble methods, bagging, boosting, Random Forest and eXtreme Gradient Boosting. Interpretability/explicability of the models;

PCAM* ZC221 Unsupervised Learning and Association Rule Mining 2

Unsupervised learning algorithms for finding regularities in the absence of explicit labels or supervised outputs; Clustering as an unsupervised learning task to find natural grouping in the data. Various clustering algorithms such as K-Means, EM Algorithm, Single Linkage Algorithm, Complete Linkage algorithm and DBSCAN. Various ways of assessing the quality of clustering and detecting outliers. Typical industrial applications of unsupervised learning algorithms; Introduction to HMM in the context of performing time series prediction; role of EM algorithm in estimating the parameters. Algorithms to learn association or discover dependencies between the data items; Apriori algorithm and different metrics to measure the interestingness of the rules.

PCAM* ZC231 Text Mining 2

Unstructured or semi structured data and their forms; Extracting the relevant text data and identifying patterns therein. Converting documents to vectors using TF-IDF, Parts of Speech Tagging, Topic modelling using LDA, sentiment analysis and recommender systems.

PCAM* ZC241 Deep Learning and Artificial Neural Networks 2

Details of neural networks as well as deep learning architectures. An algorithmic perspective and implementation details of ANN, RNN, LSTM, CNN, RCNN, Faster RCNN, Autoencoders, Generative deep learning models like Boltzmann Machine, Deep Belief Machines and GAN etc.

PCAM* ZC321 Capstone Project 3

Real life problems encompassing a typical data science pipeline obtained from organizations/third party vendors; Jointly mentored by the industry experts and faculty; Comparative study of the relevant techniques covered in the course; Presenting the results in the required format; Fortnightly review of progress of the project.

PCGM* ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales

promotion, positioning, marketing regulation, market research basics of industrial marketing.

PCGM* ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

PCGM* ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

PCGM* ZC416 Managerial Economics 4

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation, economics of information, problem of adverse selection, moral hazard problem, market failure, externalities, public goods.

PCMP* ZG511 Managing People & Organizations 4

Concepts and principles of management as applied to a variety of organizations; study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; planning activities, leadership & control; manpower development; organizational behavior and theory.

PCMP* ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

PCMP* ZG537 Lean Manufacturing 5

Course description is same as given under MBA ZG537

PCMP* ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

PDMM* ZG511 Managing People & Organizations 4

Concepts and principles of management as applied to a variety of organizations; study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; planning activities, leadership & control; manpower development; organizational behavior and theory.

PDMM* ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

PDMM* ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

PDMM* ZG537 Lean Manufacturing 5

Course description is same as given under MBA ZG537

PDMM* ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

PDMM* ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

PDMM* ZC416 Managerial Economics 4

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation, economics of information, problem of adverse selection, moral hazard problem, market failure, externalities, public goods.

PDMM* ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

PE*ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, singlephase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

PE* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

PE* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

PE* ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

PE* ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

PE*ZC214 Pharmaceutical Analysis 3

Basic techniques of pharmaceutical analysis, data handling and analysis, sources of error in analysis. The analytical methods would comprise of various titrimetric methods, such as acid-base, complexometric, non-aqueous, oxidation-reduction, precipitation, conductometric; physical and instrumental analysis such as gravimetric, polarography, nephelometry, amperometry, turbidometry, potentiometry; chromatographic separations such as TLC, coloumn, ion-exchange,

extraction methods such as gel-filtration, fractionation processes, analysis of metallic and non-metallic elements; water content, as well as evaluation of drug constituents in various pharmaceutical preparation.

PE* ZC221 Disinfection & Sterilization Processes 3

Common sources of microbes, contamination methods; processes involved in disinfection of materials; enclosed space, sanitation; sterilization methods – dry heat, moist heat, air, filtration; aseptic processing, sterility testing, indicators and sampling methods; skin disinfection.

PE* ZC231Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

PE* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

PE* ZC234 Manufacturing Processes 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

PE* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

PE* ZC241 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

PE* ZC242 Thermodynamics & Kinetics 3

Importance and Fundamental concepts of Thermodynamics, concept of states, systems, equilibrium, extensive and intensive properties, homogeneous and heterogeneous systems, First Law of Thermodynamics, Internal energy, heat capacity, isothermal, and adiabatic processes, Second law of Thermodynamics, criteria of equilibrium, Maxwell's relations, Gibbs-Helmholtz equation, Entropy, Kinetic Theory, Auxiliary Functions, Heat Capacity, Enthalpy, Phase Equilibrium in one component system, Concept of Third law, relation between Cp and Cv, Fugacity, equilibrium constant, use of Y S - functions, Ellingham-Richardson diagrams, phase stability diagrams, Behaviour of Solutions, Thermodynamics of non-reacting mixtures, reaction rate theory, Introduction to metallurgical kinetics, heterogeneous reaction kinetics-gas-solid, solid-liquid, liquid-liquid and solid-solid systems, concept of Johnson- Mehl equation, effect of temperature on reaction rates, energy of activation, Solutions, partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, Change of standard state, Phase relations and phase rule, Free energy composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines, Effect of pressure on phase transformation and phase equilibria.

PE* ZC252 Mineral Beneficiations and Agglomeration 3

Early development in Metal Extraction, General methods of extraction, The necessity and methods of beneficiation, mineralogical assessment, Minerals and ores, refining, importance of mineral dressing, principles of flotation, Refractories, different comminution methods-fracture, Crushing and Grinding machines, liberation, size-criteria, energy-size relationships, crushing grinding and attrition, screening and classification, cyclones, concentration processes-density, electrical, magnetic separators and other physical methods, Interfacial phenomenon, surfactants, Floatation principles and froth floatation, liquid-solid

separation-floculation, thickening, classification, free and hindered settling, Dry and wet sizing, Jigging, surface chemistry of minerals, dewatering, Pollution in beneficiation plants, Agglomeration: Basic processes-Nodulization, briquetting, Pelletization, sintering, Material Balances in process flows: Component and total mass balances of reactive and non-reactive systems including recycling, Batch and steady state flows, Unit Processes in pyrometallurgy: calcination, roasting, sintering, smelting , converting, distillation, Metallothermic reduction and hydrogen reduction, refining processes with examples for metals like copper, nickel, lead, zinc, etc. Unit processes in hydrometallurgy: leaching, purification of leach liquor, solvent extraction and ion exchange process, metal recovery from aqueous phase. Unit processes in electrometallurgy: Faraday's laws of electrolysis, concept of overvoltage, limiting current density, overall cell voltage, series and parallel electrical circuits in refining, Electrowinning and electrorefining with reference to Cu, Zu, Al, Mg.

PE* ZC262 Iron Making 3

World production of Iron and steel, occurrence and distribution of iron ore, coal and limestone in India and world, General layout of integrated steel plant, Raw materials in ferrous production metallurgy, coke production, agglomeration of iron ores. Technology of blast furnace iron making - operational details, Study of blast furnace processes and blast furnace slag, Blast furnace reactions, Raceway, Cohesive zone, Thermodynamics of slag-metal reactions, high top pressure, oxygen enrichment, injection of auxiliary fuels. Blast furnace design, Furnace productivity, the coke rate, hot metal quality. Alternate routes of iron making, Temperature profile, Aerodynamics, different factors, Irregularities etc., Heat exchange zones in blast furnace.

PE* ZC272 Furnace Technology 3

Conventional, non-conventional and newer sources of energy, energy management problems in metallurgical Industries, role of high temperature systems and materials, deposits, manufacturing, properties and testing of solid, liquid and gaseous fuels; Principles of fuel combustion and burner design. Classification of refractory, manufacturing and properties of common refractories such as silica, fire clay, high alumina, dolomite, magnesite and chrome refractories. Furnaces, Types, Design of high temperature furnaces, waste heat utilization, heat recuperators and refrigerators, stack design, gas cleaning, heat balance diagrams; furnace dynamics: fluid flow calculations, fuel fired furnaces, electric arc furnaces, vacuum, electron beam, plasma, laser furnaces.

PE* ZC311 Chemical Engineering Thermodynamics 4

Concept of heat and work, Ideal and real gas systems, Thermodynamic Laws, P-V-T behaviour of real gases, Concept of entropy, Heat effects, First and Second law analysis of processes including power plants and refrigeration systems, Thermodynamic Property relations, Vapour liquid equilibrium, Solutions thermodynamics: Theory and applications, Chemical Reaction equilibria, Special topics in Phase equilibrium, Role of thermodynamics in process simulation, Case studies.

PE* ZC312 Steel Making & Casting 3

Fundamentals of Steel making, Historical development of steel making processes. Open hearth, basic oxygen, electric arc and induction furnace steel making, processes, Thermodynamics, kinetics and transport phenomena in steel making, Introduction to ladle metallurgy. Refining of Steel. Continuous Casting, near net shape making, clean steel practices, stainless steel making and emerging trends in steel making and continuous casting. Introduction to casting, Molding Equipment Processes, Molding Sand, Cores, Core Materials, Solidification of Metals.

PE* ZC313 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

PE* ZC314 Power Plant Engineering 3

Classification of power plants. Components and layout of; thermal, nuclear, hydroelectric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

PE* ZC316 Transport Phenomena – I **4**

Diffusional transport of fluid heat and mass (a comparison), Fluid statics, Laminar and turbulent flows, Boundary layer concept (hydrodynamic, thermal and concentration), Continuity equation, Bernoulli's equation, Introduction to equations of motion, Laminar and turbulent flow in pipes, concept of drag, packed beds and fluidization, steady state heat conduction, concept of heat transfer coefficient, convective heat transfer (forced and natural convection correlations), introduction to radiative heat transfer, interphase mass transfer and mass transfer coefficients, analogy between fluid flow, heat and mass transfer.

PE* ZC317 Transport Phenomena – II **4**

Transportation and metering of fluids (pumps, fittings, valves and compressors), flow measurement, Condensation and boiling, heat exchange equipment, absorption, concept of equilibrium stage operations, distillation, extraction selected operations like crushing, grinding, drying, filtration, evaporation, etc.

PE* ZC318 Fundamentals of Transport Processes **4**

Concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, Concept of pressure drop and drag, Introduction to conduction, convection (free and forced) and radiation including Fourier's law of heat conduction, Newton's law of cooling, Stefan Boltzmann and Kirchhoff's laws, concept of resistance and lumped capacitance; Boundary layer theory (momentum, thermal and mass), Heat transfer correlations; Phase change heat transfer, Diffusion fundamentals including Fick's law, Interphase mass transfer, Concept of mass transfer coefficient, Momentum, heat and mass transfer analogies, Introduction to transport equations.

PE* ZC319 Unit Operations - 1 **4**

Pumps and compressors, Flow measurement devices, piping networks, Agitation and mixing, Packed and fluidized beds, Heat exchangers including boilers and condensers, LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation, Distillation, Absorption, Leaching, Humidification and drying, Cooling towers.

PE* ZC320 Unit Operations - II **4**

Sedimentation, Evaporation, Liquid – Liquid extraction, adsorption, Mechanical separations like filtration, centrifugation, froth floatation etc., Solid separations based on size reduction including sieving operations and related equipment like crushers, mills, pulverizers etc., special separation processes like ion-exchange, membranes, chromatography etc.

PE* ZC321 Chemical Process Calculations **3**

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

PE* ZC322 Process Design Principles **4**

Process invention using heuristics and analysis (The Design process, Process creation and heuristics for process synthesis), Sequencing of separation trains, concept of pinch technology and heat exchanger network analysis, Cost estimation and profitability analysis, Role of simulators in process engineering, Case studies.

PE* ZC323 Corrosion Engineering **3**

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: Materials selection, alteration of environment, design, cathodic and anodic protection, Coatings, Case Studies.

PE* ZC324 Chemical Reaction Engineering **3**

Ideal reactor concepts, design equations for batch and continuous reactors (constant and variable volume), Kinetics and interpretation of batch reactor data, Catalytic reactors including external diffusion and intra-particle diffusion effects, Non-ideal reactor concepts, Industrial reactor systems.

PE* ZC331 Quality Control Assurance & Reliability **3**

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control,

methods of applying total quality management, production process.

PE* ZC342 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; appraisal and control; just in time (JIT); automation in materials management.

PE* ZC343 Industrial Pharmacy 3

Pharmaceutical processes and equipment commonly used in pharmaceutical industries; drug extraction and clarification; mixing and granulation; pharmaceutical preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions etc.; galenical products like infusions, decoctions, tinctures, extracts, etc, glandular preparations and blood plasma substitutes.

PE* ZC344 Thermodynamics & Reaction Engineering 4

Development and applications of the combined first and second laws; relations between state properties; chemical equilibria in reacting and non-reacting systems; Kinetics of homogeneous, heterogeneous reactions; ideal reactors; selectivity; analysis and design of chemical reactors.

PE* ZC345 Pharmaceutical Quality Control & Regulatory Affairs 3

Course description to be developed.

PE* ZC352 Energy Management 4

World and Indian Energy scenario including production, consumption and pricing, Energy conservation and its importance, Energy conservation act and its features, Energy Management and Audit including energy audit instruments, Energy action planning, Energy monitoring and targeting, Energy economics, Energy efficiency in thermal utilities, Energy efficiency in electrical utilities, Energy performance assessment for equipment and utilities, Application through case studies.

PE* ZC353 Industrial Engineering 3

Industrial systems and organization; engineering economy; work measurement techniques; motivation and time studies; factory planning and materials handling; industrial standardization; critical path methods; quality control; reliability; maintenance and management planning; scheduling; job analysis (evaluation); value engineering.

PE* ZC361 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

PE* ZC362 Steel Processing 3

Introduction to metal casting, Moulding, materials and processes, patterns, sand and binders. directional solidification, rapid solidification. Solidification of short & long freezing range alloy castings, Gating and Risering of castings, Cupola, rotary furnace, induction furnace, crucible furnace melting, Introduction to cast alloys, classification, microstructures and properties of cast irons, plain carbon and Hadfield Manganese steels, Heat treatment of cast alloys, Casting defects and remedy, Special casting processes, Introduction to metal joining processes, welding, Fundamentals of metal working, Temperature, strain rate, friction & lubrication, Rolling, Classification & processes Forging, Extrusion, Drawing, cold working and warm working, Bulk and sheet metal forming, Mechanical and Hydraulic Presses, Stretching, drawing and bending of sheet metal, Metallurgical changes during metal working; thermo-mechanical processes. Slab analysis of plane strain and axisymmetric upsetting.

PE* ZC382 Cement Technology 3

Indian & Global Cement Industries; Geological classification of rock; Geo-chemistry of lime stone; Crushing, Grinding and Raw material handling process; different type of milling systems and applications - Raw mill, Coal mill, Cement mill; Kiln system and process, Fuel and firing system, Clinker cooling, storage, grinding and packing; merging trends in cement manufacture.

PE* ZC385 Fertilizer Technology 3

Introduction, fertilizer industry in India during last few decades; technology / production of fertilizer products such as intermediates, nitrogenous fertilizers, phosphatic fertilizers, potassic fertilizers, complex fertilizers; guidelines for mixing fertilizers.

PE* ZC383 Extractive Metallurgy 3

Introduction, Methods of extraction and refining of metals, principles of pyrometallurgy, heat transfer and fluid flow, rates of metallurgical reactions, analysis of unit processes, principles of electro and hydrometallurgy.

PE* ZC411 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

PE*ZC412 Process Equipment Design 4

Process design of major fluid, heat and separation equipment including pumps and heat exchangers, Mechanical Design considerations and material of construction, Pressure vessel design, Storage vessel design, Design of flange and vessel heads, Mechanical design of specific equipment like heat exchangers, distillation columns etc., Case studies.

PE* ZC423 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

PE* ZC423T Project Work 10

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project. At the beginning of the semester, the student should select an area of work that is considered vital to the sponsoring organization, and prepare a detailed project outline, in consultation with his/her Mentor. The student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, and taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar and viva-voce.

PE* ZC434 Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

PE* ZC442 Advances in Materials Science 3

Deformation of materials, deformation at high temperatures and creep, recovery, recrystallization and grain growth, fracture of materials and fatigue failure, deterioration of materials, corrosion and oxidation, surface properties, surface energy and tribology, polymers and fibre reinforced polymeric composites, mechanical testing, nondestructive testing techniques.

PE* ZC452 Process Plant Safety and Environment 4

Role of safety in society; engineering aspects of process plant safety; chemical hazards and worker safety; hazardous properties of chemicals; safety aspects in site selection and plant layout; design and inspection of pressure vessels; storage, handling and transportation of hazardous chemicals; risk assessment methods; toxic release, fire and explosions; boiling liquid expanding vapor explosions; safety audit; emergency planning and disaster management; Introduction to air pollutants, water pollutants and solid wastes; sampling & analysis techniques; impact of these on environment; national and international regulations, case studies.

PE* ZC453 Process Control & Instrumentation 4

Importance of Process Control; Process dynamics, modeling and transient response; Control actions and feedback control; Hydraulic-, pneumatic- and electronic controllers; Controller design, tuning and stability; Measuring instruments and their working principles; Instrument characteristics and transmission; Transducers, sensor and actuators; Control valves; Piping and Instrumentation diagrams; Signal conditioning and processing; Display and recording; Signal-flow graph and Mason's gain formula; Feed forward, cascade and ratio control; Direct digital control; Programmable logic controllers; DCS and SCADA systems; PC basedinstrumentation; Introduction to multivariable control system.

POM* ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and

morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

POM* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

POM* ZG511 Disinfection and Sterilisation 4

Theories and kinetics of the disinfection reaction, study of the principles involved in vivo and in vitro evaluation of disinfectants and antiseptics, structure activity relationships of the representative groups of disinfectants, sterilization, heat, ionizing and ultraviolet radiations, ultrasonic waves, filtration, gaseous sterilization and cellular dessication methods, controls used and special problems involved.

POM* ZG512 Dosage Form Design 5

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; micro-encapsulation; radio pharmaceuticals.

POM* ZG513 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

POM* ZG515 Pharmaceutical Administration and Management 5

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

POM* ZG521 Statistical Process Control 5

What is SPC, history & development of SPC, averages & measures of dispersion, process variation, variable & attribute data, simple statistical problem solving tools: check sheets, histograms, Pareto diagrams, stratification graph, scatter plots, cause & effect diagram; Various types of control charts, control chart for attributes, cumulative sum charts, X bar R charts; construction & interpretation of control charts process capability; Lot try lot acceptance sampling for attributes, acceptance sampling variables, other acceptance sampling procedures.

POM* ZG522 Quality Assurance & Regulatory Affairs 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

POM* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

POM* ZG525 Pharmaceutical Process Development & Scale-up 4

Optimization techniques in pharmaceutical processing; development of test systems to evaluate performance of dosage forms and unit operations; Scale-up of unit operations related to various pharmaceutical formulations; process analytical technology (PAT) and its applications in solving problems of scale-up.

POM* ZG531 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

POM* ZG532 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

POM* ZG534 Advanced Pharmaceutical Technology 5

Overview of pharmaceutical processes used in pharmaceutical manufacturing; advanced manufacturing equipments for various pharmaceutical dosage forms; current manufacturing techniques for large scale production of tablets, hard and soft gelatin capsules, aerosols, semi-solid preparations including ophthalmic formulations, small and large volume parenterals, and multiparticulate systems; approaches of in-process quality assurance and documentation in automated manufacture; advanced packaging technology for various pharmaceutical dosage forms.

POM* ZG541 Modern Analytical Techniques 4

Fundamentals and applications of sophisticated analytical instruments like NMR, Mass spectrometer; X-ray crystallography; GC, HPLC, UV, IR, Atomic absorption spectrophotometer, High voltage electrophoresis, gel electrophoresis, ultracentrifuge, spectrofluorimeter, DTA, DSC polarimeter in pharmaceutical industry including spectral data analysis and molecular characterization

POM* ZG542 Production and Operations Management 4

Production & operations management functions; capacity requirement planning; inventory control; layout, handling & location decisions; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods, quality control, management of R&D, technological forecasting, equipment replacement and interfaces with other functional areas.

