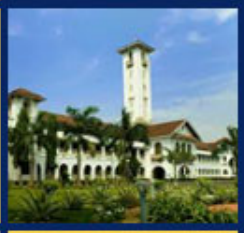
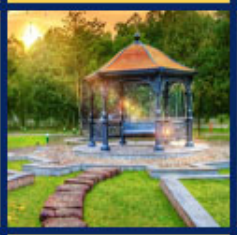
Joint M.Tech/MCP-Ph.D Programme

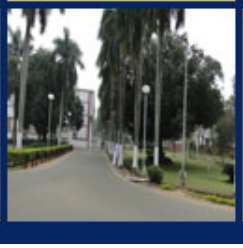
2016 - 2017

Indian Institute of Technology Kharagpur

Kharagpur - 721302







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THE INSTITUTE

Indian Institutes of Technology (IITs) were established to cater to the country's growing need for trained manpower with higher learning in science and technology. The Indian Institute of Technology Kharagpur, first of the chain of IITs, was established in 1950 in the idyllic and sylvan settings at Hijli in West Bengal. From a modest start in the dilapidated Hijli jail building, IIT Kharagpur has grown into one of the largest and most well-known technological institutes of the country. The handsome main building with its majestic tower was inaugurated in 1956. Pandit Jawaharlal Nehru in the first convocation in the same year said "here in the place of that Hijli detention camp stands this fine monument of India, representing India's urges, India's future in the making. This picture seems to me symbolic of changes that are coming to India".

Today, IIT Kharagpur has come a long way to its present position of pre-eminence with 23 academic departments, 8 multidisciplinary centres, a School of Management, a School of Telecommunications, a School of Medical Science and Technology and a School of Intellectual Property Law, a School of Water Resources, a School of Infrastructure Design and Management, a School of Engineering Entrepreneurship, a School of Energy Science, a School of Environmental Science and Technology, a School of Nano-Science and Technology and several sophisticated central facilities. It is the largest and the most diversified among all the IITs and continuously strives to produce scientists and technologists of the highest calibre and integrity to help the nation become self-reliant in its technological needs and to provide leadership in the field of technical education and research. Some of the distinctive features of the programmes at IIT Kharagpur are science based engineering education, emphasis on complete education, continuous internal evaluation and flexibility for experimentation, upgradation and innovation in curriculum design. IIT Kharagpur has a number of distinctions to its credit among all the IITs, such as the first Master's programme on Management, first Master's Programme on Medical Science and Technology for practicing Medical Doctors. In a study, sponsored by the Department of Science and Technology, Government of India, IIT Kharagpur is found to have the highest relative employment productivity index among the IITs and is the top supplier of fresh engineers/technologists to the public and private sector industries. It also ranked first among the IITs in the production of science and engineering Ph.Ds.

ACADEMIC STRUCTURE OF THE INSTITUTE

Number of Departments	: 19
Number of Centres	: 08
Number of Schools	: 12
Number of UG Courses	: 17
Number of Dual Degree Courses	: 15
Number of PG Courses	: 53
Number of Int. M.Sc. Courses	: 07
Number of LLB Courses	: 01

POSTGRADUATE DEGREES CONFERRED IN THE YEAR 2015

M.Tech/MCP/MBA /MS/MMST/MHRM : 797 M.Sc.: 263 LLB : 46 Dual Degree : 469

Ph.D. conferred during the 61st annual convocation held on 7th August 2015 : 220

LIBRARY

Central Library, IIT Kharagpur is one of the largest libraries in science, technology, medical science and management in Asia, having an excellent collection of over 3.8 lakh documents, and subscribing to 1250 print journals, 40000 e-books, and providing online full-text access to 10000 e-journals of the major publishers like Elsevier, Science, Springer, IEEE, IEE, ACM, ASME, ADCE etc. Beside that the Central Library also provides access to major bibliographical databases like Compendex, INSPEC, SciFinder, Scholar, Web of Science, Scopus and MathScience Net. All regular library services have been automated using library software package **"LibSys"**. Central Library has an excellent digital library section to facilitate seamless access to various subscribed IINDEST-AICTE Consortium e-resources as well as provide access to Institutional Repository Server, installed for faculty, research scholars and others to post their intellectual output. The library has installed CCTV cameras in each of the reading halls and at strategic locations of Central Library buildings for auto-surveillance and security. Recently, 5000 selected text books have been made RFID enabled through an RFID pilot project sponsored by MHRD. The Central Library has access to all Springer e-books published during the years 2005 to 2013 and CRCnetBASE e-books published during the years 2004 to 2013.

TECHNOLOGY STUDENTS GYMKHANA

The concept of the Technology Students' Gymkhana as a forum of Sports and Games, Social and Cultural and Technology activities, in which the students, the faculty, staff and their families can take deep interest is unique, and was introduced at IIT Kharagpur for the first time way back in the fifties. The Technology Students' Gymkhana is an organization for fostering and developing extra-curricular activities among the students. Through sports, games and cultural activities it helps to cultivate the spirit of constructive co-operation, leadership qualities and organizational abilities among the students. The Gymkhana is the nerve-centre of this residential campus and has enriched the quality of student life. Gymkhana has a large number of facilities that include a well-equipped modern Gymnasium, a standard swimming pool and two stadia, namely, Jnan Ghosh stadium and Tata Sports Complex. Besides these, there are also floodlit Basketball, Volleyball and Tennis Courts. Club activities are also encouraged where students can display and develop their talents in various fields, e.g. photography, dramatics, social service, Yoga, etc. The Gymkhana also organizes annual social and cultural festival "Spring Festival", and Techo-Management festival "Kshitij", which are considered to be the largest of their kind in Asia in terms of student participation.

ACCOMMODATION AND AMENITIES

The Institute is fully residential. Students are accommodated in 22 Halls of Residence, 14 for boys and 06 for girls and 02 with family accommodation for the Research Scholars/ Defence Personnel (M. Tech.). The halls have 24-hour internet connectivity. All the Halls of Residence also have regular catering facilities. Some additional food outlets are also located within the campus; a few late evening canteens are available as well in some of the Halls of Residence. Several restaurants including few air-conditioned ones and a Café Coffee Day unit are located in the campus, mainly in the hostel area. For daily necessities and groceries, one can walk down to the Technology Market (Tech. Market) within the Campus. A larger market, Golebazar, is about 5 kms. and Bigbazar is about 6 kms. from the Campus. Three banks with ATM facility are located inside the Campus. The State Bank of India branch with core banking services is in the campus close to the Institute Main building and it provides foreign exchange facilities as well. An extension counter of Syndicate Bank is situated on the first floor of the Institute main building. A branch of Punjab National Bank is situated in the Tech. Market where business transactions are carried out in the afternoon. In addition, an Axis Bank ATM is available as well inside the Gymkhana premises. Post Office is located close to the State Bank branch. Outlets of a few courier services are also available within the campus.

South Eastern Railway has been operating a reservation counter in the Institute Main Building area extending Railway ticket booking facilities, especially to the students and the campus residents.

There are also a few privately run outlets in the campus to provide services for railway ticket booking, air ticket booking, car rental and STD / ISD phone calls.

RECREATIONAL/EXTRA-CURRICULAR ACTIVITIES

IIT Kharagpur aims at the all round development of personality, with emphasis on physical, socio-cultural and value-oriented education. In the rich tapestry of culture that is the hallmark of this IIT, students play a vital role. They are an integral part of almost all decision-making bodies of the Institute, starting from hostel administration to Senate. They organize cultural and techno-management activities throughout the year, culminating in the Spring Fest and Kshitij.

Technology Students' Gymkhana, the nerve centre for sports, cultural and social activities. It helps to cultivate the spirit of constructive co-operation, leadership qualities and organizational abilities among the students. It has a number of outdoor and indoor stadia for sports and games, a modern swimming pool and a gymnasium. Photography Club, Fine Arts Club, Publicity Club, Music Club, Yoga Club, Film Society, Dramatics Society, Aquatics Society, Astronomy Club and many more special interest groups are supported by the Gymkhana. Lately a large number of technology and social service focused student societies have been formed, quite often as local chapters of reputed international bodies or societies. The halls of residence also offer a few in-house sports facilities in addition to the central facilities.

HEALTH CARE

The B. C. Roy Technology Hospital is located at the center of the Campus. It provides indoor and outdoor medical facilities for common ailments. However, a few specialized visiting medical practitioners regularly attend the outdoor chambers. The Hospital has its round the clock emergency medical attendance arrangement, and a 24x7 medicine counter. Complicated cases are referred for treatment to the State Hospital or to the Railway Hospital or to Hospitals in Kolkata. The Institute has Students' Medical Insurance Coverage which is obligatory on the part of the students and which usually covers a part of medical expenses for such referred cases. 24 hours Institute ambulance service is also available for the purpose of shifting the patients to other hospitals for better management. A few specialized medical practitioners are also available around the IIT campus for private consultation; this list of neighbourhood medical facilities is posted at http://noticeboard.iitkgp.ernet.in/hospi.htm.

COUNSELLING CENTRE

The Counselling Centre offers a broad range of services including psychological assessment, individual therapy, group therapy, as well as medication and management to promote mental health, life skills training, emotional resilience and overall wellbeing of the student community. Full-time clinical psychologists and a visiting psychiatrist are available for consultation. The centre has also initiated an *outreach program* that involves building up a team of sensitized wing representatives from each Hall of Residence to help reach students in need.

SPONSORED RESEARCH AND INDUSTRIAL CONSULTANCY CELL (SRIC)

The synthesis of teaching and research is fundamental to IIT Kharagpur. IIT Kharagpur is highly rated for the quality and breadth of its research enterprise, for the innovation of its faculty, for the excellence of its Ph.D programs, and for the amount of funding received in support of its research initiatives. IIT Kharagpur is noted for its openness to multidisciplinary research. Several new initiatives expand along IIT Kharagpur tradition of cross-disciplinary research and collaboration. The impact of this research is felt throughout India and around the world. IIT Kharagpur's research programs reach across the campus and beyond, linking together 19 departments, 16 academic centers and a large number of advanced R&D laboratories, stimulating the integration of inquiry, new knowledge, and education.

During the year 2014-2015 the Institute received from the Government, private and international funding agencies/enterprises 269 research projects for a total value of Rs. 149 crores and 125 consultancy projects worth Rs. 13 crores aggregating a total of 394 projects for Rs. 162 crores.

IIT Kharagpur is entrusted with the development of ASICs for the read out system for CBM experiment at the Facility for Antiproton and Ion Research (FAIR), Darmstadt, Germany, the new international accelerator facility and one of the largest research projects world-wide. IIT Kharagpur has a distinguished track record in the development of specialized software for power management, telemedicine, communication empowerment for physically challenged, software for medical measurements, tools for security and biometric authentication and ocean dynamics for storm surge measurements. An advanced research facility in reliability engineering with active participation of top government agencies including BARC has recently been created. Other examples of research in frontier areas include MEMS based components for RF application, development of functional groups for immobilization of functional proteins on MEMS based microsensor surfaces etc. IIT Kharagpur's pioneering works on advanced chip design and CAD for VLSI and MEMS continue to attract researchers and funding from the best institutes and well-known companies of the world. In the past year the institute has started setting up of a major research infrastructure for MOCVD and initiated development of MBE cluster tool based epitaxial nano-semiconductor infrastructure and process integration facility.

In the areas of Life Sciences, ongoing interdisciplinary research in non-invasive measurements, advanced image processing, implants, protein structure analysis and drug design, merit special mention. The Institute has sustained activities in artificial heart development program, male contraceptive (RISUG), green technology, insect resistant cotton, enzymatic processes, Aloe Vera processing, and bio depolymerisation of low grade lignite .

The major research initiatives in nanotechnology and nano-materials include work on polymer nano-composites, nano-wires and semiconductors. The micro-fluidics and bio-nano-MEMS based techniques for DNA hybridization, micro-scale cooling for electronic components and digital microfluidics are some examples of on-going cutting-edge research.

In the area of environment, the Institute has taken up a major initiative under the Ganga River Basin Management Plan funded by the Ministry of Environment and Forests to address issues related to environmental water quality, water resources management, ecology and bio-diversity as well as socio-economic policy, law and governance. In Earth Sciences, a major activity is undertaken for seismic hazard assessment, microzonation and evaluation of vulnerability, risk & socio-economic impacts for the city of Kolkata. IIT Kharagpur has won one of the eleven IBM International Centennial Grants awarded this year for supporting its smarter planet strategies to community service.

IIT Kharagpur has continued its long standing research commitment to the Energy Sector through sustained activities in biomass production, biofuels, fuel cells, lithium-ion batteries and energy materials, production of renewable hydrogen combined with CO_2 capture etc. Our newly developed P. K. Sinha Centre for Bioenergy is taking an integrated and collaborative approach to solve energy, climate change and economic challenges, collaborating with internationally renowned Bioenergy Centers such as University of California at Berkeley (UCB) and Energy Biosciences Institute (EBI), Purdue University and University of California at Davis.

Industry – academia partnership at IIT Khargpur is thriving with industries forming partnerships in joint research projects, acquiring technologies developed in the institute and seeking consultancy supports. Some of the major research initiatives in recent years include Centre for Railway Research. Steel Technology Center, major R&D Centers in Energy Sector in collaboration with DVC, Tea Engineering Research Center, Vodafone-Essar-IIT Kharagpur Centre of Excellence in Telecommunications, National Program in Marine Hydrodynamics, Centre of Excellence in Information Assurance, National facilities for EPMA, General Motors Collaborative Research Laboratory in Electronics Controls and Software (ECS) and a Regional Center for Rural Technology Action Group (RUTAG) are some of the recent such successful initiatives.

JOINT M.TECH/MCP-Ph.D PROGRAMME OF IIT KHARAGPUR

IIT Kharagpur invites applications for the Joint Masters and Ph.D programme in Engineering and City Planning for the admission year 2016-2017. This programme encourages bright and motivated students to enrol themselves for Ph.D after completion of first year of M.Tech/MCP programme.

Under this programme, at the end of first year, interested students having CGPA 8.0 and above are eligible to appear for written test and/or interview to judge their suitability to enrol for Ph.D. **Those who do not qualify for Ph.D can continue with their two-year M.Tech/MCP programme.**

Students selected for Ph.D will have to complete the two year academic requirements of M.Tech/MCP programme before enrolment for Ph.D. For these students the M.Tech/MCP and Ph.D degree will be awarded together upon successful completion of Ph.D.

The programme is open to students of all categories with a Bachelor's degree in Engineering/Technology/Architecture/ MSc or equivalent professional degrees (AMIE etc.) and having a valid GATE score. Seats are reserved for OBC/SC/ST candidates and Persons with Disability (PwD) as per Government of India rules.

INFORMATION ABOUT VARIOUS DEPARTMENTS/SCHOOLS/CENTRES

DEPARTMENT OF AEROSPACE ENGINEERING

Department of Aerospace Engineering, established in 1965, offers B. Tech, Dual degree and M. Tech programmes in Aerospace Engineering. Active research programme, leading to MS and PhD degrees also exists. The Department has a large number of well-equipped laboratories in the areas of Aerodynamics, Structures and Propulsion, System and Control, and Intelligent Systems. Facilities in the Aerodynamics Laboratory include an airflow bench, subsonic wind tunnel, supersonic tunnel, cascade tunnel and smoke tunnel, etc. The other major wind tunnels include an industrial tunnel for studying wind effect on structures and a gust tunnel for studying unsteady flow problems. The Structures Laboratory is equipped with electrodynamics vibration shakers, Multi-axis Shake table, a ten ton capacity universal testing machine, a torsion testing machine, computerized experiments related to deflection of curved bars, shear centre apparatus and buckling of struts having Interface for digital display of force, strain, deflection and angle with Experiment Software for each experiment, vibration fundamental kits(VFT). The Instron 1342 (upgraded model), servo-hydraulic materials testing machine with HP-300 High Speed Data Acquisition System for static, dynamic and fatigue testing of structural elements and Vibration Shake Table are excellent facilities in this department.. The laboratory also possesses photo elasticity unit with artificial vision system used for quality measurement in any point and suitable for the introduction and study of photo elasticity, pin jointed frameworks, virtual work and forces in truss (Resolution) with computerized digital display of force, strain, deflection etc. Uni-axial and Bi-axial test rigs for Plate Experiments incorporating parametric excitations and measurements are unique features of the Structures Laboratory. Application of Follower forces are also depicted in the laboratory experiments. Major Propulsion Laboratory facilities include Axial Flow Fan Test Set, Centrifugal Fan Test Unit, Ram Jet and Pulse Jet facility, Reaction Turbine Test facility, Nozzle Pressure Distribution Unit, Flame Propagation and Stabilization Unit, Nozzle Performance and Jet Reaction Unit and Droplet Combustion Test Rig. Major flight Mechanics laboratory facilities include 2DOF Rotor System, Inverted Pendulum system, Magnetic Levitator System, Servo system, etc. The Department also has excellent computational laboratories equipped with high performance computational facilities besides a large number of workstations and high end PCs. The department also offers adequate facilities to the students to design build and fly remotely controlled/auto-controlled model aircrafts including UAVs and MAVs. The Department offers M. Tech Degree in:

AE AEROSPACE ENGINEERING

Core Subjects: Aerodynamics, Aerospace Structures, Propulsion and Combustion, Flight Mechanic & Controls, Machine Computation Laboratory.

Elective Subjects: Computational Aerodynamics, Wind Tunnel Design and Testing, Computational Fluid Dynamics (CFD), Industrial Aerodynamics, Turbulence, Gas Dynamics, Hypersonic Aerodynamics, Advanced Viscous Flow, Introduction to Atmospheric Boundary Layer, Missile Aerodynamics, Aeroelasticity, Advanced CFD, Advanced Structural Dynamics, Experimental Stress Analysis, Fracture Mechanics, FEM in Aerospace Structures, Composite Structures, Smart Structures, Vibration Instrumentation and control, Plates and Shells, Nonlinear Vibration, Nonlinear FEM, Advanced Propulsion System, Combustion Process in Jet Engines, Aircraft Fuel Systems, Advanced Gas Turbine Theory, Advanced Air Breathing Propulsion, Automatic Control of Aircraft, Space Dynamics, Principles of Aircraft Design, Neuro Fuzzy Control, Automatic Control of Aircraft, Satellite and Inertial Navigation Systems. etc.

Major Thrust Areas of Research: (1) Unmanned Aerial Vehicles and related Technologies, (2) Smart and Composite Structure, (3) Experimental and Computational Research on Turbulent Flows, (4) Propulsion & Combustion, and (5) Flight Dynamics & Control.

Detailed areas of Research: Computational Fluid Dynamics, Industrial Aerodynamics, Unsteady Aerodynamics, Drag Reduction, Turbulence, Aeroacoustics, Hypersonic Reacting Flows, turbulent reacting flows turbulence-radiation interaction, High performance computing, Flow-Induced Vibration and Fluid-Structure Interaction, DNS, LES, Structural Dynamics, Computational Structural Mechanics, Solid Mechanics, Aeroelasticity, Uncertainty Quantification in Aircraft Analysis and Design, FGM, Structural Health monitoring, Nonlocal Elasticity, Nano-composites, Multi-Scale Modeling, Injector Studies, Droplet/Spray Characterization and Burning, Propulsion systems for high speed flight, i.e., Scramjet Ramjet studies, Nanotechnology for Energy Applications, Supersonic Combustion Atomization and Sprays, Laser Spark, Combustion Driven Shock Tunnel, Spacecraft Dynamics and control, Intelligent Systems, Navigation (Aircraft and Satellite), System Identification/Parameter Estimation - Neural Networks, Inter Planetary Satellite Orbit Determination, Flight Testing , Micro Air Vehicle, development of liquid spray burner, laser diagnostic.

The Department is currently running a large number of sponsored research projects from different sponsoring agencies such as Aeronautics R & D Board, DRDO, DRDL, DST, Aeronautical Development Agency, Indian Space Research Organization, Indian Railway and others.

DEPARTMENT OF AGRICULTURAL AND FOOD ENGINEERING

Among the IITs, only IIT Kharagpur has the distinction of having Agricultural and Food Engineering Department. The Department has been established on a broad pattern and takes up research in interdisciplinary areas with an integrated approach of science and technology. It has a wide-ranging postgraduate programme in six specializations and offers research programmes in diverse areas. The undergraduate and postgraduate teaching is well established and has been well received by the industries and other organizations. The Department offers the following specializations at M.Tech. level:

AG1 Farm Machinery and Power

AG2 Land and Water Resource Engineering

AG3 Food Processing Engineering

AG4 Agricultural Biotechnology

AG5 Aquacultural Engineering

AG6 Agricultural Systems and Management

Course Content:

AG1: Tractor Systems Design I and II, Farm Machinery Design and Testing, Soil Dynamics in Tillage and Traction, Alternative Energy Sources, Instrumentation and Research Techniques, Tractor Ergonomics, Land Grading and Earth Moving Machinery Systems for Precision Agriculture, Computer Aided Design of Tractors and Farm Machines.

AG2 : Surface Water Hydrology, Advanced Groundwater hydrology, Geo-Informatics for Land and Water Resources, Water Resources Systems Analysis, On-farm Water Management, Climate Change and Water Resources, Watershed Management, Pumping Systems, Non-pint Source Pollution and Management, Vadose Zone Hydrology, Modelling and Simulation for Agricultural Water Management.

