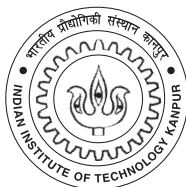


M. Tech., M. Des. and Ph.D. Programmes

# Information Brochure



2013

INDIAN INSTITUTE OF TECHNOLOGY KANPUR  
KANPUR - 208 016

(website : [www.iitk.ac.in/doaa](http://www.iitk.ac.in/doaa))

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## INTRODUCTION

The goals of the post graduate programmes at the Indian Institute of Technology Kanpur are:

The development of high quality scientific and engineering manpower with a broad grasp of the fundamental principles of sciences and the scientific methods, deep understanding of their areas of specialization, innovative ability to solve new problems, and the capacity to learn continually and interact with multi- disciplinary groups. Above all, the students should develop the capacity for free and objective enquiry, courage and integrity, awareness and sensitivity to the needs and aspirations of the society. The programmes are designed to impart knowledge, strengthen concepts and intellectual skills through course work, seminars and project/thesis work and thus cater to the needs of Industry, R & D organizations and educational institutions.

These programmes are intended to prepare students to enter their professions with a perspective and breadth of knowledge related to the principal divisions of their respective fields of specialization through courses and research experience. A post-graduate student will typically be enrolled for three or four courses each semester until he/she has fulfilled all the course requirements. The thesis work is aimed at providing the research experience in the relevant field of specialisations. This brochure provides general information sought by those seeking admission at IIT Kanpur in any of the following approved postgraduate programmes. For rules pertaining to any particular issue, decisions of the competent authority would be applicable.

### **M.TECH.: MASTER OF TECHNOLOGY (4 Semester Programme)**

Aerospace Engineering  
Biological Sciences and Bio-engineering  
Chemical Engineering  
Civil Engineering  
Computer Science & Engineering  
Electrical Engineering  
Environmental Engineering & Management  
Industrial & Management Engineering  
Photonics Science & Engineering  
Materials Science & Engineering  
Mechanical Engineering  
Materials Science  
Nuclear Engineering & Technology

### **M.DES.: MASTER OF DESIGN (4 Semester Programme)**

#### **Ph.D.: DOCTOR OF PHILOSOPHY Engineering:**

Aerospace Engineering	Industrial & Management Engineering
Biological Sciences and Bio-engineering	Photonics Science & Engineering

Chemical Engineering  
Civil Engineering  
Computer Science & Engineering  
Electrical Engineering

#### **Sciences**

Chemistry  
Mathematics & Statistics  
Physics

Materials Science & Engineering  
Mechanical Engineering  
Materials Science  
Nuclear Engineering & Technology

#### **Humanities and Social Science**

English (Literature and Linguistics)  
Economics  
Philosophy  
Psychology  
Sociology

#### **Management**

Ph.D. in Management

#### **Design**

Ph.D. In Design

## ELIGIBILITY REQUIREMENTS

The eligibility conditions given below are the absolute minimum. Departments may prescribe any requirements over and above these. The 'specified minimum' marks/CPI (Cumulative Performance Index), referred to in subsequent sections, implies a minimum of 55 percent marks /5.5 (on a 10 point scale) as long as it is not less than the minimum pass marks/CPI; otherwise, the 'specified minimum' marks/ CPI implies the minimum pass marks/ CPI.

**M.Tech.:** A Bachelor's degree in engineering or Master's degree in science with marks/CPI not below the prescribed minimum. For M.Tech in Biological Sciences and Bioengineering, candidates with MBBS, or B.Pharma Degree may also be considered. Valid GATE score is required for financial assistance. Graduate from any of the IITs with a minimum CGPA of 8.0 are exempted from this requirement.

**M.Des.(Master of Design):** A Bachelor's degree in Engineering or Design or Architecture (only) with marks/CPI not below the prescribed minimum. Students with Bachelor's degree in a Fine Art are not eligible. Valid GATE/CEED score is required for financial assistance.

**Ph.D. in Design:** The applicant must have a master's degree in Engineering/ Technology/ Design with marks/CPI not below the specified minimum. Applicants with a bachelor's degree in Engineering/ Technology/ Design (four years programme) with a minimum of 75 percent marks / 7.5 CPI or Master's Degree in Science or an allied area satisfying each of the following criteria may also be considered.

- A minimum of 65 percent marks/6.5 CPI in the Master's Degree
- First division in Bachelor's Degree, and
- Valid GATE/CEED score

**Ph.D. in Engineering:** The applicant must have a master's degree in engineering with marks/CPI not below the specified minimum. Applicants with a bachelor's

degree in engineering with a minimum of 75 percent marks/7.5 CPI, or master's degree in science or an allied area, satisfying each of the following criteria may also be considered:

- (a) a minimum of 65 percent marks/6.5 CPI in the master's degree.
- (b) first division in bachelor's degree, and
- (c) JRF/95 percentile or higher in GATE.

For admission into Ph.D. in Biological Sciences and Bio-engineering, applicants having master's degree in pharmacy/medicine with marks/CPI not below the specified minimum, or bachelor's degree in pharmacy/medicine with a minimum of 75 percent marks/7.5 CPI, may be considered. However, valid GATE/UGC/CSIR score is required for financial assistance, except for graduates from IITs with a minimum CGPA of 8.0.

**Ph.D. in Sciences:** A Master's degree in the relevant subject or a Bachelor's degree in engineering with marks/CPI not below the prescribed minimum. Valid GATE/UGC/CSIR score is required for financial assistance, except for graduates from IITs with a minimum CGPA of 8.0.

**Ph.D. in HSS:** A Master's degree in the relevant subject or a Bachelor's degree in Engineering or a Master's degree in sciences or in an allied field of HSS with marks/CPI not below the prescribed minimum. Valid GATE/UGC/CSIR score is required for financial assistance, except for graduates from IITs with a minimum CGPA of 8.0. Applicants in Economics should have at least +2 Level mathematics background.

**Ph.D. in Management:** A Master's degree in Management/Arts/Commerce/Science/Industrial Engineering/Production engineering/Operations research, or other relevant disciplines in Engineering/Technology, or a Bachelor's degree in Engineering/Technology with CPI not below the specified minimum. Valid GATE/UGC/CSIR score is required for financial assistance, except for graduates from IITs with a minimum CGPA of 8.0.

### **FINANCIAL ASSISTANCE**

Financial aid (Assistantship/Scholarship) is available to the M.Tech., Ph.D. and M.Sc.-Ph.D. (Dual degree) Programmes.

Student is expected to carry out the assigned duties for teaching and Research Assistantship. The M.Tech. student currently carries a monthly stipend of Rs.8,000/- for 8 hours of work per week. For Ph.D. students the corresponding financial assistance is Rs.18,000/- (for engineering) and Rs.16,000/- (for Sciences/Social Sciences) for the first two years and there after its is raised to 20,000/- and 18,000/- respectively for another two years. A 50% tuition fee waiver for M.Sc.-Ph.D. (Dual degree) students is also available after the first semester.

In addition to this several attractive fellowships from Industries/DAE are also available.

### **SELECTION CRITERIA**

For both M.Tech. and Ph.D. programmes, some departments/programmes may call a selected number of candidates for test and/or interview in May/June for

admission in first semester and in November for admission in second semester. Other departments/ programmes may process the applications only on the basis of earlier academic records and/or GATE/UGC/CSIR scores where the same be required and offer admissions directly. All students who are offered admission will be informed normally by the first week of June (for admission in first semester) or first week of December (for admission in second semester). There also exists a provision of walk-in interview for admission to the Ph.D. programmes round the year.

### **CONCESSIONS TO SC/ST/OBC CANDIDATES**

In each discipline, 15% seats are reserved for SC candidates, 7.5% seats for ST candidates and 27% seats are reserved for OBC (for non-creamy layer). SC/ST/OBC candidates must also satisfy the eligibility requirement for admission. However, while considering their cases, only suitability for the programme is ensured and the SC/ST/OBC candidates are not compared with those belonging to other categories.

### **CONCESSIONS TO CANDIDATES WITH PHYSICAL DISABILITY (PD)**

In total, 3% reservation (horizontal) shall apply for candidates with physical disability as per Govt. of India norms (minimum 40% disability; an appropriate certificate must be furnished). Such candidates must satisfy the eligibility requirements for admission. However, while considering these cases, only suitability for the programme is ensured and the candidates are not compared with those belonging to other categories.

### **ADMISSION TO PART-TIME STUDIES**

The Institute also offers part-time postgraduate programmes leading to the M.Tech/Ph.D. degrees for local professionally employed personnel such as working engineers, scientists and teachers who can, while employed, attend regular classes as per schedule of the Institute.

The applicant must be an employee of a recognized organization with at least two years of service at the time of admission and be engaged in professional work in the area to which admission is sought. An application for the part-time studies should be forwarded by the employer.

### **ADMISSION TO EXTERNAL REGISTRATION PROGRAMME FOR Ph.D.**

A candidate working in an R & D establishment which is equipped with the necessary research and library facilities may be considered for admission only to the Ph.D. programmes in engineering. Such a candidate must be sponsored by his/her employer and must have been in employment with the sponsoring organization for at least 2 years at the time of admission. The employer must expressly undertake to pay full salary to the candidate and relieve him/her to stay on the campus to enable the candidate to complete his/her residence requirement. A candidate applying for admission to the external registration programme must provide detailed information about the research facilities available at his/her organization and a certificate that these would be available to him/her for carrying out research. He/she should also provide the biodata of the prospective supervisor who would supervise the candidate's work at his/her organization.

An application for admission from a candidate working in the approved organization will be considered only if he/she wishes to work in the specified area.