POM* ZG545 Intellectual Property Rights and Pharmaceuticals 3

Key aspects of intellectual property law and their impact on Pharmaceutical industry; concept of property with respect to intellectual creativity; emerging debates, policy issues and law reforms related to IPR with respect to pharmaceuticals; Issues of Intellectual Property such as Patents, Copyright, Trademarks, and Design; rules and regulations of marketing and competition; Patent processing, infringement of patents, ethics and economic issues related to IPR.

POM* ZG551 Advanced Physical Pharmaceutics 5

Preliminary evaluations and molecular optimization, Drug substance considerations including protein, peptide and biological products, Bulk characterization, Solubility analysis, Rheology and dispersed systems, Micromeritics and shape factor analysis, Compression and compaction, Principles of dissolution, Dissolution test design and release kinetics evaluation, Compatibility testing, Stability analysis and test design according to international standard, Studies of broad category of polymers used in drug delivery, Rationale basis of formulation recommendation.

POM* ZG611 Strategic Management & Business Policy 5

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

POM* ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

POM* ZG631 TQM Tools and Techniques 5

Benchmarking; introduction, why benchmark; Planning: what to benchmark, benchmarking partners, data collection methods; Analysis: determining the current competitive gap, projecting future performance levels; Integration: developing action plan, implementing specific actions & monitoring progress, re-calibration; Maturity: beyond benchmarking; Quality function deployment, QFD concept, overview & QFD process, the voice of customer developing a QFD matrix, reviewing the matrix for priority items, organizing teams & planning QFD projects; Process RE-engineering, BPR philosophy, possibilities & pitfalls, BPF framework, opportunity assessment, planning & BPR project, risk & impact assessment, planning & implementing the transition; Failure mode & effect analysis; FMEA: concepts & applications in TQM; Quality cost, concepts, quality cost definitions, quality cost program implementation use of quality cost, reducing quality cost.

POW*ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, poly phase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

POW* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

POW* ZC231 Thermodynamics 3

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of non-reacting mixtures.

POW* ZC232 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

POW* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

POW* ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

POW* ZC242 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

POW* ZC313 Power Generation 4

Indian power scenario, sources of energy, working of thermal, nuclear, IC engine, gas turbine, hydro and renewable energy based power plants, power

plant building and layout, economics of power generation, environmental impact assessment of power generation.

POW* ZC314 Prime Movers & Fluid Machines 4

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems, laboratory exercises in testing reciprocating machines.

POW* ZC315 Transport Phenomena 4

Fundamental concepts of fluid flow, concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, concept of pressure drop and drag; Heat transfer: steady state and unsteady state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; Elements of mass transfer; one dimensional compressible flow; associated laboratory on condenser, boiler, economizer, super heater etc.

POW* ZC316 Power Electronics 4

PNPN devices, power transistor characteristics, rating and specifications; triggering mechanism and commutation circuits; controlled power rectifiers, Inverters (DC to AC converters), choppers (DC to DC Converters); speed control of DC motors, speed control of AC motors; other industrial applications of thyristors and power transistors; voltage regulation and starting of electrical drives; logic modules for static converters; introduction to application of microprocessors for electrical drives.

POW* ZC321 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

POW* ZC332 Energy Management 3

System's view of energy in society involving societal goals, energy resources, the sub-systems for the generation. T&D, and utilization of energy carriers, energy economics and analysis, energy strategies, policies, policy instruments, policy agents and policy implementation. The "development-oriented end-use approach" to energy analysis, strategy design and policy formulation involving the disaggregation and scrutiny of demand beyond sectors into end-uses and basic needs. Energy management at the national, state, firm, city and village levels.

POW* ZC342 Power Systems Engineering I 3

Parameters of transmission lines, electrical and mechanical characteristics of transmission line, synchronous phase modifiers - overhead insulators - underground cables - distribution lines - substation practice -relevant portions of Indian Electricity Act.

POW* ZC343 Microprocessors & Microcontollers 3

Introduction to microprocessors and microcontrollers. Architecture of 8086 microprocessors; Assembly directives, Assembly language programs with algorithms, Memory interfacing and timing diagrams; Architecture of 8-bit microcontrollers; Assembly language programming for microcontrollers; Interfacing I/O devices; System design examples.

POW* ZC344 Instrumentation & Control 4

Generalized measurement system and performance characteristics, Transducers - principles and applications, Signal conditioning circuits – bridges, amplifiers, data converters, filters; Process control – control schemes, controllers, multi-loop control configuration, Control valves; Programmable Logic Controllers, DCS and SCADA, Simulation, Case Studies.

POW* ZC411 Environmental Pollution Control 3

Environmental pollution: Solid, liquid and gaseous pollutants; removal of soluble and particulate pollutants from atmosphere, natural water systems and process systems; use of current literature for pollution control problems.

POW* ZC413 Process Control 3

Dynamic modeling and simulation of momentum, energy and mass transfer and reacting systems; analysis of the dynamic behaviour of lumped and distributed parameter systems; analysis and design of simple feedback and advanced control systems; design of control systems with multiple input and multiple output; introduction to computer control.

POW* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

POW* ZC431 Maintenance & Safety 3

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety; maintenance of components and equipment's; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

POW* ZC434 Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

POW* ZC441 Power Systems Engineering II 3

Elementary principles of power system economics - Powers systems stability, equal area criterion and step by step method - protection, relays and relaying, protection of transmission lines, transformer and generators - High Voltage Protection - Symmetrical components, symmetrical and unsymmetrical faults.

POW* ZC412 Power System Operation & Control 3

POW* ZC422 Power System Drawing and Design 3

Course description for the above courses to be developed.

POW* ZC452 Renewable Energy 3

Introduction of renewable energy, advantages, potential, status of development, broad details of different renewable energy systems such as solar, wind, biomass, microhydel, geothermal etc.; Renewable energy development policy, Renewable energy industries, international co-operation, HRD and career growth opportunities, consultancy areas and future thrust areas in renewable energy development.

POW* ZC471 Power Electronics & Drives 3

Course description for the above courses to be developed.

POW* ZC481 Plant Layout & Design 4

Factors affecting plant layout, Types of layout, procedure for plant layout, techniques and tools for planning layout, quantitative layout analysis, material handling equipment, improving and revising existing layout, evaluation of layout, plant location, evaluation of location, design of layout, computer applications in layout design.

PS* ZC111 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal ES* ZGand student's t-distribution; test of hypothesis; correlation and linear regression.

PS* ZC112 Human Anatomy and Physiology 3

Structure and functions of the various systems of the human body; Homeostatic mechanisms; Progression of disease; Principles of drug action.

PS* ZC113 General Mathematics - I 3

Review of coordinate geometry, Theory of equations, Progression and series, permutations and combinations, Binomial theorem, Functions: Trigonometric (with identities), Transcendental. One Dimensional Calculus: Limit and continuity,

Differentiation, Integration. Applications of derivatives and definite integration.

PS* ZC114 General Mathematics – II 3

Polar coordinates, Function of several variables, Multiple integrals, Vector valued functions. Complex functions and their analyticity. First order and second order ordinary differential equations, Laplace transformations and its applications to ordinary differential equations.

PS* ZC212 Basic Statistical Process Control 3

Course description to be developed.

PS* ZC213 Scale –Up of Pharmaceutical Operations 3

Pilot plant design including process and product layout; Scale-up consideration in solid dosage forms including powder mixing, granulation, compaction, and coating; Scale-up considerations in non-sterile liquids and semi-solids including principles of similarity, dimensionless numbers method, inter-relationship between surface area and volume upon scale-up; Sterile drug product scale-up; Synthetic scale-up; Chromatographic scale-up; Scale-up of biotechnology derived products.

PS* ZC214 Utilities in Pharmaceutical Operations 3

Course description to be developed.

PS* ZC221 Business Communication 3

Managerial communication – national and international contexts, Interpersonal Communication, persuasive communication, communication technology, effective listening group communication, professional presentation.

PS* ZC222 Pharmaceutical Quality & GMP 4

Regulatory perspective for drug product filing and approval, NDA, ANDA, sNDA and drug user fee act; Quality systems including concepts of TQM, ICH guidelines like Q1, Q3, Q6, Q7 and Q9; Quality control and validation including process validation, prospective and retrospective validation, analytical method validation; Good manufacturing practices in pharmaceutical industry; SUPAC guidelines; Quality audits.

PS* ZC223 Fundamentals of Biochemistry and Microbiology 4

Prokaryotic and eukaryotic cells; Chemistry of biomolecules like carbohydrates, proteins & peptides, lipids, vitamins and nucleic acids; Enzymes – classification, mechanism of action, kinetics and regulation of activities; Growth of microorganisms including media requirements, growth curve, preserving and obtaining bacterial culture; Viruses; Sterilization techniques including principles, instruments and methods; Antiseptics, disinfectants and preservatives; Sterility testing, pyrogen testing, evaluation of antimicrobial drugs, Biosafety.

PS* ZC224 Novel Drug Delivery Systems 3

Course description to be developed.

PS* ZC225 Environmental Studies 3

Environment, human population, and industrialization; natural resources and the impact of man-made activities on them; structure and function of ecosystem, population ecology, biodiversity and its conservation, overview of natural resources, environmental pollution, social issues and the environment, and environmental impact assessment.

PS* ZC231 Physical & Inorganic Chemistry 3

Atomic structure and chemical bonding including the concepts of hydrogenic atoms and VB theory; Thermodynamics and chemical kinetics; Electrochemistry including Nernst equation and its application, electrochemical series; Concepts in inorganic chemistry including electronegativity, measure of acid-base strength, Systematics of acid base interactions, Hard soft acid base(HSAB) concept- relevance to diverse metal-ligand interactions, symbiosis; Main group elements (Periodicity); Introduction to co-ordination compounds including double salts, chelates and isomers, VB and CF theories, organometallic chemistry, bio-inorganic chemistry.

PS* ZC232 Chemistry of Synthetic Drugs 3

Synthesis of Five-membered heterocyclic drugs; Six-membered heterocyclic drugs; Five-membered heterocyclic fused with benzene ring; Six-membered heterocyclic fused with benzene ring; Seven-membered heterocyclic fused with benzene ring; Heterocycles fused to two benzene rings; Heterocycles fused to other heterocyclic rings.

PS* ZC233 Pharmaceutical Packaging 3

Course description to be developed.

PS* ZC234 Techniques in Pharmaceutical Analysis 4

Principles of titrimetric analysis including acid-base, redox and complexometric titrations; Modern analytical techniques used in drug product analysis – concepts, instrumentation, method of analysis and interpretation; UV-Visible spectroscopy, Spectro-fluorimetry, Infrared spectroscopy, NMR spectrometry, Mass spectroscopy,

Chromatography including Paper, TLC, GC, HPLC and electrophoresis.

PS* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

PS* ZC241 Pharmaceutical Chemistry 3

This course deals with study of important classes of organic compounds such as alcohols, ethers, esters, aldehydes etc and their reactions. The mechanisms for various reactions will also be dealt with to comprehensively cover the basics of chemical reactions. Some important five and six member heterocycles with their reactions will also be part of the course. This course also emphasizes the use of inorganic compounds in pharmacy.

PS* ZC244 Physical Pharmacy 3

This course is designed to make the students conversant with the applications of physico-chemical principles to the study of the drug stability behaviour of drug powers and of other pharmaceutical systems; it includes the discussion of drug degradation, micromeritics, rheology and interactions of drugs.

PS* ZC311 Pharmaceutical Unit Operations – I 3

Various pharmaceutical unit operations like Extraction, Distillation, Evaporation, Re-crystallization, Filtration and Drying; Equipment used; Factors affecting the process and the properties of the product obtained; Identification of the critical factors; Relevance to manufacturing of various pharmaceutical products.

PS* ZC312 Pharmaceutical Unit Operations – II 3

Various pharmaceutical unit operations like Size reduction & Size Separation, Mixing, Granulation, Compression & Consolidation, Humidification & De-humidification and Materials of Construction; Equipment used; Factors affecting the process and the properties of the product obtained; Identification of the critical factors; Relevance to manufacturing of various pharmaceutical products.

PS* ZC313 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

PS* ZC314 Pharmaceutical Jurisprudence in India 3

Growth of modern pharmacy & pharmaceutical industry, brief overview of pharmacy act; Central Drugs Standard Control Organization (CDSCO): about the CDSCO, importance, functioning, and regulation; Drugs and Cosmetics Act; Various provisions of Schedule M; Branded and Generic medicines; Ministry of chemical and fertilizers: importance, functioning, and regulations; Indian Pharmacopoeia Commission: importance, functioning, and regulations; Provisions of Drug Price Control Order and National Pharmaceutical Pricing Authority; Narcotic and Psychotropic Substances Act; Medicinal and Toilet Preparations Act; Bonded and non-bonded laboratories; Drugs and Magic Remedies Act (Objectionable advertisements); The prevention of cruelty to animals act; Provision of Insecticide Act; Consumer protection Act.

PS* ZC318 Fundamentals of Transport Processes 4

Concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, Concept of pressure drop and drag, Introduction to conduction, convection (free and forced) and radiation including Fourier's law of heat conduction, Newton's law of cooling, Stefan Boltzmann and Kirchhoff's laws, concept of resistance and lumped capacitance; Boundary layer theory (momentum, thermal and mass), Heat transfer correlations; Phase change heat transfer, Diffusion fundamentals including Fick's law, Interphase mass transfer, Concept of mass transfer coefficient, Momentum, heat and mass transfer analogies, Introduction to transport equations.

PS* ZC321 Chemical Process Calculations 3

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

PS* ZC322 Pharmaceutical Quality by Design 3

Course description to be developed.

PS* ZC323 Sterile Pharmaceutical Products 3

Sterile products characteristics; Sterile dispersed systems; Sterile manufacturing process; Freeze drying of sterile products; QA & QC of sterile drug products; Process validation & equipment qualification in sterile product manufacturing; Packaging of sterile drug products.

PS* ZC324 Name Reactions in Chemical Synthesis 3

Stereochemistry in drug action; Rearrangement reactions and their applications to drug synthesis; Name reactions and examples in drug synthesis.

PS* ZC331 Pharmaceutical Formulations- I 3

Various liquid dosage forms and semi-solid dosage of drugs manufactured in pharmaceutical industries; Excipients used and their role in liquid dosage forms and semi-solid dosage forms; Manufacturing methods and equipment used in manufacturing liquid and semi-sloid dosage forms; Various quality control tests performed; Selection of suitable liquid and semi-sloid dosage form for a given drug.

PS* ZC332 Pharmaceutical Formulations – II 4

Various solid dosage forms and aerosols manufactured in pharmaceutical industries; Excipients used and their role in solid dosage forms and aerosols; Manufacturing methods and equipment used in manufacturing solid dosage forms and aerosols; Various quality control tests performed; Selection of suitable solid dosage form for a given drug.

PS* ZC341 Drug Discovery and Action 4

Drugs discovery process; Different regulatory requirements in the process of drug discovery; Effect of drugs on living organisms and application to therapeutics; Mechanism of action; physiological and biochemical effects (pharmacodynamics); Absorption, distribution, metabolism and excretion (pharmacokinetics); Adverse effects and interactions.

PS* ZC342 Medicinal Chemistry 3

This course deals with the study of important classes of drugs. Various aspects like structure, properties, therapeutic and pharmaceutical importance and the uses of drug molecules both of natural and synthetic origin will be covered. Study of physico-chemical properties, mechanism of action, S.A.R. and metabolism of drugs dealt will also be emphasized. Special emphasis will be given on Important topics such as Anti hypertensive drugs, Drugs affecting sugar metabolism, Antimalarial drugs, Anticancer agents, Antiviral agents etc.

PS* ZC343 Professional Ethics 3

Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.

PS* ZC344 Natural Drugs 3

The course imparts a knowledge of the crude drugs of natural origin used in pharmaceutical and medical practice. Study will include the different systems of classifications of crude drugs; cell contents; general principles of cultivation, collection, drying, storage and commerce of natural products of current medical and pharmaceutical importance; their morphologial and microscopical study: use and knowledge of common substitutes and adulterants.

PS* ZC361 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

PS* ZC414 Biopharmaceutics 3

Biopharmaceutics and Biopoharmaceutical aspects of drug delivery covering absorptions, distribution, metabolism and elimination (ADME) characters of drugs. Compartment model, pharmacokinetics of drugs and their applications, bioavailability, bioequivalence and their studies, drug-drug interactions and other related matters.

PS* ZC229T Project 5

Apply the knowledge of chemical technology operations in the manufacture of API or formulation technology operations in the manufacture of pharmaceutical drug product and assess the quality of the same; the student's actual day-to-day task involvement would constitute the central thread of the learning process. The evaluation will recognize this aspect by demanding day-to-day engagement and productivity of the student.

PS* ZC499T Capstone Project 15

Real-life problems related to the manufacture and quality control of active pharmaceutical ingredients and pharmaceutical drug products, as per applicable regulatory guidelines; Jointly mentored by the industry experts and faculty; Presentation of the progress and results in appropriate forms; Periodic review of the progress of the project.

QM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

QM* ZC472 Precision Engineering 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

QM ZG514Leadership & Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

QM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

QM ZG524Quality Management Systems 5

Quality system & quality management, evolution of quality post world war II era i.e. Quality control, quality assurance, total quality control & total quality management; ISO 9000 series of standards, formation of ISO (1947), background & development of ISO 9000. ISO 9000 family of standards, selection & use of appropriate model of ISO 9000. Requirements of ISO 9001; System demonstration & documentation, how to organize formal quality assurance system, pyramid of quality system documentation structure, two tier, three tier & four tier documentation, preparation of quality manual & quality procedures, quality records; Implementing documented quality system, how to proceed, how to implement change, obtaining top management commitment, assessing current company position, developing the implementation plan, initiating people (employees) to own the system, system development; System audit & review, objective of system audit, types of quality audit, product Vs system audit, internal quality audit, management review; System certification, benefits of third party certification, choice of certification body, route to certification, surveillance & renewal; Other quality system standards, relating ISO 9000 with QS 9000 and ISO 14000.

QM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

QM ZG526Operations Management 5

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

QM ZG528Reliability Engineering 5

Basic Reliability Models, Reliability of Systems, Design for Reliability and Maintainability, Maintainability, availability and reliability; Data Collection and Empirical Methods, Reliability Testing, Identifying Failure and Repair Distributions, Reliability Estimation and Application.

QM ZG531Statistical Quality Control 5

Sources of Variation: Common and Assignable Causes, Descriptive Statistics, Statistical Process Control Methods, Control Charts for Variables, Control Charts for Attributes, C-Charts, Process Capability, Acceptance Sampling, Operating characteristic curve, Statistical Quality Control in Services.

QM ZG532 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability

QM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

QM ZG535Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

QM ZG536 Design of Experiments 4

Course description to be developed.

QM ZG539 Six Sigma 4

History of Six Sigma, Implementing Six Sigma, Becoming a Customer and Market-Driven Enterprise, Customer Expectations and Needs, Linking Six Sigma Projects to Strategies, Attributes of Good Metrics, Using resources wisely, Project Management Using the DMAIC and DMADV Models, The Define Phase, The Measure Phase, Measurement System Analysis, Analyzing Data: Value Streams and Dealing with Variations, Designing Experiments, The Improve Phase, The Control Phase.

QM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

QM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

QM ZG661Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

QM ZG663 Concurrent Engineering 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

QM ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SE* ZC132 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

SE* ZC142 Computer Programming 4

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

SE* ZC213 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

SE* ZC222 Advanced Programming Techniques 3

Dynamic memory management; low level processing; debugging techniques; symbolic debugging tools; visual programming environments; user interfaces; event driven programming; visual design methodologies; prototyping with visual programming aids; creating multi-threaded applications; other emergent advanced programming topics.