AG3 : Food Chemistry, Advanced Mechanical Operations in Food Processing, Food Process and Products Technology, Advanced Thermal Operations in Food Processing, Transfer Process in Food Engineering, Fat and Oil Technology, Grain Process Engineering, Food Handling and Packaging, Nutraceuticals and Functional Foods, Advanced Food Technology, Food Process Modelling, Food Plant and equipment Design, Instrumentation and Control in Food Industry.

AG4 : Principles of Plant Breeding, Plant Metabolites and Separation Technology, Crop Breeding and biotechnological Applications, Recombinant DNA Technology, Modern Genetics, Advanced Plant Physiology, Environmental Microbiology and Biopollution Control, Pharmacognosy and Metabolic Engineering, Seed Technology, Food Biotechnology.

AG5 : Fishery Biology and Fish Culture Techniques, Open Channel Hydraulics and Coastal Engineering, Design of Aquacultural Facilities and Equipment, Planning and Design of Aquacultural Projects, Water Quality Management Practices, Principle and Fishing Technology, Advanced Aquaculture Technology, Computational Techniques in Fisheries, Water Resources System Analysis, Processing and Preservation of Aquacultural Products, Advanced Fishing Technology, Unit Operations in Aquacultural Products Processing Transfer Processes in Food Engineering.

AG6 : Crop Production Systems, Soil Systems, Management and Productivity, Systems Approach in Agriculture, Plant Nutrition, Wasteland and Forest Management, Soil-Plant-Water Relationships, Water Resources System Analysis, Climate Change and Agricultural Production System, Seed Technology, Tea Science and Process Technology, Marketing of Food and Agricultural Products, Agro Project Cash Flow Analysis and Management.

Areas of Research: Tractor systems design, Modelling and performance simulation, Machine operators' safety and comfort, Precision agriculture and bioinstrumentation, Tillage and traction modelling, Combination tillage implements, Electronic Seed metering mechanisms, Solar, Wind and Biomass energy application, Biodiesels.

Optimal control and decision support systems for irrigation projects, Hydrological modelling of agricultural watersheds, Integrated watershed management, Application of remote sensing and GIS in natural resources management, Furrow irrigation modelling, Rainwater harvesting, Artificial groundwater recharge, Groundwater modelling, Automation of drip and sprinkler irrigation systems, Quantification and Control of non-point source pollution of water resources.

Osmo-air drying, Concentration and dehydration, Extrusion, Biomass and by-product utilization, Cryopreservation and cryogrinding, Expression and solvent extraction of vegetable oil, Parboiling and milling of paddy, UHT processing of milk, Biodegradable packaging film, Tea processing, Detoxication of mycotoxins, Cold storage, Control atmosphere storage, Biosensors, CFD in Food Processing and Preservation, Health Foods and Nutraceuticals, Microwave drying and heating systems, Heat transfer in non Newtonian Flow.

Plant tissue culture engineering, Biotechnology of medicinal, aromatic and ornamental plants, Micropropagation and cryopreservation of medicinal plants, Screening and isolation of plant bioactive compounds, Molecular cloning of genes for plant secondary metabolites, Harnessing biodegradable polymers and bioactive compounds from microalgae, Production of microalgal fuels (biodiesel and bioethanol), Production of herbal and microbial-based biopesticides, Production of microbial and therapeutic enzymes, Microbial biotransformation of complex biopolymers to value added products, Waste water management.

Plant nutrition and soil management, Organic farming, Wasteland development and forest management, Water management, Weed management, Cropping systems management, Water and solute transport, Ecology and environmental pollution, Cultivation and utilization of medicinal plants, Climate change adaptation/mitigation, Economics of agro-production and processing, Marketing of agro-commodities.

Computer aided design of Aquacultural farm, Fish feed development, Water quality control, Waste utilization in aquaculture, Stability and hydrodynamics of fishing gears and vessels, Development and performance evaluation of aeration systems.

DEPARTMENT OF ARCHITECTURE AND REGIONAL PLANNING

The Department of Architecture and Regional Planning was established in 1952 in this Institute, and has been involved in teaching and research in the areas of Architecture, Regional Planning, and City Planning. It is recognized as one of the leading Departments in the country offering undergraduate, post-graduate and doctoral programmes. The department currently offers a postgraduate course in **Master of City Planning.**

City planning has been described as the art and science of ordering the use of Land and siting of buildings and communication routes so as to secure the maximum degree of economy, convenience and beauty, whose main impetus is thus “foreseeing and guiding change.” Thus City Planning is a process of formulating a plan, which narrates a blue – print of actions and decisions to reach a predetermined goal, within a predicted period of time.

The city planning course offered here is unique. On one hand it is broad based, exposing students to grasp complex issues of urban development, surveying techniques, analytical tools, decision making processes and management techniques. On the other hand the second year is devoted for in depth learning and specialisation, spending considerable time in seminars, viva-voce and preparing dissertation thesis.

The academic input among others, focuses on issues related to, Socio-Economic and Physical Aspects of Human Settlements, Housing, Transportation Planning, New Town Planning, Urban Revitalisation and Conservation, Utilities and Infrastructure Planning, Development Economics, Environmental Planning, Urban Design, Landscape Planning, GIS and Remote-sensing, Tourism and Recreation Planning. The Department offers following specialization:

AR City Planning

Course Content:
The Core Courses are: Planning Theory and Process, Statistical Techniques and Computer Programming, Transportation Planning and Traffic Engineering, Planning Legislation and Professional Practice, Development Management and Finance, Planning Workshop I and II (including Two-week field study in each).

Depending on their interests, the students are required to take up three Elective Courses in the first and second semesters each. The electives are grouped as follows:

Elective – I: Housing and Community Planning, Housing Policies and Programmes, District and Rural Area Planning;

Elective – II: Social Aspects of Human Settlements, Dynamics of Settlement Systems, Regional Development and Planning;

Elective – III: Utilities and Services Planning, Water Resources Economics, Development of Human Resources, Disaster Management;

Elective – IV: Remote Sensing and GIS in Planning, Systems Modelling and Analysis, Planning Informatics;

Elective – V: Quantitative Methods in Planning, Regional Analysis and Programming, Environmental Planning, Metropolitan Planning;

Elective – VI: Tourism and Recreational Planning, Urban Conservation Studies, Urban Design, Landscape Planning;

The students are also required to take up an eight weeks summer-internship. This would be undertaken in any leading planning organization, development authority, or planning laboratory. The Department provides assistance in organizing the training programme. Seminars, presentations and group-discussions are regular components of the course. A comprehensive viva-voce is conducted to review their knowledge base at the end of the stages of learning. The students finally work on a dissertation on an area of their interest, and defend it through the final viva-voce.

Areas of Research: Urban Fringe Areas, Housing and Community Planning, Urban Open Spaces, Transportation Planning, Watershed Management, Heritage Studies and Conservation, Infrastructure Planning and Systems Management, Computer Applications in Architecture and Planning, GIS and Remote-sensing Applications. The Department is engaged in various live projects on urban planning.

DEPARTMENT OF BIOTECHNOLOGY

Biotechnology program in IIT Kharagpur was initiated in 1986 with the introduction of an M.Tech Course in Biotechnology with the generous support from the Department of Biotechnology, Government of India. The program bred excellence in the spheres of teaching / training and research. The wide appreciation of the program in the country and abroad led to introduction of an undergraduate course in Biotechnology and Biochemical Engineering in 1994, and an independent Department in 1999, with B.Tech (Hons.), Dual degree M.Tech, Two years M.Tech, Ph.D and Post-Doctoral activities. In the M Tech course, a balanced exposure (both in theory and in practice) of modern biology and bioprocess engineering is given. The achievements in Industry-Institute collaborative research, process / product / equipment development, patent and technology transfer on inventions are indicative of the excellence of the program. The faculty has strong interaction with reputed Institutions of national and international importance. The Department has state-of-the-art facilities in Cell and Molecular Biology, Structural Biology (Macromolecular crystallography), Plant Biotechnology, Biochemistry, Fermentation, Biochemical Engineering, Downstream Processing, Bioinformatics, r-DNA Technology, Bio-separation, Microbiology and Immunology, Molecular Genetics, Protein Chemistry, Proteomics, Genomics. The Department offers M.Tech degree in:

BT Biotechnology and Biochemical Engineering

Course Content:
Core Subjects: Bioseparation Technology, Immunotechnology, Biotechnology of Plant Metabolites, Recombinant DNA Technology.

Electives: Aspects of Biochemical Engineering, Process modeling and simulation, Secondary Metabolism in Plants and Microbes, Protein Engineering, Immobilization Technology, Biophysics and Instrumentation in Biology, Quality control in Biotechnology, Bioprocess Plant and Equipment Design, Crop Breeding and Biotechnological Application, Transgenic Technology, Statistical Techniques in Computer Programming, Data Warehousing and Data Mining, Object oriented programming, Industrial relations, Total Quality Management, Development of human resources, Interpersonal communication.

Lecture classes are supported by well planned laboratory experiments in Animal Cell culture, Immunotechnology, Bioseparation and Bioprocess Technology, Plant Biotechnology and Recombinant DNA Technology.

Areas of Research: Bioprospecting healthcare metabolites and nutraceuticals from plants and microbes, Production and analysis of transgenic plants; Hydrogen production by bacterial fermentation;Bioprocess development modeling and optimization; Microbial and microalgalbiorefinery; Biofuels and value added products; Microbial fuel cell; Marine biotechnology; Biomaterials for tissue engineering; Characterization of virus infecting tasar silk worms; Gene expression

in prokaryotic and eukaryotic system; Lectin and mushroom glucans as immunomodulators; Biomicrofluidics for single cell Biology and multiplex diagonostic development, Proteomics and protein-protein interaction; Monoclonal antibody production, recombinant protein production in plant, animal and microbial cells; Metagenomics ; geomicrobiology, bioremediation; Functional genomics of bacterial cell wall; Mechanisms of antimicrobial resistance; baceterial biofilm formation and its inhibition;Biofilim structural Biology and protein crystallography of important proteins from M.tuberculosis and S.aureus; Structure based inhibitor/drug design; Structural bioinformatics. DNA repair mechanisms in response to topoisomerase I poisoning, DNA repair mechanisms in kinetoplastid parasites, Regulation of gene expression in protozoan parasite Entamoeba histolytica and E. invadens. Study of signal transduction in trophozoite and encysting Enatamoba.

DEPARTMENT OF CHEMICAL ENGINEERING

Department of Chemical Engineering is one of the premier and oldest Departments of this Institute. This Department has been in the forefront of Chemical Engineering education and research in India, providing undergraduate and postgraduate education. New courses along with state-of-the-art research facilities meeting the needs of ever changing world are the strong points of this Department. The Department has a large number of well-equipped laboratories covering the areas of Unit Operations, Petroleum Refining and Petrochemical Technology, Separations Technology, Reaction Engineering, Process Dynamics and Control, Computer Aided Process Engineering (CAPE), Mineral Processing, Physical Measurements and Instrumental Analysis. Keeping pace with the frontier areas of development in the profession, research facilities have been created in the areas of Membrane Technology, Interfacial Phenomena and Micro-scale Heat Transfer, Multiphase Flow, Polymer Composites, and Pollution Control. Active participation of faculty and students in sponsored research projects equips the students with skills for research as well as industrial assignments.

The Department offers M.Tech degree in:

CH Chemical Engineering

Core subjects: Advanced Fluid dynamics, Advanced Mass Transfer, Advanced Heat Transfer, Process Dynamics and Control, Advanced Mathematical Techniques in Chemical Engineering.

Elective subjects: Optimization Techniques in Process Design, Process Modeling and Simulation, Industrial Pollution Control, Petroleum Refinery Engineering, Advanced Thermodynamics, Multiphase Flow, Reservoir Engineering, Green Technology, Transport Processes in Physiological Systems, CFD Applications in Chemical Processes, Microscale Energy Transport, Polymer Engineering, Energy Conservation in Process Industries, Chemical Engineering Principles in Polymer Processing. Advances in Biochemical Engineering, Real Time Intelligent Process Systems, Novel Separation Processes, Petrochemical Technology, Chemical Reactor Analysis, Combustion Engineering , Mineral Beneficiation, Reactor Stability and Control, Computer Process Control, Fluidization Engineering, Project Engineering and Management, Hazard Analysis and Risk Management in Chemical Industry, Flow of Complex Mixtures, Manufacturing and Characterization of Polymer Matrix Composites, Storage and Handling of Materials, Hazardous Waste Treatment and Management.

Areas of Research: Transport Processes, Reaction Kinetics, Process Modeling and Simulation, Molecular Simulation, Nonlinear Control, Membrane Technology, Environmental Engineering, Micro-scale Heat Exchange, Reaction Engineering and Chemical Process Development, Petroleum Refining and Petrochemicals, Coal Processing, Particle Technology and Mineral Beneficiation, Bioprocess Engineering and Bio fuels, Surface science and Nanotechnology, Modeling of Physiological systems.

DEPARTMENT OF CIVIL ENGINEERING

The Civil Engineering Department started to function in August 1951 from the historic Hijli Detention Camp to train young engineers in this profession of socio-economic relevance. The early philosophy of the department towards teaching was to encourage a practical 'Hands-on' approach to engineering. The current vision of the department is also to impart advanced education with an appropriate blend of theory and practice to the M. Tech students.

The students, faculty members and the staff members of the department have been making major research contributions in different fields of civil engineering which led to the department being identified as one of the top two civil engineering

departments in India with the highest number of research publications per faculty and with the highest H-index during 2001-2015. The department ranks in the range of 51-100 in the QS World ranking of Civil engineering departments.

The department currently offers MTech programmes in the following SIX specializations.

CE1 Hydraulic and Water Resources Engineering

CE2 Transportation Engineering

CE3 Environmental Engineering and Management

CE4 Geotechnical Engineering

CE5 Structural Engineering

RR Railway Engineering

(Students admitted to the M.Tech programme in Railway Engineering are eligible to a top-up fellowship of Rs 8,000 per month in addition to their MHRD stipend, subject to satisfactory academic performance as per Institute norms)

Course Content:

CE1 : Free surface flow; Applied hydrology; Advanced Hydraulic structures; Viscous fluid flow; Geohydraulics; Geoinformatics for land and water Resources; Advanced computational hydraulics; Hydraulics of sediment transport; Turbulent fluid flow; Integrated watershed management; Hydropower engineering; River engineering.

CE2 : Pavement Materials; Analysis and Design of Pavements; Pavement Construction; Pavement Evaluation and Rehabilitation; Geometric design of streets and highways; Transportation System Planning; Transportation Economics; Transit Planning and Operation; Traffic Engineering; Design and Planning of Airports; Analysis of Transportation systems.

CE3 : Water Supply Systems; Wastewater Management; Industrial Water Pollution Control; Solid Waste Management; Air Quality Management; Environmental Impact Assessment; Environmental Management; Environmental Chemistry and Microbiology; Advanced water and waste water treatment; Hazardous waste management; Environmental hydraulics.

CE4 : Soil Exploration-planning and methods; Characterization of soils; Basic Geo Mechanics; Applied Soil Mechanics; Foundation Engineering; Soil Structure Interaction; Soil Dynamics and Earthquake Engineering; Rock mechanics and Tunnelling; Computational Geomechanics; Behaviour of Unsaturated Soil; Ground Improvement; Offshore Geotechnical Engineering; Optimization.

CE5 : Advanced Structural Analysis; Elasticity, Plasticity and Visco-elasticity; Elastic Stability; Reinforced Concrete Structures; Metal Structures; Pre-stressed Concrete; Composite Structures; High-rise Structures; Random Vibration and Earthquake Resistant Structures; Shell Structures; Probabilistic Design; Optimization; Offshore Structures; Computational Mechanics; Finite Element Analysis; Construction Management and Planning.

RR : The programme has three broad components (a) Railway Engineering: comprising rolling stock, power systems, signalling, control and communication systems, railway asset management (b) Railway Civil Works: comprising bridges, tunnels, track, embankments, rail stations (c) General Engineering: comprising design and analysis subjects in civil, mechanical and electrical engineering.

(More details about the Curriculum and detailed syllabi of different MTech programmes can be found at https://erp.iitkgp.ernet.in/ERPWebServices/curricula/specialisationList.jsp?stuType=PG on the IIT Kharagpur official web site under ACADEMIC > ACADEMIC CURRICULUM > PG CURRICULUM > CIVIL ENGINEERING. Lists of electives and the syllabus for each subject can be seen by clicking on appropriate links).

Areas of Research:

Hydraulic and Water Resources Engineering: Sediment Transport and Jet Diffusion; Stochastic hydrological analysis; Flood forecasting; Clear water scour; Sediment transport and jet diffusion; Mathematical modelling of unsteady flow on fluvial beds; Bridge pier scour and confluence scour; Surface water and ground water hydrology; Climate impact on Hydrology and Water Resources; Ground water engineering; Hydrologic extreme analysis (Droughts and Floods); Drought analysis; Numerical models for free surface flow; Physical models of hydraulic structures; Resource mapping and flood analysis using remote sensing and GIS; Application of Artificial Intelligence techniques in water resources engineering.

Transportation Engineering: Traffic flow simulation; Planning of rural and urban transport systems; Development of new pavement materials; Modification and evaluation of bituminous binders using polymers and waste rubbers; Pavement analysis and design; Non-destructive evaluation of pavements.

Environmental Engineering and Management: Environmental impact assessment; System analysis and water quality management; mathematical modelling of river and estuarine pollution control; bio-reactors; water-hyacinths and aquatic weeds for pollutant removal; Water distribution networks and physico-chemical process for water quality control, Solid waste management, Heavy/trace metal removal, Industrial air pollution and control; Rural Water Supply; Aerobic/anaerobic treatment of waste waters; Pesticides removal and degradation; Bio-filtration for air pollution control; Process modification for pollution minimization. Environmental life cycle assessment.

Geotechnical Engineering: Disaster Mitigation; Characterization of Insitu Geomaterials; Geomechanics & Material Research; Reliability in Gotechnical Engg; Pile foundations; Soil Dynamics; Computational Geotechnical Engineering; Seismic Analysis of Underground Structures; Soil Stabilization; Geotechnical Earthquake Engineering; Reinforced Soil Structures; Shallow foundation; Soil-Structure Interaction; Ground Improvement; Foundation on Soft Soil; Landslide Hazard Mitigation.

Structural Engineering: Improved Structural stability; Reliability based design; Structural Health Monitoring; Disaster Resistant Structures; Structural Retrofitting; Structural Fire Engineering; Recycled Aggregates for Concrete; Bamboo-reinforced concrete; Fiber Reinforced Polymer (FRP) to prolong life of concrete structures; Conservation and safety assessment of historic structures; Improved armour materials for ballistic impact; Improved sandwich composites; Molecular dynamics and nano-scale simulations to explain structural response; Meso mechanics based studies of concrete.

Railway Engineering: Advanced Materials and Manufacturing; Heavy Haul Technology; High Speed Rail; Advanced Maintenance and Operation.

(Brief Information about the faculty members of Civil Engineering Department, their research activities and departmental brochure can be seen at ACADEMIC > ACADEMIC UNITS > CIVIL ENGINEERING. Clicking on “More information” in the Civil Engineering web site will take you to a separate web site maintained by the department containing more details)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

The Institute initiated its undergraduate program in Computer Science and Engineering in 1982. Since then the activities of the CSE Department have proliferated in various directions. The postgraduate degree programme of CSE Department was introduced in the 1986-87 session and leads to an M.Tech degree in Computer Science and Engineering. The School of IT, of IIT Kharagpur merged with the CSE Department on 20th November 2015. Thrust on research activities leading to a Ph.D degree was initiated in the 80s with the first Ph.D being granted in 1986. The department has excellent hardware and software facilities. The hardware laboratory has the latest equipments such as FPGA boards and microprocessor controller kits to support modern CSE curricular requirements, training, research and development. The software laboratory is generously equipped with Internet enabled graphics workstations, high-end servers, GPU and blade servers -- all connected over fast/gigabit Ethernet. The Department has complete WLAN coverage. The departmental LAN is well integrated with the Institute LAN backbone. In addition, the Department also has specialized research laboratories in areas such as security, verification, machine learning, embedded systems, tele-medicine. Online access to journals and conference proceedings is available through the centralized subscription made by the Institute. The departmental library is well equipped and books are available in various areas of Computer Science and Engineering. The course contents and other details for the M.Tech specialization are given below.:

CS Computer Science and Engineering

Course Content: The curriculum of the course consists of three core courses and seven electives. A wide range of electives is offered to enable the students to select subjects in their special areas of interest. Some of the courses are listed below:

Advances in Algorithms, High Performance Computer Architecture, Distributed Systems, Logic for Computer Science, Testing and Verification of Circuits, Cryptography and Network Security, Algorithms for Bioinformatics, Artificial Intelligence, Advanced Graph Theory, Computational Complexity, VLSI System Design, Speech and Natural Language

Processing, Object Oriented Systems, Internet Protocols and Applications, Data Warehousing and Data Mining, Database Engineering, Advanced Microprocessor Based Systems, Intelligent Systems, Advances in Operating Systems Design, Parallel and Distributed Algorithms, Real Time Systems, Theory of Programming Languages, Machine Learning, Fault Tolerant Systems, Computational Geometry, Software Engineering, CAD for VLSI Design, Quantum Computing, Advances in Digital and Mixed Signal Testing.