### **ADMISSION OF SPONSORED CANDIDATES**

A candidate who is sponsored by his/her employer and who meets the additional conditions specified below may be admitted through a separate selection committee appointed specifically for the purpose.

A sponsored candidate must have been in service of the sponsoring organization for at least two years at the time of admission. The sponsoring organization must specifically undertake to provide full salary to the candidate and to relieve him/her to pursue the programme for its full duration.

Fulfillment of GATE eligibility requirement may be waived for such candidates. However, the sponsored candidates seeking admission to the M.Tech./M.Des/Ph.D. programme who have not taken GATE/CEED will be called for interview and may in addition be asked to take a written test.

### **GENERAL INFORMATION**

Each postgraduate student is required to register in every semester till he/she completes the requirements of his/her programme. These requirements are counted in terms of credits which roughly reflect the number of contact hours. Normal load in a semester is 16 credits. A typical PG course is of 4 credits. The minimum residence requirement for students registered in M.Tech. Programme is four semesters. They are required to complete a minimum of 64 credits of which at least 24 credits should be through course work and at least 28 credits would be through research work.

The minimum residence requirement for students holding M.Tech. degree registered for Ph.D. Programmes in engineering is four semesters. They are required to complete a minimum of 64 credits of which at least 16 credits must be in terms of postgraduate courses and at least 32 credits in terms of research work.

The minimum residence requirements for students holding B.Tech. degree registered for Ph.D. programmes in Engineering is six semesters. They are required to complete a minimum of 96 credits of which at least 40 credits must be through P.G. courses and at least 32 credits through research.

The minimum residence requirement for students holding M.Sc., MA., M.B.A. or M.Phil. degree registered for Ph.D. programmes in Sciences/HSS/Management is five semesters. They are required to complete a minimum of 80 credits of which at least 24 credits must be in terms of postgraduate courses and at least 32 credits in terms of research work. In order to graduate, students must obtain a minimum CPI of 6.50 at the Master's level and 7.00 at the Ph.D. level.

The institute, being residential, requires that all registered students must reside in the campus. The Institute has nine hostels for boys and two hostels for girls with capacities of 5000 and 500, respectively. Seventy Two (72) Single Bed Room Apartments (SBRA) have been earmarked for allotment to married students. The married students are, however, advised to bring their family only after allotment of a SBRA.

## **AEROSPACE ENGINEERING**

The Department of Aerospace Engineering offers a comprehensive program of teaching and research at undergraduate and postgraduate levels leading to B.Tech, B.Tech-M.Tech dual degree, M.Tech and Ph.D degrees. Specializations are available in four major streams: (i) Aerodynamics: focusing on High Speed Aerodynamics, Low Speed Aerodynamics, Hypersonics, Experimental Fluid Dynamics, CFD/High Performance Computing, Flapping Flight, (ii) Propulsion: focusing on Turbo machinery, Combustion, Flame, Active and Passive flow Control, Micro Air Vehicles (iii) Structures: with focus on Composite Structures, Smart Structures and Optimization, Computational Mechanics, Fracture Mechanics, Random Vibration, Structural Dynamics and Aeroelasticity, Helicopter Dynamics and Aeroelasticity. Autonomous Helicopter, (iv) Flight Mechanics: including Space Dynamics, Flight Control,

The Department has undertaken several consultancy, and sponsored R&D projects funded by agencies such as, Aeronautics R & D Board, Indian Space Research Organization, Aeronautical Development Agency, Department of Science & Technology, Hindustan Aeronautics Ltd., Delhi Metro Railways Corporation, NAL, Indo-French Centre for the Promotion of Advanced Research (IFCPAR), TERI, PCRA, DRDO etc., have been undertaken by the Department. The major contributions of the faculty are in the design and development of high speed and low speed wind tunnels, flow measurements using hotwire and laser Doppler anemometry, PIV, reacting flow, industrial and wind energy aerodynamics; CFD including subsonic, transonic, supersonic and hypersonic flow computations; unsteady aerodynamic modeling and parametric estimation techniques; satellite dynamics; flight control; rocket propulsion; flow through turbo-machines; combustion, flame; structural dynamics, random vibration, design and optimization of fibre reinforced composite structures for static, dynamic and random loading; adaptive finite element analysis; smart structures; multi scale modeling; damage in composite structures; behavior of adhesive joints; helicopter dynamics, aeroelasticity; modeling of advanced materials, micro/mini air vehicles, autonomous helicopter and insect flight.

### **FACULTY**

**Abhishek, Ph.D. (Maryland):** Helicopter Aeromechanics, Multibody Dynamics, Micro Air Vehicles.

A K Ghosh, Ph.D. (IIT/K): Flight Mechanics, Neural Networks, Flight Testing.

**A Kushari, Ph.D. (Georgia Tech.):** Propulsion, Combustion, Liquid Atomization, Flow Control.

**A Tewari, Ph.D. (Missouri - Rolla):** Flight Mechanics, Aeroservoelasticity, Space Dynamics and Control.

**Ashoke De, Ph.D(Louisiana State University):**CFD, Turbulent combustion, Gas turbine propulsion, Stochastic combustion modeling.

**A C Mandal, Ph.D. (IISc Bangalore):** Experimental Aerodynamics, Flow instability and transition, Turbulent Shear flow.



**C S Upadhyay, Ph.D. (Texas A&M):** Computational Mechanics, Damage Mechanics.

**C Venkatesan, Ph.D. (IISc Bangalore):** Helicopter Dynamics and Aeroelasticity, Autonomous Helicopter, Smart Structures

**D Das, Ph.D. (IISc. Bangalore):** Theoretical and Experimental Aerodynamics, Aeroacoustics, Instability and Transition, Vortex Dynamics, Unsteady Aerodynamics, Bird and Insect Flight.

**D P Mishra, Ph.D. (IISc Bangalore):** Combustion, Atomization, CFD.

D Yadav, Ph.D. (IIT/K): Structural Dynamics, Stochastic Processes, Optimization.

**E Rathakrishnan, Ph.D. (IIT/ Madras):** Gas Dynamics.

K Poddar, Ph.D. (San Diego): Aerodynamics, Turbulence, Low and High Speed Flows.

**P M Mohite, Ph.D. (IIT/K):** Damage Mechanics of Composites, Composites, Material Characterization, FEM.

**R Kitey, Ph.D. (Auburn):** Solid Mechanics, Fracture Mechanics, Optical Metrology, Boundary Element Method.

**R Kumar, Ph.D (Penn State):** Hypersonics, Rarefied Gas Dynamics, Microfluidics, Molecular Dynamics, Heat Transfer & Thermal Design.

**S Mahesh, Ph.D. (Cornell):** Material Modeling, Fracture.

**S Mittal, Ph.D. (Minnesota):** CFD, Aerodynamics, Shape Optimization.

**S Kamle, Ph.D. (Purdue):** Experimental Stress Analysis, Smart Structures.

**T K Sengupta, Ph.D. (Georgia Tech):** Theoretical and Computational Fluid Dynamics, Transition and Turbulence, Aerodynamics.

## PROGRAMMES

The M. Tech program is designed to acquaint the student with various aspects of Aerospace Engineering through several courses both introductory and in the specialized area followed by research, leading to a thesis on a topic in the area. M. Tech students have the opportunity to do experiments with the National Wind Tunnel Facility (NWTF) (See FACILITIES below) and acquire actual flying experience in the Flight Laboratory as a part of the curriculum. The Ph.D program is aimed at helping the student acquire proficiency in the chosen area through course work, followed by research leading to a Doctoral thesis.

Candidates for admission in the M.Tech program in Aerospace Engineering at IIT Kanpur must have a Bachelor's degree in Aeronautical/Aerospace, Mechanical, Civil, Chemical Engineering, Naval Architecture, Electrical, Electronics/Electronics and Communication, Automobile, Metallurgy/Metallurgy and Material Science. Those for admission in Ph.D must have a Master's degree in the respective disciplines, or a Master's degree in Sciences with a minimum of 3 years of relevant R & D experience in aerospace engineering for sponsored candidates and also a valid GATE/UGC/CSIR score for non-sponsored candidates.

Admissions in M.Tech and Ph.D programs are made to a particular stream, i.e. area of specialization in the department (as given in first para). Also note that problems of multidisciplinary nature can be suitably taken up for thesis.

A student in the M.Tech program is required to complete at a satisfactory level, a minimum of 8 courses and 32 units (two semester load) of research leading to a thesis. A Ph.D student is required to complete a minimum of 4 courses and 32 units (two semester load) of research subject to a minimum total academic load of 4 semesters. He is also required to pass the Ph.D comprehensive examination held on completion of his course work.

In the first semester, a student in the M.Tech program will be registered for 4 courses. At the time of admission he will be assigned to a field of specialization on the basis of his aptitude, background, and availability of the faculty. A thesis supervisor will also be assigned towards the end of first semester. In the second and third semesters, the student will take four or more elective courses and initiate his research. In the third and fourth semesters he/she will continue research work towards completion of his thesis.

A student in the Ph.D program will register for four elective courses, as advised by D.P.G.C. member belonging to his area of specialization, if thesis supervisor has not been decided at the time of registration. In other cases, he may register for thesis on the advice of supervisor. In the subsequent semester he registers for research and courses as advised by his supervisor. At the end of the course work the student will appear for the Ph.D comprehensive examination, and continue his research towards completion of his Doctoral Thesis.