SE* ZC241 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

SE* ZC252 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SE* ZC264 Digital Electronics & Microprocessors 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SE* ZC312 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

SE* ZC313 Object Oriented Programming & Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

SE* ZC324 Database Systems & Applications 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

SE* ZC333 Systems Programming 4

Batch processing Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

SE* ZC343 Software Engineering 4

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SE* ZC353 Computer Organization & Architecture 4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies

SE* ZC363 Data Structures & Algorithms 3

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

SE* ZC373 Compiler Design 4

Introduction - Compilation and Execution Environments -Compilers and Interpreters – Requirements and Motivation; Front-end and Back-end of compilers/interpreters; Intermediate Representation and Intermediate Languages; Compile Time vs. Execution Time; Translators, and Assemblers; Virtual Machine -Just-in-Time Compilers. Structure of a Compiler – Phases and Passes. In-memory data - intermediate versions of code, symbol table. Lexical Analysis: Regular expressions and DFA (introduction where needed), Defining tokens using regular expressions, Designing and implementing scanners / lexical analyzers. Parsers: Context Free Languages (introduction where needed) and Recognizing CFLs. Parsing techniques – LL,LR - LR (0), LR(1), LALR) . Intermediate Representation: Parse Trees and Abstract Syntax Trees; 3-address code. Semantic Analysis. Back End Phases: Machine Independent optimizations: Loop Optimization Techniques - Loop Unrolling, Induction variable based optimization, Loop-Invariant code elimination. Procedure Call Optimization, and Dead Code Elimination. Target Code Generation: Data Flow Analysis, Register Allocation, Instruction Selection & Scheduling. Memory Management: Memory allocation support, Memory- de-allocation – Garbage Collection Techniques. Advanced Topics: Issues in compiling Object Oriented Languages, Functional Languages, Concurrent Languages, Script & Query Languages.

SE* ZC424 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and accessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

SE* ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SE* ZC434 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

SE* ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

SE* ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SE* ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SE* ZC464 Operating Systems 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

SE* ZC465 Machine Learning 4

Introduction to Machine Learning, Various kinds of learning, Supervised Learning, Unsupervised Learning, Model Selection; Bayesian Learning, MAP Hypothesis, MDL Principle, Bias Variance Decomposition, Bayes Optimal Classifier, Naive Bayes Classifier; Linear Models for Regression, Linear Models for Classification; Non-Linear models, Decision trees; Instance Based Learning, KNN Algorithm, CBR Learning; Support Vector Machines, VC Dimension; Neural Networks, Perceptron Learning, Back Propagation Algorithm; Introduction to Genetic Algorithms.

SE* ZC467 Computer Networks 4

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SE* ZC472 Computer Graphics 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

SE* ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-

machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SE* ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SE* ZG512 Object Oriented Analysis & Design4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SE* ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SE* ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SE* ZG517 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues; Application of Usability Engineering in typical live projects to validate improved software usability.

SE* ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SE* ZG519 Data Structures & Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization). Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes,

Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SE* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SE* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

SE* ZG526 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

SE* ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SE* ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SE* ZG533 Service Oriented Computing 4

Introduction to Web Services: Distributed computing using software component technologies like DCOM and EJBs-overview about Service Oriented Architecture- RPC and Document centric SOAP enabled web Services-Describing information using XML -SAX and DOM based XML parsers-XSLT-XPath. SOAP Protocol for web services- Describing Web Services using WSDL-Publishing and Finding web services using UDDI Registry-UDDI SOAP APIs-Inquiry APIs-Publisher APIs. Web Services security –Need for secured web service-confidentiality of web service invocation using XML encryption and its advantages over SSL security -Integrity of soap message using xml digital signing-Maintaining confidentiality and integration together for soap messages -Authentication mechanisms for Web service client – Security Assertion Markup Language- Incorporating saml assertions for web service client authentication- IP layer security for web service- Need for work flow of web services-Usage of Business Process Execution Language for describing workflow of web services-Rest web service, its protocol and usage-Usage of Ajax in invoking Rest web service-Role played by web services in cloud computing.

SE* ZG544 Agile Software Processes 4

Course description to be developed.

SE* ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SE* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi-processing and distributed systems.

SE* ZG554 Distributed Data Systems 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques. Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization. Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

SE* ZG566 Secure Software Engineering 5

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

SE* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

SE* ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

SE* ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SE* ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SE* ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

SE* ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SE* ZG652 Software Maintenance Management 4

Issues in software maintenance, conceptual issues, scale of effort issues, organizational issues, productivity techniques issues, problem area issues; application systems; maintenance effort; impact of development tools and organizational controls; problems of maintenance; software evolution and maintenance; change management; impact analysis; system release planning; corrective maintenance; adaptive maintenance; perfective maintenance; reengineering source code, restructuring code, maintainability, flexibility, reusability, reliability, efficiency, reengineering tools; software testing & maintenance testing; system release and configuration management; managing the software maintenance process.

SE* ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SS ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

SS ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SS ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

SS ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SS ZG514 Object Oriented Analysis and Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-

oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SS ZG515 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SS ZG516 Computer Organization & Software Systems 5

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

SS ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SS ZG519 Data Structures & Algorithm Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization). Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SS ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SS ZG521 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SS ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

SS ZG526 Distributed Computing 5

Course description to be developed.

SS ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing

models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SS ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SS ZG536 Advanced Statistical Techniques for Analytics 4

Course description to be developed.

SS ZG537 Information Retrieval 4

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

SS ZG538 Infrastructure Management 4

Course description to be developed.

SS ZG547 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues; Application of Usability Engineering in typical live projects to validate improved software usability .

SS ZG548 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SS ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SS ZG554 Distributed Data Systems 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques. Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization. Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

SS ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SS ZG566 Secure Software Engineering 5

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

SS ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

SS ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SS ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

SS ZG652 Software Maintenance Management 4

Issues in software maintenance, conceptual issues, scale of effort issues, organizational issues, productivity techniques issues, problem area issues; application systems; maintenance effort; impact of development tools and organizational controls; problems of maintenance; software evolution and maintenance; change management; impact analysis; system release planning; corrective maintenance; adaptive maintenance; perfective maintenance; reengineering source code, restructuring code, maintainability, flexibility, reusability, reliability, efficiency, reengineering tools; software testing & maintenance testing; system release and configuration management; managing the software maintenance process.

SS ZG653 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SS ZG656 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network

equipment; Modeling distributed real-time systems; Quality of service maintenance.

SS ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SS ZG681 Cyber Security 4

Understanding the Cyberspace Environment & Security threat, the Attacks in Web, malicious Web Content, Email Attacks, threats to Network Communications, Port Scanning, Denial of Service, Bots, Botnets, Network Encryption, Firewalls, Virtual Private Networks, Intrusion Detection and Prevention, Incidents Management, Business Continuity Planning, Cyber Crime , Classifications of cybercrime, Tools and Methods used in Cybercrime, Cyber laws and Ethics, Computer Forensics, Network Forensics and Anti Forensics.

ST* ZG511 Matrix Methods in Civil Engineering 5

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

ST* ZG513 Advanced Computational Techniques 4

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

ST* ZG514 Structural Optimization 4

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

ST* ZG521 Topics in Structural Engineering 5

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

ST* ZG522 Structural Health Assessment and Rehabilitation 4

Introduction, Overview of present repair, retrofitting, and strengthening practices, Distress identification, Repair management, Causes of deterioration and durability aspects, Holistic models of Deterioration of RCC, Durability Aspects, Intrinsic and Extrinsic causes an stages of Distress, Condition Survey and Non-destructive

Evaluation, Classes of Damages and Repair Classification, Structural Analysis and Design, Reserve Strength, Evaluation of Building Configuration, Repair materials and their selection, Rehabilitation and Retrofitting Methods, Analysis and Design of Externally FRP and ECC Strengthened Structures, Retrofitting using External Unbonded Post-tensioning and Near Surface Mounted FRP Rebars, Durability Based Design of FRP Reinforced/Strengthened Bridge Girders, Case Study Problems.

ST* ZG523 Advanced Concrete Technology 4

Components of Concrete, chemical properties of cement & cementitious paste, properties of aggregates; chemistry of admixtures: mineral, chemical; effect of concrete composition on properties of fresh concrete and hardened concrete; Durability of concrete and its relation with concrete composition; Techniques for non-destructive evaluations (NDE) of concrete; Concrete mix design; Special concrete, Concrete with alkali activated binder.

ST* ZG524 Advanced Concrete Structural Design 5

Design of indeterminate beams and frames; Design of beam-column joints, Design of flat slabs, Analysis of slab using yield-line theory; Design of circular slabs; Design of beams curved in plan, Design of Folded plates and cylindrical shells, Design of Water Tanks.

ST* ZG532 Advanced Soil Mechanics 4

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi-infinite elastic soils; vibration problems.

ST* ZG533 Advanced Composite Materials for Structures 4

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

ST* ZG551 Dynamics of structures 4

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration, analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

ST* ZG552 Advanced Structural Mechanics and Stability 4

Analysis of stress and strain in three-dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degree of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to post buckling of plates.

ST* ZG553 Theory of Plates and Shells 4

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series, membrane theory of shells, and case study on plates and shells using numerical tools.

ST* ZG554 Advanced Structural Design 4

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall, water tank, towers, etc using both the steel and concrete materials. Modeling of

structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

ST* ZG610 Computer Aided Analysis and Design in Civil Engineering 5

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of preprocessor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

ST* ZG612 Advanced Steel Structures 4

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

ST* ZG613 Advanced Concrete Structures 4

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

ST* ZG614 Prestressed Concrete Structures 4

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

ST* ZG615 Earthquake Engineering 4

Single and multi-degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

ST* ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

ST* ZG617 Advanced Structural Analysis 4

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three dimensional analysis of structures; shear deformations, shear wall analysis; interactive software development for analysis of structures.

ST* ZG618 Design of Multi-Storey Structures 4

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

ST* ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

ST* ZG620 Advanced Foundation Engineering 4

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

ST* ZG621 Fluid Dynamics 5

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory; flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

ST* ZG622 Soil-Structure-Interaction 4

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations,

prediction of failure mechanism, economic considerations.

ST* ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

ST* ZG631 Selected Topics in Soil Mechanics and Geotechnical Engineering 4

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends.

ST* ZG641 Theory of Elasticity and Plasticity 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

TA ZC163 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

TA ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

TA ZC142Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

TA ZC233 Engineering Measurements 4

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

TA ZC312 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

TE* ZG511 Soil Mechanics for Highway Engineering 4

Origin and classification of soils; physicochemical properties, index properties of soil, IS classification of soils and their applications in roads, airfields and embankments, Stresses within a soil, effective stress principle, Soil - water systems - capillarity, flow, Darcy's law, permeability, and tests for its determination, Stresses due to applied load, Stress analysis for embankments and pavements, Compressibility and consolidation characteristics, over consolidation ratio, determination of coefficients of consolidation and secondary compression (creep), consolidation under construction loading, Shear Strength and Mohr Coulomb strength criterion, direct and triaxial shear tests, drained, consolidated undrained and undrained tests, strength of loose and dense sands, NC and OC soils, dilation, pore pressures, Skempton's coefficients. Compaction

characteristics, water content – dry unit weight relationships, OMC, maximum dry unit weight, field compaction, quality control, etc. Analysis and design of highway embankment, Characterization of ground, site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and dynamic tests, in-situ permeability and groundwater level, etc., Earth Pressure Theories, Selection and design of earth retaining structures.

TE* ZG512 Soil Exploration and Field Techniques 4

Necessity and Importance of soil exploration, Method of sub surface exploration Test pits, Trenches, Wash boring, Percussion drilling, Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth of various Civil engineering structures. Indirect method of exploration, Seismic method, Electrical resistivity, Resistivity sounding and profiling, Different method of stabilization of the bore holes, their relative merits and demerits. Different method of ground water observation: Time lag in observation, sampling of ground water. Source of disturbance and their influence. Type of sampler, Principle of design of sampler, Representative and undisturbed sampling in various types of soils. Surface sampling, Amount of sampling, Boring and sampling record, Preservation and shipment of sample, preparation of bore log. Penetration tests, Standard penetration tests, Dynamic cone penetration tests with and without bentonite slurry, Static cone penetration tests, Pressure meter, Dilatometer, factors affecting the penetration tests. Various corrections in the test results. Interpretation of test result for design and determination of modulus of deformation. Small size penetrometers, Plate load test, Field CBR, Dynamic cone penetrometer for CBR evaluation. Various corrections, empirical correlations and interpretation of test result for design in transportation engineering.

TE* ZG513 Reinforced Soil Structures for Transportation Engineering 4

Introduction and need for geosynthetics, Types, functions, properties and testing of geosynthetics, Strength analysis of reinforced soil, different types of soil retaining structure, Design codes for reinforced soil retaining walls, External and internal stability of reinforced soil retaining walls, Bearing capacity of footings resting on reinforced soil, Geo-synthetics in flexible pavements, geosynthetics application and design for Separation, Filtration, drainage, erosion control, barrier in highway engineering, Reinforced slope, Design and Construction of Geosynthetic Reinforced Embankments on Soft Subsoils, Other methods of reinforcement like soil nailing, rock bolting, stone columns etc., Practical case studies of reinforced soil structures, Applications of Geocell, PVD, Jute Geotextile and Coir Geotextile in transportation engineering, case studies.

TE* ZG514 Advanced Concrete Technology in Transportation Engineering 4

Cements including blended cements, chemical and physical processes of hydration; concrete admixtures: pulverized fuel ash, ground granulated blast furnace slag, silica fume; effects on properties of concretes, mortars and grouts; methods of test; applications; mixer blends and blended cement; admixtures: Review of types and classification; chemical composition; origin and manufacture; actions and interactions; usage; effects on properties of concretes, mortars and grouts; methods of test; applications; Aggregates: Review of types; elementary mineralogy and petrology; aggregate prospecting; quarrying and gravel-winning practice; production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grouts; Fresh concrete: Rheology of concentrated suspensions, pastes, mortars and concretes; workability, segregation and bleeding. Theory and principles governing the correct placing and compaction of concrete; Setting and hardening concrete: Plastic settlement and plastic shrinkage; exothermic characteristics; early age thermal movements; strength development; maturity, accelerated curing; assessment of safe stripping times; hot and cold weather concreting; Properties of hardened concrete: Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes. Thermal properties; Durability of concrete and concrete construction: Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulphate attack; alkali silica reaction; delayed ettringite formation; methods of providing durable concrete; short-term tests to assess long-term behaviour; Mix design: Review of methods and philosophies; mix design for special purposes; Special concretes: Lightweight concrete: autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete. High strength concrete;

refractory concrete; high density and radiation-shielding concrete; polymer concrete; fibre-reinforced concrete; mortars; renders; recycled concrete; Special processes and technology for particular types of structure: Sprayed concrete; underwater concrete; grouts, grouting and grouted concrete; mass concrete; slipform construction; pumped concrete; concrete for liquid retaining structures; vacuum process; concrete coatings and surface treatments; Ready-mixed concrete; Precast concrete; Concrete for roads and industrial floors

TE* ZG515 GIS Applications in Transportation Engineering 4

Remote sensing: Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multi concept, FCC, Interpretation of remote sensing images. Digital image processing: Satellite image – characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Land use and land cover classification system. Geographic information system (GIS): Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modelling, Data output, GIS applications. Global positioning system (GPS): Introduction, Satellite navigation system, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS. Applications in Transportation Engineering: Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport System Management, Road Network Planning, Collecting Road Inventory

TE* ZG516 CAD Laboratory in Transportation Engineering 4

Basic AUTOCAD commands, exercises on earth work computations, cross sections of highways, exercises on packages like MX Roads to compute earth work, geometric design of highways, Exercises on HDM 4 package

TE* ZG517 Road Safety and Audit 4

Characteristics of accidents, accidents vs. crash, land use and road environment for safety, Multidisciplinary approach to planning for traffic safety and injury control; pre-crash and post-crash models; role of vehicle, roadway traffic, driver, and environment on road safety, crash and injuries.; accident analysis, conflict points at intersections, pedestrian safety, road safety improvement strategies; Road safety audit and analysis: Stages, aim and objectives, principles, process, roles and responsibility, Specific parameters, design standards, various stages of road safety audit, Road safety audit for rural roads, Checklists, Structuring of report. Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled; Crash reconstruction: understanding basic physics, calculation of speed for various skid, friction, drag, and acceleration scenarios; Engineering Measures: Speed humps and bumps, speed tables and cushions; Community awareness and education; Enforcement- Non-physical measures- physical measures; Road Safety Audit Case study.

TE* ZG518 Pavement Analysis and Design 4

Types of pavements, flexible, rigid and semi-rigid; components of pavement structure; stresses and strains in flexible and rigid pavements: layered systems, visco-elastic solutions; stresses and deflections in rigid pavements; computer programmes for analysis of stresses and deflections in rigid pavements; traffic loadings, load equivalency factors, traffic projections and analysis; material characterization as input to pavement design; flexible pavement design using IRC, AASHTO, MEPDG methods; Rigid pavement design using IRC, AASHTO, MEPDG, ACI and PCA methods; design of overlays; Considerations in pavement drainage design.

TE* ZG519 Pavement Evaluation Field Project 4

Structural condition, Functional Condition and Safety evaluation of pavements, Flexible and Rigid Pavement Rating and establishment of Pavement Condition Index, Case study, involving a failed pavement structure, to investigate the condition and suggest remedial measures, Use of HDM 4 software for establishing the best alternative remedy for the chosen case study.

TE* ZG520 Infrastructure Planning and Management 4

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure;

Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

TE* ZG521 Environmental Impact Assessment 4

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

TE* ZG523 Transportation Systems Planning and Management 4

System and environment; sequential transportation systems planning: trip generation, trip distribution, modal split and traffic assignment. Transportation Systems Management (TSM) actions: traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions; planning for pedestrians, parking planning; Methods of accident data collection and analysis.

TE* ZG524 Urban Mass Transit Planning, Operations and Management 4

Modes of public transportation and application pf each to urban travel needs; Comparison of transit modes and selection of technology and transit service; Estimating demand in transit planning studies and functional design of transit routes; Terminal design; Management and operation of transit systems, Model for operational management; Fleet and crew management; Terminal management; Fiscal management.

TE* ZG528 Selection of Construction Equipment and Modeling 4

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

TE* ZG534 Pavement Material Characterization 5

Soil properties for highway engineers: Origin, properties of soils, tests on soils, Aggregates: origin, classification, requirements, properties, importance of aggregate gradation; bituminous materials: origin, preparation, properties and tests, criterion for selection of different viscosity grades of bitumen, modified binders and bituminous emulsions, Bituminous mixture design: Marshall method of mixture design, SUPERPAVE procedure of mixture design; mechanical properties of bituminous mixtures: resilient modulus, dynamic modulus, visco-elastic and fatigue characteristics. Warm mix asphalt, micro-surfacing, slurry seal, dense bituminous Macadam and bituminous concrete Cement concrete pavement materials: requirements and design of concrete mixture for rigid pavement, IRC and IS specifications and tests, joints, filler and sealant materials.

TE* ZG535 Highway Geometric Design 4

Highway functional classification; route layout and selection, design controls and criteria: turning paths, driver performance, traffic characteristics; highway capacity; access control; safety; environment; Elements of design: sight distance, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves; highway cross-sectional elements and their design; at-grade Inter-sections – sight distance consideration and principles of design, channelization, mini roundabouts, layout of roundabouts, inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design, geometric design for express ways.