Areas of Research: Algorithms, Artificial Intelligence and Knowledge based systems, Computer Networks, Computer Architecture, Computer Vision and Image Processing, Computer Graphics, Computational Geometry, Data Base Management Systems, Distributed and Parallel processing, Fault tolerant computing, Logic and Semantics, Real-time systems, Verification of Hardware and Software, Programming Languages, Software Engineering, VLSI Systems Design.

DEPARTMENT OF ELECTRICAL ENGINEERING

The first postgraduate programme to be started in the department was on "Electrical Machines" in the year 1955, followed by "Control Systems" in 1959. With the establishment of a Power Electronics Laboratory in 1972, the courses under "Electrical Machines" were updated and the programme was redesignated as "Machine Drives and Power Electronics" in 1981. The third specialization on "Power Systems" was introduced in 1965, that has now been redesignated as "Power and Energy Systems" since 2010. The program on 'Instrumentation' which started in 1972 has been revised in 2012 and renamed as 'Instrumentation and Signal Processing'. Thus, the Department offers the following areas of specialization for the M. Tech degree:

EE1 Machine Drives and Power Electronics (MDPE)

EE2 Control System Engineering (CSE)

EE3 Power and Energy Systems (PES)

EE4 Instrumentation and Signal Processing (ISP)

Course Contents:

Core Courses:

EE1: The subjects presently offered are: Switched Mode Power Conversion, Machine Analysis, Electric Drive Systems, Advanced Machine Drives, Advanced Power Electronic Converters, Power Electronics and Machines Laboratory and Machine Drives Laboratory.

EE2: The subjects presently offered are: Control Theory, Estimation of Signals and Systems, Optimal Control and Non-linear Control and Control Systems Laboratory.

EE3: The subjects offered are: Renewable and Distributed Energy Systems, Power System Analysis and Operation, Power System Protection, Power System Dynamics and Control, HVDC and FACTS, Power & Energy Systems Laboratory and Power & Energy Systems Simulation Laboratory.

EE4: The subjects offered are: Analog Signal Processing, Programmable and Embedded System, Statistical Signal Processing, Mixed Signal Circuits and Systems on Chip, Advanced Sensing Techniques, Embedded Systems Laboratory, Real-Time Signal Processing Laboratory and Instrumentation Laboratory.

In addition to the "core" subjects mentioned against each specialization above, students are required to choose five "elective" subjects (one of which may be a HSS / Management subject) in their special areas of interest. Practical oriented laboratory exercises are carried out in the first two semesters. Three hours per week are earmarked for "seminar" in the first two semesters followed by a comprehensive viva voce at the end of the second semester. A project dissertation on a relevant problem under the supervision of a faculty member and / or persons from industry follows the course work of two semesters.

The Department offers a large number of electives for specialization in various areas. Some of the electives are: Electric Vehicles, Special Electrical Machines, Wind Energy, Nonconventional Electrical Energy Systems, Intelligent Control, Robust Control, Digital Control, Artificial Intelligence applications to Power System, High Voltage and Insulation Engineering, Industrial Applications of High Voltage Engineering, Digital Signal Processing, Computational Methods and Algorithms in Signal Processing, Data Communication Systems, Digital Image Processing, Biomedical Signal Processing,

Advanced Digital Signal Processing, Industrial Automation and Control, Process Monitoring and Fault Diagnostics, Industrial Instrumentation, etc. In addition, students can choose appropriate elective subjects from other departments i.e. Computer Science and Engineering, Electronics and Electrical Communication Engineering, Mechanical Engineering, Aerospace Engineering, Mathematics, School of Medical Science and Technology, G. S. Sanyal School of Telecommunication, Reliability Engineering Centre and Materials Science Centre.

Areas of Research: The current research activities in the Department are mainly centered on the following areas:
DSP / FPGA-based controllers for induction and synchronous machines, parameter-adaptive controllers for indirect field-oriented AC motor drives and speed sensor less operation, direct field orientation of induction motors with rotor flux observers, matrix converter fed drives, power converter topologies for medium voltage drives, variable speed constant frequency wind power generation systems, power converters for grid interactive photovoltaic power generation, linear induction and synchronous machine-based propulsion systems, electric vehicle propulsion systems, VLSI-based design of DC-DC converters, analysis of bifurcation in power electronic converters.

Control and optimization of linear systems, application of neural networks for control and system studies, model order reduction, nonlinear dynamical systems, robust control, fuzzy control, sliding mode and variable structure control, large scale systems, fractional order systems, orthogonal functions, genetic algorithm applications in control, periodic controllers, decentralized control, systems with time delay, discrete event systems, fault tolerant control.

Optimal load-flow studies, Load forecasting and contingency analysis, Power System Operation and Control, Stability analysis of large interconnected power systems, Power System Protection, Fiber optic and other optoelectronic CTs and RTs for power systems, Wide Area Measurement System, Smart Grid, High Voltage Engineering, Condition monitoring of power system equipments, Flexible AC Transmission Systems, HVDC transmission systems, Electric Power Distribution System, Non-conventional energy sources and their Grid integration, Microgrid Operation, Power system restructuring, Sensors Development, MEMS and Mixed Signal VLSI, Embedded Systems, Estimation & Detection of Signals & Systems, Signal & Image Processing, Medical Informatics and Machine Learning.

DEPARTMENT OF ELECTRONICS AND ELECTRICAL COMMUNICATION ENGINEERING

The Department of Electronics and Electrical Communication Engineering (E&ECE), IIT Kharagpur was established right at the inception of the institute in 1951. In its initial years, the department's activities were restricted to research, primarily fulfilling the country's needs. Thereafter undergraduate studies started and the students used to receive B. Tech (Hons.) degree in Electrical Engineering and the subjects on Electronics were offered in the final year. As the area grew further, from 1958 the Institute started offering B. Tech (Hons) degree in Electronics and Electrical Communication Engineering. Since its inception, the E&ECE department of IIT Kharagpur has been a pioneer in introducing subjects in the fields of Communications, Microwave and Computer Engineering. The department has been involved in teaching and research in diverse aspects of Telecommunication, Microelectronics, Computer Vision, Electromagnetics, and Light wave Engineering. The Department offers M.Tech degree in:

EC2	**Micro Electronics and VLSI Design**
EC3	**RF and Microwave Engineering**
EC4	**Telecommunication Systems Engineering**
EC5	**Visual Information and Embedded Systems Engineering**

Course Content:
Core Course:

EC2 Solid State Circuits, VLSI technology and process modelling, VLSI CAD, VLSI circuits and systems, and five number of elective subjects to be chosen from core subjects of EC1, EC3, EC4, EC5, or elective list. It also includes one HSS elective and three number of laboratory subjects distributed over two semesters and a seminar each in the two semesters.

EC3 Electromagnetic engineering, Antenna theory and practice, Analytical and computational techniques in electromagnetics, RF and microwave integrated circuits, and five number of elective subjects to be chosen from core subjects of EC1, EC2, EC4, EC5, or elective list. It also includes one HSS elective and three number of laboratory subjects distributed over two semesters and a seminar each in the two semesters.

EC4 Modern digital communication techniques, Digital voice and picture communication, Mobile Communication and Fading, Telecommunication switching and networks, and five number of elective subjects to be chosen from core subjects of EC1, EC2, EC3, EC5, or elective list. It also includes one HSS elective and three number of laboratory subjects distributed over two semesters and a seminar each in the two semesters.

EC5 Digital Image Processing, Embedded systems Design, Pattern Recognition and Image understanding, Computer communication and Networks and five number of elective subjects to be chosen from core subjects of EC1, EC2, EC3, EC4, or elective list. It also includes one HSS elective and three number of laboratory subjects distributed over two semesters and a seminar each in the two semesters.

Electives: Neural networks and applications, Estimation and prediction in computer control, Machine intelligence and expert systems, Computer visualization and solid engineering and automation, Adaptive system and signal processing, Parallel and distributed processing, Design and analysis of algorithms, Multimedia systems and applications, Mobile computing, Fuzzy set theory and application, Digital system testing and testable design, Formal languages and automata theory, Performance evaluation of computer systems and networks, Relational and object oriented database design, Optical signal processing, Fibre optic sensors, Nonlinear optics, Laser Technology, Lightwave networks, Compound semiconductor and applications, Architectural design of ICs, Hybrid Microcircuits Technology, Optoelectronic and display devices, Microwave semiconductor devices, Digital signal processing and applications, Technology CAD, MEMS and Microsystems, Nanoelectronics devices engineering, Superconducting devices and application, Bioelectronics, EMI and EMC techniques, Microwave remote sensing and radar cross section, Phased array antennas, Microwave measurement Telecommunication systems modelling simulation and software, Mobile communications and fading, Secure communications, Telematics and informatics.

Areas of Research:

Thrust Areas of the Department:

1.	Silicon Heterostructures	2.	Nanoelectronics
3.	MEMS	4.	CAD and VLSI Technology
5.	Wireless Communication	6.	Wireless Networks
7.	Optical Communication	8.	Optical Networks
9.	Sensor Networks	10.	Computational Electromagnetics
11.	EMI / EMC	12.	RF System Design
13.	Smart Antennas	14.	Digital Signal Processing
15.	Image and Video Processing	16.	Multimedia Processing
17.	Machine Intelligence Systems	18.	Speech Recognition
19.	Integrated Optics	20.	Embedded Systems

The research activities can be grouped under several major areas as mentioned below:
Communication Engineering: Digital Modulation Techniques, Digitization of Speech; Bandwidth Compression of Speech Signals; Picture Coding; Spread Spectrum Techniques; Speech Frequency, Multimedia Encryption, Satellite Communication, Mobile Communication, Computer Communication.

Visual Information and Embedded Systems: Computer Vision, Computer Networks, Microcontrollers and embedded systems, Fuzzy Techniques and Pattern Recognition, Image and Video Processing, Video and Multimedia Coding, Automated Visual Inspection, Gesture Recognition, Real-time Architectures for Image and Video Processing, Video Transcoding, Multimedia Networking, Video Indexing and Retrieval, Biomedical Image Processing.

Microwave, Millimeterwave and Antenna Engineering: Microwave Antennas, RF and Microwave Integrated Circuits, Millimetric Waves, Magnetostatic Waves, Microstrip Antennas, Phased Array Antennas, EMI/EMC/PSD, Microwave and Millimeterwave Systems and Propagation, Computational Techniques, Radar Cross Section.

Microelectronics: CVD for Silox and Polysilicon, Plasma Processing and Ion-beam, High Speed Address Multipliers, Gate Array, Process Modelling, Special purpose Signal Processors and their application in Biomedical Instrumentation, CAD of LSI/VLSI Systems, Device Modelling, MEMS.

Fibre Optics and Lightwave Engineering: WDM-based Backbone and Access Networks, IP-over-WDM, Optical Bursth Switching, Nonlinear Phenomena in Optical Fibres, Integrated Optics, Coherent Optical Communication.

DEPARTMENT OF GEOLOGY AND GEOPHYSICS

Started in 1951, the Department of Geology and Geophysics offers advanced specializations and research opportunities in traditional, modern and applied areas of Earth Sciences. The Department, one of the largest in the country, has a long record of quality teaching and research. The Department runs a collaborative research and training programme with DAAD, Germany. The alumni of the department have set up highly distinguished tradition all over the globe and include six recipients of S.S. Bhatnagar Prize, two Vice-Chancellors, one Director General of GSI, Director AMD and ONGC. Over the years a large number of graduates of this Department have also come to occupy important positions in professional organizations, several universities and research institutes both in India and abroad. The Department has contributed textbooks and reference books to the national and international Earth Science community.

Outstanding faculty, excellent work atmosphere and modern laboratories with wide-ranging research activities have been the strong points of this department. The major facilities for analytical geochemistry include X-ray Fluorescence Spectrometer, Atomic Absorption Spectrophotometer with FIAS and Graphite furnace, Laser Raman Microspectrometer, Total Organic Carbon Analyzer, Gas Chromatograph, Differential Thermal Analyzer/ Differential Scanning Calorimeter, Hot-Cold Stages for Fluid Inclusion Studies. The Department houses two National facilities such as the Stable Isotope Gas Source Mass Spectrometer (for O,S and C isotopic ratios in geological materials) and equipment for Anisotropy of Magnetic Susceptibility studies (for studying deformation records in rocks).

A Global Broad-band Seismological Observatory indicates a significant milestone in the infrastructure for Earthquake Seismology. The Department also possesses state-of-the-art equipment for gravity, magnetic, electrical and electromagnetic studies. The Nuclear Geophysical laboratory has the Radon and Thoron Measurement facilities using Solid State Nuclear Track Devices and other Emanometric Techniques. The department possesses state of the art geophysical equipment such as McSeisSX 48 channel engineering seismograph, Accelarographs, Broadband seismometer and Recorders, Gravimeter, Fluxgate and Proton Precession Magnetometers, Aquameter, DDR and Signal Stacking Resisvitymeters, VLF electromagnetic instrument, Magnetotelluric instrument.

Basic infrastructure for research and teaching includes research-level polarizing and stereo microscopes, and excellent computational facilities.

Intensive field training in, structural geology, sedimentary geology, and geophysical techniques of prospecting is an integral part of the curriculum. In addition, students have the opportunity to participate in the activities of the Earth Science Study Circle, which promotes both curricular and extra-curricular activities.

The Department offers M.Tech degree in:

GG1 Exploration Geosciences

Hydrocarbon Exploration, Applied Micropaleontology, Basin analysis and Reservoir Characterization, Instrumental Methods in Geosciences, Experimental Techniques in Geosciences Lab, Shallow Surface Geophysics, Advanced Petrology and Geochemistry, Advanced Techniques of Mineral Exploration, Groundwater Exploration and Management, Remote Sensing and GIS (Theory and Lab), Engineering Properties of Rocks and Solids (Theory and Lab), Geostatistics, Geoinformatics and Data Analysis, Geophysical Exploration Techniques, Digital Signal Processing in Geophysics, Geophysical Tomography, Isotope Geology and Environmental Modeling, Environmental Hydrogeology, Advanced Vertebrate Paleobiology, Marine Geosciences.

Course Content: Mathematical Methods in Seismology, Applications of Inverse Theory in Geophysics, Geophysical Signal Processing Laboratory, Coputational Seismology, Physics of Earth and Geodynamics, Computational Seismology Laboratory, applied Elasticity and Plasticity, Continuum Mechanics and Rheology, Finite Element Method in Engineering, Structure Dynamics and Earthquake Engineering, Advance Structure Analysis, Stochastic Process Simulation, Computational Linear algebra, Logics of computer Science, Digital Image Processing, digital Signal Processing and applications, Neural Networks and Applications, Geographical Information System, Artificial Intelligence, Computational Geomechanics, Geotechnical Earthquake Engineering, Dynamics of soil and foundation, Overview of computer Science, Data Structure and Algorithm, computer Graphics, Pattern Recognition in Geosciences, computer Graphics and Visualization, Database Engineering, Theory of Programming Languages, Multimedia systems and Applications, Geoinformatics and Data Analysis, Fuzzy Set Theory and applications, Management of Human Resources and Industrial Relations, Enterprise Resource Planning, Advanced Production and Inventory control, IT and Management of Information System.

Areas of Research: The faculties are currently engaged in research in a broad range of disciplines. These include

Crustal evolution studies: Investigation of the evolutionary history of ancient and modern cratons and mobile belts from phase petrologic, structural and fluid inclusion data, and integrated studies involving one or more components. Granite tectonism and emplacement mechanisms. Study of the ancient and modern sedimentary rock record targeted towards understanding sedimentary basin evolution under different tectonic conditions, and monitoring palaeoenvironmental changes. Metallogeny of base and precious metals in tandem with crustal evolution in different parts of India, with special emphasis on relevance to the Mineral Industry.

Paleontological studies: Analysis of ancient life forms (invertebrates and vertebrates) to understand palaeobiology, lifestyle and evolution. Micropaleontological research on marine and inland fauna to understand past climatic conditions, with special emphasis on reconstructing monsoonal patterns.

Geophysical research: Earthquake source studies, reconstruction of the 3-D architecture of the continental lithosphere in active as well as ancient orogenic belts from seismic, electromagnetic/ magnetotelluric gravity and magnetic data. Integrated geophysical investigation of geothermal areas, Mapping of mid-crustal conductors using MT studies, Integrated Electrical and EM studies for groundwater and mineral exploration, Geophysical and tomography, Modeling and inversion of various geophysical data for complex 2-D and 3-D structures using numerical methods.

Environmental research: Pollution of soil-air-water by natural and anthropogenic causes, and utilization of waste in restoration of wasteland. Hazard assessment due to natural radioactivity and at waste disposal sites. Seismic microzonation for assessment of earthquake hazard.

Interdisciplinary research work using techniques of Remote Sensing and GIS are carried out in the field of resource potential mapping for ground water and mineral deposits and groundwater contamination.

DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

Department of Industrial Engineering and Management has a long history of teaching, research, and consultancy in the areas of Industrial Engineering, Productivity Improvement, Operations Research, Systems Engineering, Production/Operations Management, Materials Management and Inventory Systems, Quality Engineering and Management, Supply Chain Management, MIS, ERP, and E-Commerce in the country. It offers BTech (Hons) in Industrial Engineering, Dual Degree in Industrial Engineering and Management, two year M.Tech in Industrial Engineering and Management, MS and Ph.D programmes. Also in collaboration with the Department of Mechanical Engineering, it offers a Five-year Dual Degree Programme leading to BTech (Hons) in Manufacturing Engineering with M.Tech in Industrial Engineering and Management.

The faculty members of the department undertake a large number of industry-sponsored projects in which the BTech and M.Tech students actively participate and get valuable industrial and project handling experience. The department offers M.Tech degree in:

IM Industrial Engineering and Management

Course Content: The compulsory subjects include: Decision Modelling, Work System Design, Production Planning and Inventory Control, Advanced Decision Modelling, and Systems Modelling and Analysis. In addition, a large number of elective subjects are offered in various areas of Operations Management, Information Technology, Quality, and Ergonomics that includes Supply Chain Management, Networks and Project Management, Human Factors Engineering, Quality Engineering, Facility Layout and Design, Financial Management and Accounting, and so on. After the completion of the two-semester course work, a student carries out a project work leading to a thesis on a live industrial problem. Seminars and group discussions on various topics are some of the regular features of the course.

Areas of Research: Work System Design and Ergonomics, Facilities Planning, Inventory Control and Analysis, Supply Chain Management, Enterprise Resource Planning, Productivity Management, Project Engineering and Management, Maintenance Management, Quality Engineering and Management, Financial Management, Corporate Planning, System Dynamics Modelling and Simulation, Simulation Games, Management Information System, Decision Support Systems, Software Engineering, Environmental Management, Technology Management, Intellectual Property Systems, E-commerce.

DEPARTMENT OF MATHEMATICS

The Department of Mathematics has started its journey in 1951. During the initial days, the main focus was on strengthening teaching and initiating research groups in various areas of Mathematics and Statistics. However, after few decades, considering the rapid growth of Theoretical Computer Science as an area of Mathematical Sciences, the department started focusing also on Computer Science related subjects and included as part of curriculum in various programs offered by the department. Since from the inception, the department had a strong group involving areas like Fluid Mechanics, Variational methods etc. Currently, the department has expertise on various areas of Mathematics, Statistics and Theoretical Computer Science. The Department offers a five-year integrated M.Sc. course in Mathematics and Computing, a Joint M. Sc-PhD course in Mathematics, and a Joint M. Tech-PhD course in Computer Science and Data Processing. The Department also offers Mathematics, Statistics and Computer Science subjects to students of other departments. The department has an excellent computing environment in its own Computer laboratories which are equipped with Wipro NetPower Server and Dell PowerEdge R710 two blade servers for high end computational needs of students and research scholars. Apart from these high end servers the department is equipped with high configuration PCs about 150 in number, ranging from Dell Optiplex 990, Lenovo Thinkcenter Edge, Dell Optiplex 9010, Acer Desktop including high performance i5 desktops. All these systems are connected to other computing facilities in the Institute through LAN of the institute. For further information about the department, one may visit its website: www.webmath.iitkgp.ernet.in

The department offers Joint M. Tech-Ph.D program in **Computer Science and Data Processing**. This program gives an opportunity to students, who have not specialized in Computer Science at degree level but have adequate foundations in Mathematics or Electronics/Electrical/Physics, to specialize in Computer Science. The program aims to produce software professionals who can design and develop systems and applications software, maintain available systems efficiently, and can adapt themselves to research and developments in the rapidly changing field of Computer Science. It is expected that students joining this course should be acquainted with at least one high-level programming language.

MA Computer Science and Data Processing

Course Content

Core subjects: Theory and Practice of Programming Languages, Algorithms and Data Structures, Systems Programming, Operating Systems.