## COURSES

Introduction to Aerospace Engineering, Mathematics for Aerospace Engineers, Aerodynamics-I, Aerodynamics-II, Viscous Flows, Advanced Computational Methods in CFD, Boundary Layer Instability and Transition, Finite Element Methods for Fluid Dynamics, Introduction to Environmental Fluid Mechanics, Wind Engineering, Turbulence, Computational Fluid Dynamics, Turbulent Flows, Perturbation Methods in Fluid Mechanics, Transition and Turbulence, Advances in Turbulent Shear Flows, Continuum Hypersonic Aerodynamics, Advances in Wind Energy Conversion, Advanced Dynamic Stability, Space Dynamics-I, Space Dynamics-II, Introduction to Hypersonic & Trans-Atmospheric Flight, Control Theory, Flight Dynamics, Flight Stability and Control, Fundamentals of Aerospace Propulsion, Applied Combustion, Aircraft Propulsion, Thermal Turbo Machinery, Combustion Problems in Rocket Propulsion, Selected Topics in Turbo-Machines, High Speed Internal Flow Problems, Airbreathing Missile Propulsion, Transonic Aerodynamics, Aerospace Structural Analysis-I, Solid Mechanics, Rocket and Missile Structures, Advanced Aircraft Structural Analysis, Introduction to Finite Elements Methods, Aeroelasticity, Vibration Control, Theory of Vibrations, Non-Linear Oscillations, Reliability Analysis of Engineering System, Composite Materials, Analysis of Composite Structures, Random Vibrations, Aircraft Materials and Processes, Deterministic and Random Vibration, Helicopter Theory: Dynamics and Aeroelasticity, Aerospace Structural Analysis-II, Dynamics and Vibration, Introduction to the Theory of Smart Structures, High Temperature Gas Dynamics, Applied Mathematics for Engineers, Instrumentation, Measurement and Experiments in Fluids, Introduction to Virtual Instrumentation, Nonlinear Finite Element Method, Molecular Gas Dynamics, Fundamentals of Liquid Atomization, Principles of Acoustics, Theory of Combustion.

## FACILITIES

The department has several well established laboratories focusing on various research and academic activities. They are: High Speed and Low Speed Aerodynamics Lab, Propulsion Lab, Combustion Lab, Fire Lab, Structures Lab, Aeromodelling Lab, Unsteady Aerodynamics Lab, Autonomous Helicopter Lab, CFD Lab, High Performance Computing Lab, Structural Analysis Lab, Flight Lab and National Wind Tunnel Facility. The experimental facilities include several low speed wind tunnels, a high speed blow down tunnel, high speed jet facility, anechoic chamber for noise measurements, hot wire and laser Doppler anemometry; facility for static and dynamic tests of materials, cascade tunnel, continuous combustion unit and gas turbine test rig; Malvern Spraytech particle size analyzer, Gas Chromatograph. Flight laboratory, with four powered airplanes and several gliders and an operational aerodrome for flight research; NWTF (National Wind Tunnel Facility) which is a unique facility, with latest technology and automated instrumentation and a very large test section of 3m x 2.25m, capable of testing (aerodynamics) a full-scale model of car.

## BIOLOGICAL SCIENCES AND BIO ENGINEERING

The Department of Biological Sciences and Bioengineering (BSBE) was established in September, 2001. The department offers both undergraduate (B.Tech) and postgraduate programs (M.Tech and Ph.D) and the faculty conduct research in diverse areas of basic and applied biology. Research interests of the department include cell & molecular biology, genetics and developmental biology, structural & computational biology, bioinformatics, biomaterials, tissue engineering, bioprocess engineering, biomechanics and bioelectronics. The department has developed extensive research facility and infrastructure to support its teaching and research activities. The research activities in the department are funded by various funding agencies including DBT, DST, CSIR, ICMR and ICAR. BSBE faculty members are engaged in collaboration with scientists within India and abroad. They have received many awards and honors in recognition of their excellence in research.

The department currently has twelve members in its faculty with expertise in diverse areas of research.

### FACULTY

**Bushra Ateeq, Ph.D. (Aligarh Muslim University):** Molecular oncology, Genetic alterations, Cancer pathogenesis, diagnosis and therapeutics

Amitabha Bandyopadhyay, Ph.D. (Albert Einstein College of Medicine, New York): skeletal development and differentiation; metabolomics.

**Mainak Das, Ph.D. (Univ. of Central Florida):** Bioengineered retina, engineering prototype of photosynthetic machinery, and materials for bioelectronics.

**Ganesh S, Ph.D. (BHU, Varanasi):** Human molecular genetics, model systems for human disorders, neuroscience.

**Dhirendra S. Katti, Ph.D. (Bombay Univ.):** Tissue engineering, biomaterials, drug delivery systems and nanobiotechnology.

**Ashok Kumar, Ph.D. (IIT Roorkee):** Downstream processing, biomaterials, nanobiotechnology, affinity interactions and cell separation, bioprocessing, and tissue engineering.

**Balaji Prakash, Ph.D. (IISc., Bangalore):** Structural biology, bioinformatics, macromolecular crystallography.

**Jonaki Sen, Ph.D. (Albert Einstein College of Medicine, New York):** Retinal development and differentiation; developmental neurobiology.

**Pradip Sinha, Ph.D. (BHU, Varanasi):** Cancer genetics, growth control & pattern formation in fruit fly, *Drosophila* model.

**Sankararamakrishnan R, Ph.D. (IISc., Bangalore):** Bioinformatics, molecular modelling of membrane proteins and bimolecular simulation.

**Subramaniam K, Ph.D. (IISc., Bangalore):** Developmental biology – germ cell development in *C.elegans*; Functional genomics using RNAi – plant-parasitic nematodes.

**Ashwani Kumar Thakur, Ph.D. (Inst. of Microbial Tech., Chandigarh) :** Protein aggregation in diseases and therapeutic design; self assembly of proteins; and biopharmaceuticals.

## FACILITIES

Molecular Biology lab: Centrifuges, Gel-documentation system, PCR machine, hybridization oven, transfer apparatus for nucleic acids and protein, automated DNA sequencer, and culture setup for bacterial and mammalian cells.

Imaging Facility: Microscopic setup for confocal/fluorescence imaging, photodocumentation and image analysis software, Environmental Scanning Electron Microscope (ESEM).

Computational Facility: HP and IBM servers; molecular modelling and graphics packages; bioinformatics tools.

Facility for Protein Chemistry: peptide synthesizer, FPKC, CD spectropolarimeter and UV-VIS spectrophotometer

## PROGRAMMES

### M.Tech. in BSBE (4 Semesters)

Master of Technology (M.Tech) program in BSBE meets a variety of career objectives in research and industry. The program is also supported by the Department of Biotechnology (DBT), Govt. of India. The Program is for four semesters of which the last two semesters involve hands-on training and research. Midway through the program, students may apply for switchover to the Ph.D. program of BSBE. The program is designed for students from both biology and non-biology background.

### WHO CAN APPLY?

Candidates who have a Master's degree in any area of science (mathematics, physics, chemistry or life sciences) or Bachelor's degree in Technology/Engineering,

Medicine (MBBS), Pharmaceutical (B.Pharm), Agricultural or Veterinary Sciences are eligible to apply. Applicants should have secured a minimum CPI of 6.6 (or 60 percent marks) in their qualifying degree (and should be at least seven percent higher than the minimum pass marks/CPI) and should either have a valid GATE score or qualified in the national level tests conducted by the UGC, CSIR, DBT, ICAR or ICMR. The requirement of a GATE score is waived for M.B.B.S. degree holders and for engineering graduates from IITs with an overall CGPA of 6.5 and a CGPA of 8.0 during the last two semesters. Candidates appearing in the final examinations of the qualifying degree are also eligible to apply.

## Ph.D in BSBE

Ph.D. Program in BSBE is intended for students interested in carrying out distinguished scholarly activities. Excellence in research apart, the program envisages comprehensive development of students for leadership in science and engineering in both industry and academia. Therefore, the Ph.D. Program involves intense course work covering diverse areas of biology and bioengineering for competence in both analytical and quantitative skills.

### WHO CAN APPLY?

Candidates should meet one of the following 4 conditions. Candidates appearing in the final examinations of the qualifying degree are also eligible to apply.

- (1) Should have a master's degree in engineering (ME/M.Tech.), or medicine (MD) or M.Sc. (Agri) or equivalent with minimum of 55 percent marks/ 5.5 CPI (on a 10 point scale) as long as it is not less than the minimum pass marks/CPI.

OR

- (2) Should have a bachelor's degree in engineering (B.E/B.Tech) or pharmacy (B.Pharm) with a minimum of 75 percent marks/7.5 CPI, and a valid GATE score or qualified in the JRF of UGC, CSIR, DBT, ICAR or ICMR.

OR

- (3) Master's degree in sciences or an allied area (M.Sc.), satisfying each of the following criteria may also be considered.

- (a) a minimum of 65 percent marks/6.5 CPI in the master's degree.

- (b) first division in bachelor's degree, and
- (c) UGC, CSIR, DBT, ICAR or ICMR junior research fellowship (JRF)  
OR 95 percentile or higher in GATE.

OR

- (4) MBBS degree holders with a minimum of 60% marks in the qualifying degree.

## CHEMICAL ENGINEERING

The Department of Chemical Engineering offers academic programme leading to B.Tech., M.Tech. and Ph.D. degrees in Chemical Engineering.

The Department imparts graduate education with emphasis on chemical engineering fundamentals and applications. It prepares students for a high level of competence in the conventional areas like process engineering, process simulation, optimization and control, separation processes, polymer engineering and transport phenomena, and in frontier areas of energy and environment, nanosciences, molecular simulations, biotechnology and biocomputations.