TE* ZG536 Traffic Engineering and Safety 4

Road users and their characteristics; traffic studies- volume, speed, origin-destination (O-D) and delay studies; analysis and interpretations of traffic studies; traffic forecasting; capacity and level of service analysis; traffic characteristics at un-

signalized and signalized intersections; design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination; traffic controls: signs, markings, street furniture; traffic regulations; parking studies; nature of traffic problems and their solutions; traffic safety: accidents- data collection and analysis; causes and prevention.

TE* ZG537 Transportation Economics and Finance 4

Need for economic evaluation; concept of total transport cost; fixed and variable costs, elasticity of demand, marginal costs; value of travel time, accident costs; methods of economic evaluation; taxation in road transport, user charges: fees and tolls; highway legislation; investment policies and pricing, issues in financing and subsidy policy, public private partnership (PPP) options in transport sector: BOT, BOOT, BOLT; feasibility studies, identification and sharing of risks in PPP projects, operation and management agreements.

TE* ZG539 Introduction to Discrete Choice Theory 4

Introduction, element of choice process, individual preferences, behavioral choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbors; application of fuzzy logic and artificial neural network in discrete choice modeling.

TE* ZG543 Traffic Flow Theory 4

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic models; car-following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

TE* ZG545 Airport Planning and Design 4

Air Transport-structure and organization; forecasting air travel demand: trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport planning: site selection, layout plan, orientation and length of runway; airport capacity and configuration; geometric design of runway, taxiway and aprons; passenger terminal function, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport drainage; pavement design; airport access problem; environmental impact of airports.

TE* ZG546 Highway Construction Practices 4

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing of the road construction area; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MORTH specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction; field quality control ; road making machinery.

TE* ZG547 Pavement Failures, Evaluation and Rehabilitation 4

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

TE* ZG548 Pavement Management Systems 4

Components of pavement management systems, pavement maintenance measures; pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipment; evaluation of pavement distress modeling and safety; pavement

performance prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM-IV models, comparison of different deterioration models, functional and structural condition deterioration models; ranking and optimization methodologies: Recent developments, economic optimization of pavement maintenance and rehabilitation.

TE* ZG549 Rural Road Technology 4

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

TE* ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

TE* ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

TE* ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, lowering the water table, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques, Modern methods of ground improvement with rubber tires, construction wastes, bio-cementation.

PART VIII

ADMINISTRATIVE STRUCTURE











BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
ADMINISTRATIVE STRUCTURE

VICE-CHANCELLOR

Director, Pilani Campus	Director, K K Birla Goa Campus	Director, Hyderabad Campus	Director, Dubai Campus	Director, Off-Campus Programmes and Industry Engagement

Divisions										Departments	
Dean	Dean	Dean	Dean/Associate Dean	Dean	Dean	Dean	Dean	Dean	Dean	Head of the Department (HoD)	
Administrati on	Academic – Graduate Studies and Research	Academic – Under Graduate Studies	Student Welfare	Alumni Relations	Sponsored Research and Consult ancy	Faculty Affairs	Practice School	Work Integrated Learning Programmes	International Programmes and Collaboration		
	Associate Deans Faculty In -charge Nucleus members	Associate Deans Faculty In -charge Nucleus members	Chief Warden Nucleus members	Associate Deans	Associate Deans Nucleus members	Associate Deans Nucleus member	Associate Deans Nucleu s members	Associate Deans Nucleus members	Associate Deans		
Administration and Finance	Admissions Operation of Flexibilities (Transfer, etc.) Registration Planning & Operation Academic Records of Students Eligibility Transcripts, Provisional Certificates Counselling Timetable Teaching Allocation & Implementation Feedback & Monitoring Academic Programs & Growth Curriculum Design & Implementation Pedagogic Practices Ph.D. Programmes	Admissions Operation of Flexibilities (Transfer, Dual Degree etc.) Registration Planning & Operation Academic Records of Students Eligibility Transcripts, Provisional Certificates Counselling Timetable Teaching Allocation & Implementation Feedback & Monitoring Academic Programs & Growth Curriculum Design & Implementation Pedagogic Practices	Hostels, NSS, Games & Athletics Student Activities Railway Concessions Scholarships & Aids Students Personal Files & Testimonials Student Discipline Recreational Activity Forum	Connect with global alumni and conceptualiz e, develop and organize various alumni led initiatives related to campus development, student life, and academic processes Alumni Records	Sponsored Research and Consultancy, interface with external funding agencies and Industry, Innovation and IP management, Technology Transfer & Commercializati on	Faculty Recruitment, Performance Appraisal, Faculty Training & Development, Extension & Reappointment of Faculty	Establishment of Stations Faculty Allocation Feedback & Monitoring Student Needs at PS Location Station Operation Student Assignment & Evaluation	Off-Campus Work Integrated Learning Programmes Operation of Centres Preparation and delivering of Courses Academic Monitoring Board Admissions, Registration & Students Records	Promotes relations with renowned Institutions abroad for student and faculty exchanges and collaborative research with peers at foreign Universities	Chemical Engineering Civil Engineering Computer Science & Information Systems Electrical & Electronics Engineering Mechanical Engineering	Biological Sciences Chemistry Economics and Finance Management Mathematics Pharmacy Physics Humanities and Social Sciences

Registrar	*Section Head*	*Section Head*	*Unit Chief*	*Unit Chief*	*Unit Chief*
General Administration	**HR Section**	**Accounts and Finance Section**	**Centralized Purchases**	**Placement**	**Workshop**
Meetings, Institute Records, Award of Degrees/ Diplomas & Medals Scrutiny of Grades/ Reports Legal Affairs, Statutory Compliances	Recruitment, Personal Records of all employees, Compensation & Benefits, Employee Welfare (PF, ESI, Gratuity, Pension), PMS, Training, Budget preparation, Medical, LTC, Loans (Housing, Computer & Vehicle loan), Statutory Compliances, etc.	Accounts, Finance Planning, Budget preparation, Auditing, Statutory Compliance, GST, PF, Fixed Assets Management, Direct-Indirect taxes, Depositions & Accounting, Payroll-returns, Handling Govt. Grants, Treasury Management & Banking, MIS, etc.	Central Purchase Central Inventory of equipment	Campus Interviews, Placements	Student Training Fabrication Servicing & Maintenance

Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge & Estate Manager	Faculty-in-Charge
Center for Innovation, Incubation & Entrepreneurship	**Educational Technology Support**	**Estate Management**	**Infant Care Center & Institution Functions**
Entrepreneurship Development CEL and Network Activities TBI, PIED Technology Innovation Centre	Education & Research	Electricity & Water Supply Campus Planning, Buildings' Construction, Maintenance	Extension Activities Infant Care Centre Inter National Relational

Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge	Faculty-in-Charge
Institutional Knowledge Analysis Cell (IKA)	**Information Processing Centre**	**Instrumentation, Reprography**	**Public Relations (including VFAST & Cafeteria)**	**Publications & Media Relations**	**Societal Development**	**Software Development & Educational Technology**	**Teaching Learning Centre**	**Transport Services Section**
Benchmarking, Rankings & Accreditation	Centralized Computer Facilities	Service & Maintenance of instruments EPABX Projection facilities Stage Light and Public Address System Printing	Public Relations, VFAST & Cafeteria	All publications of the Institute Publicity through audio-visual and print media publications Media Relations Printing & Reprography	NSS NIRMAN	Software Research & Development Software Consultancy Identification and deployment of Educational Technologies e-Learning technologies, course management etc. Video-conferencing	Faculty Orientation & Teaching Learning	Transportation services

Librarian	Chief Medical Officer	Section Head
Library	**Medical Centre**	**Security Section**
Information Centre: Electronic resources- Databases, Journals and E-books, Publications	Healthcare services	Security services

ADMINISTRATIVE STRUCTURE

The Institute has a functional administrative structure (pages VIII-1 and VIII-2). Vice-Chancellor is the executive head of the Institute, including all its campuses. Further, each Campus has a Director who takes care of the day-to-day academic and administrative operations of the Campus.

Various activities and requirements arising out of innovative educational programmes have been grouped into functions and each functional Division is headed by a Dean and each Unit by a Chief. Similarly the departments are headed by the Head of the Department. There are also faculty members designated as Incharge of various activities such as Instruction, Registration, Practice School, etc.

For each Division and Unit, there are cohesive teams of faculty known as the nucleus to support the activities of the Division/Unit. The administrative officers are:

Dean: Head of a Division

Chief: Head of a Unit

Head: Head of a Department

Every faculty member of the Institute is administratively attached to a Department / Division / Unit or to offices like Vice-Chancellor's Office and Director's Office, etc.

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Prof. R.N. Saha, Dubai Campus

Prof. Gunaje Raghurama, K K Birla Goa Campus

Prof. G. Sundar**,** Hyderabad Campus & Off-Campus Programmes and Industry Engagement

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Mr. Arun Khetan

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Mr. N Sreekanth Reddy

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Mr. G. Balasubramanian

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Mr. Puram Ramachandra

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Prof. Dhananjay Madhukar Kulkarni, K K Birla Goa Campus

Prof. Niranjan Swain, Hyderabad Campus

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Prof. R. Karthikeyan, Dubai campus

Faculty incharge, Academic Research

Prof. Chandradew Sharma, K K Birla Goa Campus

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Nucleus, AUGS

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Prof. Shamik Chakraborty Higher Degree and Ph.D. Admission Tests, Pilani Campus

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Prof. Amit Nag, Hyderabad Campus

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Dr. Chandu Gurappa Lamani, Physical Education Instructor, K K Birla Goa Campus

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Dr.N Kishore Kumar (Programme Co-ordinator), Hyderabad Campus

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Faculty-incharge CPU

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Unit Chief, Placement & Workshop

Prof. Kuldip Singh Sangwan

Faculty Incharge, Placement

Prof. Amalin Prince A., K.K Birla Goa Campus

Prof. Alivelu Manga Parimi, Hyderabad Campus

Dr. Parameshwaran R, Hyderabad Campus

Senior Manager - Placements

Mr. Tabir Mishra, Pilani Campus

Mr. R.B. Mouli, KK Birla Goa Campus

Placement Manager

Mr. Biju Rajan, Hyderabad Campus

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Faculty Incharge

Prof. DipenduBhunia, Estate Management, Pilan Campus

Estate Manager

Lt. Col. Ashok Kumar Bhataiya, Pilani Campus

Mr. Anand Kumar Patil, K K Birla Goa Campus

Mr. B. Muthukrishnan, Hyderabad Campus

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Mr. Ernest Samuel Ratnakumar J, Registrar

Deputy Registrar

Dr. R. C. Dagar, Pilani Campus

Mr. Sailesh Narayan Mohanty, KK Birla Goa Campus

Mr. Rajneesh Mishra, Hyderabad Campus

Assistant Registrar

Mr. Ashish Gupta, Pilani Campus

Ms. Anjali Dixit, K K Birla Goa Campus

Mr. Akshay Chutani, Dubai Campus

PUBLICATIONS AND MEDIA RELATIONS

Faculty Incharge

Prof. Sangeeta Sharma, Pilani Campus

Mr. Arjun Candrakant Halarnkar, K K Birla Goa Campus

Dr. Maya Vinai, Hyderabad Campus

ACCOUNTS & FINANCE SECTION

Head, Accounts & Finance

Shri Satyen Sharma, Pilani Campus

Mr. S Baskar, K K Birla Goa Campus

Ms. Sunitha Suresh, Hyderabad Campus

Manager, Finance

Shri V.N. Sharma, Pilani Campus

Mr. Mohammad Akram, Dubai Campus

Manager, MIS

Shri Rahul Rastogi, Pilani Campus

Mr. Ian Francis Sardinha, K K Birla Goa Campus

Accounts Officers

Mr. Ram Singh Lamba, Pilani Campus

Mr. Krishna Kumar Kedia, Pilani Campus

Chief Accountant

Shri Mukesh Kumar Jangir, Pilani Campus

Mr. G Manoj Kumar, Hyderabad Campus

SECURITY SECTION - (Security Officers)

Mr. Kishore Singh, Pilani Campus

Mr. Pradip Kr. Yadav, K K Birla Goa Campus

Mr. Ramesh Narayan, Hyderabad Campus

HUMAN RESOURCE SECTION

HR Managers

Mr. Arvind Soundarajan, Pilani Campus

Ms. Sonia Gaurav Nagarsekar, K K Birla Goa Campus

Ms. Vasundhari Alluri, Hyderabad Campus

Mr. Srikanth Sridhar, Hyderabad Campus

Mr. Abdul Khaleed Mohammad, Hyderabad Campus

OTHER FACULTY INCHARGE

Pilani Campus

Prof. Vishal Saxena, Institutional Knowledge Analysis Cell (IKA Cell) - Institute Wide

Prof. Yashvardhan Sharma, Information Processing Centre, Software Development & Educational Technology

Prof. Karunesh Kumar Gupta, Instrumentation Unit, Reprography

Prof. Virendra Singh Nirban, Public Relations (including VFAST, Transport & Cafeteria)

Dr. Satyendra Kumar Sharma, Entrepreneurial Leadership

Dr. Virendra Singh Shekhawat, Educational Technology Support

Prof. Devika, Infant Care Centre and Institute Functions

Prof. UdayanChanda, Timetable

K K Birla Goa Campus

Prof. Vinayak Shashikant Naik, Computer Centre

Prof. Radhika Vathsan, Community Welfare

Prof. Ram Shanker Patel, Central Sophisticated Instrumentation Facility (CISF)

Hyderabad Campus

Dr. Arti Dhar, Community Welfare

Prof. R Gururaj, Computer Centre

Prof. Pradyumn Kumar Sahoo, Time Table & Exams

HEAD OF DEPARTMENT

Pilani Campus

Prof. Prabhat Nath Jha, Biological Sciences

Prof. Hare Krishna Mohanta, Chemical Engineering

Prof. Saumi Ray, Chemistry

Prof. Anshuman, Civil Engineering

Prof. Poonam Goyal, Computer Science and Information Systems

Prof. Arun Kumar Giri, Economics and Finance

Prof. V K Chaubey, Electrical & Electronics Engineering and Instrumentation

Prof. S K Choudhary, Humanities and Social Sciences

Prof. Jyoti, Management

Prof. B K Sharma, Mathematics

Prof. Mani Sankar Dasgupta, Mechanical Engineering

Dr. Paul Atish Tulshiram, Pharmacy

Prof. Raj Kumar Gupta, Physics

K K Birla Goa Campus

Prof. Saroj Sundar Baral, Head, Department of Chemical Engineering.

Prof. Amalin Prince A., Head, Department of Electrical & Electronics Engineering

Dr. Ranjit Shankarrao Patil, Head, Department of Mechanical Engineering..

Prof. Ashwin Srinivasan, Head, Department of Computer Science and Information Systems

Prof. Srikanth Mutnuri, Head, Department of Biological Sciences

Prof. Anjan Chattopadhyay, Head, Department of Chemistry

Prof. Aswini Kumar Mishra, Head, Department of Economics & Finance

Prof. Reena Cheruvalatha, Head, Department of Humanities & Social Sciences

Prof. Prasanna Kumar Nekkare, Head, Department of Mathematics

Dr. Deepak Narayana Murthy Pachattu, Head, Department of Physics

Hyderabad Campus

Prof. Srikanta Dinda, Head, Dept. of Chemical Engineering

Prof. Sridhar Raju, Head, Dept. of Civil Engineering

Prof. Sanket Goel, Head, Dept. of EEE

Prof. Amit Kumar Gupta, Head, Dept. of Mechanical Engineering

Prof. D. Sriram, Head, Dept. of Pharmacy

Prof. Tathagata Ray, Head, Dept. of Computer Science and Information Systems

Prof. Naga Mohan Kommu, Head, Dept. of Biological Sciences

Prof. Manab Chakravarty, Head, Dept. of Chemistry

Prof. Sunny Jose Gosman, Head, Dept. Humanities and Social Sciences

Dr. Sudatta Banerjee, Head, Economics and Finance

Prof. Dipak Kumar Satpathi, Head, Dept. of Mathematics

Prof. P.K. Thiruvikraman, Head, Dept. of Physics

Dubai Campus

Dr. Nishant Harishbhai Pandya, Head, Dept. of Chemical Engg.

Dr. R. Karthikeyan, Acting Head, Dept. of Civil Engineering.

Dr. Anand Kumar, Head, Dept. of Electrical & Electronics Engg.

Dr. R. Karthikeyan, Head, Dept. of Mechanical Engineering.

Dr. Sujala D Shetty, Head, Dept. of Computer Science

Dr. D.J. Shariff, Head, Dept. of Biotechnology

Dr. Vijaya Ilango, Head, Dept. of General Sciences

Dr. Shazi Shah Jabeen, Head, Dept. of Humanities and Social Sciences

OFFICERS OF OTHER ACTIVITIES

Scholarships & Fellowship Committee (SFC)

Prof. Srikanta Routory (Convener), Prof. Navin Singh, Prof. Suresh Gupta, Dr. Jitendra Singh Rathore, Mr. Manas Srivastava, Mr. Adit Mittal, Mr. Sahib Aggarwal.

Scholarship Committee (SC), Dubai Campus

Prof. Priti Bajpai(Convener), Prof. K. Kumar, Prof. R. Karthikeyan, Dr Santhosh Kumar, Ms. Nahid Afshan, Mr Mohd. Akram.

Students Aid Fund (SAF)

Prof. Srikanta Routory (Convener), Prof. Navin Singh, Prof. Suresh Gupta, Dr. Jitendra Singh Rathore, Mr. Mihir Garg, Mr. Parth Misra, Mr. Devashish Pant, Mr. Harshwardhan Mukul Mittal, Mr. Palash Dhakar, Mr. Siddharth Mehta.

Recreational Activity Forum (RAF), Pilani Campus

Prof. Srikanta Routroy (Incharge), Prof. Bharti Khungar, Prof. Rajesh Prasad Mishra, Mr. Ashish Gupta, Mr. Atul Runthala, Mr. Aviral Sinha, Mr. Yatharth Singh, Mr. Raghav Agrawal, Mr. Arpit Agarwal, Mr Nishank Malik, Mr. Tanmai Choudhary.

Students Union (2018-19)

Mr Satyansh Rai (President), Mr Akash Singh (General Secretary)

Committee for Combating Sexual Harassment Problems, Pilani Campus

Prof. (Ms.) Surekha Bhanot (Presiding Officer), Dr. Shibani K. Jha, Ms.Neelam Bhatia, Mr. N. Sreekanth Reddy, Dr. M. Kasturi.

Internal Complaints Committee for Prevention of Sexual Harassment of Women at Work Place

Dubai Campus:- Prof. Shazi Shah Jabeen - Presiding Officer, Prof Karthiyayini**,** Prof. Priti Bajpai, Dr Maneesha, Dr. Santosh Kumar, Ms. Reema Menon Vellat - External Member, Mr Akshay Chutani - Member Secretary.

K K Birla Goa Campus:- Prof. Sutapa Roy Ramanan, Presiding Officer, Prof. Bhavana P., Member, Prof. C K Ramesha, Member, Mr. R B Mouli, Member, Ms. Anjali Dixit, Member, Ms. Sisira C, External Member

Hyderabad Campus:- Prof. M G Prasuna, Presiding Officer, Prof. Chittaranjan Hota, Member, Dr. Maya Vinai, Member, Ms. Amitha Malipeddi, Member, Mr. N Sreekanth Reddy, Member, Ms. Kondaveeti Satyavathi, External Member.