Electives: Object-oriented Programming, Discrete Structures in Computer Science, Advanced Numerical Techniques, Theory of Compiler Design, Fuzzy sets and Applications, Software Engineering, Graph Theory and Algorithms, Parallel Algorithms, Formal Languages and Theory of Computation, Mathematical Logic and Logic Programming, Pattern Recognition and Scene Analysis, Queueing Theory in Computer Science, Switching and Automata Theory, Information and Coding Theory, Artificial Intelligence, Advanced Computer Algorithms, Computer Networks, Computer Graphics, Multi-Objective Programming, File Organization and Database Systems, Advanced Techniques in Operations Research, Cryptography and Security Issues, Computational Linear Algebra, Time Series and Forecasting.

The curriculum demands at least six hours of laboratory classes per week in the first two semesters, a seminar in each semester and a comprehensive viva and a two semester project work after the course work.

***Areas of Research*:** Complex Analysis, Functional Analysis, Fluid Mechanics, Bio-Mechanics, Numerical Analysis, Integral Equations, Mathematical Modeling, Operations Research, Data-mining, Image Processing, Queueing Theory, Reliability Theory, Inventory Control, Decision Theory, Fuzzy Mathematics, Graph Theory and Combinatorics, Optimization, Theoretical Computer Science, Cryptography, Information and Coding Theory.

DEPARTMENT OF MECHANICAL ENGINEERING

The Department is organised into three broad areas of Applied Mechanics, Thermal Science and Engineering, Manufacturing Processes and Systems.

M.Tech courses are offered in three specializations with wide flexibility in selecting subjects of interest. Research is emphasized at all phases to promote curiosity, creativity and confidence aimed at the intellectual and material advancement of the nation. All twenty three laboratories of the department are well equipped with computational and experimental research facilities in wide ranging fields of mechanical engineering. The Department facilities include computer controlled UTM, hip and knee joint simulators, tribological test rigs, stress analysis test facilities, machinery fault simulator, rotor dynamics test rigs, modal test facility, noise and vibration control facility, digital laser vibrometer, test rigs for evaluation of acoustical materials, robots, robot controllers and flexible manipulators, several high speed data acquisition systems, infrared thermal imaging system, stereoscopic particle image velocimetry (PIV) system, micro PIV system, vibration isolated optical table, low speed wind tunnel, measuring instruments related to flow, pressure and heat transfer, hot wire anemometer, two-phase flow probes, high speed camera system, IC engines performance test rig, gas chromatograph, CAM, instrumented resistance welding machine, synergic MIG welding machine, cutting tool performance test rig, EDM and ECM setup, CNC High Efficiency Deep Grinding (HEDG) system, PVD hard and soft tool coating system, vibration measurement and fault diagnosis, high power fiber laser, pulsed Nd-YAG, excimer and cw CO_2 lasers, plasma coating and selective laser sintering machines. There is an excellent central workshop equipped with conventional and modern CNC machine tools. An excellent computing environment has been created with state-of-the-art facilities and related accessories all networked with the institute backbone. Advanced software packages are available in the areas of neural network, CAD, FEM, rigid body dynamics, system modeling, control systems and CFD. In the last few years, the department research and laboratory facilities have been significantly augmented through major sponsored projects and institute funding. The faculty members teaching the courses are actively engaged in research and consultancy in their areas of specialisation.

The M.Tech courses offered are:

ME1	**Manufacturing Science and Engineering**
ME2	**Thermal Science and Engineering**
ME3	**Mechanical Systems Design**

Course Content:

ME1: The course is a balanced mix of advanced courses in the area of manufacturing processes and systems. Subjects cover areas of Primary manufacturing processes, Machining, Computer control and monitoring of manufacturing system along with electives in Surface engineering, Micro manufacturing, Abrasive machining, Soft computing, Modern manufacturing processes, Welding technology, Metal forming, Manufacturing information system, Laser processing of materials, Rapid prototyping, Intelligent machines and systems, and numerical modeling of manufacturing processes etc.

ME2: Advanced thermodynamics, Heat transfer, Fluid mechanics, Computational methods, Computational Fluid Dynamics, Experimental methods, and a large number of electives from sub-specialisation areas of thermal science, such as Refrigeration and air-conditioning, Energy conservation, Compressible flows, I.C. Engines, Solar energy technology, Gas turbines and Jet propulsion, micro-fluidics, multiphase flow etc.

ME3: Advanced mechanics of solids, Vibration analysis, Automatic Control, Applied Elasticity, Lubrication and rotor dynamics, Experimental stress analysis, Tribology, Mechanics of Composites, Machinery fault diagnosis and signal processing, Engineering design optimization, Vibration isolation and control, Continuum mechanics, Robotics and robot applications, Fluid drives and control, Human body mechanics, Micro and Nanomechanics, Modern control, Nonlinear vibrations, Fracture mechanics, etc.

Areas of Research: Fluid mechanics, CFD, Two phase flow, Heat transfer, Liquid fuel atomisation and Spray combustion, I.C. engines, Fluidised bed combustion, Refrigeration and air conditioning, Transcritical CO_2 based heat pumps, Thermal system modelling and optimization, Solar energy, Optical diagnostics of thermo-fluid systems, Thermal hydraulics of nuclear plants, Micro-fluidics and Micro-scale transport processes, Rheology, Transport processes in nano-fluids and magnetic fluids, Multi sensor measurement and data fusion, Flow of granular material.

Casting, Welding and Metal forming, Machining and grinding, Machine tools, Cutting tools and Coatings, Tool condition monitoring,Thermally sprayed coatings, Electro-physical machining processes, Precision manufacturing, and Laser processing. Computer aided design and manufacture, Computer aided process planning, Rapid prototyping, Intelligent machines and systems, Numerical modeling of manufacturing processes, Modeling and control of microsystems, MEMS.

Vibration based condition monitoring, Automotive Engg., noise and Vibration and Noise Control, Signal Processing in Mechanical Systems. Systems modeling and design using Bond Graphs, Finite element and Boundary element methods, Computational solid mechanics, Non-linear mechanics, Fracture mechanics, Composite materials, Non-linear elasticity, Smart materials and Structures, Biomechanics, Industrial, bio- and nano-Tribology, Surface engineering. Mechanical systems dynamics, Rotor dynamics, Vehicle dynamics, Bifurcation and Chaos, Fault tolerant control, Industrial fluid power and control, Mechanical Drives and Gear Engineering.

DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING

The Research and Development Program of the Department encompasses various areas like Corrosion Science and Technology, Extractive Metallurgy, Mechanical Metallurgy, Melting, Casting and Solidification Processing, Modeling & Simulation, Physical Metallurgy, Powder Metallurgy, Surface Engineering etc. In the field of Extractive Metallurgy significant contributions for metal value extraction, particularly Cu, Ni and Co from sea nodules has been made. Direct reduction of iron ore using mine generated ore and coal fines is another major research area. Understanding CO_2 mitigation in steel industry through process models has emerged as a developed area of research. In the domain of Mechanical metallurgy, a pioneering achievement has been the design and development of fatigue testing using rotating bending machine to study short, long and non-propagating crack behaviour in several steels. Investigations related to structure-property relationship of various ceramic and metal-matrix composites, high temperature materials and advanced alloys are thrust areas of activity. Development of newer grades of dual phase and micro alloyed steels through fracture based studies, correlation between fracture and wear characteristics of materials, development of thin sheet steel components are some important fronts in this direction. In addition, research is progressing in the area of mechanical behaviour of small volume materials. The major areas in the field of Melting, Casting and Solidification Processing include: development of cast micro-alloyed steels, studies on the hot tearing of long freezing range Al alloys, austempered ductile iron through non-conventional route, grain refinement of Al alloys and the development of cast metal matrix composites. Success has been achieved in improving the mechanical properties of some hypoeutectic and eutectic Al-Si alloys. In addition to mathematical modeling works in the areas of surface engineering, phase transformation, solidification processing, facture & fatigue, some more new areas have surfaced and these are: application of genetic algorithm for the optimization of metallurgical systems, mathematical simulation of welding, iron and steel making, and other high temperature metallurgical systems by application of computational fluid dynamics, and heat and mass transfer, atomistic simulation of gas hydrates, molecular dynamic simulation of nanostructured materials etc. Several Al-Cu-TM and Al-TM-Si (TM = transition metal) Al-Ni-Ti ternary alloys, and Al-alloys containing rare earth metals have been synthesized and characterized to explore the possibility of developing bulk amorphous Al-alloy by mechanical alloying and identifying the criteria of selection of such amorphous alloy compositions. The present activities of the Powder Metallurgy group include synthesis of particulate reinforced mullite and their property evaluation, production of Al_2O_3 reinforced Ni_3Al thorough reaction sintering route, reaction sintering of silicon carbide, recovery of copper from printed circuit etchant sludge and production of silicon carbide from fly ash silica. Research has been initiated in the area of semi-solid processing for casting and forming operations of Al-alloy matrix composites. In addition, significant progress has been achieved in the synthesis of Fe-TiC, Fe-ZrC and Fe-TiB2 composites from cheaper raw materials by aluminothermic reduction method. Development of low temperature copper based composites, steel matrix composites are also prominent areas in the area of composite materials. Activities related to surface engineering involves laser assisted surface modification, ion implantation and plasma spray deposition, development of nano-structured coating by electro-deposition. The research activities in the area of Environmental Degradation embraces fundamental studies relating to film/scale growth processes on different metal-oxygen and metal-halogen systems with emphasis on kinetics and growth mechanisms, defect structures of compounds, transport properties of different species, adhesion and protective properties of the scales etc. Studies on high temperature oxidation behaviour of multi-phase refractory metal-silicides like Molybdenum and Niobium Silicides are in progress. In the area of aqueous corrosion, the current activities are concentrated on the studies relating to corrosion behaviour of amorphous and nanocrystalline Zr-based binary alloys, corrosion and stress corrosion performance of aluminum based composites and Al-Ni alloys and stress corrosion cracking of nickel alloys in hydrogen fluoride environment. Development of lead free Sn based solder material, and solid oxide fuel cell are also some areas of active research. In the area of joining research on joining of similar and dissimilar materials using electron beam welding is getting prominence. Development of Lithium Ion Battery (LIB) Technology for applications in Electric Vehicles in India has taken the role of a prominent research area in the Department.

The Department offers the following specialization:

MT Metallurgical and Materials Engineering

Course Content:

Core Courses: The Core courses in this programme are thermodynamics of Engineering Materials, Metallurgical Kinetics, Principles and Techniques of Materials Characterization, Programming and Numerical Methods in Materials Engineering, Principles of Materials Engineering (for students with Non-Metallurgy background). A large number of elective courses are also offered, so that the students can specialize in any of the following fields :

Extractive Metallurgy and Modeling, Physical Metallurgy/Materials Engineering, Manufacturing/process Metallurgy, Powder Metallurgy, Corrosion Science and Technology.

Elective Courses: Agglomeration and Direct Reduction of Iron Ores, Rate Phenomena in Metallurgical Processes, Diffusion in Metallurgical Processes, Principles of Materials Engineering, Diffraction Techniques in Materials Engineering, Advanced composite Materials, Interfaces in Nanostructure Thin Film Semiconductors, Ceramics and Refractories : Synthesis, Properties and Applications, Advanced Ceramic Technology, Surface Modification and Coating Technology, Solidification Processing, Processing by powder Metallurgy Techniques, Vacuum Techniques, Advanced Mechanical Behaviour of Materials, Laser Engineering, Computational Fluid Flow, Heat and Mass Transfer in Metallurgical Processes, Surfaces and Interfaces , Dislocation Theory, Mechanical and Thermal Behaviour of Polymers, Crystals Growth and Characterization, Glass Technology, Secondary steel making , Modeling and Simulation of Metallurgical Processes, Fracture Mechanics and Analysis of Engineering Failures, Phase Transformation and phase Equilibria, Heat Treatment Technology, High Temperature Corrosion Biomaterials Advanced Materials and Processes, Thin Film Technology, Amorphous Materials and Applications, Advances in Iron and Steel making , Energetics in Metallurgical Industries, Theory and Practice of Sintering, Advanced Welding Technology, Experimental Stress Analysis, Advances in Mechanical working of Materials, Advances in Electron Microcopy and Analysis, Optoelectronic Materials and Devices, Polymer Reaction Engineering and Reactor Design, Technology of Polymer composite, Magnetism and Magnetic materials, Texture in Materials Engineering, Laser Processing Materials, Imperfections in solids.

These apart, the students can also opt for relevant electives offered by other Department and Centres.

The Laboratory courses include Computer Programming Lab (compulsory), Physical Metallurgy Lab (Compulsory for students with Non-Metallurgy background), Ferrous process Metallurgy and Modeling lab, X-ray and Electron Metallography lab, Phase Transformation Lab, Fracture Mechanics and Analysis of Engineering Failures lab, Materials joining Lab, Powder Metallurgy Lab, and Corrosion and Oxidation lab.

DEPARTMENT OF MINING ENGINEERING

The Department of Mining Engineering at Indian Institute of Technology was started in 1956, with the approval of the Planning Commission and the All-India Council of Technical Education (AICTE).The first batch of twenty B. Tech students graduated in 1961 and currently the sanctioned strength of the undergraduate program is 78 B. Tech students.

The department has introduced a modern Mining Engineering curriculum in India, taking full advantage of the well-developed infrastructure for technical education at the institute. Over the years, the department has offered pioneering subjects of study including rock and geo-mechanics, mineral processing,numerical methods, geo-statistics, GIS & remote sensing, GPS, reliability and quality engineering, safety engineering, environmental science and technology, industrial management, operations research, computer programming and network applications. The facultyis actively involved in sponsored research and industrial consultancy to maintain close relationships with the industry and to develop solutions for industrial problems.

The department has produced a large number of quality textbooks and monographs for mining and allied fields in India. A number of continuing education programs for industry executives and teachers are offered on a regular basis.

Facilities for research have been created over the years in the areas of fire and explosions, subsurface aerodynamics, experimental geo-mechanics, environmental quality assessment, mineral processing and numerical modeling. The tradition of inter-departmental research cooperation at IIT, Kharagpur significantly enriches the M. Tech. and Ph.D. programs of the department. This department has awarded more doctoral degrees in mining engineering than any other

Institution in India. Quality facilities exist for computer-based investigations, and the students have access to a wide variety of engineering software, testing facilities, and analytical equipment available throughout the institute.

The department will strive to remain in the forefront of science and technology related to mining and natural resources engineering.

Milestones

The department undertook a leadership role in the development of modern and broad-based mining engineering curricula balancing advancement of scientific knowledge and the needs of industries it serves. A two-year interdisciplinary postgraduate program in Mineral Engineering was offered by the department in collaboration with the departments of Chemical Engineering and Geology & Geophysics in 1966. A new postgraduate course in Mine Planning and Mechanization was started in 1970 marking the first full-fledged postgraduate program in the department. An inter-departmental postgraduate program in Mineral Resources Development and Management was also offered.

The department has recently introduced a new dual degree program entitled 'Mine Safety Engineering' to develop students with skills to address the challenges of safety in the minerals and allied industries.

The Department offers M.Tech degree in:

MN Mining Engineering

Course Content: The course emphasizes the following aspects of mining engineering and allied earth sciences subjects: Geo-mechanics and Ground Control, Subsurface Environment, Surface Mining and Surface Environment, Geomatics and Remote Sensing, Economics and Mine Planning, Occupational Hazards Assessment and Safety Engineering, Reliability and Quality Engineering, Environment Pollution and Control, Quantitative Decision Making, Numerical Analysis, Remote Sensing, GIS and GPS, and Advanced Mineral Processing. Areas of Research: Reliability, Quality, Safety and Occupational Hazards: Human Behavior Analysis; Quality Control and Reliability; Supply Chain Management; Injury Epidemiology Safety Management; Geo-statistics. Rockmechanics and Ground Control: Floor Bearing Capacity; Longwall Ground Control; Reinforcement and Roof Support Design; Drilling and Blasting; Stability of Large Underground Excavations; Image processing for rock mass characterization; Finite and Discrete Element Methods. Subsurface Environment: Fluid dynamics for shock loss analysis; Mine climate simulation and ventilation. Mine System Engineering: Neural Networks; Fractals and Fuzzy Theory; Genetic Algorithms for Mining Systems; Optimization of Mining Systems; Mine System Design and Mine Machinery Analysis. Mine Planning: Mine Closure Planning; Slope Stability Analysis; Facility location; Capacity Utilization; Investment and Financing Strategic Planning; Ground Movement Analysis. Environmental Pollution Control: Active and Passive Treatment of Water Pollution; Dust and Hazard Estimation; Ground Water Modelling; Environmental Policy Studies; Contamination Migration, Clean Coal Technology; Advanced surveying and GPS; Geo-spatial and Geo-imaging; Rescue Robotics.

Areas of Research: Reliability, Quality, Safety and Occupational Hazards: Human Behaviour Analysis; Quality Control and Reliability; Supply Chain Management; Injury Epidemiology Safety Management; Geostatistics. Rockmechanics and Ground Control: Floor Bearing Capacity; Longwall Ground Control; Reinforcement and Roof Support Design; Drilling and Blasting; Stability of Large Underground Excavations; Image processing for rock mass characterization; Finite and Discrete Element Methods. Subsurface Environment: Fluid dynamics for shock loss analysis; Mine climate simulation and ventilation. Mine System Engineering: Neural Networks; Fractals and Fuzzy Theory; Genetic Algorithms for Mining Systems; Optimization of Mining Systems; Mine System Design and Mine Machinery Analysis. Mine Planning: Mine Closure Planning; Slope Stability Analysis; Facility location; Capacity Utilization; Investment and Financing Strategic Planning; Ground Movement Analysis. Environmental Pollution Control: Active and Passive Treatment of Water Pollution; Dust and Hazard Estimation; Ground Water Modelling; Environmental Policy Studies; Contamination Migration, Clean Coal Technology; Advanced surveying and GPS; Geo-sptial and Geo-imaging; Rescue Robotics.

DEPARTMENT OF OCEAN ENGINEERING AND NAVAL ARCHITECTURE

The Department of Ocean Engineering and Naval Architecture set up in 1952 to offer a degree course in Naval Architecture was the first of its kind in India. It started offering a postgraduate diploma in Naval Construction from 1973-74 and a postgraduate diploma in Ship Design and Construction from 1974-75, following a request from the Ministry of Defence, Government of India. The postgraduate diploma was subsequently upgraded to the degree of Master of Technology in Naval Architecture from 1980-81 based on the recommendation of Nayudamma Committee. With the

changing scene worldwide, BTech (Hons) is now awarded in 'Ocean Engineering and Naval Architecture' from 1991-92 and M.Tech. in Ocean Engineering and Naval Architecture from 2001-02.

Besides offering the BTech and M.Tech programmes, the Department also offers a five-year dual degree M.Tech programme in Ocean Engineering and Naval Architecture. Research oriented programs leading to MS and Ph.D in the different research areas of the Department are pursued.

The Department is equipped with different laboratories and facilities created over the years and this includes **(a)Ship Hydrodynamics Laboratory** – The laboratory consists of a towing tank 150m long, 4m wide and 2.5m deep and equipped with a towing carriage of maximum speed of 6m/sec. The towing carriage has resistance and propulsion dynamometers with NI based hardware to control the carriage speed and Labview based data acquisition system. A 2D wave maker, single paddle, wetback type with AWACS (Automatic Wave Absorption and Control System) that can generate regular and irregular waves up to 40cm wave height and up to 3 sec wave period is installed at one end of the towing tank. The laboratory has a GPRS linked, Motion Recording Unit (MRU) that can record all 6 DoF. The hydrodynamics laboratory conducts resistance, propulsion and seakeeping experiments for ship models. The laboratory also has a 3-D velocity component measuring unit (acoustic type) for measuring flow dynamics around submerged body /sediment flow. The laboratory has underwater load cells for measuring mooring loads on floating structures **(b)Circulating Water Tunnel** – A circulating water tunnel with a test section of 6m long, 2m wide, 1.5m deep and water speed of 1m/sec with flow control facilities enables studies of flow around floating and submerged bodies as well as measurement of sediment transportation. **(c)Welding and Marine Construction Laboratory** – This laboratory is equipped with various welding units, namely submerged arc welding, shielded metal arc welding, friction stir welding and gas welding. The laboratory also has a set up plate forming using line heating. The welding units have suitable computer support for data acquisition and analysis. Work carried out in this laboratory is in the area of welding simulation, residual stress, weld induced distortion and control. **(d)Structure and Vibration Laboratory** - The laboratory is equipped with a 50kN Universal Testing Machine complete with all accessories to carry out experiments with tensile, compressive and bending loads. The equipment also has a multipoint digital strain data logger. **(e) Model Making Workshop** – To support the experimental activities for the above mentioned laboratories, the Department has a well equipped workshop to fabricate ship models and other accessories for experiments. The models are made of wax, wood, fibre glass, perspex, foam, etc. The Department also has a Computational Hydrodynamics Laboratory (sponsored by Naval Research Board) and a CAD Laboratory. The laboratories of the Department are equipped with various softwares like WAMIT, ORCAFLEX, NAPA, MAXSURF, MULTISURF, SHIPFLOW, CD-ADAPCO, STAAD, ANSYS, Symbols Grapher, Rhinoceros, FLUENT, Midas Civil for structural analysis, Photomodeler for programmatic measurements, ADCIRC, SACS etc. The Department is continuously upgrading the hardware and software facilities of all the laboratories with state of the art instruments and data acquisition systems.