Most of the graduate courses have a strong engineering science and state-of-the-art orientation. They are primarily intended to prepare students for careers in computer oriented design, simulation and controls, teaching, research and development. Our students find employment in renowned industrial and academic organizations. The department has a young and dynamic faculty who are recognized both nationally and inter nationally, who have received numerous awards and honours for excellence in research (e.g. Shanti Swarup Bhatnagar prize, Herdillia, Amar Dye-Chem and NOCIL awards of IChE, of ISTE, Fellowships of Academies of Sciences and of Engineering, etc.). This research in diverse areas of Chemical Engineering is published in prestigious inter national journals. The department faculty has also authored over 35 textbooks and research monographs through reputed publishers in India and abroad which reflects the faculty's commitment to teaching and research. A number of projects have been sponsored by various national funding agencies including DRDO, DST, AICTE, ARDB, CSIR, DBT and MEF, MHRD, Planning Commission, Centre for High Technology etc. The department enjoys an excellent rapport and professional interaction with various industrial organizations. A few faculty members engage in high level consultancy work in industry during summers, whereas some others undertake sponsored projects funded by industry (e.g. IPCL, GSFC, Duncans Industries, U.P. State Agro Industries, Engineers India Limited, IOC, CHT, Gas Authority of India Limited, Hindustan Lever, Bharat Petroleum Corporation Limited, etc.).

### FACULTY

**P Apte, Ph.D. (Ohio):** Statistical Mechanics, Interfacial Thermodynamics, Nucleation.

**P K Bhattacharya, Ph.D. (IIT/B):** Membrane Separations, Pulp and Paper Technology, Environmental Engineering

**R P Chhabra, Ph.D. (Monash):** Non-Newtonian Fluid Particle Systems, Transport Properties of Liquid Metals and Molten Salts

**S Garg, Ph.D. (Connecticut):** Bio-informatics; Computer Aided Molecular Design; Flexibility Analysis



**A Ghatak, Ph.D. (Lehigh):** Adhesion and friction on soft interfaces, Fracture of soft thin sheets, Bio-inspired approaches in design of engineering materials.

**Goutam Deo, Ph.D. (Lehigh):** Heterogeneous Catalysis, Kinetics, Transport Phenomena

**S K Gupta, Ph.D. (Pennsylvania):** Simulation and control of Polymerization Reaction, Optimization

**Y M Joshi, Ph.D. (IIT/B):** Rheology, Polymer Science & Engineering, Fluid Mechanics

**Ashok Khanna, Ph.D. (IIT/K):** Process Control, Polymer Engineering, Two Phase Flow

**Anil Kumar, Ph.D. (Carnegie-Mellon):** Simulation and Control of Polymer System Process Design

**Nitin Kaistha, Ph.D. (Tennessee):** Process Monitoring & Control, Reactive Distillation

**D Kunzru, Ph.D. (Pittsburgh):** Catalyst Deactivation, Kinetics, Pyrolysis of Hydrocarbons, Petroleum Processing

**Raj Ganesh Pala, Ph.D. (Utah):** Sustainable energy, Heterogeneous catalysis, Photo chemical analysis, Quantum and classical simulation of condensed matter systems.

**S Panda, Ph.D. (Houston):** Chemical Sensors, Micro/ Nano Fabrication processing of electronic materials Microfluidics, Lab-on-a-chip.

**V Shankar, Ph.D. (IISc B'lore):** Stability of Fluid Flows, Dynamics and Rheology of complex fluids.

**Ashutosh Sharma, Ph.D. (SUNY, Buffalo):** Colloid and Interface Engineering, Nanotechnology, Thin Films.

**Jayant Singh, Ph.D. (SUNY, Buffalo):** Molecular Simulation, Statistical Thermodynamics, Structure, Dynamics and Phase Behaviour of Complex Fluid

**Sri Sivakumar, Ph.D. (Victoria):** Synthesis and characterization of nanomaterials, Layer by layer assembly polymer capsules, Thin films, Drug delivery and photonic crystals

**Nishith Verma, Ph.D. (Arizona):** Adsorption, Environmental Pollution Control, Mathematical Modelling & Simulation,

**Raghvendra Singh, Ph.D., (SUNY, Buffalo):** Computational Biology, Gene Therapy, Embryonic and Adult Stem Cell, Tissue Engineering, Biomaterials.

**Abhijit Chatterjee, Ph.D., (Detaware):** Heteroepitaxial and thin film growth, Diffusion in metals and ionic materials, Design of multifunctional materials.

**Raju Kumar Gupta, Ph.D., (NUS Singapore):** Synthesis of Nanomaterials, Molecular assembly, Design and engineering of nano structures for energy applications, Thin films.

**Naveen Tiwari, Ph.D., (University of Massachusetts, USA):** Transport Phenomena, Instabilities in micro-scale free surface flows, Flow through porous media.

## PROGRAMMES

The M.Tech. students are required to complete a minimum of 64 units of which at least 24 units (equivalent to 6 courses) must be in terms of advanced postgraduate courses and research work equivalent to minimum of 28 units. The students are required to take at least three compulsory courses, one each from the four areas : Applied Mathematics, Transport Phenomena, Thermodynamics and Chemical Reaction Engineering. Besides these, the students take additional courses from a wide range of electives. The electives reflect the broad spectrum of research interests of the faculty. The electives offered keep changing from time to time and they are the means through which both faculty and students keep abreast of the latest developments. The electives may be chosen either from the departmental or outside departmental courses.

Students holding B.Tech. degrees registered for Ph.D. are required to complete a minimum of 96 units of which at least 40 units (equivalent to 10 courses) must be in terms of advanced post graduate courses. Students holding M.Tech. degree registered for Ph.D. are required to complete a minimum of 64 units of which at least 16 units (equivalent to 4 courses) must be in terms of advanced post graduate courses.

Research projects for M.Tech./Ph.D. thesis work are offered by the faculty in their fields of specialization.

## ELECTIVE COURSES

New Separation Processes, Thermodynamics of Fluids and Mixtures, Principles of Heterogeneous Catalysis, Applied Statistics for Chemical Engineers, Optimization, Hazard Analysis and Reliability, Plant Safety and Hazard Assessment, Petroleum, Mechanics of soft materials, Introduction to nanoscience and technology, Polymer science and technology.

Refinery Engineering, Reaction Engineering of Polymers, Principles of Polymer Processing, Molecular Theories of Polymeric Systems, Environmental Pollution and Control, Engineering Applns. of Rheology, Advanced Process Dynamics and Control, Computer Aided Processes Control, Two Phase Flow and Heat Transfer, Design of Fluid-Particle Systems, Colloid and Interface Science and Engineering

Modelling and Simulation in Chemical Engineering, Introduction to polymer physics and Rheology of Soft Matter, Introduction to Molecular Simulation, Analytical and material characterization techniques for engineers.

Electrochemical energy conversion and storage, CFD of Multiphase Reactors, Nuclear Chemical Engineering, Structure and Rheology of Complex Fluids, Process Engineering Principles in Microelectronics Fabrication.

## FACILITIES

Besides the central facilities, at the Institute level, the Chemical Engineering Department has its own workshop, library, GLCS, GPC, AAS, catalyst characterization facilities, centrifuges, fermentor, incubator-shaker, cryostats, IBM compatible personal computers, Magnetic flow meters, Ultrafiltration, Reverse Osmosis, AFM, Electro dialysis, Goniometer, Haake & Physica Viscometers and Rheometer, Parr Reactors, Laser Printer, Density meter, Dedicated NO gas analyzer, Ion chromatography, on line IR Gas analyser, Softwares such as MATLAB, SPEEDUP, ASPEN+, Langmuir-Biodeget deposition, Ellipsometr, Spin-coater etc. For more details visit [www.iitk.ac.in](http://www.iitk.ac.in)

## CIVIL ENGINEERING

Postgraduate education in the Department is aimed at attaining an understanding of the basic scientific principles underlying various disciplines in Civil Engineering. In addition, the research component of the graduate programmes is meant to develop capabilities to confidently undertake an independent analysis of complex field situations. Our graduates have gone on to become leaders in their professions and have significantly contributed to research and development. Keeping in view the needs of the society and the challenging problems faced by the profession, the postgraduate programmes have been developed in several fields of specialization.

## FACULTY

**Purnendu Bose, Ph.D. (Massachusetts, Amherst):** Environmental Engg.—Physico-chemical processes for water and wastewater treatment, Advanced oxidation processes for water and wastewater treatment, Abiotic remediation of groundwater resources.

**Partha Chakroborty, Ph.D. (Delaware):** Transportation Engg.—Traffic flow theory and traffic engineering, Optimal transit system design, Transport system evaluation and management.

**Sekhar K Chakrabarti, Ph.D. (Arizona, Tucson):** Structural Engg.—Interfaces and interactions in structural connections, Rehabilitation of structures, Advance concrete materials.

**Sarvesh Chandra, Ph.D. (IIT/K):** Geotechnical Engg.—Soil structure interaction, Ground improvement technique, Rock mechanics, Computer aided design and railway geotechnology.

**Animesh Das, Ph.D. (IIT/KGP):** Transportation Engg.—Pavement design, Pavement materials, Pavement evaluation and maintenance.

**Onkar Dikshit, Ph.D. (Cambridge):** Geoinformatics—DIP, GPS, GIS, Remote Sensing and Pattern recognition applications.

**Priyanka Ghosh, Ph.D. (IISc):** Geotechnical Engg.—Bearing capacity of foundations and Stability of slopes under both static and seismic cases, Method of characteristics, Upper bound limit analysis and Finite element analysis, Liquefaction analysis.

**Anubha Goel, Ph.D. (Maryland):** Environmental Engg.—Fate and transport of pollutants, Environmental modeling, climate change.