ACADEMIC COUNSELLING CELL

Convener: Prof Devika

Professional Counselor: Mr. Emerson Noble Scott

Mentors (Core Members): Prof. Abhijeet K. Digalwar, Dr. Girish Kant, Dr. Priya C. Sande, Dr. Jayendra, Dr. Virendra Singh Shekhawat, Dr. Vandana Agarwal, Dr. Pawan Ajmera, Dr. Murali Monohar Pandey, Dr. Sunil Dubey, Dr. Rakhee, Dr. Ashis Tiwari, Dr. Pratyush Banerjee, Prof. Sangeeta Sharma, Prof. Devika, Prof. Pushp Lata, Dr. Meghana Tare, Dr. Rajdeep Chowdhury, Dr. G Muthukumar, Dr. Bibhas R Sarkar, Dr. Sailaja Nandigama

Auxiliary Members (Core Members): Dr. Kaushar Vaidya, Dr. Sudeshna Mukherjee

International Students Advisor

Prof. Suman Kapur

Central Analytical Laboratory (CAL)

Head, Dept. of Pharmacy (Dr. Paul Atish Tulshiram), Head, Dept. of Biological Sciences

(Prof. Prabhat N. Jha), Head, Dept. of Chemistry (Prof. Saumi Ray), Head, Dept. of Physics (Prof. Raj Kumar Gupta).

Technology Innovation Centre (TIC)

Prof. V.K Chaubey

Centre for Innovation, Incubation & Entrepreneurship (CIIE)

Professor Incharge (Institute Wide):

Prof. P Yogeeswari, Hyderabad Campus

Faculty-InCharge:

Dr. Trupti Swarup Gokhale (Dubai Campus)

Dr. Rajorshi Sen Gupta (K K Birla Goa Campus)

Prof. Aruna Malapati (Hyderabad Campus)

Teaching Learning Centre (TLC)

Faculty Incharge:

Dr. Kaushar Vaidya, Pilani Campus

Dr. Maneesha, Dubai Campus

Prof. Gaurav Dar, K K Birla Goa Campus

Dr. Rahul Nigam, Hyderabad Campus

Members:

Pilani Campus: Dr. Manoj Kannan, Dr. Amol Marathe, Dr. Pankaj Kumar Sharma, Dr. Gautam Singhvi, Dr. Jayashree Mahesh, Dr. Rajan Pandey, Prof. Tapomoy Guha Sarkar **Mentors:** Prof. Chandra Shekhar, Prof. Arvind K. Sharma, Prof. Sanjiv Chaudhry

Dubai Campus:- Dr. Gomathi Bhavani Rajagopalan, Dr. Nishant Harishbhai Pandya, Dr. Sunil Thomas, Dr. Vincent Shantha Kumar

K K Birla Goa Campus:- Prof. Radhika Vathsan, Dr. A. Baskar , Prof. Rajesh Mehrotra,

Hyderabad campus: Prof. Punna Rao Ravi, Dr. Aruna Malapati, Dr. Asma Ahmed, Dr. Santosh Kumar Mahapatra, Prof. Jayati Ray Dutta (Co-opted members)

HOUSE ALLOTMENT COMMITTEE

Pilani Campus:- Prof. S.K. Verma (Convener), Prof. Dipendu Bhunia, Prof. B.K.Rout, Shri R.C. Dagar

K K Birla Goa Campus: Prof. Dibakar Chakrabarty (Chair Person), Mr. Anand Kumar Patil (Convenor), Prof. Amrita Chatterjee (Member), Mr. Sailesh Narayan Mohanty (Member), Ms. Sonia Gaurav Nagarsekar (Member).

Hyderabad Campus: Prof. Niranjan Swain (Convenor), Prof. Arti Dhar, Member, Prof. S. P. Regalla, Member and Prof. BVVSN Prabhakara Rao, Member

Campus Planning & Maintenance Committee

Prof. Ajit Pratap Singh (Convener), Dr. Anshuman, Lt. Col. A.K. Bhataiya, Prof. Kuldip Singh Sangwan.

The committee for the selection of faculty members of BITS Pilani – Pilani Campus for the "Additional Competitive Research Grant"

Prof. Ajit Pratap Singh (Convener), Prof. Chandra Shekhar (EEE), Prof. Sudeept Mohan, Prof. Kuldip Singh Sangwan, Prof. Jitendra Panwar, Prof. Navneet Gupta

PURCHASE COMMITTEE

Pilani Campus :- Prof. N. V. Muralidhar Rao (Convenor), Prof. Ashoke Kumar Sarkar, Prof. S.K. Verma and Mr. Satyen Sharma.

Dubai Campus : Dr K K Singh, Dr B.B. Gulyani, Dr Abdul Rajak, Mr Akshay Chutani, Mr Mohammad Akram, Mr Amitabh Sinha (secretary)

K K Birla Goa Campus: Mr. Anand Kumar Patil (Convenor), Mr. S Baskar (Member), Mr. Surendra Kinlekar (Member)

Hyderabad Campus: Prof. A Ramesh Babu (Convener), Prof. KVG Chandrasekhar (Member), Prof. BVVSN Prabhakar Rao (Member), Prof. Sajeli Begum (Member), Dr. Bahurudeen (Member), Mr. Rajneesh Mishra (Member)

Centre for Robotics & Intelligent System : Dr. Bijay Kumar Rout (Coordinator), and Prof. Sudeept Mohan, (nucleus member), Invited Faculty member from CS/IS and EEE/Electronics and Instrumentation

Centre for Desert Development Technologies: Prof. Rajiv Gupta (Coordinator),

Shri Gyanendra Singh, Shri Shiv N. Sanwal, Shri K. C. Sacheti, Shri Pradeep Bishnoi, Prof. Surekha Bhanot, Prof. Kuldip Singh Sangwan.

Centre for Materials Science & Technology

Prof. Mani Shankar Dasgupta

Centre for Renewable Energy and Environment Development (CREED): Dr. Manojkumar Surajkaranji Soni (Coordinator), Dr. Hari Om Bansal, Dr. Hitesh Datt Mathur, Dr. Pratik N. Sheth, Dr. Rajneesh Kumar, Dr. Ravi Inder Singh.

Embedded Controller Application Centre: Dr. Vinay Chamola, Mr. Devesh Samaiya (Incharge), Mr. Karri Bahu Ravi Teja

Staff Association: Dr. Arun Kumar Vaish (President), Dr. Navin Singh (Vice President), Dr. Sunil Kumar Dubey (General Secretary), Dr. Virendra Singh Shekhawat (Joint Secretary), Dr. Chandra Shekhar (Treasurer), Dr. Niladri Sarkar (Member)

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BITS COOP

Prof. A. K. Sarkar (President), Prof. Sanjay Kumar Verma (Vice-President), Prof. Jitendra Panwar (Secretary), Prof. Hitesh Dutt Mathur (Treasurer).

MEDICAL CENTRE

Pilani Campus:- Dr. Rajiv Gupta Physician (Chief Medical Officer),Dr. (Mrs.) Sanjana R. Bhat Gynecologist (Deputy CMO) and Dr. Rajendra Prasad Pareek Physician (Medical Consultant)

Visiting Doctors: Dr. Sanjay Katewa (Dentist), Dr. H.S. Sankhla (ENT Specialist), Dr. Diwakar Pathak (Homeopathic Specialist), Dr.Karan Beniwal (Pediatrician),Dr. Ramesh P Jajoo (Ayurvedic).

K K Birla Goa Campus:- Dr. Raghavendra Kota Madhyastha (Chief Medical Officer), Dr. Nayna Vinayak Kantak (Medical Officer), Dr. Babasaheb Dnyandev Kumbhar (Medical Officer, General Duty) Dr. Shradha Anand Naik (Medical Officer) and Dr. Steffi Soares (Medical Officer)

***Visiting Doctors*:** Dr. Sandeep Fowkar (Orthopaedic), Dr. Satish Khandeparkar (Orthopaedic), Dr. Shailesh Kamat (OBG), Dr. Sreedhara Hande (Paediatrician), Dr. Parag Sawant (ENT), Dr. Sanjay Althekar (Gastroenterology), Dr. Ankita Parrikar (Dermatology), Dr. Navneet Kaur (Dental science), Dr. Nidhin Philip Jose (Orhthodontics), Dr. Anshu Vijayvargia (Physiotherapy)

Hyderabad Campus:- Dr. G Kalyan Kumar (Medical Officer), Dr. Jenny Mercy Augustine (Deputy Chief Medical Officer), Dr. Kishore Kumar Misra (Medical Officer), Dr. Kasimkota Nagajyothi (Medical Officer)

Visiting Doctors:- Dr. Afra Fatima, Dr. E Chandrakala, Dr. Swathi V, Dr. Satyendra Kumar

CERTAIN OTHER ORGANISATIONS IN PILANI

Dr. R.K.Jain(CMO), Dr.B.P.Singh(Anaesthetist), Dr. Rajinder Sharma (Physician), Dr. Prashant Singh(Ortho), Dr. (Ms.)Rinku Singh (OBG), Dr. (Ms.) Sarita Sharma(OBG), Dr. Gaurav Garg (Paediatrician),Dr. Mohit Khetan (Dentist), Dr. P.K.Gupta(GDMO), Dr. Sanjay Soni (GDMO), Dr. R.P. Jajoo(BAMS), Dr. Hemant Sharma (BAMS), Dr. Pawan Kumar(BAMS), Dr. Sanjay Saini(BAMS),Dr.Rakesh Saini (Physiotherapist)

Visiting Doctors: Dr. Anil Sharma (Urologist), Dr.Vijay Binwal (Nephrologist), Dr.Anil Jangir (Gastroenterologist), Dr. Mukesh Yadav (Cardiologist), Dr. Rajeev Singh Gharsa (Neurosurgeon),Dr. Sandeep Dudi (Psychiatrist)

Shri Mahadeo Singhi Eye Hospital

Dr. P.K. Sehgal (CMO), Dr. Amitabh Chakrabarti, Dr. G. B. Mathur, Dr.Ankit Khullar, Dr.Pankaj Kataria, Dr. Basant Sharma (Dental Surgeon).

Birla Museum

Dr. V.N. Dhaulakhandi (Director)

Central Electronics Engineering Research Institute (CEERI)

Prof. Santanu Chaudhury

DISCIPLINE-WISE LIST OF FACULTY

Name	Designation	Campus
BIOLOGICAL SCIENCES		
Suman Kapur, Ph.D.	Senior Professor	Hyderabad
S K Verma, Ph.D.	Professor	Pilani
Ashis Kumar Das, Ph.D.	Professor	Pilani
P R Deepa, Ph.D.	Professor	Pilani
Jitendra Panwar, Ph.D.	Professor	Pilani
Utpal Roy, Ph.D.	Professor	Goa
Meenal Kowshik, Ph.D.	Professor	Goa
Srikanth Mutnuri, Ph.D.	Professor	Goa
Dibakar Chakrabarty, Ph.D.	Professor	Goa
Vijayashree Nayak, Ph.D.	Professor	Goa
Vidya Rajesh, Ph.D.	Professor	Hyderabad
Ramakrishna Vadrevu, Ph.D.	Professor	Hyderabad
Uma S Dubey, Ph.D.	Associate Professor	Pilani
Shibasish Chowdhury, Ph.D.	Associate Professor	Pilani
Vishal Saxena, Ph.D.	Associate Professor	Pilani
Prabhat Nath Jha, Ph.D.	Associate Professor	Pilani
Shilpi Garg, Ph.D.	Associate Professor	Pilani
Rajdeep Chowdhury, Ph.D.	Associate Professor	Pilani
Judith Maria Braganca, Ph.D.	Associate Professor	Goa
Veeky Baths, Ph.D.	Associate Professor	Goa
Anasuya Ganguly, Ph.D.	Associate Professor	Goa
Sumit Biswas, Ph.D.	Associate Professor	Goa
Angshuman Sarkar, Ph.D.	Associate Professor	Goa
Kundan Kumar, Ph.D.	Associate Professor	Goa
Sandhya Mehrotra, Ph.D.	Associate Professor	Goa
Rajesh Mehrotra, Ph.D.	Associate Professor	Goa
Jayati Ray Dutta, Ph.D.	Associate Professor	Hyderabad
Kumar Pranav Narayan, Ph.D.	Associate Professor	Hyderabad
Sankar Ganesh P, Ph.D.	Associate Professor	Hyderabad
Naga Mohan Kommu, Ph.D.	Associate Professor	Hyderabad
B Vani, Ph.D.	Assistant Professor, Gr-I	Pilani
Pankaj Kumar Sharma, Ph.D.	Assistant Professor, Gr-I	Pilani
Sandhya Amol Marathe, Ph.D.	Assistant Professor, Gr-I	Pilani
Sudeshna Mukherjee, Ph.D.	Assistant Professor, Gr-I	Pilani

Name	Designation	Campus
Manoj Kannan, Ph.D.	Assistant Professor, Gr-I	Pilani
Meghana Tare, Ph.D.	Assistant Professor, Gr-I	Pilani
Syamantak Majumder, Ph.D.	Assistant Professor, Gr-I	Pilani
Malabika Biswas, Ph.D.	Assistant Professor, Gr-I	Goa
Sukanta Mondal, Ph.D.	Assistant Professor, Gr-I	Goa
Indrani Talukdar, Ph.D.	Assistant Professor, Gr-I	Goa
Arnab Banerjee, Ph.D.	Assistant Professor, Gr-I	Goa
Raviprasad Aduri, Ph.D.	Assistant Professor, Gr-I	Goa
Tusar Tirtha Saha, Ph.D.	Assistant Professor, Gr-I	Goa
Sridev Mohapatra, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Debasri Bandyopadhyay, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Vivek Sharma, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Jamma Trinath, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Gireesha Thipperudrappa Mohannath, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Ruchi Jain Dey, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Piyush Khandelia, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Pragya Komal, Ph.D.	Assistant Professor, Gr-I	Hyderabad
BIOTECHNOLOGY		
Dawood Jalaluddin Shariff, Ph.D.	Professor	Dubai
Neeru Sood, Ph.D.	Professor	Dubai
Ramachandran Subramanian, Ph.D.	Associate Professor	Dubai
Trupti Swarup Gokhale, Ph.D.	Associate Professor	Dubai
Pallab Sanpui, Ph.D.	Assistant Professor	Dubai
Mainak Dutta, Ph.D.	Assistant Professor	Dubai
Namita Khanna, Ph.D.	Assistant Professor	Dubai
CHEMICAL ENGINEERING		
Srinivas Krishnaswamy, Ph.D.	Professor	Goa
Sutapa Roy Ramanan, Ph.D.	Professor	Goa
Arvind Kumar Sharma, Ph.D.	Associate Professor	Pilani
Banasri Roy, Ph.D.	Associate Professor	Pilani
Hare Krishna Mohanta, Ph.D.	Associate Professor	Pilani
Suresh Gupta, Ph.D.	Associate Professor	Pilani
Sheth Pratik N, Ph.D.	Associate Professor	Pilani
Smita Raghuvanshi, Ph.D.	Associate Professor	Pilani
Bharat Bhushan Gulyani, Ph.D.	Associate Professor	Dubai
Prakash Kumar Beri, Ph.D.	Associate Professor	Dubai
Sampatrao Dagu Manjare, Ph.D.	Associate Professor	Goa

Name	Designation	Campus
Saroj Sundar Baral, Ph.D.	Associate Professor	Goa
I Sreedhar, Ph.D.	Associate Professor	Hyderabad
Balaji Krishnamurthy, Ph.D.	Associate Professor	Hyderabad
Ramesh Babu Adusumalli, Ph.D.	Associate Professor	Hyderabad
Srikanta Dinda, Ph.D.	Associate Professor	Hyderabad
Karthik Venkateshan, Ph.D.	Associate Professor	Hyderabad
Nishant Harishbhai Pandya, Ph.D.	Assistant Professor	Dubai
Eldhose Iype, Ph.D.	Assistant Professor	Dubai
Amit Jain, Ph.D.	Assistant Professor, Gr-I	Pilani
Ajaya Kumar Pani, Ph.D.	Assistant Professor, Gr-I	Pilani
Abhishek Suresh Dhoble, Ph.D.	Assistant Professor, Gr-I	Pilani
Arghya Banerjee, Ph.D.	Assistant Professor, Gr-I	Pilani
Bhanu Vardhan Reddy Kuncharam, Ph.D.	Assistant Professor, Gr-I	Pilani
Etika Krishna Chaitanya, Ph.D.	Assistant Professor, Gr-I	Pilani
Priya Christina S, Ph.D.	Assistant Professor, Gr-I	Pilani
P Chattopadhyay, Ph.D.	Assistant Professor, Gr-I	Pilani
Srinivas Appari, Ph.D.	Assistant Professor, Gr-I	Pilani
Somak Chatterjee, Ph.D.	Assistant Professor, Gr-I	Pilani
Samir Ramdas Kale, Ph.D.	Assistant Professor,(OC)-Gr-I	Pilani
K Santosh Sopanrao, M.E.	Assistant Professor,(OC)-Gr-I	Pilani
Manjuri Kumar, Ph.D.	Assistant Professor, Gr-I	Goa
Jegatha Nambi Krishnan, Ph.D.	Assistant Professor, Gr-I	Goa
Asima Shaukat, Ph.D.	Assistant Professor, Gr-I	Goa
Rajagopal Vellingiri, Ph.D.	Assistant Professor, Gr-I	Goa
Vivek Rangarajan, Ph.D.	Assistant Professor, Gr-I	Goa
Pradeep Kumar Sow, Ph.D.	Assistant Professor, Gr-I	Goa
Richa Singhal, Ph.D.	Assistant Professor, Gr-I	Goa
Anirban Roy, Ph.D.	Assistant Professor, Gr-I	Goa
Sharad Sontakke, Ph.D.	Assistant Professor, Gr-I	Goa
Amol Deshpande, Ph.D.	Assistant Professor, Gr-I	Goa
Paramita Haldar, Ph.D.	Assistant Professor, Gr-I	Goa
D Purnima, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Vikranth Kumar Surasani, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Angan Sengupta, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Amarthaluri Satyapaul Singh, Ph.D.	Assistant Professor, Gr-I	Hyderabad
B Nandini, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Pamidipati Sirisha Nagaraju Padmaja, M.Tech.	Assistant Professor, Gr-II	Hyderabad

Name	Designation	Campus
CHEMISTRY		
G Sundar, Ph.D.	Senior Professor & Director	Hyderabad
S C Sivasubramanian, Ph.D.	Professor	Pilani
Ram Kinkar Roy, Ph.D.	Professor	Pilani
Dalip Kumar, Ph.D.	Professor	Pilani
Anil Kumar, Ph.D.	Professor	Pilani
Aditya Prasad Koley, Ph.D.	Professor	Goa
Sunil Bhand, Ph.D.	Professor	Goa
Narendra Nath Ghosh, Ph.D.	Professor	Goa
Bhavana P., Ph.D.	Professor	Goa
N Rajesh, Ph.D.	Professor	Hyderabad
Sumithra Kanakamma, Ph.D.	Professor	Hyderabad
Subit Kumar Saha, Ph.D.	Professor	Hyderabad
Saumi Ray, Ph.D.	Associate Professor	Pilani
Ajay Kumar Sah, Ph.D.	Associate Professor	Pilani
Bharti Khungar, Ph.D.	Associate Professor	Pilani
I R Laskar, Ph.D.	Associate Professor	Pilani
Madhushree Sarkar, Ph.D.	Associate Professor	Pilani
Indresh Kumar, Ph.D.	Associate Professor	Pilani
Surojit Pande, Ph.D.	Associate Professor	Pilani
Rajeev Sakhuja, Ph.D.	Associate Professor	Pilani
Shamik Chakraborty, Ph.D.	Associate Professor	Pilani
Raghu Nath Behera, Ph.D.	Associate Professor	Goa
Anjan Chattopadhyay, Ph.D.	Associate Professor	Goa
Ranjan Dey, Ph.D.	Associate Professor	Goa
Rabi Narayan Panda, Ph.D.	Associate Professor	Goa
Prakash Halan, Ph.D.	Associate Professor	Goa
Mainak Banerjee, Ph.D.	Associate Professor	Goa
Amrita Chatterjee, Ph.D.	Associate Professor	Goa
Anupam Bhattacharya, Ph.D.	Associate Professor	Hyderabad
K V G Chandra Sekhar, Ph.D.	Associate Professor	Hyderabad
Subbalakshmi Jayanty, Ph.D.	Associate Professor	Hyderabad
Krishnan R, Ph.D.	Associate Professor	Hyderabad
Manab Chakravarty, Ph.D.	Associate Professor	Hyderabad
Ramakrishnan Ganesan, Ph.D.	Associate Professor	Hyderabad
Amit Nag, Ph.D.	Associate Professor	Hyderabad
Sounak Roy, Ph.D.	Associate Professor	Hyderabad