The Earth Science and Technology Cell (ESTC) is also located in the Department of Ocean Engineering and Naval Architecture. The objective of the Cell, established by the Ministry of Earth Science, Govt. of India, is to promote R&D activities in Ocean Science and Technology having societal impact. The cell invites suitable proposals for funding in relevant thrust areas of ocean science and technology. The Department has a "National Programme on Marine Hydrodynamics", sponsored by Naval Research Board, New Delhi, to promote research and development in the area of naval hydrodynamics.

Department offers M.Tech degree in

OE Ocean Engineering and Naval Architecture

Course Content: The basic concepts necessary for an appreciation of the field of Ocean Engineering are provided through various core courses such as Analysis of Ocean Structures, Ocean Hydromechanics, Marine Construction and Repair Techniques, Advanced courses in specific area of Ocean Engineering including CAD-CAM in Design and Production, Dynamics of Ocean Vehicles, Computational Methods in Structural Mechanics and Hydromechanics are available in the form of electives. Some of the elective courses offered by the Department are: Ocean Engineering Materials, Dynamical Oceanography, Safety and Marine Pollution, Coastal Engineering, Hydroelasticity, Mechanics of Floating Systems, Ocean Engineering Vehicles and Systems, Powering of Ocean Vehicles, Ship Design, Advanced Ocean Structural Analysis, Computational Methods in Marine Hydrodynamics, CAD-CAM in Marine Design and Production, Port and Harbour Engineering, Ocean Circulation and Wave modeling, Offshore Technology. The courses are so designed that the students from other engineering disciplines can easily adopt themselves to the course curriculum and later specialize themselves in areas like Structural Mechanics, Hydrodynamics, Marine Design and Production and Ocean Technology, Ocean environment. Experimental work in the Department Laboratories also forms a part of the M.Tech programme. M.Tech applicants are required to submit a dissertation, which may be in one of the areas of research in the Department.

Areas of Research: In the last half a century, the Department has made significant contributions to the development of the shipbuilding, shipping, offshore and related industries in the country by providing technical manpower of high quality and by carrying out research and development of international standard. Apart from basic research, the Department is also actively involved in various sponsored research and consultancy projects. The research areas can be classified into the three broad fields as below :

Design and Production: Computer Aided Design and Computer Aided Manufacture, Structural Reliability, Ship Design Optimization, Knowledge Based Systems, Different Welding Methods for Production, Design and analysis of Welded Joints, Methods for Calculation/Estimations of Welding Deformation and Residual Stresses.

Hydrodynamics: Resistance and Propulsion, Computational Fluid Mechanics, Water Wave Mechanics, Coastal Hydrodynamics, Hydroelasticity, Motion of Floating Bodies, Wave loads on Coastal/Offshore Structures.

Structural Engineering: Finite Element Method of structural analysis applied to ship and ocean structures such as stiffened plates, stiffened shells, submerged panels, offshore structures, articulated towers, etc., analysis of the fibre reinforced structures as applied to ocean, aerospace and general engineering systems.

Ocean Environment: **C**oastal processes and ocean wave modelling.

Placement opportunities: Employment opportunities for Ocean Engineers and Naval Architects exist in various offshore industry, shipbuilding and ship repairing yards, marine classification societies and other government regulatory bodies dealing with marine systems, Navy and Coast Guard, coastal engineering companies, Naval Defense R&D, environmental protection agencies for coastal protection, etc. Being multidisciplinary in nature, students from this program generally receive a broad engineering background, and this helps finding employment in other allied engineering fields as well including management and IT industry. Every year, a section of the students opt to go for higher study in core branches of Ocean Engineering and Naval Architecture and other allied branches of Engineering and Science.

DEPARTMENT OF PHYSICS

The Department started functioning from the very inception of the Institute in 1951. The Department, apart from teaching Physics to undergraduate students and offering 5-year integrated M.Sc. course and 2-year M.Sc. course in Physics, also offers M.Tech. course in:

PH1 Solid State Technology

Course Content: The prime objective of the MTech course in Solid State Technology is to educate the post MSc and post BTech students, at advanced level, on such modern areas of solid state science and technology as have developed during the last five decades. To make the course better balanced and inter-disciplinary, the course curriculum and syllabus have been framed in cooperation with Department of electronics and electrical Communication Engineering, Materials Science Centre, and Cryogenic Engineering Centre and several related subjects from these Department and Centres have also been included in the curriculum .

The outline of the course content is as follows:
Physics of materials, solid state devices, Analytical techniques, Science and technology of nanomaterials, Magnetic and superconducting properties of solids, Soft condensed matter, Physics of semiconductor devices, IC technology, Thin film technology, Surface science, Physics and technology of Optical fibers, Integrated optics, Optoelectronics, Computational methods and advanced experiments on solid state devices.

Areas of Research: The department is actively engaged in both experimental and theoretical research and many of these are of interdisciplinary in nature. A brief outline of the main areas is as follows:

Structure-property correlation of amorphous and crystalline materials, electrical transport, thermal, magnetic, and optical properties of materials. Phase transition phenomena in solids. Preparation of nanomaterials, semiconductor thin films, disordered solids, ferroelectric materials, polymer composites etc. X-ray diffraction, Raman spectroscopy, Laser spectroscopy, Impedance spectroscopy, and Crystal growth techniques. Device studies on photonic crystals, optical fibers, spintronics, fuels cells, solar cells, energy storage, memories etc. Theoretical research are in different areas which include high-Tc materials, correlated systems, high energy physics, astrophysics, cosmology, nuclear physics, non-linear dynamics, chaos etc.

ADVANCED TECHNOLOGY DEVELOPMENT CENTRE

The Advanced Technology Development Centre (ATDC) was thus established in July 1998 in IIT Kharagpur. The aim of this centre is to achieve excellence in research using latest technology at the global level and produce trained professional man power for the industry. Advanced Technology Development Centre is an interdisciplinary research centre carrying out research in emerging areas that typically involve researchers from multiple disciplines and niche academic programmes at the postgraduate level. Other than departments, several stare-of-the-art research units of the Institute carry out research under the academic umbrella of ATDC. These include the Advanced VLSI Design Laboratory, MEMS Design Laboratory, Micro-science Laboratory, Advanced Laboratory for Plant Genetic Engineering, Communication Empowerment Laboratory, Kalpana Chawla Space Technology Cell, Centre for Theoretical Studies, Micro-fluidics Laboratory, GM CRL on ECS, P K Sinha Centre for Bio-Energy, Centre for Railway Research, etc. A large number of interdisciplinary research projects are carried out under ATDC.

Micromachining and MEMS are one of the major areas of research at the centre. Research and development in Bio-MEMS is also one of the thrust areas of the centre. Bio-MEMS devices like micro channel for cell culture, cell separation etc are being undertaken in the Centre. Several Govt. Dept. including NPSM/ADA, ISRO, DRDO, DST and BARC have funded projects to develop micro-sensors for special application. During the last few years the MEMS devices developed in the laboratory include silicon piezoresistive accelerometer, quartz based accelerometer, micro-thruster, micro-valve, micro-pump, and flow sensor. MEMS design laboratory, a national facility created under NPSM program is actively involved with design work on MEMS including micro fluidic devices. A number of students from various departments like ATDC. Electronics & ECE, Electrical, Mechanical, Bio-Technology, School of Medical Science, Civil engineering department, etc. are involved in the design centre for their project/thesis work. Research and development is also undertaken in the field of integrated optics. A number of thrust areas have now immerged based on core competency available in Advanced VLSI laboratory. This include analog and RF circuit, wireless communication and broadband processing, direct conversion receiver, power management circuits, processors and IP cores for embedded applications design for testability. Fifteen leading companies have joined AVLSI consortium and more that twelve ongoing collaborative research projects funded by Govt. of India and leading companies including National Semiconductor, Intel, Texas Instrument and General Motors. Integrated-optic design software has been developed and copyrighted. Fabrication and characterization of Ti in diffused Li niobate wave guide, directional coupler, power splitters, switches for fiber optic communication network have been performed. Research is being carried out in thin film nanostructure, semiconductor, ferroelectric and magneto-resistive films for microelectronics and sensor applications under various Govt. sponsored projects at Micro Science Laboratory under Dept. of Physics.

AT Embedded Controls and Software

Course Content:

Core Courses: Embedded Control Systems, Embedded Software Design & Validation, Software Design and Validation Laboratory, Embedded Controls Laboratory, Embedded Applications Laboratory, Seminar, Comprehensive Viva-Voce.

Elective Courses: Embedded Systems, Logics for Computer Science, Testing and Verification of Circuits, Cryptography and Network Security, Artificial Intelligence, Advanced Graph Theory, VLSI System Design, Object-Oriented Systems, Control Theory, Estimation of Signals and Systems, Industrial Instrumentation, Digital Signal Processing, Intelligent Control, Digital Control, Modeling and Simulation, Process Monitoring and Fault Diagnosis, Embedded Systems Design, Modelling and Simulation of Dynamic Syst., Machinery Fault Diagnostics & Signal Proc., Automatic Control, Reliability Analysis & Prediction, Communication Systems and Networking, Embedded Low Power Systems, MEMS and Biosensors, Stochastic Process Simulation, MEMS and Applications, Wireless Adhoc and Sensor Networks, Intelligent Machines and Systems, Fluid Drives and Control, High Performance Computer Architecture, Real-Time Systems, Distributed Systems, Advanced Microprocessor Based Systems, Intelligent Systems, Advances in Operating Systems Design, Machine Learning, Fault Tolerant Systems, CAD for VLSI Design, Advances in Digital and Mixed Signal Testing, Advanced Control Theory, Adaptive and Learning Control, Advanced Estimation Theory , Discrete Event Systems, Real Time Systems, Advanced Digital Signal Processing, Optimal Control, Non-Linear Control, Adaptive Systems and Signal Processing, Mechatronics, Computer Controls of Machines and Processes, Robotics , Internet and Web based Technologies, Information and System Security, Software Reliability, Fault Diagnosis and Predictive Maintenance, Computer Process Control, Real Time Intelligent Process Systems, Process Dynamics and Control, MEMS and Microsystems Technology, Signal Processing / Telecommunication Ics, Multimedia Systems, Fluidic Instrumentation and Control, Electric Vehicles, Analog Signal Processing, Power System Dynamics and Control, Industrial Automation and Control, Biomedical System Engg. and Automation, Multimedia Systems and Applications, Audio Systems Engineering, Mechanical Drives, Air-conditioning and Ventilation, Biomedical Instrumentation, Mechanisms and Robot Kinematics, CAD of Cryogenic Process Plants, Reactor Stability and Control, Human Behaviour Systems, Development of Human Resources, Economic Efficiency & Human Resource Use, Industrial

Relations, Project Engineering and Management, Human Behaviour and Management, Management Information Systems.

Areas of Research: Current areas of research focus in laboratories directly under ATDC include VLSI Design and CAD, MEMS and BIO-MEMS, Nano-electronics and material sciences, MBE and MoCVD Technology, Bio-energy, Embedded Controls and Software, Plant Genetic Engineering, Communication Empowerment, High-speed and Heavy-Haul Technology for Railways, Reliability Analysis, Micro and nano-Fluidics, etc

CENTRE FOR EDUCATIONAL TECHNOLOGY

The Centre is a leading presence in the field of Distance Education and E-learning in India with high-end Multimedia and CAL laboratories. The centre combines strong expertise in Information and Communication Technologies with Pedagogy and Instructional Systems. It has 3 professional studio-cum-classrooms for recording full-semester courses of the institute. More than 100 full semester Video courses of the institute are digitized and stored in a bank of servers. All lectures of these courses are now available on the Internal LAN of IIT Kharagpur in the VOD mode.

Initial trials have been carried out successfully in tutorial classes of the course on "Networks signals and systems" at the UG level. With a valid ID, students can join a live tutorial classroom through the institute LAN connection. It allows students to pose questions and see and hear the responses of the teacher. They could interactively participate in the class from their Halls of Residence. It uses one-way (classroom to students) video and two-way audio / text transmission.

The on-going Virtual Laboratory project is aimed at reproducing the hands-on laboratory experience of selected courses very closely, on computer screens - through advanced modelling and simulation techniques. Ten experiments of 1st and 2nd year Electrical Engineering laboratory are now available in the web-enabled client-server mode. This tool allows a student to simulate and conduct experiments on a computer. A software has been developed and implemented for conducting on-line tests for selection of paramedical personnel to NIOH.

CET is also involved in the National Project in Technology Enhanced Learning (NPTEL) along with the other IITs and IISc, Bangalore. The first phase of the project has been completed - leading to a resource material generation of 240 video-based and web-based courses. The second phase is due to begin from 2007, with a target of producing 500 more such courses. All courses would be distributed free-of cost to all engineering colleges - with a bid to improving the standard of engineering education in the country. CET also pioneered the first off-campus Distance Education Programme in various IT related areas between 1997 and 2003. CET is also involved in the multi-crore project of MHRD on "Pedagogic Research" and "Standardization of Quality Assurance of web-based courses".

Students who have completed 4 year degree programme or equivalent in Electronics & Communication Engineering, Electrical Engineering, Computer Science Engineering, Information Technology, Electronics and Instrumentation or similar disciplines are eligible to join this M.Tech program.

Students from different batches have been employed in organizations like Texas Instruments, Clouth IT, Sasken Communications, Samsung, IBM, KPI Cummins, Diginoc, Delloitte and others. A number of students have opted for higher study in different institutions.

The Centre offers following specialization:

ET Multimedia Information Processing

Course Content :

Core Courses: Digital Image Processing and Applications, Digital Voice and Picture Communication, Media Systems Laboratory, Audio Systems Engineering, Multimedia Processing and Networking, Media Process Simulation Laboratory, Seminar, Comprehensive Viva-Voce.

Elective Courses: Advanced Image Processing and Computer Vision, Linear Algebra and Error Control Coding, Advanced Digital Signal Processing , Pattern Recognition and Image Understanding, Real Time Embedded Systems, Advanced Topics in Speech Processing, Mobile Communication and Fading, Data Structure and Algorithms, Microprocessor and Instrumentation, Switching and Automata Theory, Human Computer Interface, Instructional System Design.

The lecture classes are supported by well-planned laboratory demonstrations in Sound and Media engineering and lectures by renowned experts in the area.

Areas of Research: Digital Image Processing, Video System Engineering, Computer Vision, Speech and Audio, Digital Speech Processing, Audio System Engineering, Multimedia Processing and Networking, Digital Voice and Picture Coding, Advanced Image Processing and Computer Vision, Linear Algebra and Error Control Coding, Advanced Digital Signal Processing, Pattern Recognition and Image Understanding, Real Time Embedded Systems, Advanced Topics in Speech Processing, Mobile Communication and Fading, Data Structure and Algorithms, Microprocessor and Instrumentation, Switching and Automata Theory, Human Computer Interface, Instructional System Design.

CENTRE FOR OCEANS, RIVERS, ATMOSPHERE AND LAND SCIENCES

The Centre for Oceans, Rivers, Atmosphere and Land Sciences (CORAL) at Indian Institute of Technology, Kharagpur was established in March, 2005 for imparting quality teaching and advanced training in Earth System Sciences and Technology. The vision of the Centre is to become a world class educational and research hub for the development of high quality manpower in the area of Oceanography, Atmospheric Science, Land System, River Science and related physical, biological, and societal systems. It will also act as a knowledge integrator and scientific innovator towards contributing to the development of predictive earth System Science. The important mission of the centre is to identify and address the challenges of the Earth Systems Science such as climate changes, Ocean State simulation, Tsunamis, Cyclones and so on.

At present the Centre is offering a two year Postgraduate Program i.e. Master of Technology in Earth System Science and Technology. Meritorious students working in the project are allowed for MS. The Centre is also having Ph.D program. It is coincident that the start of the master's program by CORAL almost coincides with the establishment of Ministry of Earth Sciences by Government of India. The Centre is having Computing and Visualization Laboratory for integration of numerical models and visualization of these products. The Centre is also having a national atmospheric observational tower facility.

The Department offers M.Tech degree in:

CL Earth System Science and Technology

Course Content: The two year M.Tech in Earth System Sciences and Technology is designed to meet the trained manpower in the area of Oceanography, Atmospheric Science, Land System, River Science and related physical, biological, and societal systems. The course is divided in four semesters with first two semesters having the course work of theory and laboratory. The third and the fourth semesters are mainly devoted to project work. The program is structured in line with the other M. Tech Programmes of the institute providing ample flexibility to the students to learn as per the course and the interest. The core subjects include; Advance Meteorology, Dynamics of Fluvial Systems, Ocean Dynamics, Global Tectonics and Climate with electives covering a set of vast topics from Advanced Instrumentation Techniques, Satellite Oceanography, Ocean Colour and Applications, Ocean Circulation and Wave Modelling, Marine Biotechnology, Polar Science, Modelling of Extreme Events, Carbon Cycle and Global Climate Change, Climate Modelling, Climate Risk Assessment in Agriculture, Land System Studies, Neural Networks and Applications, Advanced Computational Hydraulics, Groundwater Modelling and Simulation, Integrated Watershed Management, Aqueous Environmental Geochemistry, Geo-informatics and Data Analysis to Environmental Hazard Management etc. The centre is also offering laboratory courses on Atmospheric and Hydrological Modelling, Ocean and Storm Surge Modelling and Data Analysis and GIS Applications.

Areas of Research: The centre is involved in frontier research in oceanographic and atmospheric observational and modelling. In oceanography, the areas of present research activities include numerical modelling of Bay of Bengal and Indian Ocean, wave modelling and ocean circulation. In atmospheric research, the present focus is on the observations and modelling studies of severe thunderstorms. Besides, the centre is also involved in mesoscale modelling of extreme weather events viz., tropical cyclone, heavy rainfall, and flash floods etc. The areas of specific interest in this direction are mesoscale data assimilation and micro-physical processes. The centre is also involved in observational modeling studies of urban boundary layer, regional climate modelling and impact assessment studies. Space based observations, retrievals; validation and assimilation of geophysical parameters of ocean, atmosphere and land are another area of research of the Centre. In view of India's active research in Antarctica, the Centre is also focusing on the remote sensing of sea-ice and southern ocean in relation to climate studies.

CRYOGENIC ENGINEERING CENTRE

Cryogenic Engineering Centre was established in 1976 on the recommendation of Nayudumma Committee for the advancement of cryogenics and cryogenic engineering. This is the only department in India that is engaged in conducting postgraduate studies in Cryogenic Engineering through its M.Tech., M.S. and Ph.D. programme. The Cryogenic Engineering is a multi-disciplinary academic curriculum with inputs from three major disciplines, namely, Physics, Mechanical Engineering, and Chemical Engineering. The objective is to generate expert manpower in this advanced field of science and technology through teaching and research.

Teaching, sponsored research and consultancy remain at the core of activities of the centre. The Centre offers several courses related to cryogenics and cryogenic engineering at both undergraduate and postgraduate levels. Research and development activities are carried out through its postgraduate and doctoral programmes as well as through inter-departmental undergraduate and postgraduate studies. The Centre is also active in continuing education programme of the Institute by conducting short term courses and workshops in specialised areas to train engineers from industries, faculty from academic institutions and scientists from R&D organisations.

Major research areas pursued at the Centre include superconducting magnets and applications, magnetic materials and devices, nanocomposites and nanofluids, oxygen safety, helium cryogenics, cryogenic heat transfer and fluid flow, cryogenic heat exchangers and rotating machines, cryogenic rocket propulsion, natural gas and hydrogen energy, air separation, carbon capture and sequestration etc.

Alumni of the centre are holding positions in different national and international organisations and serving actively different cryogenic and allied industries. Several of our students are working in the different national and international laboratories or they have joined academics in IITs or NITs.

The Centre receives sponsored and consultancy projects from various government agencies and industries. Some of these include DST, BARC, ISRO, MHRD, CSIR, ONGC, BHEL etc. A substantial amount of funding was received from DST to develop liquid-helium-free superconducting magnet-based research facility in the Centre. Besides these, research facilities and cryogen-production facilities were modernized through bi-nation collaboration under Indo-FRG Cooperation in cryogenic engineering.

The Centre, through interactions with industries and academia at both national and international levels, commits itself to excel in cryogenic engineering and allied areas. The Centre offers M. Tech Degree in:

CR Cryogenic Engineering

Course content: The course contents include subjects like Cryogenic Air Separation, Cryogenic System, Cryogenic Heat Transfer, Mass Transfer and Separation Processes, Cryofuel Systems, Hydrogen Energy, Cryophysics, Vacuum Techniques, Design of Cryogenic Equipment and Accessories, Cryogenic Rocket Propulsion, Superconducting Materials Magnets and Devices, Superconductivity and Vacuum Technology Laboratories, Heat Transfer Laboratory etc. Students can also take up a few appropriate electives from other Departments/Centres.

Areas of Research: Current research activities of Centre focus on cryogenic refrigeration and liquefaction system; sorption cooling; fluid flow and heat transfer; porous media heat transfer; miniature heat exchangers and regenerators; gas-bearing; gas separation and purification by absorption; adsorption and membrane processes; modeling and simulation of separation processes; natural gas processing, liquefaction and utilization; carbon dioxide capture and sequestration, in-flight air separation; propulsion; process intensification; energy optimization; hydrogen energy; safety under oxygen rich environment; simulation of helium plant and cryogenic system for fusion reactor; nanostructured materials, nanofluids and bio-composites; dielectric and magnetic materials, thin films; gas and magnetic sensors; superconducting magnetic energy storage; superconducting magnets for nuclear fusion/electrical industry etc; high field / low temperature cryogen-free magnets; spintronics and magnetic nonmagnetic heterostructure, multiferroics and functional materials; vacuum technology and process applications; energy efficient system; thermoelectrics, spin freezing phenomena, spin glasses.