**Saumyen Guha, Ph.D. (Princeton):** Environmental Engg.—Biotic and abiotic processes governing the fate and transport of pesticides in nature, Uptake of nutrients and heavy metals by plants, Enhancement of the effectiveness of fertilizers and moisture holding capacity of agricultural soil, Detection of pathogenic contamination in natural water samples, Industrial wastewater treatment.

Tarun Gupta, Sc.D. (Harvard): Environmental Engg.—Development of instruments for aerosol measurement, Engineering control of particles in ambient and indoor settings, Physico-chemical characterization of atmospheric pollutants, Personal exposure assessment and health effects of inhaled particles.

**Vinay K Gupta, Ph.D. (Southern California):** Structural Engg.—Random vibrations, Earthquake engineering.

**Ashu Jain, Ph.D. (Kentucky):** Hydraulics & Water Resources Engg.—Surface hydrology, Rainfall-runoff modeling & Soft Computing.

**Sudhir K Jain, Ph.D. (Caltech):** Structural Engg.—Earthquake engineering, Structural dynamics.

**Bharat Lohani, Ph.D. (Reading):** Geoinformatics—Terrestrial and airborne laser scanning, Remote sensing, GIS, GPS, Electronic surveying, Terrain modeling, Geodata visualization, and Applications.

**Javed N Malik, Ph.D. (Baroda):** Engg. Geosciences—Active tectonics, Paleoseismology, Paleo-tsunami deposits, Geomorphology and sedimentology.

**Sudhir Misra, Ph.D. (Tokyo):** Structural Engg.—Durability and deterioration of concrete structures, Non-destructive testing, Concrete materials.

**Sudib K Mishra, Ph.D. (Arizona, Tucson):** Structural Engg.—Multi-scale, Multi-physics in materials and Mechanics, Stochastic optimization, Reliability analysis of structures, structural damage assessment.

**Pranab K Mohapatra, Ph.D. (IIT/K):** Hydraulics & Water Resources Engg.—Computational hydraulics, Experimental hydraulics, Surface water hydrology, Frequency response in pipe.

**Nihar R Patra, Ph.D. (IIT/KGP):** Geotechnical Engg.—Pile foundations, Soil-structure interactions and ground engineering, Soil arching, Liquefaction potential evaluation.

**Debajyoti Paul, Ph.D. (Cornell):** Engg. Geosciences—Geochemistry, Petrology, Environmental geology, Paleoclimate.

**Durgesh C Rai, Ph.D. (Michigan, Ann Arbor):** Structural Engg.—Experimental seismic behavior of structures, Seismic evaluation and strengthening, Energy dissipation devices, Masonry and Steel-RC composite members.

**Samit Ray Chaudhuri, Ph.D. (California, Irvine):** Structural Engg.—Structural dynamics, Earthquake Engg., Performance-based design, structural rehabilitation, seismic soil-structural interaction, structural health monitoring & structural testing.

**Prishati Raychowdhury, Ph.D. (California, San Diego):** Geotechnical Engg.—Soil dynamics, Geotechnical Earthquake Engineering, Seismic soil-structure interaction.

**Rajesh Sathiyamoorthy, Ph.D. (IIT/B):** Geotechnical Engg.—Numerical and Physical modeling, Geo-Environmental Engineering, Geosynthetics, Unsaturated soil mechanics, Railway Geotechnology.

**Mukesh Sharma, Ph.D. (Waterloo):** Environmental Engg.—Air quality modeling and management, Fate processes of organic pollutants and parameter estimation.

**Rajiv Sinha, Ph.D. (Cambridge):** Engg. Geosciences—Fluvial geomorphology and sedimentology, Tectonic geomorphology, Remote sensing and GIS applications, Climate change.

**Rajesh Srivastava, Ph.D. (Arizona, Tucson):** Hydraulics & Water Resources Engg.—Flow and transport through variably saturated porous media.

**Vinod Tare, Ph.D. (IIT/K):** Environmental Engg.—Water and wastewater treatment, modelling and simulation of environmental systems.

**Sachchida N Tripathi, Ph.D. (Reading):** Environmental Engg.—Laboratory measurements of aerosol absorption and hygroscopic properties, Fog processing of aerosols, Aerosol climate impacts, Electrical properties of aerosols, Development of new techniques to measure carbonaceous aerosols.

**Shivam Tripathi, Ph.D. (Purdue):** Hydraulics & Water Resources Engg.—Statistical hydrology, Sediment transport, Eco-hydrology.

**Vinod Vasudevan, Ph.D. (Nevada, Las Vegas):** Transportation Engg.—Traffic safety, Pedestrian safety, Highway financing and policy analysis.

## 1. PROGRAMMES

Graduate programmes leading to the degrees of Master of Technology (M.Tech.) and Doctor of Philosophy (Ph.D.) are offered with specializations in Engineering Geosciences, Environmental Engineering, Geoinformatics, Geotechnical Engineering, Hydraulics & Water Resources Engineering, Structural Engineering and Transportation Engineering.

Admissions to the M.Tech. programme in the above disciplines are offered in the first semester of each academic year. However, admissions to the Ph.D. programme are offered in both semesters. Admissions to Ph.D. programme are also offered throughout the year on walk-in-interview basis.

## 2. ELIGIBILITY REQUIREMENTS

Following are the eligibility requirements for various programmes:

### 2.1 M.Tech. Programme

**Engineering Geosciences:** B.Tech./B.E. degree in Civil/Geosciences Engineering, or M.Sc. degree in Earth Science streams. Some candidates having M.Sc. degree in other science streams may also be considered. Candidates with M.Sc. degree must have mathematics as one of the subjects at B.Sc. level.

**Geoinformatics:** B.Tech./B.E. degree in Civil/Mining/Electrical/Computer Science/Electronics Engineering/Information Technology/Geoinformatics, or M.Sc. degree in Earth Science streams or Geography/Physics/Mathematics/Environmental Sciences. Candidates with M.Sc. degree must have mathematics as one of the subjects at B.Sc. level.

**Geotechnical Engineering:** B.Tech./B.E. degree in Civil Engineering.

**Hydraulics & Water Resources Engineering:** B.Tech./B.E. degree in Civil/Agriculture Engineering. The candidates must have taken at least one mathematics course at the undergraduate level.

**Structural Engineering:** B.Tech./B.E. degree in Civil Engineering. Some candidates with Bachelor's degree in Architecture, Building Construction and allied subjects may also be considered.

**Transportation Engineering:** B.Tech./B.E. degree in Civil/Mechanical/Aerospace Engineering.

#### Notes:

1. In addition to the above, a valid GATE score is also needed.
2. The GATE requirement is waived for B.Tech. graduates from IITs with a minimum overall CGPA/CPI of 6.5 and a minimum CGPA/CPI of 8.0 in the last two semesters in B.Tech. However, such candidates are not entitled for Institute Assistantship if their overall CGPA/CPI is below 8.0.
3. Candidates with AMIE certificates are not eligible to apply.

### 2.2 Ph.D. Programme

**Engineering Geosciences:** M.Tech./M.E. degree in Civil Engineering/M. Tech. or M.Sc. degree in Earth Science streams.

**Environmental Engineering:** M.Tech./M.E. degree in Civil/Environmental/Chemical/ Mechanical/Metallurgical Engineering or in related engineering branch\*.

**Geoinformatics:** M. Tech./M.E. degree in Civil/Mining/Electrical/Computer Science/Electronics Engineering/Information Technology, or M.Tech./M.Sc. degree in Earth Science streams or Geography/Physics/Mathematics/Environmental Sciences\$.

**Geotechnical Engineering:** M.Tech./M.E. degree in Civil Engineering.

**Hydraulics & Water Resources Engineering:** M.Tech./M.E. degree in Civil/Aerospace/ Agriculture Engineering.

**Structural Engineering:** M.Tech./M.E. degree in Engineering. Some candidates with Master's degree in Architecture, Building Construction and allied subjects may also be considered.

**Transportation Engineering:** M.Tech./M.E. degree in Civil Engineering.

\* Some bright and motivated candidates with M.Sc. degree may be considered under certain circumstances; however, they should provide documentary proof of having taken Mathematics at the 10+2 level.

\$ Candidates with M.Sc. degree must have taken Mathematics as one of the subjects at B.Sc. level.

#### Notes:

1. Candidates with a bachelor's degree in engineering with marks not below 75% marks (or CGPA/CPI of 7.5 on a 10-point scale) may be considered for admission. However, a valid GATE score is needed (the waiver for IIT graduates as mentioned in the notes above for the M.Tech. programme applies).
2. Candidates with M.Sc. degree must satisfy each of the following criteria: (a) a minimum of 65 percent marks/6.5 CGPA/CPI in the M.Sc. degree, (b) first division in B.Sc. degree, and (c) JRF/95 percentile or higher in GATE.

### 3. COURSES

For M.Tech. degree, a minimum of 32 credits should be earned through coursework, while maintaining a minimum CPI of 6.5, and a minimum of 32 credits through research. The minimum total credits requirement for a Ph.D. student with M.Tech./M.E. degree is 64. Out of this, a minimum of 16 credits should be earned through coursework (in a minimum of 4 courses), while maintaining a minimum CPI of 7.0, and a minimum of 32 credits through research. The minimum credits requirement for a Ph.D. student with B.Tech./B.E./M.Sc. degree is 96. Out of this, a minimum of 40 credits should be earned through coursework (in a minimum of 10 courses) and a minimum of 32 credits through research. The various courses offered from time to time in each area of specialization are listed below:

**Engineering Geosciences:** Earth System Processes; Environmental Geology; Geological Hazards; Satellite Remote Sensing and GIS for Geo-resource Evaluation; Photogeology in Terrain Evaluation; Global Climate Change; Paleoseismology and Tectonic Geomorphology; Laboratory Practices in Geoscience; Isotope Geochemistry and Applications.