Name	Designation	Campus
Prashant U Manohar, Ph.D.	Assistant Professor, Gr-I	Pilani
Paritosh Shukla, Ph.D.	Assistant Professor, Gr-I	Pilani
Bibhas Ranjan Sarkar, Ph.D.	Assistant Professor, Gr-I	Pilani
Tincy Lis Thomas, Ph.D.	Assistant Professor, Gr-I	Goa
Rashmi Chauhan, Ph.D.	Assistant Professor, Gr-I	Goa
Jayadevan K P, Ph.D.	Assistant Professor, Gr-I	Goa
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Amit Ashok Vernekar, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Himanshu Aggarwal, Ph.D.	Assistant Professor, Gr-I	Hyderabad
CIVIL ENGINEERING		
Ashoke Kumar Sarkar, Ph.D.	Senior Professor & Director	Pilani
Rajiv Gupta, Ph.D.	Senior Professor	Pilani
Ajit Pratap Singh, Ph.D.	Professor	Pilani
S B Singh, Ph.D.	Professor	Pilani
Vasan A, Ph.D.	Professor	Hyderabad
Anshuman, Ph.D.	Associate Professor	Pilani
Manoj Kumar, Ph.D.	Associate Professor	Pilani
Anupam Singhal, Ph.D.	Associate Professor	Pilani
Ravi Kant Mittal, Ph.D.	Associate Professor	Pilani
Dipendu Bhunia, Ph.D.	Associate Professor	Pilani
V R Vinayaka Ram, Ph.D.	Associate Professor	Hyderabad
Jagadeesh Anmala, Ph.D.	Associate Professor	Hyderabad
Sridhar R, Ph.D.	Associate Professor	Hyderabad
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Sridhar Gangaputhiran, Ph.D.	Assistant Professor	Dubai
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Murari Raja Raja Varma, Ph.D.	Assistant Professor, Gr-I	Hyderabad
Chandu Parimi, Ph.D.	Assistant Professor, Gr-I	Hyderabad
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COMPUTER SCIENCE, INFORMATION SYSTEMS & SOFTWARE SYSTEMS		
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Sudeept Mohan, Ph.D.	Professor	Pilani
Navneet Goyal, Ph.D.	Professor	Pilani
S. Balasubramaniam, M.S.	Professor	Pilani
Sangili Vadivel, Ph.D.	Professor	Dubai
Vijayakumar Balakrishnan, Ph.D.	Professor	Dubai
Neena Goveas, Ph.D.	Professor	Goa
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Mukesh Kumar Rohil, Ph.D.	Associate Professor	Pilani
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G Geethakumari, Ph.D.	Associate Professor	Hyderabad
Aruna Malapati, Ph.D.	Associate Professor	Hyderabad
Lalita Bhanu Murthy Neti, Ph.D.	Associate Professor	Hyderabad
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Sapna Sadhwani, M.Tech..	Lecturer	Dubai
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Sunil Thomas, Ph.D.	Assistant Professor	Dubai
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Shazia Hasan, Ph.D.	Assistant Professor	Dubai
Gomathi Bhavani Rajagopalan, Ph.D.	Assistant Professor	Dubai
Swarnalatha Rajaguru, Ph.D.	Assistant Professor	Dubai
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Vinay Chamola, Ph.D.	Assistant Professor, Gr-I	Pilani
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Mahima Raina	Assistant Professor	Dubai
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The list of scientistis / professionals from industries / collaborating organizations who are currently involved and actively participating in running specific collaborative programmes is given below:

BITS - Dell EMC, Bangalore, Collaboration: M.Tech. in Software Engineering

Organization Professionals:

Narayanan Jayapalan

Guest Faculty

Prof. Vivekananda Reddy	Computer Science
Prof. Raghavendra TS	Computer Science
Prof. Anitha Murthy	Computer Science
Prof. Ajay Misra	Computer Science
Prof. Raghavan P	Computer Science
Prof. Vinay Joshi	Computer Science
Prof. Priya N	Computer Science

BITS - Oracle India, Bangalore, Collaboration: M.Tech. Software Engineering

Organization Professionals:

Mr. Vinodkumar Chithambaram, Mr. Mukul Goswami

Guest Faculty

Prof Ajit Kumar Sarangi	Computer Science
Prof Nagarajan R	Computer Science

BITS – SAP Labs, Bangalore, Collaboration: M.Tech. Software Engineering

Organisation Professionals:

Markus Bell, Pooja Suresh, Zoya Kapoor

Guest Faculty

Mr. Badri Nath	Computer Science & Information Systems
Mr. Kavi Arasu	Computer Science
Prof. Ramakanth	Computer Science
Mr. Srevats	Mathematics
Mr. Nithin Krishna	Computer Science
Mr. Sunil Teggihalli	Computer Science
Dr.Naveen NC	Computer Science
Prof. Veena N	Computer Science
Prof. Tabassum Ara	Computer Science

CLUSTER PROGRAMME, Bangalore: M.Tech. in Design Engineering

Organization Professionals: NA

Guest Facutly:

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Prof. P N Subramani	Mechanical
Prof. Venkatesh Babu Donekal	Mechanical
Prof. Satyanaryana A	Mechanical
Mr. Ven Holalker	Mechanical
Dr. Keshav	Mechanical
Mr.Indrajit Mukherjee	Mechanical

CLUSTER PROGRAMME, Bangalore: M.Tech. Microelectronics

Organisation Professionals: NA

Guest Faculty

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Prof. Nagabhushanam	Electronics
Prof. Sunitha Murthy	Electronics
Prof. Paresh Joshi	Electronics
Mr. Rejesh N A	Electronics
Prof. Premananda	Electronics
Prof. Venu	Electronics

CLUSTER PROGRAMME, Bangalore: M.Tech. Embedded Systems

Organization Professionals: NA

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Mr. Basavaraju	Electronics
Prof. Anand Natarajan	Electronics

BITS - UTAS, Bangalore, Collaboration: M.Tech. Embedded Systems

Organization Professionals:

Basavaraj Gadigeppagoudar, Della Thomas

Guest Faculty:

Prof. Shirdinath Tekur, Mr. Ajay Sood

BITS - CISCO, Bangalore, Collaboration: M.Tech. Software Systems

Organization Professionals:

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Guest Faculty

Prof.S Vagdevi	Computer Science

Prof.Channabasappa Heralgi	Computer Science
Mr.Siva Sankar Anumula	Computer Science
Mr.Kallol Pal	Computer Science
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BITS - CISCO, Bangalore Collaboration: M.Tech. Embedded Systems

Organization Professionals:

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BITS - CISCO, Bangalore, Chennai, Pune, Gurgaon, Collaboration: M.Tech. Software Systems

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BITS-Avaya, Pune, Collaboration: M.Tech. Software Engineering

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BITS - Bharat Forge Limited, Pune, Collaboration: B.Tech. Manufacturing Technology

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Mr. Srikant Madiwale	Mechanical
Mr. Mukesh Ghogre	Instrumentation
Mr. N K Josh	Mechanical
Mr. Vikas Jadhav	Mathematics
Mr.Amjad Shaik	Mathematics
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CLUSTER PROGRAMME, Pune: M.Tech. Embedded Systems

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Prof. Pushkar Barve	Embedded System
Prof. Narendra Lakal	Mechanical
Prof. Anju Kulkarni	Electronics and Telecommunication
Prof. Pandit Jagtap	Electronics

CLUSTER PROGRAMME, Pune: M.Tech. Design Engineering

Organisation Professionals:

Dr. Raj Kumar Singh Mr. Jitendra Divgi

Guest Faculty:

Mr. N K Joshi	Mechanical
Mr. Ayaz Khan	Mechanical
Mr. Harish Deshpande	Mechanical
Dr. Umesh Chavan;	Mechanical
Dr. Suhas Deshmuk	Mechanical
Mr. Anand Mahulkar,	Mechanical
Mr. KW Deshmukh	Mechanical
Ms Sandhya Pande	Mechanical
Mr. Vikas Jadhav	Mathematics
Dr. Ganesh Kakandekar	Mechanical

BITS-Cybage India Limited, Pune, Collaboration: M.Tech. Software Engineering

Organisation Professionals:

Ms.Dipti Trivedi, Ms.Kirti Mahadik, Ms.Aishwarya Suryavanshi

Guest Faculty

Dr. Sunil Dhore,	Computer Science & Information Systems
Prof. Sourish Banerjee	Computer Science & Information Systems
Mr. Sanjay Joshi	Computer Science & Information Systems

BITS-IGATE Ltd., Mumbai and Pune, Collaboration: M.Tech. Software Engineering

Organisation Professionals:

Mrs. Veena Deshpande, Mr. Sachin Patankar, Mr. Pravin Tekade, Ms Mahima Sharma, Mr. Pramod Patwardhan

Guest Faculty

Mr. Sameer Chimurkar	Computer Science & Information Systems
Ms. Seema Shah	Computer Science & Information Systems
Mr. Abhijeet Patankar	Computer Science & Information Systems
Mr. Parmanand Barik	Computer Science & Information Systems
Mr. Santosh Chobe,	Computer Science & Information Systems
Mr. Ashutosh Nivargi.	Computer Science & Information Systems

BITS-JOHN DEEERE, Pune, Collaboration: M.Tech. Design Engineering; B.Tech. Engineering Technology

Organisation Professionals:

Mr. Lalit Ganwir

Guest Faculty

Mr. Prakash Pednekar	Mechanical
Mr. Prasad Deshpande	Mechanical
Mr. Amjad Sheikh	Mathematics
Mr. NK Joshi	Mechanical
Mr. Milind Ramgir	Mechanical
Dr. Suhas Deshmukh.	Mechanical

BITS - Kirloskar Oil Engines Ltd., Kagal, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr. Krishna Gawade, Mr. Vinayak Patil

Guest Faculty:

Mr. Ashish Patil	Mechanical
Mr. Sunil Kardikar	Mechanical
Mr. Bhimsen Shinde	Mathematics
Mr. Amar Bhandare	Mechanical

BITS - SKF India Limited, Pune, Collaboration: M.Tech. Design Engineering

Organisation Professionals:

Ms Anjali Byce, Ms. Nitasha Rawat, Ms Priya Shetty

Guest Faculty:

Mr. N.K Joshi	Mechanical
Mr. Shrikant Madiwale	Mechanical
Mr. Milind Ramgir	Mechanical
Mr. Ayaz Khan	Mechanical

BITS - TACO India Ltd., Pune, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr. Ajay Tondon, Mr. Siba Satapathy, Mr. Kanchan Kumar Biswas

Guest Facutly:

Mr Sunil Divekar	Mechanical,
Mr. Anand Mahurakar	Mechanical,
Mr. Amol Shinde	Mechanical,
Mr. Prasad Deshpande	Mechanical,
Mr. Mahadev Chougule	Electrical and Electronics,
Mr. Sandeep Wankhede	Mechanical,
Mr. Harish Deshpande	Mechanical,
Ms. Puja Awachat	Language

BITS - Tata Motor, Pune: Collaboration: M.Tech. Automatic Engineering

Organisation Professionals:

Mr. Sushant Routray, Ms. Anupama Shukla, Mr. Nishant Jaiswal

Guest facuty:

Dr. Benu Madhav	Mechanical
Dr. Ganesh Soni,	Mechanical
Mr. Sarvesh Mahajan,	Mechanical
Mr. Amol Shinde	Mechanical

BITS - Tata Motors (ERC), Pune: Collaboration: M.Tech. Automatic Engineering

Organisation Professionals:

Mr. Angsuman Sharma , Ms. Archana Saraf

Guest Faculty:

Mr. Vijay Sonawane	Mechanical
Mr. Girish Muraleedharakurup	Mechanical
Mr. Shrikant Madiwale	Mechanical
Ms. Sandhya Pande	Mechanical

Mr. Millind Ramgir	Mechanical
Ms. Yogeshri Gaidhani	Mathematics

BITS - Tata Motor, Pune: Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr. Gajendra Chandel , Mr. Mukund Vyas, Ms. C. Sneha

Guest faculty:

Mr. Satya Balaji	Mechanical
Mr. Amol Shinde	Mechanical
Mr. Sunil Divekar	Mechanical
Mr. Mahadev Chougule	Electrical & Electronics

BITS - Tata Motors (ERC), Pune: Collaboration: B.Tech. Engineering Technology

Organisation Professionals:

Mr. Angsuman Sharma , Ms. Archana Saraf , Mr. Ashish Sharma

Guest Faculty:

Mr. Amol Shinde	Mechanical
Mr. Sudhir Sindagi	Mechanical
Mr. Millind Ramgir	Mechanical

BITS - Mahindra Vehicles Manufacturing India Ltd., Pune, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Ms. Shubangi Jagtap, Mr.Mahesh Karindkar,Mr. Sunil Mane.

Guest faculty:

Mr. Sandip Wankhade	Mechanical
Mr. Rahul Kale	Languages
Mr. Wallace Jacob	Management

BITS – Samsung, Noida, Collaboration: M.Tech. Software Systems

Organisation Professionals:

Ms. Anumeha

Guest Faculty:

Mr. Piyush Kulshreshtha- Computer Science & Information Systems

Mr. Sheshadri Chatterjee- Computer Science & Information Systems

Mr. Dhiraj K. Prasad - Computer Science & Information Systems;

BITS - Tata Technologies, Pune, Collaboration: M.Tech. Automotive Engineering

Organisation Professionals:

Mr. Subhendu Ghosh, Mr. Aditya Roy Choudhary, Mr. C. Surendra Nath, Ms. Anumeha Jain, Mr. Indranil Bhattacharya.

Guest faculty:

Dr. Sanjay Pohekar	Mechanical

BITS - Tech Mahindra Limited, Pune, Mumbai, Bangalore, Hyderabad, Chennai, Noida, Collaboration: M.Tech. Software Engineering and M.Tech. Telecommunications and Software Engineering,

Organisation Professionals:

Ms. Vaishali Pathak, Mr. Joseph Salibindla, Ms. Gargi Banerjee, Mr. Saurabh Agrawal, Mr. Abhishek Kumar, Mr. Saravanan Mariappan, Mr. Sindhu Rajendra, Mr. Nagraj Vaidya, Mr. P.V. Mathew, Ms. Rajpreet Kaur, Mr. Ankush Bhirat and Ms. Yamjila Aruna.

BITS - Cummins India Ltd., Pune: Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Ms. Gayatri Phadke, Ms. Shabanam Pathan, Ms. Prerna Koppiker

BITS - Tata Motors Limited, Jamshedpur, Collaboration: B.Tech. Manufacturing Technology

Organisation Professionals:

Mr. Sampath Kumar Morri, Mr. Ravi Ranjan, Ms. Nilanjana Mohanty, Mr. Rajiv Ranjan.

Guest Faculty

Mr. Buntu Kumar	Mechanical
Mr. Ashutosh Tripathy	Mechanical
Mr. Subhashis Ghosh	Mechanical

Mr. Rakesh Kumar Sarangi (Electrical & Electronics)

BITS - Tolani Maritime Institute, Pune, Collaboration: B.Tech. Marine Engineering and B.Tech. Nautical Technology

Organisation Professionals:

Dr. Sujata Naik-Tolani, Dr. B. K. Saxena, Capt R. K. Razdan, Capt. Krishnamurthy N Iyer, Dr. Sanjeet Kanungo

Guest Faculty

Dr. D.D. Mundhra, CDr. (retd)	Mechanical
Mr. S Dasgupta	Marine
Capt. Manoj Hirkane	Nautical
Mr. Wallace Jacob	Applied Science

Mr. Shishir kumar Srivastava	Marine
Mr. Arun Mahajan	Marine
Mr. Naresh Kumar Mishra	Marine
Mr. Shailendra Kumar	Marine
Mr. Upinderjeet Singh	Marine
Mr. Premkumar Ramrakhiani	Marine
Mr. Sankar K Subramanian	Marine
Cdr. (Retd) Bhaskar Walimbe	Marine
Dr. Rajendra Prasad	Marine
Col. (Retd) G. P. Krishnamurthy	Mechanical
Mr. N. K. Joshi	Mechanical
Dr. Nitin D Junnarkar	Mechanical
Ms. Anjali V Deshpande	Applied Science
Mr. Sudhir C. Sindagi	Marine
Mr. Ajit Singh Aidhen	Marine
Capt. V B Sathaye	Nautical

BITS - Verizon Data Services Ltd, Chennai and Hyderabad, Collaboration: M.Tech. in Software Engineering

Organisation Professionals:

Mr. Jose Francis M, Ms. Anisha Joseph

Guest faculty:

Mr. Aravind Appan	Computer Science & Information Systems
Ms. Uma Ganesan	Computer Science & Information Systems
Mr. Mahavir	Computer Science & Information Systems
Mr. Muruganandam	Computer Science & Information Systems
Mr. Raja Chidambaram	Computer Science & Information Systems
Mr. M.J.Shankarraman	Computer Science & Information Systems
Mr. Vijaykumar Athithyan	Computer Science & Information Systems
Mr. Krishnamoorthy Rao	Computer Science & Information Systems

Mr. Balamurugan Computer Science & Information Systems

Mr. Prabhu Sunderraman Computer Science & Information Systems

BITS - Chennai Cluster Online Collaboration: M.Tech. in Design Engineering

Guest faculty:

Mr. Sankarakrishnan	Mechanical
Mr.Ven Holalkere	Mechanical

BITS-Chennai Cluster (Face to Face) Collaboration: M.Tech. in Design Engineering

Guest faculty:

Mr.Shashank Tiwari	Mechanical
Mr.Sathya Priyan	Mechanical

Delhi Cluster: M.Tech. Design Engineering & M.Tech. Embedded System

Guest Faculty

Mr. Amit Sharma	Mechanical
Dr. Ashish Aggarwal	Mechanical
Dr. Umang Soni	Mechanical
Dr. Girish Kumar	Mechanical
Mr. MD Zubair	Mechanical
Mr. Wasim Alram	Mechanical
Mr. GNS Harsha	Electrical & Electronics
Mr. Ravinder Kumar Chahar	Electrical & Electronics

BITS - Maruti Suzuki India Ltd, Gurgaon, Collaboration: B.Tech. Manufacturing Technology

Organization Professionals:

Mr. Deepak Kumar, Mr. L.K. Gupta, Mr. Devanshu Wadhawan, Mr. C D Sharma, Mr N. K. Das

Guest Faculty:

Dr. Umang Soni – Mechanical

Prof. Ashutosh Pandey – Mechanical

Mrs. Monika Garg – Mathematics

Prof. Imran Siraj – Computer Science & Information Systems

Mr Rahul Katna - Mechanical

BITS – BPCL, Mumbai, Collaboration: B.Tech. Process Engineering

Guest Faculty

Prof. Umesh Mahind	Electronics Engg
Prof. Ganesh Dhamal	Mathematics
Prof. Sonal Dhar	Mechanical Engg
Prof. Pramod Bide	Computer Science & Information Systems

BITS - Sun Pharma, Vadodara, Collaboration:

Organisation Professionals:

Mr. Pradipta Swain, Mr. Atul Choudhari, Mr. Amit Kumar Sharma, Ms. Monica Shukla

Guest Faculty

Mr Jayawant Gokhle	Computer Science & Information system

Dr Ashish Ghosh	Management

BITS – Lupin Ltd., Mumbai, Collaboration: M.Tech. Pharmaceutical Operation and Management

Guest Faculty

Prof. Gokhale Jayanti	Computer Science & Information Systems
Mr. Viswanathan	Management

BITS – Lowes, Bangalore

Guest Faculty

Mr A.M. Prasad	Computer Science & Information Systems
Mr Satyanarayan Reddy K	Computer Science & Information Systems
Mr Menaja S	Computer Science & Information Systems

BITS - Wipro Notchup, Collaboration: M.Tech. Software Systems

Guest Faculty:

Mr. Sridhar Venkataraman, Mr. C R Sarma, Mr. N Krishna Murthy, Mr. Naveen Samala, Mr. Ajit Kumar Sarangi, Mr. Jawahar J Rao

BITS - Wipro Infotech, Bangalore, Mumbai, Hyderabad, Mumbai, Gurgaon, Collaboration: M.Tech. Systems Engineering, and B.Tech. Information Systems.