MATERIALS SCIENCE CENTRE

The Centre was established in the year 1971 with the objective of (i) developing interdisciplinary research, (ii) developing new materials and composites of technological importance and (iii) offering man power training for scientists and engineers in the area of engineering materials. Excellent laboratory facilities have been built up in three areas of specialisation: Ceramics, Polymers, Semiconductors and allied materials which include Ultrasonic interferometers, Brabender Plasticorderextrusiograph, Plastic extruder, Rheometer, Mercury porosimeter, Tensile tester, Bridgman-Czochralski Crystal Growth system, R.F. Sputtering System, Liquid Phase Epitaxy reactor, Pulsed ruby Laser, Plasma enhanced CVD, Turbulent Flow Rheometer, Rheotest 11, Ultrasonic Pulse echo system, C-MaticThermoconductometer, Dynamic Mechanical analyser and equipment for mechanical characterisation. MOCVD Reactor, Spray-CVD, C-V Analyser, Optical Microscope (Versamet), Crystal polisher (Multipole-2), Atomic Layer Beam Deposition Unit, High Temperature Controlled Atmosphere, Furnaces, Polymer mixing mill, Closed Cycle (10-300 K) Helium Cryostat, Electrical and Magnetic characterisation Facility, Hall Effect Set Up, Flocculator, Turbidity Meter and Clean Air Vertical Flow System, Photo luminescence set up, Double Crystal X-Ray diffraction. The Centre has undertaken large number of sponsored research projects and consultancy projects. Many of them have been successfully completed. The course emphasizes one of the following branches.

1. Ceramics 2. Polymers 3. Semiconductors and Allied materials.

The Centre offers M.Tech degree in:

MS Materials Science and Engineering

Course Content: The course consists of four compulsory subjects as an introduction to different types of materials, their preparation, characterization, technology and applications – structure property relations in materials, science and technology of polymers, science and technology of semiconductors, science and technology of ceramics. Additionally, there are two compulsory courses on characterization techniques in the second semester. Students may specialize in their chosen areas by taking electives from subjects like: Refractories & thermal barriers, Spectroscopy and structure of glass, Technology of ceramics for electronic applications, Ceramic fabrication & processing, Glass and glass materials, Ceramic synthesis, Solar energy materials, Optoelectronic materials and devices, Semiconductor technology, Introduction to nanotechnology & nano-structured materials, Epitaxy of compound semiconductors, Introduction to biomaterials, Manufacture of industrial polymers, Polymer rheology and mixing, Processing and fabrication of polymers, Technology of polymer composites, Technology of natural and synthetic elastomers, Industrial polymer production technology, Polymer blends and alloys.

The project work is conducted often in collaboration with industry.

Areas of Research: Nanostructured materials, catalysis, fuel cells, surface, and electrochemistry, resorbable bio-ceramics for bone regeneration, refractory materials and coatings for thermal barrier and tribological applications, structural ceramics and porous ceramics, advanced glasses and glass ceramics, bulk amorphous alloys, mesoporous solids, GMR and GMS materials, magnetoelectric materials, high-energy materials, structure-property correlations, thermo-mechanical processing and structure evolution.

Catalyst free growth of InP quantum dots on Si by MOCVD, low dimensional structures of III-V semiconductors, development of materials for waste heat recovery (thermoelectricity), III-V MOS, embedded ZnO nanostructures in graphene oxide (GO) matrix, functional electro-ceramic materials by soft solution processing, multiferroic ceramics, semi-conducting ceramics for gas sensing applications and intercalating oxides as electrode materials for lithium rechargeable batteries, CVD growth of CNTs and Silicon Carbide epilayers, oxide nanostructures and superlattices, superhydrophobic surfaces from inorganic nanostructures, epitaxy of rare earth oxides and Group IV superlattices and interfaces.

Synthesis and characterization of high performance polymers, low dielectric constant polymers, polymers for membrane based application e.g. pervaporation, gas separation and proton exchange membranes, hyperbranched polymers and polymers for electronic applications, polymer blends, reactive compatibilization of multiphase mixtures, rubber toughening, polymer-clay nanocomposites, polymer based sensors, jute and ramie based products, biodegradation of polymers, polymeric PTCR (positive temperature co-efficient to resistivity) composites, conductive polymer composites, polymeric supercapacitors and EMI shielding materials, LCP based binary and ternary blends, welding of thermoplastic nanocomposites, smart polymeric materials, stimuli responsive and self-healing polymers.

The Materials Science Centre was established in 1971 to undertake research activities in the areas of glass and ceramics, polymers, semiconductor, allied materials and composites. The development of know-how and manufacturing technologies of many strategic and advanced materials like Opto-electronic Materials and Devices, Semiconductor Lasers, Polymer Blends etc were taken up by the centre. With state-of-the-art infrastructure the centre conducts major sponsored research projects and has developed a range of products today and applications, including Ferromagnetic insulator cermets for Telecom Equipment, Alumina composites, Drag Resistant Polymers for Sprinkler Irrigation Systems, Ceramic Components by Gel Casting, Synthesis of Nano sized Non-oxide Ceramic Powders. Over 200 Ph.D students and 400 M.Tech students have passed out to join academic organizations, industry and research institutions in India and abroad.

The Centre has an active M.Tech Programme in Materials Science since 1980. The annual intake strength is 25 students. The programme is inter-disciplinary and draws on students from physics, chemistry, materials science and engineering, polymer chemistry, etc. The programme is tailored to have mainly core subjects in the 1st semester with more specialized electives in the subsequent semester and a strong component of project work for a year. This is especially useful for the students in generating employment in industry as well as preparing them for a career in research since they get hands-on training on various synthesis/processing tools as well as advanced characterization facilities. The three major emphases of the M. Tech program are: Ceramics, Polymers and Semiconductors.

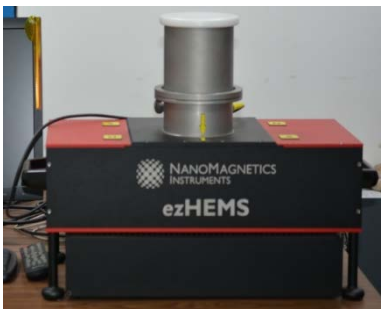
The Centre also contributes actively to B.Tech programmes by offering courses tailored to the needs of the different Engineering Departments. It is now starting a new thin specialization in Materials Science for B. Tech students of all disciplines.

The major research facilities available in the Centre include a Keithley 4200-SCS Parameter Analyzer, Thermal transport measurement facilities (Hot Disk TP2500S), Photoluminescence (PL) unit (PTI USA), Tescan Vega 2 SEM, Quantachrome BET, Rigaku Ultima III XRD, Class AAA Solar Simulator (Photo Emission Tech, USA), Seebeck Coefficient set up (Advance Riko ZEM-3HR), Cryo-cooled Electrical Probe Station (Janis, USA), Rapid Screening Calorimeter (THT, UK), Zwick UTM, Differential Scanning Calorimeter (TA, USA), Thermogravimetric Analyzer (TA, USA), Perkin Elmer UV-Vis Spectrophotometer, Ferroelectric Loop Tracer (Radiant Technologies, USA), Contact Angle Measurement system, ezHEMS Hall Effect measurement system (Nanomagnetics, UK), Optical Microscope (Leica, Germany), E-beam evaporation system, DC Sputtering system , Spin coater, Langmuir-Blodgett film Deposition system, Dip coating system, High Temperature Furnaces, CVD systems, Polymer processing and synthesis facilities, etc.

Major Research Facilities available at Materials Science Centre

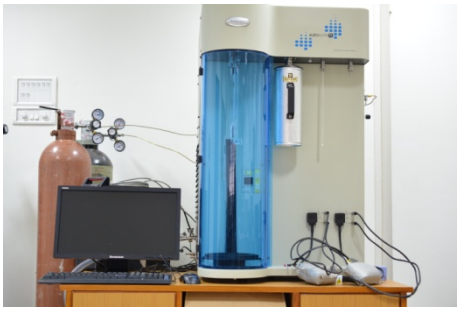
Keithley 4200-SCS Parameter Analyzer

Thermal Transport Measurement Facilities



Hall measurement

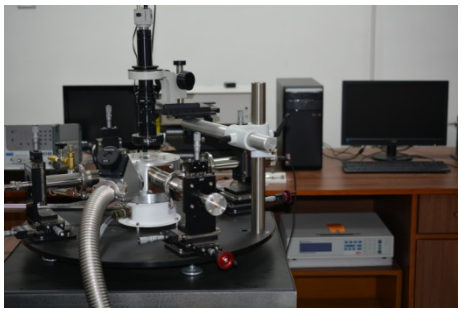
SEM



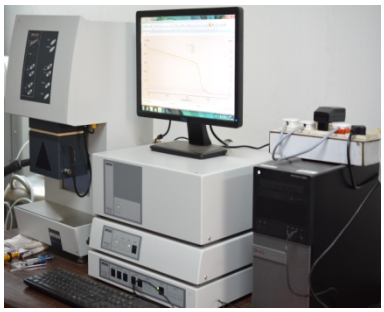
BET

XRD

Solar Simulator



Cryo-Cooled Electrical Probe Station



DMA

DSC and TGA

Seebeck Coefficient Measurement

UV-Vis Spectrophotometer

RELIABILITY ENGINEERING CENTRE

Reliability Engineering is an interdisciplinary branch of study offered by our centre located in old building of institute premises. We have faculty members specialized in reliability engineering with basic degrees in different engineering branches. Similarly, our intake students are also from different engineering disciplines. In this unique centre of excellence, our team of faculty members will be too happy to impart you the best standard of education in reliability engineering that is available in our country. Infact, the standard of our programme is one of the best in this area and comparable with any international university offering similar specializations. The course curricula of this study are carefully designed to include latest developments, tools, techniques, as well as providing industrial exposure to our students. We offer post graduate degrees such as MTech, MS and PhD. Apart from these, the Centre also offers micro-specialization in System Reliability Engineering to the UG students of the Institute and short term courses for working professionals in industry and R&D organizations. The centre is also actively involved in industrial consultancy and research. All our students are placed well in various organizations and the feedback we receive from them is very encouraging.

About Department

In the present scenario of global competition, Reliability Engineering plays a vital role in design, maintenance, operational safety/security and management of engineering systems. It is considered one of the most important performance assessment index for most of the industrial products, processes and services. Reliability Engineering is an inter-disciplinary area and plays an important role at different stages of a product life cycle starting from conceptual design to detailed design, manufacturing, operation, maintenance, and disposal. Reliability engineering helps to improve designs for operation, safety, easy/faster maintenance, understand the failure process, identify the root causes, suggests better fault diagnosis and maintenance, and quantifies the product performance over a period of its mission life.

Reliability Engineering Centre, established in 1983, is the first and unique centre of excellence in India offering Masters' and research programs in Reliability Engineering. The conventional engineering branches mainly focus on design of systems for certain specific functional requirements. But in Reliability engineering, students are trained on how to design, predict, estimate, and demonstrate performance of a product throughout its mission life for failure free operation, which is also safe and easy to maintain deriving maximum benefits. In short, the Centre focuses on overall improvement in engineering skills of students by exposing students to theory and practices in Reliability engineering through its academic programs, involving students in research and consultancy projects for Industries and R & D organizations, (viz., BARC, DRDO, NPCIL, L&T, AERB, Vodaphone, Indian Army, ECIL, ISRO, Crompton & Greaves, Robert Bosch, GE, Covedien, TATA Motors, Secure Meters, Indian Railways, Bosch etc.), exposing students to life testing/ prediction/ estimation/ demonstration of engineering items, and encouraging for extracurricular activities etc.

There is great scope and demand of reliability engineers with B.E. / B. Tech. in Mechanical, Electronics, Electrical, Chemical engineering, Computer Science, Production, Manufacturing, and their allied areas. Students of the Centre are well placed in MNC's and reputed organizations like BARC, Bloom Energy, Crompton & Greaves, DRDO, Eaton, ENTITY SOLUTIONS, GE, GM, Goodrich, HCL, Honeywell, IBM, INFOSYS, ISRO, LM Glass Fiber, Maruti Udhyog, NPCIL, SATYAM, TATA Steel, TCS, Time Tooth, WIPRO, TVS, Bosch and many m**ore.** The Centre offers M. Tech. degree in:

RE Reliability Engineering

Course Content: Reliability Analysis and Prediction, Maintenance Engineering, Reliability Design, Reliability Estimation and Life Testing, and Reliability Engineering Laboratory are the core subjects. To make the course more balanced and interdisciplinary, a number of other department elective subjects are included in the curriculum. All students have to take an elective subject in management. Besides this, the centre also offers a number of elective subjects including Statistical Methods in Reliability, Probabilistic Risk Assessment, Statistical Process Control, Environmental Testing and Reliability Demonstration, Failure Data Organization and Analysis, Performance Engineering for Sustainability, Reliability Centred Maintenance, Maintenance Management, Fault Diagnosis and Predictive Management, Safety Engineering, Human Reliability, Software Reliability, and Reliability Management.

Areas of Research: The Centre is actively engaged in research in the areas of: Failure mechanism and failure analysis of electronic, electrical and mechanical component/devices, Reliability prediction and testing of components and devices, Hazard and safety analysis of systems and devices, condition monitoring and fault diagnosis of machines and plants, Design of cost optimal and performance based maintenance policies, reliability centred maintenance, quality engineering, network reliability, power system reliability, software reliability, Probabilistic risk assessment, big data security and cloud service reliability.

RUBBER TECHNOLOGY CENTRE

In the mid fifties (1955) the Ministry of Education, Govt. of India, decided to establish facilities for promoting rubber technology in the country and established a rubber technology laboratory at IIT Kharagpur in the Department of Applied Chemistry under the aid from Colombo Plan and Technical Collaboration Mission. Subsequently, an independent Rubber Technology Centre was established in the year of 1981 to cater to the need of country's growing technical manpower in the field of rubber technology and allied areas. After its establishment, the centre has earned an excellent reputation of its own for promoting postgraduate teaching and research in different areas of rubber technology. Available facilities include Mixing Mills, BrabenderPlasticorders, Press, Rheometer, Plastimeter, Mooney Viscometer, Impact Tester, Hounsfield UTM, Compression Set Apparatus, Dunlop Tripsometer, Abraders, Goodrich and DeMettiaFlexometers, Ageing Ovens, Zwick UTM, Thermal Analyzer, Flammability Tester, Monsanto Processability Tester, Dynamic Mechanical Anaylzer, Dielectric Thermal Analyzer, Compression Stress Relaxometer, FTIR Spectrophotometer, Optical Microscope, Brookfield Viscometer, LCR meter and Atomic Force Microscope, RPA. The centre works in close collaboration with other departments/centres of this Institute, Indian rubber industries, Rubber Board and government research establishments. Several research projects sponsored by different agencies like DST, CSIR, DRDO, DAE, BARC, MHRD and industries are in operation. This centre has successfully completed a UK Government collaboration program, and an Indo-UK and an Indo-French collaborative research programmes. The centre is also presently working on industry sponsored projects from India and abroad; for example, with TISCO, NICCO, Phoenix Yule, Goodyear Tire and Rubber Co. USA, EXXON MOBIL Chemical Co., USA, LANXESS, and Germany and so on. The centre has successfully organized three International Conferences so far. There is hundred percent placements every year. The Centre offers M.Tech degree in:

RT Rubber Technology

Course Content: Students are taught various aspects of rubber technology i.e. basic rubber science, industrial rubbers, compounding, testing, rheology and processing, component production and design, latex, tyre, adhesion technology, engineering design and characterization. In addition to the above-mentioned subjects, the students are allowed to opt for the subjects offered by other departments, i.e. computer software, management, chemical engineering and engineering drawing. The project work is carried out in different rubber and allied industries as well as in several R and D sectors in this country.

Areas of Research: Compounding and vulcanization, Polymer blends and alloys, Rubber based composites, Thermoplastic elastomers, Adhesion science and technology, Electrical and electronic applications of rubbers, Dynamic mechanical and thermal analysis, Failure mechanism, Rheology, Industrial rubber products, Modification of rubbers, Ionomers, Recycling of waste rubbers, Micro cellular rubber, Biomedical applications of rubbers, New techniques of Polymerimerzation, Smart Polymers and polymer nano-composites. Research work in different types of Polymer, Polymer based Composites, nano Composites are also research interest of the Faculty members of the Centre.

SCHOOL OF ENERGY SCIENCE AND ENGINEERING

School of Energy Science & Engineering (SES&E) was started in 2013 as an inter-disciplinary program at IIT-Kharagpur. This School provides critical research inputs in all aspects of energy sectors as well as innovative technologies for energy systems. SES&E also provides research leadership at the national and international level by offering an interdisciplinary research forum and academic program for the study of energy systems, which emphasize on technology demonstration and collaboration. This School has initiated Ph. D. programs in Energy Science and Engineering (from Autumn 2014-15) and a two-year M. Tech. program in Energy Engineering (from Autumn 2015-16). It has plans to offer MS by research and dual degree courses in future. These programs are intended to provide the students with a comprehensive exposure in energy engineering.

This school conducts and supports research activities with multidisciplinary inputs from several departments/centers such as Electrical Engineering, Mechanical Engineering, Chemical Engineering, Biotechnology, Agriculture and Food Engineering, Physics, Chemistry, Metallurgical & Materials Engineering, Materials Science, etc.

The School offers following specialization:

ES Energy Engineering

Core Subjects: Renewable Energy Sources, Thermodynamics/Machine Analysis/Advanced Fluid Mechanics, Energy Conservation and Waste Heat Recovery, Convective Heat and mass Transfer/Power Systems Analysis & Operation/Advance Heat Transfer, Energy System Modeling.

Electives: Microscale Transport Processes, Process Modelling and Simulation, Petroleum Refinery Engineering, Advance Mathematical Techniques in Chemical Engineering, Power Electronic Converters and Machine Drives, Control Theory, Power System Protection, Digital Signal Processing, Digital Control, High Voltage and Insulation Engineering, Process Monitoring and Fault Diagnostics, Computational Methods in Thermal Engineering, Refrigeration Systems, Atmospheric Flow, Internal Combustion Engine, Thermal Systems Design, Conduction & Radiation Heat Transfer, Nuclear Power Generation and Safety, Reliability Analysis and Prediction, Methods of Biomass and Bio Fuel Analysis, Fundamentals of Bio Energy, Chemical Reactor Analysis, Wind Energy, Industrial Automation and Control, Hydel Power and Wind Energy, Air Conditioning and Ventilation, Gas Turbines and Jet Propulsion, Safety & System Engineering, Fundamentals and Applications of GPS Technologies, Energy Materials, Waste to Wealth: Microbial intervention.

Lecture Classes are supported by well planned laboratory experiments. Comprehensive viva and Thesis are part of the curriculum.

Areas of Research:

Fundamentals of Energy Sciences: Thermodynamics, Thermochemical and Electrochemical Reactions, Transport phenomena including heat and mass transfer and electrochemical phenomena, Solid-state phenomena including photo, thermal and electrical aspects, Bio-processes, Nano-sciences, Deep ocean processes, Gas and Fluid Dynamics, Nuclear sciences.

Energy Resources and Recovery: Traditional resources - Coal, Petroleum, Natural Gas; Others - Solar, Wind, Geothermal, Wave, Ocean-thermal, Biomass, Hydrogen, Gas from non-conventional sources - Gas Hydrates, Coal beds, Tar sands.

Energy Systems*:* Energy Conversion Systems for Oil, Gas, Coal, Solar, Wind, Biomass, Nuclear, Hydrogen, Ocean Waves, Waste. Power generation, distribution, transmission, access; Transportation Power Systems - IC Engine, Advanced Fuel Technology based combustion ignition, Electric, and Hybrid Systems. Embedded generation systems; Smart grids; Electrochemical systems; New age Fuel systems and process development; Hybrid and electrical systems; Battery & super-capacitors; Energy systems for marine, space and difficult terrains.

Other Aspects of Energy Science & Engineering: Energy Materials; Energy Storage & Transportation; Energy Efficient Devices & Systems; Energy Efficient Design of equipment, buildings and appliances; Sustainable Energy; Conservation; Recycling and Management: Environment and Climate Change; Computational Aspects; Energy Economics; Energy by-product (particularly carbon) recycling, capture, sequestration and storage; Rural and small scale energy research.

RANBIR AND CHITRA GUPTA SCHOOL OF INFRASTRUCTURE DESIGN AND MANAGEMENT

Infrastructure is recognized today as one of the most essential requirements for economic development of any country. Its importance has been increasingly appreciated by policy makers of different countries, including India which envisages a growth rate of nine percent during the eleventh plan period (2007-08 to 2011-12) for which about Rs. Two million Crores need to be invested in key infrastructure sectors during the eleventh plan period. Besides generating the necessary finances, it is very important to build necessary capacity to realize these ambitious targets. Large infrastructure projects require strong, interdisciplinary technical and management skills. It has therefore become imperative that Institutes bestowed with solid foundations in engineering, architecture, and management skills should initiate academic programmes to develop trained manpower in this upcoming area of infrastructure design and management.