**Geoinformatics:** Introduction to Remote Sensing; Machine Processing of Remotely Sensed Data; Instrumentation, Laboratory and Field Practices in Geoinformatics; Global Positioning System; Geographical Information System; Precision Remote Sensing; Geospatial Data Processing.

**Geotechnical Engineering:** Rock Mechanics; Advanced Geotechnical Engineering; Foundation Analysis and Design; Reinforced Earth Structures; Ground Improvement Techniques; Foundation Dynamics; Geotechnical Earthquake Engineering; Constitutive Modeling of Frictional Materials; Geotechnical Investigations for CE Projects.

**Hydraulics & Water Resources Engineering:** Hydraulic Structures; Engineering Hydraulics; Fluid Mechanics Laboratory; Sediment Transportation; Hydrologic Analysis and Design; Groundwater Systems Analysis; Water Resources Engineering; Introduction to AI Techniques; Transients in Pipes; Unsteady Open Channel Flow; Stochastic Hydrology; Water Resources Systems Engineering and Management; Management and Modeling of Environmental Systems; Groundwater Hydrology and Pollutant Transport.

**Structural Engineering:** Structural Dynamics; Engineering Mechanics; Stability of Structures; Experimental Methods in Structural Engineering; Advanced Structural Analysis; Masonry Structures; Advanced Design of Reinforced Concrete Structures; Advanced Design of Steel Structures; Durability of Concrete Structures; Earthquake Analysis and Design of Structures; Random Vibrations; Theory of Plates and Shells.

**Transportation Engineering:** Traffic Flow Modeling and Simulation; Analysis and Design of Pavement Systems; Analysis and Design of Transportation Infrastructure; Traffic Engineering; Urban Transportation System; Rail Transportation Systems Planning and Design; Airport Systems Planning and Design; Characterization of Pavement Materials and Analysis of Pavements; Laboratory Course in Transportation Engineering.

In addition, Advanced Mathematics for Civil Engineers is a compulsory course in the M.Tech. programme for all areas of specialization.

#### 4. FACILITIES

In each of the areas of specialization, the Department is equipped with well developed laboratory facilities. The state-of-the-art research facilities in the Department include the following:

- ❖ Atomic Absorption Spectrometer, WDXRF, Vertical Laminar Flow Work Station, Resistivity Meter, Hydrobios Sediment Corer Echo Sounder, Water Analysis Equipment, Digital Flame Photometer, Exploration Seismograph, Stereoscopes Station for the Worldwide Aeronet Project, GPS, Drill Cores Scanner, GPR Survey Instrument, Petrological Microscopes.
- ❖ Ion Chromatograph, High Performance Liquid Chromatograph, AAS, TOC, CHNOS Analyzer, GC-ECD-FID, Weather Monitoring Station, UV Visible Spectrometer, HDTLC, GC-MS, Optical Particle Counter, Scanning Mobility Particle Sizer, Aerosol Mass Spectrometer, Micro-Orifice Uniform Deposition Impactors, Aerodynamic Particle Sizer, Cloud Condensation Nuclear Counter, Particle Soot Absorption Photometer, Particle Absorption Soot Photometer, Cloud Combination Probe, Condensation Particle Counter, Fog Chamber.
- ❖ Robotic and Motorized Total Stations, Digital and Auto Levels, Digital Theodolites, Single and Dual Frequency Geodetic Quality Differential GPS

Receivers, Navigational GPS Receivers, Permanent GPS Reference Station for Engineering and Scientific Applications, Terrestrial Laser Scanner, Range Camera, Integrated GPS and INS system, Digital Photogrammetric Workstation, Software for Geospatial Applications: ERDAS Imagine, ERMapper, ArcInfo and ArcView, AutoDesk and Bentley Microstation Suites, Terrascan, Terramodeller, Polyworks, Leica Photogrammetry Suite.

- ❖ Advanced Cyclic Triaxial Testing Facility, In-situ Testing, SCPT Plate Load Test Facility, Spectrum Analyzer for Surface Waves, Seismic Down-Hole Testing Facility, Geotechnical Digital System (GDS), Geosynthetics Testing Facility for Geogrids and Geonets.
- ❖ Complete Infrastructure for Physical Modelling of Rivers for Studying Scour Patterns and River Training Works, Facility for Hydraulic Testing of Pipes, Fluid Friction Apparatus, Momentum Measurement Apparatus, Apparatus to Calculate Sudden Losses in Expansion, Contraction and Bends, Hydrology System, Hydro-Metrological Observatory.
- ❖ Pseudo Static Cyclic Testing Facility, Shake Table Test Facility for Small Scale Models, Accelerometer-Based Wireless Measurement System, Fibre Optic-Based Strain and Temperature Measurement System, State-of-the-Art Teaching Laboratory for Structural Dynamics, Construction Materials Testing Facilities including NDT equipment, Equipments for Properties of Fresh and Hardened Concrete, Vibration Survey System (including eccentric mass shaker) for In-situ Measurement of Dynamic Properties of Existing Structures.
- ❖ Centrifuge Bitumen Extractor, Marshall Test, Fatigue Test for Bituminous Mixes, Profilograph, Rotational Viscometer, British Pendulum Tester, Driver Testing Equipment, Traffic Speed Measurement Radar, Stone Polishing Machine, Thin Film Oven Test, Asphalt Content Tester by Ignition Method, GPS Set-up, Vehicle Detection and Classification System.



## COMPUTER SCIENCE & ENGINEERING

The department offers academic programs leading to B.Tech., M.Tech., M.Tech. dual degree (B.Tech. and M.Tech) and Ph.D in Computer Science and Engineering. These programs are flexible and allow the students to choose courses from a number of elective courses offered by the department that cover a wide range of topics in Computer Science & Engineering.

### RESEARCH

The department is actively involved in research in various fields of Computer Science. The domain of research ranges from abstract theory to problems of immediate interest to industry. The research in the department can be broadly classified into the following areas:

**Algorithms:** Parallel and distributed algorithms, graphs and combinatorics, computational geometry, randomized algorithms, computational number theory, computational biology, bioinformatics, algorithms for biometric based identification, algorithms for streaming data.

**Artificial intelligence and big data analytics:** Machine learning, pattern recognition, image processing, text processing, natural language processing, machine translation, computer vision, cognition and computation, data mining.

**Computer architecture, operating systems and hardware design :** Computer architecture, operating systems, embedded systems, parallel and distributed computation, VLSI design and testing, embedded computing design and security.

**Information system and networks:** Database systems, mobile computing, transaction management and processing, distributed systems, workflow systems, protocols, network performance and analysis, IPv6, internet technologies, wireless and mobile networks, low-cost networking, sensor networks.

**Software engineering, compilers, programming languages:** Metrics and models for software architecture, quantitative approaches to project and process management, design methodologies, formal specification, programming environments, translators for declarative and functional languages, automatic generation of compilers, compilers for non-conventional architectures, parallel processing and applications, grid computing, code optimization.

**Theoretical Computer Science:** Complexity theory, Logic in computer science, functional programming, algorithmic information theory, computational number theory, cryptography, computable real and complex analysis.

**Computer Security:** Network and OS security, cryptography, biometrics

## FACULTY

**Sanjeev K Aggarwal, Ph.D. (IIT, Kanpur):** Compiler design, compilers for advanced computer architectures, parallelizing compilers, tools for compiler generation, semantics of programming languages, grid computing.

**Manindra Agrawal, Ph.D. (IIT, Kanpur):** Computational complexity theory, randomized algorithms, cryptography, computational number theory.

**Somenath Biswas, Ph.D. (IIT, Kanpur):** computational complexity theory, logic, randomized algorithms, computational biology.

**Surendra Baswana, Ph.D. (IIT, Delhi):** Graph algorithms, dynamic algorithms and randomized algorithms.

**Mainak Chaudhuri, Ph.D. (Cornell Univ.):** Computer architecture, cache coherence protocols.

**Sumit Ganguly, Ph.D. ( Univ. of Texas, Austin):** Database systems, streaming algorithms.

**R K Ghosh, Ph.D. (IIT, Kharagpur):** Mobile computing, adhoc and cellular mobile networks, parallel and distributed computing, web services, mobile commerce.

**Arnab Bhattacharya, Ph.D. (Univ. of California, Santa Barbara):** Database systems, data mining, sensor networks, bioinformatics.

**Phalguni Gupta, Ph.D. (IIT, Kharagpur) :** Biometrics, image processing, sequential and parallel algorithms, parallelization of sequential programs.

**Ajai Jain, Ph.D. (McGill Univ.):** VLSI testing, fault tolerance, computer architecture, parallel processing, operating systems, machine Ttranslation.

**Piyush P Kurur, Ph.D. (IMSc, Chennai):** Complexity theory, computational algebra, quantum computing.

**Harish Karnick, Ph.D. (IIT, Kanpur):** AI, machine learning, cognitive science, programming languages, computational biology.

**Shashank Mehta, Ph.D. (Univ. of Nebraska):** computational geometry, graph algorithms, approximation algorithms.

**Rajat Moona, Ph.D. (IISc, Bangalore):** Computer architecture, embedded computing hardware, operating systems, VLSI design and CAD for VLSI.

**Amitabh Mukherjee, Ph.D. (Univ. of Rochester):** Visual surveillance, natural language processing, machine learning, cognitive science.