Organisation Professionals:

Mr. Ajay Narayanan, Ms. Neha, Ms. Anchal Tripathi, Ms. Ashif Banu Abdul Razak, Ms. P. Monica Prisulla, Ms. Pinky Paresh Bhatt, Ms. Puhpanjali Patnaik.

BITS-Wipro Technologies, Bangalore, Chennai, Hyderabad, Kolkata, Pune, Mysore, Mumbai, Gurgaon, Kochi and Coimbatore.

Collaborations: M.Tech. Software Engineering, M Tech, Computing Systems & Infrastructure, M. Tech. in Software Systems, M.Tech. Microelectronics and B.Tech. Information Systems

Organisation Professionals:

Mr. P B Kotur, Mr. Thirunavukkarasu, Mr. Murali Punniyakodi, Mr. Satheesh Kumar, Mr. Santosh Sridhar, Mr. Nimesh Gala, Mr. Mukesh Verma, Ms. Rajani Satheesan.

Guest Faculty for Wipro Technologies and Wipro Infotech:

A Gautham	Computer Science & Information Systems
A Srivalli	Computer Science & Information Systems
A. Vijayarajan	Computer Science & Information Systems
A.M. Prasad	Computer Science & Information Systems
Abhijit Patankar	Computer Science & Information Systems
Akshaya Ganesan	Computer Science & Information Systems
Amar Kumbhar	Computer Science & Information Systems
Amit K Srivastav	Computer Science & Information Systems
Amol Joshi	Computer Science & Information Systems
Amruta K. Mohanty	Computer Science & Information Systems
Angshumitra Ghosh	Computer Science & Information Systems
Anitha N	Computer Science & Information Systems
Anjan K	Computer Science & Information Systems
ANK Prasannanjaneyulu	Computer Science & Information Systems
Ankur Pachauri	Computer Science & Information Systems
Arun V	Computer Science & Information Systems
Arun Vadekkedhil	Computer Science & Information Systems
B S Satpute	Computer Science & Information Systems
B.N. Shankar Gowda	Computer Science & Information Systems
B.V.Rangaraju	Mathematics
Bandana Priya	Mathematics
Basavaraju	Computer Science & Information Systems
Bhasker Rao K	Computer Science & Information Systems
Bhavana Tyagi	Computer Science & Information Systems
Binita Sajit	Computer Science & Information Systems
C.V. Vinay	Mathematics
Ch Ramesh	Computer Science & Information Systems
Channabasappa Heralgi	Computer Science & Information Systems

Chetna Khairnar	Computer Science & Information Systems
Chikara	Computer Science & Information Systems
Chinnaswamy C N	Computer Science & Information Systems
Chockalingam	Computer Science & Information Systems
Cvnl Sireesha	Mathematics
D P Dave	ECE/EEE
D Sujatha	Computer Science & Information Systems
D Venkata Subramanian	Computer Science & Information Systems
D. Dodde Gowda	Computer Science & Information Systems
D.V. Chandrashekhar	Mathematics
Dattathreya	ECE/EEE
Debasis Bandyopadhyay	Computer Science & Information Systems
Dhananjay Devidas Joshi	Computer Science & Information Systems
Dharmendra Jaiswal	Computer Science & Information Systems
Dhinakaran	Computer Science & Information Systems
Dhiraj Kumar Prasad	Computer Science & Information Systems
Dinesh Rawat	Computer Science & I nformation Systems
Dinesh. M.N	ECE/EEE
Dipak Kumar Sore	Computer Science & Information Systems
Dolly Gupta	Computer Science & Information Systems
DS Rao	ECE/EEE
G Krishna Kumari	Mathematics
Ganesh Dhamal	Mathematics
Ganesh S	Mathematics
Ganesh Thakur	Mathematics
Gangaboraiah	Computer Science & Information Systems
Gauri Kulkarni	Mathematics
Gayathridevi	Mathematics
Gokhale Jayanti	Computer Science & Information Systems
Guru Prasad S	Computer Science & Information Systems
Guruprasad Shenai	Computer Science & Information Systems
Gururaja. H.S.	Computer Science & Information Systems
Gyanan Aman	ECE/EEE
Harikrishnan	ECE/EEE
Harish Kumar BT	Computer Science & Information Systems
Harsh Taneja	Computer Science & Information Systems
Himanshu Chikara	Computer Science & Information Systems
Hitendra Khairnar	Computer Science & Information Systems
Indrajit Banerjee	Computer Science & Information Systems
J Jawahar	Computer Science & Information Systems
Janardhan Singh K	Computer Science & Information Systems
Jayalakshmamma D V	Mathematics
Jayalakshmi	Computer Science & Information Systems
Jayanthi M G	Computer Science & Information Systems
Jayashree. M	Computer Science & Information Systems
Jibin	Computer Science & Information Systems
K Audinarayan Reddy	Computer Science & Information Systems
K Jyothi Rathna	Computer Science & Information Systems
K Madhuri	Computer Science & Information Systems
K Senthil Kumar	Computer Science & Information Systems
K Venkatesh	Computer Science & Information Systems
K Vidhya	Computer Science & Information Systems
K. B. Ramesh	Computer Science & Information Systems
K. Satyanarayan Reddy	Computer Science & Information Systems
K. Suresh	ECE/EEE
K.B. Shadaksharappa	Computer Science & Information Systems

Kalpana Ranade	Computer Science & Information Systems
Kamalakannan C R	Mathematics
Kempa Gowda	Computer Science & Information Systems
Kempe Gowda M	Mathematics
Krishna Chaitanya	Computer Science & Information Systems
Kumar. A	ECE/EEE
KV Vamsi Krishna	Computer Science & Information Systems
Lohith J J	Computer Science & Information Systems
M Hari Prasad	Computer Science & Information Systems
M Sriram	Computer Science & Information Systems
M Sudha	Computer Science & Information Systems
M V Nimbalkar	ECE/EEE
M. Sankar	Mathematics
M. Suresh	Mathematics
M. Vasudevarao	Computer Science & Information Systems
M.Keerthi	Computer Science & Information Systems
M.Radhiga	Computer Science & Information Systems
Madhan Kumar G S	Computer Science & Information Systems
Magesh	Computer Science & I Information Systems
Mahadeo K Nikam	Mathematics
Mandar Datar	Computer Science & Information Systems
Manikantan	Mathematics
Manjula Sanjay Koti	Computer Science & Information Systems
Md Riyazuddin	Mathematics
Meghna Joshi	ECE/EEE
Merin Paul	Computer Science & Information Systems
Minati Rath	Computer Science & Information Systems
Mohammed Tajuddin	Computer Science & Information Systems
Mohan Kumar H P	Computer Science & Information Systems
Muhammed Anees	Computer Science & Information Systems
Muralidhar	Computer Science & Information Systems
Muruganandham	Computer Science & Information Systems
N Sreekanth Prasad	ECE/EEE
N Srikanth Prasad	Computer Science & Information Systems
N Srinivasan	Computer Science & Information Systems
Nagaveni R	Computer Science & Information Systems
Nagesh B S	Computer Science & Information Systems
Nanda Ashwin	Computer Science & Information Systems
Nandagopal	ECE/EEE
Naveen Samla	Computer Science & Information Systems
Nidhi Sharma	Computer Science & Information Systems
Nikhil Parashar	Computer Science & Information Systems
Nimkar CS	Computer Science & Information Systems
Nitin Kaushik	Mathematics
NL Bhikshu	Mathematics
P B Kumbharkar	Computer Science & Information Systems
P Renuka	Computer Science & Information Systems
Pankaj Patil	Computer Science & Information Systems
Parag Tamhankar	Computer Science & Information Systems
Pardha Saradhy	ECE/EEE
Parmanand Barik	Computer Science & Information Systems
Pawan Gupta	Computer Science & Information Systems
Pinaki Mukherjee	Mathematics
Piyush Kulshreshtha	Computer Science & Information Systems
Poonam Ponde	Computer Science & Information Systems
Pradnya Kashikar	Computer Science & Information Systems

Pranabananda Chakraborty	Computer Science & Information Systems
Praveen Kamath	Computer Science & Information Systems
Pravin Pawar	Computer Science & Information Systems
Purushotham B V	Computer Science & Information Systems
PV Saradhy	Computer Science & Information Systems
PVB Varma	Computer Science & Information Systems
R Candhra Shaker	Mathematics
R Nagaraja	Computer Science & Information Systems
R. Rajasudha	Mathematics
Rachna M	ECE/EEE
Rafidha Rehiman	Computer Science & Information Systems
Raghavan P	Computer Science & Information Systems
Raghavendra T.S	Computer Science & Information Systems
Raghuvanshi	Computer Science & Information Systems
Raja Sudha	Computer Science & Information Systems
Raja Thilakam	ECE/EEE
Rakesh Tarneja	Computer Science & Information Systems
Rama Satish K.V.	Computer Science & Information Systems
Ramakanthkumar P	Computer Science & Information Systems
Ramanathan	Computer Science & Information Systems
Ramesh G	Mathematics
Ramesh Ramani	Computer Science & Information Systems
Ranjita Mookherjee	Computer Science & Information Systems
Ravi Patki	Computer Science & Information Systems
Ravithammal	Mathematics
Riyaz N K	Computer Science & Information Systems
Rizwan Khan	Computer Science & Information Systems
S Ganesh Babu	Computer Science & Information Systems
S L Venkataraman	Computer Science & Information Systems
S Manjunath	Mathematics
S P Padmanabhan	Computer Science & Information Systems
S R Swamy	Mathematics
S V Menaja	Computer Science & Information Systems
S. Balasubrahmanya	Computer Science & Information Systems
S. Sandeep	Computer Science & Information Systems
S.Keshava Murthy	ECE/EEE
Sachin Vyavahare	Mathematics
Sandeep Aggarwal	Computer Science & Information Systems
Sandeep Kumar	Computer Science & Information Systems
Sandeep Kumar	ECE/EEE
Sandeep Patil	Computer Science & Information Systems
Sandip Roy	Computer Science & Information Systems
Sanjay Joshi	Computer Science & Information Systems
Sankha Mallick	Computer Science & Information Systems
Santhini	Mathematics
Santhini K A.	Computer Science & Information Systems
Santosh Chobe	Computer Science & Information Systems
Santosh Kumar Kanjo	Mathematics
Sapana Pagar	Computer Science & Information Systems
Saravanan Logan	Computer Science & Information Systems
Satheesh R	Computer Science & Information Systems
Sathish Shet. K	Computer Science & Information Systems
Saurabh Ghosh	Computer Science & Information Systems
Saurabh Mengale	Computer Science & Information Systems
Shaibal Sen	Mathematics
Shashidhara H R	Computer Science & Information Systems
Shashikala	Computer Science & Information Systems

Shobhit Khandelwal	Computer Science & Information Systems
Shuchita Vaidya	Mathematics
Siddesh G M	Computer Science & Information Systems
Siddesh.G.K	Computer Science & Information Systems
Somanchi K Murthy	Mathematics
Sonika Rathi	Computer Science & Information Systems
Sourish Banerjee	Computer Science & Information Systems
Sridevi	Computer Science & Information Systems
STVSS Yadunandan	Computer Science & Information Systems
Sudha Joshi	Computer Science & Information Systems
Sugadev	ECE/EEE
Sulabh Tyagi	Computer Science & Information Systems
Suma. V	Computer Science & Information Systems
Sunayana Potdar	Computer Science & Information Systems
Suneel B	Computer Science & Information Systems
Sunil Dhore	Computer Science & Information Systems
Sunil Kumar	Computer Science & Information Systems
Sunil Kumar M	Computer Science & Information Systems
Suresh Srinivasan	Computer Science & Information Systems
Sutripta Chanda	ECE/EEE
Swapna	Computer Science & Information Systems
Swati Tyagi	Computer Science & Information Systems
T Praveen Kumar	Computer Science & Information Systems
T. Vijaya Kumar	Computer Science & Information Systems
T.N. Suresh	Mathematics
Tanveerkram	Computer Science & Information Systems
Thangakumar	Computer Science & Information Systems
Tuhina Samanta	ECE/EEE
Udhaya Kumar K	Computer Science & Information Systems
Udhayabhaskaran	Mathematics
Udhayakumar	Computer Science & Information Systems
Uma Maheswari	Computer Science & Information Systems
Umesh Mahind	ECE/EEE
Utpal Mukhopadhyay	Computer Science & Information Systems
V Srinivasan	Mathematics
V. Chayapathy	Computer Science & Information Systems
V.G. Ravish	Computer Science & Information Systems
V.Muralidhar	Mathematics
Vagdevi S	Computer Science & Information Systems
Vasudeva Rao	Computer Science & Information Systems
Veena N	Computer Science & Information Systems
Veena Antony	Mathematics
Venkataswamy.K.V	Mathematics
Venkatesh	Computer Science & Information Systems
Vijaya Prakash A M	Computer Science & Information Systems
Vijayakumar Athithan	Computer Science & Information Systems
Vijayarangam	Mathematics
Vikas Mishra	Computer Science & Information Systems
Vinod Kumar K	Computer Science & Information Systems
Vishal Bharti	Computer Science & Information Systems
Vishwanath Murthy	Computer Science & Information Systems
Vivekanada M R	Computer Science & Information Systems
Yogesh Somvanshi	Computer Science & Information Systems

BITS – Cognizant Technology Solutions, Chennai, Collaboration: M.Tech. Software Engineering

Organization Professionals:

Mr. Vanamamalai Sridhar, Mr. A. Sridharan

Guest Faculty:

Dr. V. Maheswari, Mr. S. Prabhu, Mr. Sreekumar Gopalan, Mr. Srikanth Chavali, Mr. Rajesh C, Mr. V.S. Vasan

BITS - JSW Steel Ltd., Vijayanagar, Collaboration: B.Tech. Process Engineering

Organization Professionals

Dr. V. K. Nowal, , Mr. Pankaj Lochan, Rajmohan Narasimhan, Dipansu Laskar , Mr. Achutha Raghava, Dr. Ramakrishna, Mr. Upendra Kumar

Guest Faculty

Mr. Shakeel Ahmed Maniyar, Prof. Jeevargi Phakirappa, Dr. Rameshwar Sah, Mr. Satish Kumar Dabbiru, Dr. Mallikarjunrao Panabaka, Ms. Uma Devi, Dr. Sarbendu Sanyal, Dr. Manjini , Sambandam, Dr. Jitendra Mohapatra, Mr. Sharanappa Kalshetty, Dr. Ravi Kishore, Mr. Mrunmaya Pasupalak ,Mr. Chaitanya Ayyagari , Dr. Ravi Kishore , Mr. Vijaya Sekhar , Mr. P K , Tripathi, Prof. Pavan Kumar , Mr. Siddalingagouda, Mr. Irshad Ali , Mr. Venkatesan J, Mr. Ratnakar Bonda, RAJAN CHOLAPALLIYALIL,Prof. Gururaj KK , Mr. Krishna Rao

BITS – UTC Aerospace, Bangalore, Collaboration:

Organization Professionals

Ms. Paul, Deepika, Shankar Gowda

Guest Faculty

Mr. Shirdinath Tekur, Mr. Surendra Raju

BITS – UTC Fire & Security, Bangalore, Collaboration: M.Tech. Software Systems

Guest Faculty

Mr. Prakash Goteti, Mr. Anil Kumar, Mr. K V Vamsi Krishna

BITS – Bombay Hospital, Mumbai, Collaboration: M.B.A. Hospital and Health Systems Management

Mr. B.K. Taparia, Dr. Rajkumar V. Patil, Dr. Rajesh Choumal, Dr. Rajkumar Choudhary, Dr. Sagar Sakle, Dr. Madhulika Jain, Dr. Inder Talwar, Dr. Sunila jaggi, Dr. Sujata Mehta, Dr. Asmitqa Sakle, Dr. P.M. Bhujang, Mr. Rajesh Kukreja, Ms. G.D. Koppikar, Dr. Maya Parihar Malhotra, Dr. D.B. Modi, Dr. Nina Desai, Dr. R. Goel

BITS - Christian Medical College, Vellore, Collaboration: M.B.A. Hospital and Health Systems Management

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BITS – L V Prasad Eye Institute, Hyderabad, Collaboration: B.Optom. Optometry

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3.	Chemical Engineering	Dr. Ajay Kumar Pani
4.	Chemistry	Prof. Ajay Kumar Sah
5.	Computer Science & Information Systems	Dr. Shashank Gupta
6.	Economics & Finance	Dr. Monika Gupta
7.	Electrical & Electronics Engineering	Dr. Punit Mishra
8.	Humanities and Social Sciences	Prof. Gajendra Singh Chauhan
9.	Mathematics	Dr. Sangita Yadav
10.	Mechanical Engineering	Dr. Prateek Kala
11.	Management	Dr. Neetu Yadav
12.	Pharmacy	Dr. Sandeep Sundriyal
13.	Physics	Prof. Niladri Sarkar

Shri Giridhar M. Kunkur (Librarian) - Chairman of the Library Committee

II.	**K K Birla Goa Campus:**	
1.	Biological Sciences	Prof. Kundan Kumar
2.	Chemical Engineering	Dr. Pradeep Kumar Sow
3.	Chemistry	Dr. Jayadevan Kampurath Poduvattil
4.	Computer Science & Information Systems	Prof. Basabdatta Sen Bhattacharya
5.	Economics	Dr. Sukumar Vellakkal
6.	Electrical & Electronics Engineering	Dr. Ashish Chittora
7.	Humanities and Social Sciences	Prof. Basavadatta Mitra
8.	Mathematics	Dr. Gauranga Charan Samanta
9.	Mechanical Engineering	Dr. Vadiraj Anant Hemadri
10.	Physics	Dr. Tarun Kumar Jha

Dr. Anuradha V (Deputy Librarian) - Chairman of the Library Committee

S.N.	Department	Name of the member
III. Hyderabad Campus:		
1.	Biological Sciences	Dr. Gireesha Mohannath T
2.	Civil Engineering	Dr. Bahurudeen A
3.	Chemical Engineering	Dr. Angan Sengupta
4.	Chemistry	Dr. Tanmay Chatterjee
5.	Computer Science & Information Systems	Dr. J Jabez Christopher
6.	Economics and Finance	Dr. Bheemeshwar Reddy A
7.	Electrical & Electronics Engineering	Dr. Sumit Kumar Chatterjee
8.	Humanities and Social Sciences	Dr. Pranesh Bhargava
9.	Mathematics	Dr. Sharan Gopal
10.	Mechanical Engineering	Dr. Arshad Javed
11.	Pharmacy	Dr. Nirmal J
12.	Physics	Prof. Aranya Bhuti Bhattacherjee
	Shri M.S. Uday Kumar (Deputy Librarian) - Chairman of the Library Committee	
IV. Dubai Campus:		
1.	Biotechnology	Dr. Namita Khanna
2.	Chemical Engineering	Dr. Nishant Harishbhai Pandya
3.	Civil Engineering	Dr. Vivek Balachandra Kartha
4.	Computer Science	Dr. Angel Arul Joti Joseph
5.	Electrical & Electronics Engineering, Electronics and Communication Engineering and Electronics and Instrumentation Engineering	Dr. Nilesh Goel
6.	General Sciences	Dr. Shilpee Srivastava Saxena
7.	Humanities and Social Sciences	Dr. Sartaj Rasool Rather
8.	Mechanical Engineering	Dr. Snehaunshu Chowdhury
	Dr. R. Sivakumar (Librarian) - Chairman of the Library Committee	