Indian Institute of Technology Kharagpur has a vantage position with regard to its existing faculty and academic programmes in the areas of engineering, architecture and management. The institute, with its numerous academic departments, centers and schools with academic programmes in such wide ranging areas such as law, management, architecture and engineering, is in a uniquely advantageous position to contribute to the nation's goal of building world-class infrastructure.

The Ranbir and Chitra Gupta School of infrastructure Design and Management has been started by IIT Kharagpur in the year 2008. The school of Infrastructure Design and Management is the first such school to be set in the IIT system and also in the country.

The mission of the School is to prepare outstanding professionals capable of designing and delivering quality infrastructure projects efficiently and effectively with a comprehensive and fast-track approach. The Department offers M.Tech degree in:

ID Infrastructure Design and Management

The M.Tech programme has been designed with focus on planning, management, and effective delivery of large robust infrastructure projects in areas such as Transportation, Power, Utility Infrastructures and infrastructure facilities. The programme is multi-disciplinary in nature. Faculty members of different departments, schools and centers participate in the teaching and research activities of this programme.

Students joining this programme will have the option of selecting courses in such a way as to gain expertise relevant to the infrastructure sector of their interest.

The programme is currently designed for graduates in architecture, civil engineering, electrical engineering and mechanical engineering.

The programme has five theory subjects and three laboratories as core (compulsory) courses and five elective subjects, to be covered in the first year. The elective subjects are being so grouped (the groups being designated as *verticals*) as to enable the students to select appropriate electives depending on their background and interest.

Course Content: The five core subjects And three laboratory components to be covered by all the students are Project Engineering and management, Financing Infrastructure Projects, Infrastructure Regulatory Issues, Quantitative Methods

for Decision Making, Environmental Impact Assessment, Simulation Laboratory, Virtual Reality Laboratory, Project Management laboratory.

The **elective courses** have been grouped under the following four vertical groups:

Transportation: Urban Transportation Systems Planning, Airport Planning and Design, Bridges and Tunnels Engineering, Analysis and Design of Pavements, Traffic Engineering, Analysis and Evaluation of Transportation systems, Highway Construction Practice, Planning, Operation and Management of Transportation Facilities, Sea and Inland Port Infrastructure.

Public Utilities: Water Supply Systems, Waste Water Management, Solid Waste Management, Air Quality Management, Environmental Sanitation, Hazardous Waste Management,

Facilities Infrastructure: Transportation Planning and Traffic Engineering, Housing Infrastructure, Facility Programming and Specialized Building Design, Building Management Systems, Regional Infrastructure Development, Environmental Planning, Remote Sensing and DIS in Planning.

Power Systems: Thermal, Hydel and Nuclear Power Generation, Power Infrastructure : Generation, Transmission and Distribution, Internal Combustion Engine, Power Transmission Systems, Non-conventional Electrical Energy Systems, High Voltage and Insulation Engineering, Power Infrastructure : Economics, Management and Environment, Power System Planning and Reliability, Air-conditioning and Ventilation, Power Systems Transients and Protection, Opto-electronics based instrumentation, AI applications to Power Systems.

Areas of Research: Project management, infrastructure financing, Infrastructure planning and systems management, housing and community planning, Planning and management of rural an urban transport systems, pavement and airport management systems, environmental impact assessment, system analysis and water quality management, process modification and pollution minimization, environmental life cycle assessment, power system analysis and operation, non-conventional energy sources, power system planning and reliability.

SCHOOL OF MEDICAL SCIENCE AND TECHNOLOGY

Innovations in Technology have led to spectacular advancements in modern medicine. To meet the challenges, there is a need to bridge the two disciplines by fusion of medical science with technology.

With this philosophy in mind, Indian Institute of Technology, Kharagpur established the School of Medical Science and Technology, the first of its kind in India where the physicians are trained in Technology in the well tested IIT style. The School of Medical Science and Technology also has a mandate to further research and development on diverse aspects of technology as applied to medicine.

Apart from the existing three years interdisciplinary **Master's Program in Medical Science and Technology (MMST**) for medical doctors and MS and PhD programs in Medical Science and Technology, the school is introducing a two year **'M.Tech in Medical Imaging and Informatics'** course.

The school has collaborations with many institutions and centres of excellence throughout our globe. Some of these are: Brain Science Institute, RIKEN BSI, Japan; TU Munich, Germany; All India Institute of Medical Sciences, New Delhi; Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow; IPGMER, Kolkata; Sree Chitra Tirunal Institute of Medical Science and Technology, Trivandrum; Tata Medical Center, Kolkata.

The M Tech students will be exposed to all kinds of Imaging Modalities - Microscopic and Macroscopic and advanced Image Processing Systems, Biomedical Signal processing, Biomedical Instrumentation and Embedded systems.
The students have access to some of the finest infrastructure available in the country for interdisciplinary research and development activities, some of which are:

Automated ECG and 12-channel EEG; PC based Spiro meter, Electronic stethoscope and Phonocardiogram; DSP trainer kit with FPGA; Electro-Acoustic Transducers; 64-channel biopotentials recorder, Ultrasonogram and Color Doppler, Ultra sound scanner, Digital Radiography, Analog X-Ray Machine; OCT, Live cell imaging and Apotome, Stereo-zoom microscope.

DNA finger printing; Southern and Western blotting apparatus; PCR; Dark/cold room/radio-isotope facilities; Software for protein analysis (RASMOL, RASWIN); ELISA reader, Scintillation counter; MALDI-ToF Mass Spectrometry; Fluorescence Activated Cell sorter, AFM, 2-D Gel.

Surface tension and contact angle measuring device; Universal Testing Machine; FT-IR and UV spectrophotometer, 3-D Laser-scanner, Electro-spinning, Rheometer, CMC Machine, PCR.

Server and terminals; Video conferencing unit; Telemedicine software supporting live medical tele-consultation, PACS.

The M.Tech students have job opportunities in well known corporate houses in the field of medical imaging and instrumentations, like GE, Siemens, Wipro, Texas instruments, Philips research lab etc. They have also very good opportunity in carrying out research in the frontiers of Biomedical and Imaging sciences in India and abroad.

The Department offers MTech degree in:

SM Medical Imaging and Informatics

Course Content:

Core Subject: Digital Image Processing and Applications, Basic Human Anatomy, Physiology, and Pathology, Image Processing Laboratory, Biomedical Instrumentation, Molecular Imaging, Medical Informatics, Pattern recognition and machine intelligence in medicine, Medical Imaging Laboratory, Telemedicine Laboratory Comprehensive Viva-Voce, Seminar-I, Seminar-II.

Elective Subjects: MEMS and Biosensors, Biostatistics, Physics and Instrumentation of Medical Imaging, Digital Signal Processing, Fuzzy Sets & Applications, Telemedicine, Nuclear Imaging, Biomedical System Engineering & Automation, Pathological Image Processing, Computer Vision, Internet & Web based Technologies.

Areas of Research: Medical Imaging and Image Analysis; Rehabilitation Engineering; Biomedical sensors and Instrumentation; Healthcare Information Management System; Preventive and Promotive Healthcare System; Bio-markers and their application in Oncology; Tissue Engineering; Biomaterials; Nano-technology and MEMS in Medicine; Prosthesis, Orthosis and Implant Design. Reproductive Biology.

SCHOOL OF WATER RESOURCES

The School of Water Resources at IIT Kharagpur is one of the pioneer centres for education, research, training and consulting solutions in water quality and quantity management. It aims at providing integrated and interdisciplinary approaches involving hydrological, environmental, chemical, biophysical, economic, institutional, and policy-planning aspects, to solve the ever-growing water-related challenges in domestic, agriculture and industry sectors. It aims to develop knowledge, insight and engineering skills required to design, implement and evaluate water management policies and strategies. It also intends to establish a participatory relationship with industries, Centre and State governments, and academic institutes in order to produce skilled water engineers and managers.

The school offers interdisciplinary M.Tech. (Water Engineering and Management) and Ph.D. programmes to the students, professionals and researchers from the disciplines of Civil Engineering, Agricultural Engineering, Chemical Engineering, Biotech Engineering (only for PhD) and Mining Engineering (only for PhD).

The school is involved in interdisciplinary research with the focused thrust areas of urban water management (Water distribution, Wastewater treatment, disposal and recycling, urban flooding and its management); Water economics and pricing; Surface water – groundwater – seawater interaction; Impact of anthropogenic activities and possible climate change on water resources; Water quality management at river basin and urban scales; Hydroinformatics in urban water supply, waste water disposal and real-time flood management.

The details of the syllabus and curriculum are available on institute website.

WM Water Engineering and Management

Programme Structure: The programme consists of foundation, specialization and integration phases. The foundation phase provides latest insights, context, and concepts in integrated water and environment management issues. In the specialization phase, the students choose to make in-depth study of water quantity and quality management in rural and urban areas or in basin scale. In the integration phase, the students are challenged to bring together and apply their cumulative learning process in the form of an M.Tech. thesis.

Core Courses: Environmental Hydrology and Hydraulics; Sectoral Water Demand and Distribution; Planning and Design of Water Engineering Facilities; Fate and Transport of Contaminant in Water; River Basin Planning and Management; Geo-informatics Laboratory; Water Engineering Laboratory.

Electives: Aquatic Ecology and Microbiology; Climate Impact on Water Resources; Geogenic-water Pollution and Control; Disaster Management; Wastewater Management; Environmental Chemistry and Microbiology; Free Surface Flow; Geohydraulics; Advanced Groundwater Hydrology; Remote sensing for Land and Water Resources; Industrial Pollution Control; Advanced Mathematical Techniques in Chemical Engineering; Statistical Technique and Computer Programming; Environmental Control in Mines; Rescue and Disaster Management; Water Economics and Governance; Flood Assessment and Management; Vadose Zone Hydrology; Advanced Water and Wastewater Treatment; Industrial Water Pollution Control; Environmental Statistics and Experimental Design; Advanced Computational Hydraulics; Environmental Impact Assessment; Environmental Sanitation; Water Resources System Analysis; On-farm Water Management; Modeling and Simulation for Agricultural Water Management; Environmental Pollution and Stress; Non-point Source Pollution and Management; Novel Separation Processes; Environmental Hydrogeology; Land System Studies; Probability and Stochastic Processes.

***Areas of Research*:** Integrated water resources planning and management; River basin planning and management (considering the aspects of flood, drought or contaminant); Water and wastewater treatment; Surface and groundwater quality control; Conjunctive use of surface water and groundwater; Urban, rural and industrial water supply and distribution systems; Remote sensing and GIS application in water resources; Modelling of fate and transport of contaminants; Water governance and policy issues; Environmental impact assessment; Surface water and groundwater interaction; Water resources system analysis; Irrigation and drainage system planning, and Climate impact on water and environment.

GENERAL INFORMATION FOR APPLICANTS

Admission to the JointM.Tech/MCP–Ph.D programme of the Institute is open to all **Indian Nationals** under categories:

i. Regular applicants with assistantship (through GATE)
ii. B. Tech students graduated / graduating from IITs having a CGPA 8.00 or above (out of 10)
iii. Sponsored applicants
iv. NET qualified candidates with fellowship ONLY for MCP Programme

The admission will be based on either GATE Score only or on GATE Score (70 % weightage) and a personal interview (30 % weightage). Personal interview will be conducted to test the following: (a) Motivation and aptitude for the Programme (b) Suitability for the department/centre (c) Skills in basic science, engineering, and relevant areas. Personal interview will be conducted at IIT Kharagpur. The JMP website is to be referred for detailed selection criteria for individual programmes and specializations, new programs etc.

Important Note: (i) For specializations where admission is based on both GATE score and interview, a candidate who fails to appear for the personal interview will not be considered for admission for that specialization.

(ii) Based on the availability of seats after the final round of allotment, spot admission may be conducted to fill the vacant seats. The modalities for spot admission will be announced later.

Eligibility and Assistantship for Regular Applicants (through GATE)

- Applicants under all categories must possess a Bachelor's degree in Engineering/ Technology/ Architecture or a Masters degree in Science/Arts or qualifications obtained through examinations conducted by professional societies recognized by UPSC/AICTE, e.g. AMIE.
- Applicants must qualify in a GATE paper appropriate to the discipline of their qualifying degree if a GATE paper is available in such a discipline. Only for those disciplines where there is no relevant GATE paper, XE/XL paper of the GATE examination is applicable. NET qualified applicants are also eligible for admission to MCP.
- Candidates seeking admission to Joint M.Tech/MCP-Ph.D Programme of the Institute should have the following academic qualification.
  - For institutes a) awarding degree based on aggregate marks secured in all years of the qualifying degree OR b) awarding degree based on aggregate marks secured in the final two semesters or final year of the qualifying degree:
    - GE/OBC: Minimum of 60% marks (OR a CGPA of 6.5 on a 10 point scale)
    - SC/ST/PwD: Minimum of 55% marks (OR a CGPA of 6.0 on a 10 point scale)
  - For both the above cases, If the CGPA is on a different scale than 10.0, the eligibility of the candidates will be calculated corresponding to the equivalence stated above.
- Admission to reserved category candidates will be as per Government of India rules.
- Applicants must be in good health. In case of any discrepancy found in the certificate of medical fitness to be submitted during registration, the opinion of the Institute Medical Officer will be final.
- Persons with Physical Disability (PwD) seeking admission to various postgraduate programmes are to appear before a medical board on or before **October 31, 2016** at IIT Kharagpur. The decision of the Medical Board is final and becomes a binding to the candidate.
- **Selection of applicants whose results in the qualifying degree examination are yet to be declared will be provisional, subject to the condition that all parts of the examination must be completed in all respects before the date of joining the Institute and the marks sheet/certificate as evidence of passing the qualifying examination to be submitted latest by October 31, 2016.**
- B. Tech students graduated / graduating from IITs having a CGPA 8.00 or above (out of 10) are eligible for direct admission without having to appear in either GATE or personal interview. Please use relevant link on the website to apply.

- Students in the two-year M.Tech/MCP programme receive an assistantship of Rs. 12400/- per month. Students selected for the PhD programme will receive an assistantship of Rs. 16400/- per month in the second year of their M.Tech./MCP study, and Rs. 25000/- per month after enrolment for PhD. Programme.
- An applicant admitted to a post-graduate programme with assistantship will not be eligible for admission with assistantship in any other programme at this institute or any other Institution on the basis of the same GATE scorecard.

Eligibility for NET Qualified Applicants

1. NET Qualified candidates with fellowship having M.A or M.Sc Degree in Economics, Sociology, or Geography and having studied mathematics/statistics at the higher secondary level or at the graduate level are eligible to be considered for selection to MCP/Ph.D Programme.
2. For applicant with Master Degree in Science subject should have 60% or above (55% marks or equivalent CGPA for Master's degree holders in Arts or Social Science subjects).

Application Fee

The application fee is **Rs. 500/-** for GE/OBC Male/Transgender Candidates and **Rs. 250/-** for all Female or PwD/SC/ST Candidates. The application fee is non-refundable.

Fee payment has to be made **online only** and all the necessary qualifying certificates and documents have to be **uploaded online** at the time of submitting the application. **Hardcopy of the application and documents are not required.**

Candidates who receive offers from the institute (either based on GATE score only or GATE score + interview) have to pay a seat booking fees Rs. 30000/- to block their seat.

If a candidate after accepting the offer wishes to withdraw from the admission process, Rs. 29000/- will be refunded after deducting Rs. 1000/- towards application processing fee, provided the withdrawal is made on or before the specified due date. However, if a candidate withdraws the offer after the specified due date, the candidate will forfeit the entire seat booking fees of Rs. 30,000/- and NO refund will be made.

Choice of Courses

To help the candidates for giving their choice of courses, the following eight tables are given

Table 1	**GATE Main Paper**
Table 2	**GATE XE Sections (Engineering Sciences) Paper**
Table 3	**GATE XL Sections (Life Sciences) Paper**
Table 4	**Qualifying degree and their respective codes**
Table 5	**Qualifying discipline and their code**
Table 6	**Specialisations offered and mode of selection**
Table 7	**Eligibility for admission to different postgraduate programmes based on GATE Paper, applicant's academic background, seat distribution and mode of selection for the year 2016-17**
Table 8	**Paper wise GATE Score cut-off for the Joint M.Tech/MCP-Ph.D Programme 2015-16 at the end of 3rd round.**

- **Applicants are advised to give their choices carefully for different courses after reading the information given in Tables 1 to 7. Choices of courses are to be given in order of preference.**
- If the course to which an applicant is offered admission does not eventually run for any reason, the applicant will be offered admission to some other suitable course depending upon his/her GATE score, interview marks (if applicable) and options entered in the application. Alternatively, the applicant is free to withdraw from the programme in which case the fees and deposits paid by him/her will be refunded.
- As a guide to Regular applicants, the cut-off GATE marks for personal interview to the various courses offered last year are given in Table 8. The cut-off marks, however, differ from year to year and, therefore, ***Table 8 is only for information and will have no direct relevance for the session 2016-2017.***

How to Apply (Regular Applicants through GATE Score)

Application for Joint M.Tech/MCP-Ph.D programme is to be submitted only by an ONLINE process by accessing the website **http://gate.iitkgp.ac.in/jmp/** from **21st March 2016 to 15th April 2016**.

The application fee is Rs. 500/- for GE/OBC Male/Transgender candidates and Rs. 250/- for all Female or PwD/SC/ST candidates. The application fee is non-refundable.

Fee payment has to be made **online only** and all the necessary qualifying certificates and documents such as caste certificates, PwD certificates etc have to be **uploaded online** at the time of submitting the application. **Hardcopy of the application and documents are not required.**

The applicants are however advised to keep a copy of the completed application form for their record.

Important Dates

Calendar of events

Sl. No.	Action	Date
1	Commencement of Online Application Form submission	21st March 2016 (Monday)
2	Website closure for submission of Online Application Form	15th April 2016 (Friday)
3	Issue of call letters to Interview candidates	To be announced later
4	Release of 1st offer to direct admission candidates	
5	Last date of acceptance of 1st offer	
6	Window for interviews	
7	Release of 2nd offer including interviewed candidates	
8	Last date of acceptance of 2nd offer	
9	Release of 3rd offer	
10	Last date of acceptance of 3rd offer	
12	Release of 4th offer	
13	Last date of acceptance of 4th offer	
14	Last date for release of final offers	
15	Date of spot admission (if required)	
16	Admission to PG programmes (as per academic calendar)	14th July 2016 (Thursday)

Table 1: GATE Main Paper

GATE Paper	Code
Aerospace Engineering	AE
Agricultural Engineering	AG
Architecture and Planning	AR
Biotechnology	BT
Civil Engineering	CE
Chemical Engineering	CH
Computer Science and Information Technology	CS
Chemistry	CY
Ecology and Evolution	EY
Electronics and Communication Engineering	EC
Electrical Engineering	EE
Geology and Geophysics	GG
Instrumentation Engineering	IN
Mathematics	MA
Mechanical Engineering	ME
Mining Engineering	MN
Metallurgical Engineering	MT
Petroleum Engineering	PE
Physics	PH
Production and Industrial Engineering	PI
Textile Engineering and Fibre Science	TF

Table 2: GATE XE Sections (Engineering Sciences) Paper

XE Sections	Code
Fluid Mechanics	B
Materials Science	C
Solid Mechanics	D
Thermodynamics	E
Polymer Science and Engineering	F
Food Technology	G

Table 3: GATE XL Sections (Life Sciences) Paper

XL Sections	Code
Biochemistry	I
Botany	J
Microbiology	K
Zoology	L
Food Technology	M

Table 4: Qualifying degree and their respective codes

Qualifying Degree	Qualifying Degree Code
B.E./B.Tech. or equivalent	**A**
B. Arch./B. Plan or equivalent	**B**
M. Sc. with Mathematics at +2 level	**C**
M. Sc. with Mathematics both at +2 and B. Sc. level	**D**
M. Sc. with or without Mathematics background	**E**
MCA with Mathematics both at +2 and B. Sc. level	**F**
NET qualified candidates for MCP	**G**