**TV Prabbakar, Ph.D. (IIT, Kanpur):** Software architecture, knowledge engineering, internet technologies.

**Dheeraj Sanghi, Ph.D. (Univ of Maryland):** Computer networks, protocols at MAC/network/transport layers, Ipv6, wireless networks, internet applications, multimedia applications

**Sanjeev Saxena, Ph.D. (IIT, Delhi):** Parallel processing, algorithms and data structures, heuristics, computational geometry, graph theory, VLSI and architecture.

**Anil Seth, Ph.D. (TIFR, Mumbai):** Logic in computer science.

**Krithika Venkataramani, Ph.D. (Carnegie Mellon Univ.):** Pattern recognition, machine learning, biometrics, video surveillance, statistical analysis.

**Satyadev Nandakumar, Ph.D. (Iowa State Univ.):** Algorithmic information theory, computable real and complex analysis.

**Amey Karkare Ph.D. (IIT, Bombay):** Compilers, Program analysis and optimization, Functional programming, Intelligent Tutoring Systems.

**Subhajit Roy Ph.D. (IISc, Bangalore):** Compilers, program analysis and optimization.

**Raghunath Tewari Ph. D. (Univ. of Nebraska):** Computational complexity theory, graph theory.

## PROGRAMS

The department has a highly regarded undergraduate program. The course curriculum for the undergraduate program gives the flexibility to students to prepare for advanced specializations. The course structure provides a mix of compulsory and elective courses. The institute also has dual major (two BTech degrees) and dual degree (BTech-MTech) programs.

Admission to the B.Tech programs of all departments of IITs and some other Institutes is made once a year through a Joint Entrance Examination (JEE-Advanced). Admissions are offered on the basis of a candidate's All India Rank in JEE-Advanced. More information about admission into B.Tech program is available from the institute's JEE office.

The M.Tech program is oriented towards research and advanced training in Computer Science. It is designed for students who have a B.Tech./B.E. in computer science or equivalent degrees. The student has to do two compulsory courses (can be waived depending on background) and five (six or seven if waiver is taken) electives for a total of seven or more courses depending on his/her interests. Thesis work forms a major component of the program and begins in the second semester. Admission to the M.Tech. program is open to candidates holding a B.Tech./B.E. in any discipline or MSc. degree in science and who have qualified GATE with CS stream. Applicants with GATE in EE, EC and MATHS streams are also considered provided they have adequate CS background. Sponsored/Q.I.P. candidates need not qualify GATE, but must possess a good CS background.

The Ph.D. program is designed for students with strong motivation for doing research in computer science. Admission to Ph.D. is open to candidates holding M.Tech./M.E. degree or equivalent. Outstanding candidates with strong CS background and having B.Tech/B.E. or equivalent degree in any discipline and M.Sc in Maths, Statistics, Physics are also admitted to Ph.D. Normally a student with an M.Tech degree in CS has to complete four courses but a student with only B.Tech/BE/MSc must complete ten courses as a part of his/her Ph.D. program. The students choose these courses depending on their interest and on suggestions of their mentor. Each student must also pass a comprehensive examination which tests the breadth of his/her knowledge as well as the ability to do research.

All Ph. D. Students are provided with individual laptops, own office spaces and a shared telephone when they join. They also get office support for photocopying, laser printing, mailing, stationery, etc. Ph.D. students also get generous travel support to attend conferences inside the country and abroad. Ph.D. students get enhanced stipends depending on his/her performance. A number of industry supported fellowships are also available to Ph.D. Students.

Eligible candidates have to go through a test and/or interview conducted by the department for admission to both the MTech and Ph.D. programs.

## LABORATORY

The department has its own well-equipped laboratories apart from a state-of-art Computer Centre that is a central facility. IIT Kanpur has one of the largest campus-wide networks in the educational sector in the nation with 3Gbps connectivity to the Internet. All students get e-mail, browsing and other internet facilities.

## LIBRARY

The department library supplements the Central library by procuring proceedings of select conferences and some journals.

## ELECTRICAL ENGINEERING

The department of Electrical Engineering offers M.Tech and Ph.D programmes in almost all the sub-disciplines of Electrical Engineering. The areas include: Digital Communication Systems; Information and Coding Theory; Telecom Networks; Mobile and Wireless Communication Systems; Digital Signal and Image Processing; Computer Vision; Inverse Problems and Tomography ; Signals and Systems Theory; Control Systems and Robotics; Path Tracking and Electric Vehicle Control; Electronic and Virtual Instrumentation; Fuzzy Logic; Neural Networks and their applications; Power Systems; Smart Grid and Synchrophasors; Power Electronics; Electric Drives; Active Power Filters and Static VAR Systems; Renewable Energy Interfaces; Microelectronics; VLSI System Design; Analog and Digital Circuit Design; Semiconductor Device Modeling and Simulation; Solid State Devices; Nano-electronics and Nano-scale Devices; Spintronics; Organic Electronics; Photovoltaics; Electromagnetics; RF Engineering and Microwaves; Metamaterials, MMIC, RF and Microwave Sensors, RFID, Microwave Imaging, Electromagnetic Tomographic Imaging, Quantum Dots, Optoelectronics an Optical Communication; Photonic Networks and Systems.

### Programmes

Specialization in the M.Tech / Ph.D Programmes is possible in any of the following broad areas:

Microelectronics, VLSI and Display Technologies

Power and Control

RF, Microwaves and Photonics

Signal Processing, Communications and Networks

In addition to the above specified areas, this year the department will also offer admission in Ph.D programme in Control and Instrumentation. The candidates having engineering postgraduate degree in ECE, EE, Control or Instrumentation qualify to seek admission in Ph.D programme in Control and Instrumentation.

In the application form, the applicants must specify their choice of area(s) of specialization mentioned above. Eligibility for a specialization may depend on the candidate's choice of test paper in the GATE examination. For detailed information regarding eligibility and minimum qualifications, applicants should refer to the web-site of the Dean of Academic Affairs.

In the Master's programme, a student credits eight courses, some of which may be from a compulsory package for the area of specialization chosen, the rest being electives to be chosen in consultation with programme advisors. The programme culminates in a thesis that has to be defended in an oral examination before a thesis board.

In the Ph.D programme, a student has to complete minimum of four courses. The most important part of the doctoral programme is the research work leading to a thesis. The research should represent an original investigation and is expected to make a significant contribution to the knowledge in the subject. The thesis is examined by a board of examiners appointed by the institute and is also defended by the student in an oral examination before a thesis board.

### OPPORTUNITIES IN SPONSORED RESEARCH

Sponsored research and development activities are pursued in the department. Work on currently relevant problems involving advanced technologies is carried out in many sponsored projects. Students are encouraged to choose problems that have relevance to these activities, thus enabling them to not only use some of the sophisticated facilities available, but also to work on state of art and practically meaningful topics.

In special cases it is possible for qualifying candidates to join projects as Research Associates and concurrently carry out both Research (which will usually be related to their thesis work) and course work. Such candidates are likely to get additional remuneration than the MHRD norms for PG scholarships.

### FACULTY

**Akhtar M J, Ph.D. (Magdeburg):** Microwave imaging and nondestructive testing, Electromagnetic characterization, Electromagnetic scattering: direct and inverse problems, Microstrip Circuits, Computational electromagnetics.

**Banerjee A, Ph.D. (Notre Dame):** Cognitive radio; Error control coding; Wireless Communications; Optical Communications.

**Bansal R K, Ph.D. (Connecticut):** Universal source coding algorithms and data compression; Ergodic theory and large deviation theory – applications; Robust detection; Sequential detection of a change in distribution.

**Behera L, Ph.D. (IITD):** Intelligent control; Soft computing; Quantum computing and Information; Applied nonlinear control

**Biswas A, Ph.D. (IITD):** Electromagnetics; Microwave and millimeter wave circuits and techniques; Optical guide structure and RFICs

**Chakraborti S, Ph.D. (Newfoundland):** Power system dynamics and stability; Power system state estimation; Synchrophasor applications in power systems; Power system reliability.

**Chaturvedi A K, Ph.D. (IITK):** Communication theory and systems; Mobile communications; Spread spectrum systems.

**Chauhan Y S, Ph.D. (EPFL):** Nanoelectronics; Compact modeling of semiconductor devices: Bulk/SOI/FINFET/Tunnel FET/Nanowire/Power devices; DC/CV and RF Characterization of MOSFET

**Das S P, Ph.D. (IITKGP):** Power electronics; Electric drives; Electrical machines; Microprocessor and microcontroller systems

**Das Utpal, Ph.D. (Michigan):** High speed photonic semiconductor devices and integrated optoelectronics.

**Dutta Alope, Ph.D. (Louisiana State):** Semiconductor device modeling; IC fabrication technology, Analog/digital/mixed-signal VLSI circuits.

**Ghosh B, Ph.D. (Texas):** Device simulation; Digital and analog Circuits; VLSI technology; Photovoltaic systems; Spintronics.

**Gupta N, Ph.D. (IISC):** High voltage engineering; Dielectrics and electric insulation; Gaseous and plasma discharge process; Numerical techniques in electric and magnetic field computation.

**Gupta S, Ph.D. (London):** Digital signal processing; Image processing; Digital video signal processing.

**Harish A R, Ph.D. (IITK):** Antennas; RF Engineering; Electromagnetics.

**Hegde R M, Ph.D. (IITM):** Multimedia information processing; Speech signal processing; Array processing; Application of signal processing in wireless networks.

**Iyer S S K, Ph.D (Berkeley):** Organic solar cell; semiconductor devices.

**Jagannatham A K, Ph.D. (UCSD):** Wireless communication; Digital video processing; MIMO, OFDM and CDMA technologies; Wireless sensor networks.