ACADEMIC GOVERNING COMMITTEE

Dean, Academic – Under Graduate Studies

Prof. Ajit Pratap Singh

Associate Dean, Academic–Undergraduate Studies from each campus

Prof. Suresh Gupta, Pilani Campus
Prof. Neena Goveas, K K Birla Goa Campus
Prof. A. Vasan, Hyderabad Campus
Prof. K. Kumar, Dubai Campus

Dean, Practice School Divison

Prof. S. Gurunarayanan, Pilani Campus

Dr. Anand Kumar, Dubai Campus

Dean, Academic - Graduate Studies and Research

Prof. Srinivas Krishnaswamy

Dean, Work Integrated Learning Programmes Division

Prof. S. Balasubramaniam

Professor-incharge BITS Entrance Examinations

Prof. Chittranjan Hota, Hyderabad Campus

Associate Dean, Academic–Graduate Studies and Research from each campus

Prof. Jitendra Panwar, Pilani Campus
Prof. Bharat Madhusudan. Deshpande, K K Birla Goa Campus
Prof. Venkata Vamsi Krishna Venuganti, Hyderabad Campus
Prof. Ramanujam Karthikeyan, Dubai Campus

DOCTORAL COUNSELLING COMMITTEE

Dean, Academic - Graduate Studies and Research (AGSR)

Prof. Srinivas Krishnaswamy

Dean, Sponsored Research and Consultancy

Prof. Sunil Bhand

Dean, Academic–Undergraduate Studies (AUGS)

Prof. Ajit Pratap Singh

Associate Dean, AGSR of each campus

Prof. Jitendra Panwar, Pilani Campus
Prof. Bharat Madhusudan Deshpande, K K Birla Goa Campus
Prof. Venkata Vamsi Krishna Venuganti, Hyderabad Campus
Prof. Ramanujam Karthikeyan, Dubai Campus

One faculty member from each campus to be nominated by the Senate for a period of two years

1. Prof. Abhijt R. Asati, Pilani Campus
2. Prof. Halan Prakash, K K Birla Goa Campus
3. Prof. N. Suresh Kumar Reddy, Hyderabad Campus
4. Prof. Trupti Swarup Gokhale, Dubai Campus

Convenorship rotates amongst these members depending on the item to be discussed

ADMISSIONS COMMITTEE

Chairman - Vice-Chancellor

Prof. Souvik Bhattacharyya

Convenor: Professor-incharge BITS Entrance Examinations

Prof. Chittaranjan Hota

Members

Director, Pilani Campus
Prof. Ashoke K. Sarkar

Director, K K Birla Goa Campus
Prof. Gunaje Raghurama

Director, Hyderabad Campus
Prof. G. Sundar

Director, Dubai Campus
Prof. R. N. Saha

Director, Hyderabad Campus
Prof. G. Sundar

Special Invitees:

Dean (AGSR)
Prof. Srinivas Krishnaswamy

Dean (AUGS)
Prof. Ajit Pratap Singh

Dean (IPC)
Prof. Suman Kapur

Faculty-incharge (First Degree Admission Tests)
Dr. Sachin U. Belgamwar

Faculty-incharge (Higher Degree Admission Tests)
Prof. Shamik Chakraborty

Associate Dean (AUGS) Dubai Campus
Prof. K. Kumar

ACADEMIC CALENDAR FOR PILANI CAMPUS

SOME IMPORTANT DATES

2019

JULY

Su	M	T	W	Th	F	S
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AUGUST

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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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2020

JANUARY

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FEBRUARY

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MARCH

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APRIL

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MAY

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JUNE

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HOLIDAYS RECESS

First Semester 201 9-2020

July 4, 2019 (Th)	Registration for Practice School II
July 4, (Th)	Practice School II begins
July 29 (M)	Admission to Higher Degree and Doctoral Programmes
July 30 (T)	Admission to Integrated First Degree Programme
July 31 (W)	Freshmen Orientation Programme
August 1 (Th)	First Semester begins
August 1 (Th)	Registration for all students
August 2 (F)	Class-work begins
August 12 (M)	Id-ul -Zuha (H)
August 15 (Th)	Independence Day (H)
August 16 (F)	Last day for substitution of courses
August 24 (S)	Janmashtami (H)
September 2 (M)	Ganesh Chaturthi (H)
September 13(F) - 17(T)	BOSM 2019
September 20 (F)	Monday's Timetable to be followed
September 26 (Th)	Last day for submission of Application for Merit-Cum Need Scholarship
September 28 (S) to October 5 (S)	Mid-Semester Test (Class work Suspended)
October 2 (W)	Mahatma Gandhi's Birthday (H)
October 8 (T)	Dussehra (H)
October 12 (S)	Last day for withdrawal from courses
October 14 (M)	Last day for returning evaluated answerscripts of Mid-Semester Test
October 19 (S) - 23 (W)	OASIS-2019
October 21 (M)	Last day for Mid-Semester Grading
October 27 (Su)-28 (M)	Diwali (H)
November 12 (T)	Guru Nanak's Birthday (H)
November 15 (F)	Tuesday's Timetable to be followed
November 27 (W)	Last day of Pre-comprehensive marks display
November 29 (Th)	Last day for class work
December 2 (M)	Comprehensive Examination begins
December 14 (S)	Comprehensive Examination ends
December 14 (S)	Practice School II ends
December 14 (S)	First Semester ends
December 15 (Su) to January 5 (Su), 2020	Recess
December 25 (W)	Christmas (H)

Second Semester 201 9-2020

January 6, 2020 (M)	Second Semester begins
January 6 (M)	Registration for all students
January 6 (M)	Registration for Practice School II
January 6 (M)	Practice School II begins
January 7 (T)	Class-work begins
January 15 (W)	Makar Sankranti (H)
January 21 (T)	Last day for substitution of courses
January 26 (Su)	Republic Day (H)
January 28 (T)	Last day for submission of Application for Merit-Cum Need Scholarship
January 29 (W)	Basant Panchmi and Founder's Day(H)
March 2 (M) to March 7 (S)	Mid-Semester Test (Class work Suspended)
March 10 (T)	Holi (H)
March 14 (S)	Last day for withdrawal from courses
March 16 (M)	Last day for returning evaluated answerscripts of Mid-Semester Test
March 21 (S)	Last day for Mid-Semester Grading
March 26 (Th) - 29 (Su)	APOGEE
March 31 (T)	Friday's Time Table to be followed
April 2 (Th)	Ram Navami (H)
April 6 (M)	Mahavir Jayanti (H)
April 10 (F)	Good Friday (H)
April 14 (T)	Ambedkar Jayanti (H)
April 21 (T)	Registration for Practice School I
April 27 (M)	Last day of Pre-comprehensive marks display
April 29 (W)	Last day for class work
May 1 (F)	Comprehensive Examination begins
May 7 (Th)	Budh Purnima (H)
May 15 (F)	Comprehensive Examination ends
May 15 (F)	Second Semester ends
May 19 (T)	Summer Vacation begins
May 21 (Th)	Summer Term begins
May 21 (Th)	Practice School I begins
May 24 (Su)	Id-ul fitr (H)
July 13 (M)	Practice School I ends
July 14 (T)	Summer Term ends
July 17 (F)	Summer Vacation ends

ACADEMIC CALENDAR FOR K. K. BIRLA GOA CAMPUS

SOME IMPORTANT DATES

2019

JULY

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AUGUST

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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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2020

JANUARY

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FEBRUARY

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MARCH

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APRIL

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MAY

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JUNE

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HOLIDAYS RECESS

First Semester 201 9-2020

July 4, 2019(Th)	Registration for Practice School II
July 4, 2019(Th)	Practice School II begins
July 25(Th)	Admission to International Students
July 29(M)	Admission to Higher Degree and Doctoral Programmes
July 30(T)	Admission to Integrated First Degree Programme
July 31(W)	Freshmen Orientation Programme
August 1(Th)	First Semester begins
August 1(Th)	Registration for all students
August 2(F)	Class-work begins
August 12(M)	Eid-ul-Zuha(H)*
August 15(Th)	Independence Day(H)
August 17(S)	Last day for substitution of courses
August 24(S)	Janmashtami (H)
September 2(M)	Ganesh Chaturthi (H)
September 26(Th)	Last day for submission of Application for Merit-Cum Need Scholarship
September 28(S)-October 5(S)	Mid-semester Exam (Class-work suspended)
October 2(W)	Mahatma Gandhi's Birthday (H)
October 8(T)	Dussehra (H)
October 12(S)	Last day for withdrawal from courses
October 15(T)	Last day for returning evaluated answerscripts of Mid-semester Exam
October 23(W)	Last day of submission of Mid-semester Exam Information & Mid-semester grading
October 27(Su)-28(M)	Diwali (H)
November 8(F)	Monday's timetable to be followed
November 12(T)	Guru Nanak's Birthday (H)
November 29(F)	Last day of Pre-comprehensive exam marks display
November 29(F)	Last day for class work
December 2(M)	Comprehensive Examination begins
December 14(S)	Comprehensive Examination ends
December 14(S)	Practice School II ends
December 14(S)	First Semester ends
December 15, 2019(Su) to January 5, 2020(Su)	Recess
December 19(Th)	Goa Liberation Day(H)
December 25(W)	Christmas (H)

**** Observance of the holiday is subject to the sighting of the Moon.***

Second Semester 2019 -2020

January 6(M)	Second Semester begins
January 6(M)	Registration for all students
January 6(M)	Registration for Practice School II
January 6(M)	Practice School II begins
January 7(T)	Class-work begins
January 15(W)	Makar Sankranti (H)
January 23(Th)	Last day for substitution of courses
January 26(Su)	Republic Day (H)
January 28(T)	Last day for submission of Application for Merit-Cum Need Scholarship
January 29(W)	Basant Panchmi and Founder's Day (H)
March 2(M)-March 8(Su)	Mid-semester Exam (Class-work suspended)
March 10(T)	Holi (H)
March 14(S)	Last day for withdrawal from courses
March 18(W)	Last day for returning evaluated answerscripts of Mid-semester Exam
March 26(Th)	Last day of submission of Mid-semester Exam Information & Mid-semester grading
April 2(Th)	Ram Navami (H)
April 6(M)	Mahavir Jayanti (H)
April 7(T)	Friday's timetable to be followed
April 10(F)	Good Friday(H)
April 21(T)	Registration for Practice School I
April 29(W)	Last day of Pre-comprehensive exam marks display
April 29(W)	Last day for class work
May 1(F)	Comprehensive Examination begins
May 7(Th)	Budh Purnima (H)
May 15(F)	Comprehensive Examination ends
May 15(F)	Second Semester ends
May 19(T)	Summer Vacation begins
May 21(Th)	Summer Term begins
May 21(Th)	Practice School I begins
May 24(Su)	Id-ul-Fitr (H)*
June 18(Th)	Practice School II ends
July 13(M)	Practice School I ends
July 14(T)	Summer Term ends
July 17(F)	Summer Vacation ends

ACADEMIC CALENDAR FOR HYDERABAD CAMPUS

SOME IMPORTANT DATES

2019

JULY

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AUGUST

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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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2020

JANUARY

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FEBRUARY

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MARCH

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APRIL

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MAY

Su	M	T	W	Th	F	S
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JUNE

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HOLIDAYS RECESS

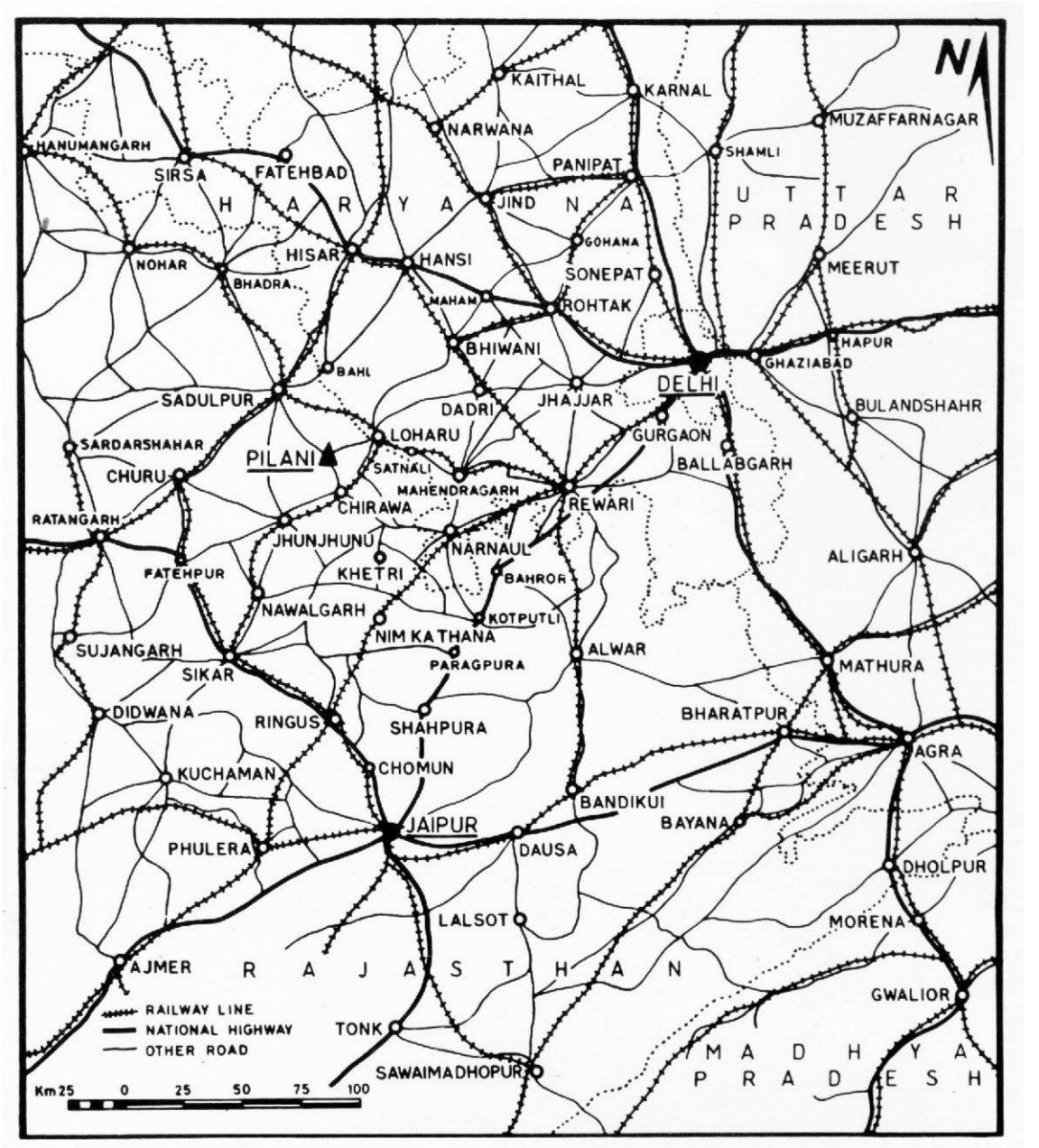
First Semester 201 9-2020

July 4, 2019 (Th)	Registration for Practice School II
July 4, 2019 (Th)	Practice School II begins
July 25 (Th)	Admission to International Students
July 29 (M)	Admission to Higher Degree and Doctoral Programmes
July 30 (T)	Admission to Integrated First Degree Programme
July 31 (W)	Freshmen Orientation Programme
August 1 (Th)	First Semester begins
August 1 (Th)	Registration for all students
August 2 (F)	Class-work begins
August 12 (M)	Id-ul Zuha (H)*
August 15 (Th)	Independence Day (H)
August 16 (F)	Last day for substitution of courses
August 16 (F)	Monday's Timetable to be followed
August 24 (S)	Janmashtami (H)
September 2 (M)	Ganesh Chaturthi (H)
September 26 (Th)	Last day for submission of Application for Merit-Cum Need Scholarship
September 28(S) to October 5(S)	Mid-Semester Test (Class work Suspended)
October 2 (W)	Mahatma Gandhi's Birthday (H)
October 8 (T)	Dussehra (H)
October 09 (W)	Saturday's Timetable to be followed
October 12 (S)	Last day for withdrawal from courses
October 14 (M)	Last day for returning evaluated answer scripts of Mid-Semester Test
October 17 (Th)	Saturday's Timetable to be followed
October 18(F)-20(Su)	ATMOS'2019
October 21 (M)	Last day for Mid-Semester Grading
October 26 (S)-27(Su)	Diwali (H)
November 01 (F)	Monday's Timetable to be followed
November 12 (T)	Guru Nanak's Birthday (H)
November 27 (W)	Last day of Pre-comprehensive marks display
November 29 (F)	Last day for class work
December 2 (M)	Comprehensive Examination begins
December 14 (S)	Comprehensive Examination ends
December 14 (S)	Practice School II ends
December 14 (S)	First Semester ends
December 25 (W)	Christmas (H)
December 15(Su) to January 5, 2019 (Su)	Recess

Second Semester 2019 -2020

January 6 (M)	Second Semester begins
January 6 (M)	Registration for all students
January 6 (M)	Registration for Practice School II
January 6 (M)	Practice School II begins
January 7 (T)	Class-work begins
January 15 (W)	Makar Sankranti (H)
January 21 (Tu)	Last day for substitution of courses
January 23(Th)-26(Su)	ARENA 2020
January 26 (Su)	Republic Day (H)
January 28 (T)	Last day for submission of Application for Merit-Cum Need Scholarship
January 29 (W)	Basant Panchami (H)
February 29(S)	Friday's Timetable to be followed
March 02 (M) to 07 (S)	Mid-Semester Test (Class work Suspended)
March 10 (T)	Holi (H)
March 14 (S)	Last day for withdrawal from courses
March 16 (M)	Last day for returning evaluated answer scripts of Mid-Semester Test
March 19(Th)	Saturday's Timetable to be followed
March 20 (F) - 22 (Su)	PEARL 2020 (Class work Suspended)
March 21 (Sa)	Last day for Mid-Semester Grading
March 25 (W)	Ugadi (H)
March 31(T)	Monday's Timetable to be followed
April 02 (Th)	Ram Navami (H)
April 06 (M)	Mahavir Jayanti (H)
April 10 (F)	Good Friday (H)
April 21 (T)	Registration for Practice School I
April 27 (M)	Last day of Pre-comprehensive marks display
April 29 (W)	Last day for class work
May 1 (F)	Comprehensive Examination begins
May 07 (Th)	Budhha Purnima (H)
May 15 (F)	Comprehensive Examination ends
May 15 (F)	Second Semester ends
May 19 (T)	Summer Vacation begins
May 21 (Th)	Summer Term begins
May 21 (Th)	Practice School I begins
May 24 (Su)	Id-ul fitr (H)*
June 18 (Th)	Practice School II ends
July 13 (M)	Practice School I ends
July 14 (T)	Summer Term ends
July 17 (F)	Summer Vacation ends

**** Observance of the holiday is subject to the sighting of the Moon.***



ROUTE TO PILANI

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- India's highest ranked non-Government Institute in 2019,ranked in QS BRICS, QS Asia, and QS India
- No. 1 Technical institute in non-govt. category in 2019 by The Week and Education World
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- Unique 30 week industry immersion embedded in the curriculum
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- Faculty "immersion" in industry brings industry perspective to classroom
- Growing industry-sponsored research and consulting

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bulletin
2019-2020