Table 5: Qualifying discipline and their code

Qualifying Discipline	Code	Qualifying Discipline	Code
Atmospheric Science	AC	Energy Studies and Petroleum	EP
Automotive Design Engineering	AD	Electronics Control System Engineering	ER
Aerospace Engineering	AE	Earth Sciences/Geological Sciences	ES
Agricultural Engineering	AG	Electronics and Tele Communication Engineering	ET
Agricultural and Irrigation Engineering	AI	Exploration Geophysics/Marine Geophysics	EX
Applied Electronics and Instrumentation	AL	Energy Technology	EY
Aircraft Maintenance Engineering	AN	Environmental Engineering	EZ
Applied Electronics Engineering	AP	Food Engineering and Technology	FO
Architecture and Planning	AR	Food Processing Engineering	FP
Aeronautical Engineering	AS	Fire and Safety Engineering	FS
Automobile Engineering	AT	Food Technology	FT
Agricultural Science	AU	Genetic Engineering	GE
Avionics Engineering	AV	Geology/Geophysics/Applied Geology/Applied Geophysics	GG
Bio Chemistry	BC	Geo Sciences Engineering	GS
Bio Informatics	BI	Industrial Chemistry	IC
Bio Medical Engineering	BM	Industrial Design	ID
Bio Physics	BP	Industrial Engineering	IE
Bio Science	BS	Information and Communication Technology	IF
Bio Technology	BT	Industrial Engineering and Management	IM
Computer Applications	CA	Instrumentation Engineering	IN
Chemical and Bio Engg,	CB	Industrial and Production Engineering	IP
Chemical and Electrochemical Engineering	CD	Instrumentation and Control Engineering	IR
Civil Engineering	CE	Information Science and Engineering	IS
Computer Science and Information Technology	CF	Information Technology	IT
Ceramic and Glass Technology	CG	Life Sciences (Botany)	LB
Chemical Engineering	CH	Life Sciences	LS
Civil Infrastructure Engineering	CI	Life Sciences (Zoology)	LZ
Chemical Science and Technology	CJ	Mathematics/Applied Mathematics	MA
Computer Science and Software Engineering	CK	Manufacturing and Management	MB
Computer and Communication Engineering	CM	Manufacturing Engineering	MC
Civil Engineering and Planning	CP	Mechanical Engineering	ME
Computer Science	CQ	Manufacturing Technology	MF
Computer Science and Electronic Engg.	CR	Mechanical and Industrial Engineering	MG
Computer Science and Engineering	CS	Metallurgy	MH
Computer Engineering	CU	Materials Science and Metal Engineering	MI
Civil and Transportation Engineering	CV	Man Made Fibre Technology	MJ
Chemistry/Applied Chemistry	CY	Mathematics and Computing	MK
Design and Manufacturing	DM	Mechanical and Automation Engineering	ML
Dairy Engineering/Technology	DT	Material and Metallurgical Engineering	MM
Electronics and Communication Engineering	EC	Mining Engineering	MN
Electronics Engineering - Design and Manufacturing	ED	Mechanical Technology	MO
Electrical Engineering	EE	Mechatronics Engineering	MP
Energy Engineering	EF	Medical Electronics	MQ
Electrical and Electronics Engineering	EG	Microbiology	MR
Engineering Physics	EH	Material Science and Engineering	MS
Electronics and Instrumentation Engineering	EI	Metallurgical Engineering	MT
Electrical and Computer Engineering	EL	Marine Electrical and Electronics Engineering	MV
Electronics and Media Technology	EM	Mining Machinery	MW
Electronics Engineering	EN	Missile Technology	MX
Electronic Instrumentation and Control	EO	Mobile Computing	MY

Qualifying Discipline	Code	Qualifying Discipline	Code
Naval Architecture	NA	Production Engineering/Production Engg. and Management	PR
Naval Architecture and Offshore Engineering	NC	Power System Engineering	PS
Naval Architecture and Ship Building	ND	Power Engineering	PW
Naval Architecture and Ocean Engineering	NO	Radio Physics	RA
Nuclear Power Technology	NP	Robotics Engineering	RB
Nuclear Science and Engineering	NS	Robotics and Automation	RC
Nanotechnology	NT	Rubber and Plastic Technology Engineering	RP
Ocean Engineering	OE	Rubber Technology	RT
Optics and Optoelectronics	OP	Safety and Fire Engineering	SA
Petroleum Engineering	PE	Software Engineering	SD
Physics/Applied Physics	PH	Solid State Physics	SF
Production and Industrial Engineering	PI	Space Technology	SG
Plastic Technology	PL	Textile Chemistry	TC
Plastic and Polymer Engineering	PM	Textile Engineering/Fiber Science Engineering	TF
Polymer Engineering	PN	Telecommunication Engineering	TN
Polymer Science and Chemical Technology	PO	Water Resources Engineering	WA
Polymer Technology	PP	Any discipline of Engineering not mentioned above	ZA*
Power Electronics	PQ	Any discipline of Science not mentioned above	ZB*

* The JMP 2016 application of all those candidates choosing ZA or ZB, will be considered for admission only when the concerned department accepts the actual qualifying discipline of the candidate as suitable for the chosen specialization.

Table 6: Specialisations offered and mode of selection

Department/Centre/School	Specialisation	Mode of selection*
Advanced Technology Development Centre	Embedded Systems and Software	Interview
Aerospace Engineering	Aerospace Engineering	Direct
Agricultural and Food Engineering	Farm Machinery and Power	Direct
	Land and Water Resources Engineering	Direct
	Food Process Engineering	Direct
	Agricultural Biotechnology	Direct
	Aquacultural Engineering	Direct
	Agricultural Systems and Management	Direct
Architecture and Regional Planning	City Planning	Direct
Biotechnology	Biotechnology and Biochemical Engineering	Direct
Chemical Engineering	Chemical Engineering	Direct
Civil Engineering	Hydraulic and Water Resources Engineering	Direct
	Transportation Engineering	Direct
	Environmental Engineering and Management	Direct
	Geotechnical Engineering	Direct
	Structural Engineering	Direct
	Railway Engineering	Direct
Computer Science and Engineering	Computer Science and Engineering	Direct
Cryogenic Engineering	Cryogenic Engineering	Direct
Educational Technology	Multimedia Information Processing	Direct
Electronics and Electrical Communication Engineering	Microelectronics and VLSI Design	Direct
	RF and Microwave Engineering	Direct
	Telecommunication Systems Engineering	Direct
	Visual Information and Embedded Systems Engineering	Direct
Electrical Engineering	Machine Drives and Power Electronics	Direct
	Control System Engineering	Direct
	Power and Energy Systems	Direct
	Instrumentation and Signal Processing	Direct
Geology and Geophysics	Exploration Geosciences	Direct
Industrial and Systems Engineering	Industrial Engineering and Management	Direct
Infrastructure Design and Management	Infrastructure Design and Management	Direct

Department/Centre/School	Specialisation	Mode of selection*
Mathematics	Computer Science and Data Processing	Direct
Materials Science	Materials Science and Engineering	Direct
Mechanical Engineering	Manufacturing Science and Engineering	Direct
	Thermal Science and Engineering	Direct
	Mechanical Systems Design	Direct
Medical Science and Technology	Medical Imaging and Informatics	Interview
Metallurgical and Materials Engineering	Metallurgical and Materials Engineering	Direct
Mining Engineering	Mining Engineering	Direct
Ocean Engineering and Naval Architecture	Ocean Engineering and Naval Architecture	Direct
Ocean, Rivers, Atmosphere and Land Sciences	Earth System Science and Technology	Direct
Physics	Solid State Technology	Direct
Reliability Engineering	Reliability Engineering	Direct
Rubber Technology	Rubber Technology	Interview
School of Energy Science & Engineering	Energy Science and Engineering	Direct
School of Water Resources	Water Engineering and Management	Direct

* “Direct” means Admission is based on GATE SCORE only.

“Interview” means Admission is based on GATE Score (70 % weightage) and Interview (30 % weightage).

Table 7: Eligibility for admission to different postgraduate programmes based on GATE Paper, applicant's academic background, seat distribution and mode of selection for the year 2016-17

Course Code	Specialization	Major		Minor		Total Seats	Mode of Admission		Qualifying Degree	Qualifying Discipline
		Paper	Seats	Paper	Seats		GATE Score only	GATE Score + interview		
AE	Aerospace Engineering	AE	17	ME,CE,XE-E,XE-D, XE-B	7	24	Yes		A	AE,CE,ME
AG1	Farm Machinery and Power	AG	17	ME	2	19	Yes		A	AG, ME
AG2	Land and Water Resources Engineering	AG	16	CE	2	18	Yes		A	AG, CE
AG3	Food Process Engineering	AG	23	CH,ME,XE-G	7	30	Yes		A	AG,CH,DT,FT,ME
AG4	Agricultural Biotechnology	BT, XL-L, XL-M	10	XL-I,XL-J,XL-K	10	20	Yes		A,C,D,E	AU, BC, BT, GE, LB, MR
AG5	Aquacultural Engineering	AG	10	CH,CE,XE-B, XE-D	8	18	Yes		A	AG, CH, CE, NA
AG6	Agricultural Systems and Management	AG	15	XL-J,XL-I,XL-K	4	19	Yes		A,C,D	AG, AU, BC, LB, MR
AR	City Planning	AR	42			42	Yes		A,B,G	AR, CE
AT	Embedded Controls and Software	CS, EC, EE, IN	12			12		Yes	A,C,D	CS, EE, EG, EO, EC, EI, IN
BT	Biotechnology and Biochemical Engg	BT	18	XL-I,XL-K,CH	6	24	Yes		A,C,D	BC, BI, BP, BS, BT, LS, LB, LZ, MR
CE1	Hydraulic and Water Resources Engg	CE	20			20	Yes		A	CE
CE2	Transportation Engineering	CE	20			20	Yes		A	CE
CE3	Environmental Engg, and Management	CE	16	CH	2	18	Yes		A	CH, CE, EZ
CE4	Geotechnical Engineering	CE	18			18	Yes		A	CE
CE5	Structural Engineering	CE	20			20	Yes		A	CE
CH	Chemical Engineering	CH	75			75	Yes		A	CH
CL	Earth System Science and Technology	PH,MA, GG,CE,AG,AE,ME	21	XE-B,XE-E	10	31	Yes		A,D	AE, AG, AI, AC, CE, ES, EZ, GG, MA, ME, NA, PH
CR	Cryogenic Engineering	AG,AE, XE-B,XE-C,CH, XE-E,EE,ME,PH,IN	21			21	Yes		A,D	AE, AG, AL, CH, CJ, EE, EG, EO, EI, EF, FO, FP, FT, MS, ME, PH, SF, SG
CS	Computer Science and Engineering	CS	67			67	Yes		A,D,F	AL, AP, CA, CU, CQ, CR, CF, CS, CK, CM, EL, EE, EG, EO, EN, EC, EI, ET, ER, ED, IS, IT, IF, IR, IN, MA, MK, SD, TN
EC2	Microelectronics and VLSI Design	EC	29			29	Yes		A	EC, EE, ET
EC3	RF and Microwave Engineering	EC	28			28	Yes		A	EC, EE, ET
EC4	Telecommunication Systems Engg,	EC	28			28	Yes		A	EC, EE, ET
EC5	Visual Information and Embedded Systems Engineering	EC	28			28	Yes		A	EC, EE, ET

Course Code	Specialization	Major		Minor		Total Seats	Mode of Admission		Qualifying Degree	Qualifying Discipline
		Paper	Seats	Paper	Seats		GATE Score only	GATE Score + interview		
EE1	Machine Drives and Power Electronics	EE	18			18	Yes		A	EE, EG, EF, PQ, PW, PS
EE2	Control System Engineering	EE	10	EC, IN	8	18	Yes		A	AL, AP, EL, EE, EG, EO, EN, EC, EI, ET, ER, IR, IN, RA, RB, RC
EE3	Power and Energy Systems	EE	18			18	Yes		A	EE, EG, EF, PQ, PW, PS
EE4	Instrumentation and Signal Processing	IN	9	EC, EE	9	18	Yes		A	AL, AP, EL, EE, EG, EO, EN, EC, EI, ET, ER, IR, IN, RA, RB, RC
ET	Multimedia Information Processing	CS, EC, EE, IN,MA,PH	15			15	Yes		A,D,F	CQ, CR, CF, CS, CK, CM, EL, EE, EG, EN, EC, EI, EM, ET, IT, IF, IN, MA, MK, PH
GG1	Exploration Geosciences	GG	24			24	Yes		C,D	ES,EX,GG
ID	Infrastructure Design and management	AR, CE	20	ME, EE	11	31	Yes		A,B	AR, CE, EE, ME
IM	Industrial Engineering & Management	ME,PI	15	AG,CE,CH,CS,EC,EE, MN	10	25	Yes		A	AG, CH, CE, CS, EE, EC, IP, IE, IM, IT, MC, MF, MG, ME, MN, PI, PR
MA	Computer Science and Data Processing	MA	25	EE,EC,PH	9	34	Yes		A,C, D	EE, EC, MA, PH
ME1	Manufacturing Science and Engg,	ME	20	PI,MT	6	26	Yes		A	MF, ME, MT, PI, PR
ME2	Thermal Science and Engineering	ME	33			33	Yes		A	ME
ME3	Mechanical Systems Design	ME	38	AE	6	44	Yes		A	AE, ME
MN	Mining Engineering	MN	16	CE	6	22	Yes		A, D	CE, CV, ES, GS, MN, MW, PE
MS	Materials Science and Engineering	CY,PH	15	XE-C,XE-F	14	29	Yes		A,C,D	CH, CY, MS, PH, PL, PO, RT, SF
MT	Metallurgical and Materials Engineering	MT	48	XE-C	6	54	Yes		A	CH, CD, IE, MM, MS, MI, MG, ME, MT, MH, PH
OE	Ocean Engineering and Naval Architecture	ME,CE,AE	10	XE-B,XE-D,XE-E	10	20	Yes		A	AE, CE, MC, MF, NA, NC, ND, NO, OE, PI, PR
RR	Railway Engineering	CE	5	ME, EE	5	10	Yes		A	CE, EE, ME
RE	Reliability Engineering	AE,CE,CH,ME,MN,PI, CS, EE,IN,EC	18	XE-C	2	20	Yes		A	AS, AE, AN, AL, AP, AT, AD, AV, CE, CI, CU, CQ, CR, CF, CS, CK, CM, DM, EL, EE, EG, EO, EN, EC, EI, ET, ER, ED, FS, IP, ID, IE, IM, IT, IF, IR, IN, MB, MC, MF, MV, ML, MG, ME, MO, MP, MQ, MT, MN, MW, MX, MY, NO, NP, NS, OP, PQ, PW, PS, PI, PR, SA, SD, SG, TN
RT	Rubber Technology	XE-C,XE-E,XE-F,CY	18	CH, ME,PI,TF	6	24		Yes	A, C, D	CH, CJ, CY, IC, MJ, PL, PM, PN, PO, PP, RT, RP, TC, TF
PH1	Solid State Technology	PH	20	XE-C	5	25	Yes		A,D	EH, MS, NT, OP, PH, SF
SM	Medical Imaging and Informatics	IN,EC,EE	10	CS,BT,PH,MA	5	15		Yes	A,D	BM, BP, BT, CS, EE, EC, IT, IN, MA, PH
ES	Energy Science and Engineering	EE, CH, ME	15			15	Yes		A	CB, CH, CJ, CD, EL, EE, EG, EO, EF, EP, EY, ML, MG, ME, MO, PQ, PW, PS
WM	Water Management	AG	8	CE,CH	4	12	Yes		A	AG, AI, CG, CB, CH, CJ, CD, CE, CP, CI, CV, EZ, WA

Table 8: Paper wise GATE Score cut-off for the Joint M.Tech/MCP-Ph.D Programme 2015-16 at the end of 3rd round.

Course	MAJOR				MINOR				PwD
	GE	OB	SC	ST	GE	OB	SC	ST	
AE	682.00	610.00	474.00	648.00	824.00	780.00	654.00	472.00	472.00
AG1	763.00	661.00	338.00	721.00	812.00	788.00	-	-	479.00
AG2	643.00	470.00	260.00	518.00	-	639.00	-	-	359.00
AG3	661.00	476.00	332.00	565.00	758.00	-	614.00	392.00	248.00
AG4	716.00	590.00	665.00	480.00	599.00	552.00	228.00	307.00	-
AG5	458.00	434.00	212.00	350.00	564.00	487.00	362.00	-	-
AG6	470.00	410.00	239.00	272.00	605.00	-	-	-	-
AR*	640.30	519.70	449.30	498.30	-	-	-	-	506.00
AT*	815.50	765.60	652.30	-	-	-	-	-	-
BT*	724.10	611.20	483.10	576.90	688.30	557.10	243.50	-	-
CE1	752.00	708.00	524.00	423.00	-	-	-	-	525.00
CE2	785.00	759.00	540.00	449.00	-	-	-	-	677.00
CE3	767.00	719.00	522.00	435.00	603.00	483.00	-	-	-
CE4	794.00	745.00	544.00	441.00	-	-	-	-	-
CE5	841.00	798.00	561.00	449.00	-	-	-	-	505.00
CH	572.00	509.00	441.00	358.00	-	-	-	-	211.00
CL	721.00	642.00	513.00	329.00	400.00	-	-	-	301.00
CR	805.00	767.00	588.00	443.00	-	-	-	-	411.00
CS	828.00	742.00	613.00	471.00	-	-	-	-	537.00
EC2	865.00	809.00	645.00	584.00	-	-	-	-	628.00
EC3	823.00	745.00	580.00	482.00	-	-	-	-	-
EC4	847.00	773.00	593.00	500.00	-	-	-	-	606.00
EC5	839.00	773.00	571.00	477.00	-	-	-	-	553.00
EE1	824.00	768.00	588.00	550.00	-	-	-	-	426.00
EE2	796.00	737.00	667.00	546.00	824.00	763.00	611.00	-	535.00
EE3	796.00	745.00	581.00	569.00	-	-	-	-	-
EE4	821.00	750.00	566.00	616.00	824.00	786.00	597.00	-	505.00
ES	798.00	772.00	639.00	479.00	-	-	-	-	421.00
ET	801.00	738.00	563.00	474.00	-	-	-	-	-
GG1	473.00	370.00	221.00	174.00	-	-	-	-	-
ID	730.00	682.00	583.00	465.00	798.00	761.00	617.00	461.00	445.00
IM	821.00	801.00	647.00	454.00	797.00	736.00	554.00	522.00	486.00
IT	812.00	732.00	593.00	454.00	-	-	-	-	531.00
MA	492.00	392.00	305.00	-	828.00	729.00	550.00	456.00	430.00
ME1	823.00	795.00	649.00	486.00	827.00	788.00	622.00	-	458.00
ME2	830.00	798.00	658.00	520.00	-	-	-	-	693.00
ME3	840.00	806.00	650.00	510.00	678.00	600.00	444.00	-	500.00
MN	625.00	475.00	431.00	536.00	809.00	782.00	617.00	444.00	-
MS	563.00	468.00	525.00	304.00	621.00	617.00	237.00	242.00	209.00
MT	569.00	465.00	298.00	243.00	448.00	411.00	-	-	-
OE	802.00	750.00	611.00	450.00	444.00	-	316.00	273.00	-
PH1	508.00	445.00	422.00	301.00	-	-	-	-	301.00
RE	784.00	736.00	554.00	441.00	427.00	-	-	-	-
RR	746.00	700.00	535.00	-	819.00	763.00	-	501.00	-
RT*	750.20	597.30	522.90	-	671.90	570.80	-	-	-
SM*	765.40	648.20	577.70	447.40	719.20	619.30	587.70	-	-
WM	595.00	452.00	278.00	248.00	703.00	677.00	513.00	-	-

*** Offer made based on GATE score (70% weightage) and Interview (30% weightage)**
For all other specializations offer made based on GATE score only
- means there is no vacancy or no candidate available

Important Note: The paper wise offer made to last GATE qualified candidates/cut-offs for calling interview vary from year to year and the figures given in the table should be used only as rough guidelines. No enquiry regarding the cut-off GATE scores will be entertained.

POST ADMISSION INFORMATION

Commencement of the Programme

1. Those who are offered admission are required to report to IIT Kharagpur on the date of registration, which is tentatively **July 14, 2016.**
2. A copy of the qualifying degree and marks sheet is required during registration. In case the result of the final degree examination is not declared, at least all parts of the examination must be completed before the date of joining. In such a case, they will have to produce at the time of joining a course completion certificate from the Principal of the institution where the candidate studied.
3. Admission is also subject to the production of a medical fitness certificate and verification of academic transcripts at the time of registration or at any time during studies.
4. Those who are in employment, must resign and produce the acceptance of resignation by the employer at the time of joining.
5. During registration, candidate must submit i) a bank draft as mess advance and mess overhead charges (to be intimated). (ii) a bank draft towards the refundable caution money (to be intimated)

Accommodation

1. Both Regular and Sponsored candidates, who are offered admission, will be provided with accommodation in the Halls of Residence. Candidates who wish to make alternative arrangements for accommodation must apply for permission to reside outside, in an area in close vicinity of the Institute.
2. There is an extreme shortage of family accommodation. Therefore no family accommodation is available in the Institute.

Fees and Deposits

Every M.Tech/MCP student is required to pay tuition and other fees as mentioned below:

Semester	Fee type	General / OBC / TG/PwD (Rs.)	SC / ST (Rs.)
First Semester	Non-refundable	11300.00	6300.00
	Refundable (caution money)	6000.00	6000.00
	Placement Service **(not applicable for sponsored candidates)**	1500.00	1500.00
	Insurance (yearly)	1226.00	1226.00
	Student Brotherhood Fund (yearly)	100.00	100.00
Each subsequent Semester	Non-refundable	9000.00	4000.00

In addition to the above, fee payable per semester is as follows:

Fee type	Amount (Rs)
Hostel overhead	8250.00
Mess Advance	13500.00

(Note: Fee structure and amount are subject to change from time to time; the non-refundable fee has a tuition component of Rs 5000.00 per semester which is waived in case of SC/ST category students)

Insurance: A compulsory insurance scheme provides insurance coverage for an annual premium of Rs. 1226.00 to all the students of the Institute

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Contact Details

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