**Joshi A, Ph.D. (Toronto):** Power electronics and drives; Electronic circuits; Digital systems; Microprocessor based systems.

**Kalra P K, Ph.D. (Manitoba):** Power systems; Expert systems applications; HVDC transmission; Fuzzy logic and neural networks applications.

**Kumar Pradeep K, Ph.D. (IITM):** Quantum and non-linear optics; quantum cryptography and computation; Fibre optics.

**Mazhari B, Ph.D. (Illinois):** Semiconductor device modeling and fabrication; VLSI design; Transducers and sensors.

**Mishra S K, Ph.D. (Florida):** Multiphase DC/DC power conversion; Power management circuits; Modeling and control of power electronics systems.

**Naik Naren, Ph.D. (IISC):** Reconstruction and analysis approaches to tomographic problems; Numerical solutions for wave propagation; Sub-surface imaging.

**Potluri R P, Ph.D. (Kentucky):** Control system theory; Practical applications of control theory; Electric vehicles.

**Qureshi S, Ph.D. (Berkeley):** Thin film transistors; Device physics and modeling; VLSI design; Nanoelectronics; Nuclear detectors and electronics.

**Rajawat K, Ph.D. (Minnesota):** Sensor networks; Cross-layer optimization; Distributed network control; Network monitoring; Network coding.

**Sensarma P, Ph.D (IISC):** Power electronic converters; Power quality; FACTS devices; Renewable energy delivery systems; Motor drives.

**Sharma G, Ph.D. (USC):** Signal processing; Communication Systems; Video signal processing; Medical image processing.

**Singh S N, Ph.D. (IITK):** Power system restructuring; FACTS technology; Optimal power dispatch and security analysis; Power system dynamics, operation and control; Power quality; Application of genetic algorithms and artificial neural networks in power systems; Wind power.

**Singh Y N, Ph.D. (IITD):** Telecommunication networks; Optical communications, networks and switching systems; Wireless networks; Wireless sensor networks; eLearning systems development.

**Sircar P, Ph.D. (Syracuse):** Signal processing and systems; Communication theory; Computational methods.

Srivastava Kumar Vaibhav, Ph.D. (IITK): RF Engineering; Microwave; Electromagnetics.

**Srivastava S C, Ph.D. (IITD):** Power systems; Energy management systems; Stability and security analysis; Technical issues in electricity markets; Wide area monitoring and control; Distribution management systems.

**Vasudevan K, Ph.D. (IITM):** Communication systems; Signal processing for communications.

**Venkatesh K S, Ph.D. (IITK):** Signal/Systems theory, Image and video processing; Computer vision applications.

**Verma N K, Ph.D. (IITD):** Data mining; Intelligent fault diagnosis; Fuzzy systems; Bioinformatics; Machine learning; GMM; HMM; Clustering algorithms; Color segmentation; Video image sequence recognition.

## COURSES

The Department offers a rich set of PG courses from the following:

Digital Circuit Design; Architecture of Advanced Microprocessors & Microcomputers; Analog/digital VLSI Circuits; VLSI System Design; Measurements, Parameter Extraction and VLSI tools in Microelectronics; solid State devices I; Semiconductor Device Modeling; Fluctuation Phenomena in Microelectronics; Integrated Circuit Technology; High Frequency Semiconductor Devices and Circuits; Organic Electronics; Nanoelectronics.



Economic Operation & Control of Power Systems; HVDC and flexible AC Transmission Systems; Advanced Power System Stability; Simulation of Modern Power Systems; Electric Power System Operation and Management under Restructured Environment; Electrical Insulation in Power Apparatus and Systems. Basics of Modern Control Systems; Control System Design; Optimal Control; Digital Control; Robust Control Systems; Nonlinear Systems; Linear Stochastic Dynamical Systems.

Basics of Power Electronics Converters; Power Electronics Applications in Power Systems; Control Techniques in Power Electronics; Modeling and Simulation of Power Electronics Systems; Fundamentals of Electric Drives; Advanced Electric Drives; Special Topics in Power Electronics.

Advanced Engineering Electromagnetics; Computational Electromagnetics; Finite Element Method for Electric and Magnetic Fields; Antenna Analysis & Synthesis; Smart Antennas for Mobile Communication; Microwave measurement and Design; Microwave Circuits; Monolithic Microwave Integrated Circuits; Microwave Imaging, Characterization and Non-destructive Testing; Computational Tomography; Fiber Optics Systems I and II; Optical Communication; Photonic Networks and Switching. Mathematical Structures of Signals and Systems; mathematical Methods in Signal Processing; Statistical Signal Processing; Advanced Topics in Digital Filtering; Image Processing; Architecture and Applications of Digital Signal Processors; Wavelet Transforms for Signal and Image Processing; Introduction to Signal Analysis; Digital Video Signal Processing; Computer Vision and Document Processing; Speech Signal Processing.

Representation & Analysis of Random Signals; Communication Theory; Detection and Estimation Theory; Information and Coding Theory; Satellite Communications; Topics in Stochastic Processes; Topics in Cryptography and Coding; Digital Switching; Wireless Communications; Queuing Systems; Digital Communication Networks; Sensor Networks; Application of CDMA to Cellular Communication.

Knowledge Based Man-machine Systems; Computational Bio-instrumentation & Neural Networks; Fuzzy Set, Logic & Systems and Applications; Neural Systems and Networks; Virtual Instrumentation.

#### **FACILITIES:**

The department has excellent research laboratories and support facilities in several areas.

Micro fabrication lab with basic semiconductor processing capability for silicon as well as organic material based devices (OLED, organic solar cells, OTFT, etc.); Solar cell characterization lab; photo mask making facility; Semiconductor device lab with capability to synthesize organic materials for organic LEDs and solar cells; Integrated circuits simulation and VLSI design laboratory with all the modern EDA tools, (e.g. Cadence, Synopsis, Mentor Graphics, Xilinx based gate array design & programming tools, etc.) and adequate hardware in the form of servers and good number of workstations for research and course work with provision to fabricate chips at different technology nodes.

Three teaching/training labs have been developed to train students in areas related to organic electronics. These are the organic electronics processing lab, the organic electronics characterization lab and the organic electronics simulation lab.

Robotics lab equipped with 7 DoF manipulators, mobile robots, and visual systems for autonomous navigation of mobile robots, multi-robot formation and control. Control system lab with facilities for multi-motor coordination, control networks and intelligent vehicle control.

Modern high voltage laboratory with AC, DC and impulse test facilities, partial discharge monitoring, electrometer for polarization and loss factor tests, outdoor insulation test bay; Power electronics and solid state drives laboratory; Power systems simulation laboratory; NAMPET laboratory with complete fabrication and testing facilities for research in power electronics including frequency response analyzer, solar photovoltaic panels. Power management lab with solar simulator, frequency response analyzer, electronic loads and fabrication facility

RF and Microwaves lab having network analyzer up to 67 GHz, spectrum analyzers, signal generators, power meters, noise figure meter, shielded anechoic chamber for antenna and RCS measurements, microwave imaging and material testing facility over a wide frequency range, dielectric probe kit, rectangular waveguide and coax calibration kits for various frequency bands.

Fiber optics laboratory equipped with optical spectrum analyzer and interface development facility for fiber optic links, clean room for semiconductor optoelectronic device fabrication and photonic measurement laboratory.

Networks laboratory with scalable and configurable test-bed for simulating complex network topologies, 802.11 WiFi links, software radio, multiservice network and QoS, etc.

Speech processing and multi-modal information processing lab equipped with the state of art multi-channel audio visual data acquisition test bed along with dedicated data and voice server connected on E1 digital telephony line enabling research on multi-channel and multi-modal information processing and content delivery; Digital signal processing laboratory with multiple PCs and DSP hardware based on Texas instrument's DSPs; Computer vision lab equipped with chroma keying, controlled illumination, structured light sources, various kinds of camera and associated computational resources.

Electronic equipment maintenance and calibration facility; Multilayer (up to six layers) PTH printed circuits fabrication facility, including CAD facility for printed circuits design and verification; Department library with a good collection of specialized books, research reports and data catalogues; An extensive campus wide LAN with a high speed internet connectivity.

The wide-ranging research facilities and various sponsored research activities ensure that the students are thoroughly exposed to modern trends in Electrical Engineering. The informal atmosphere and free discussions between the students and the teachers are a source of inspiration to both the sides and maintain the standards of academic progress.



## INDUSTRIAL AND MANAGEMENT ENGINEERING

The Department of Industrial and Management Engineering at IIT Kanpur was established with the aim of synergizing technology with management. This synergy, which commenced with the M.Tech and PhD programmes offered by the department, was consummated with the introduction of MBA programme in the year 2001.

We focus on developing techniques and skills relevant to students with diverse backgrounds who may wish to subsequently pursue a career in academics or in different managerial positions. The department covers all areas of management that include Services Management, Management of Technology, Innovation and Entrepreneurship, Marketing Management, Manufacturing, Operations and Supply Chain, Quantitative Methods & Decision Making, Organizational Behaviour, Human Resource Management, Business Economics, Infrastructure and Public Systems, Corporate Governance, Finance and Control Systems, Financial Markets and Models, Enterprise Information and Knowledge Systems, Leadership, Ethics, Strategic Management, Business Policy, etc.

### Ph.D. Programme

Students in the Ph.D. program are required to take at least eight courses. A student may be required to take additional courses depending on his/her background and research interest. At the end of the course work, the student appears for the Ph.D. comprehensive examination, which includes both written and oral parts. On successfully completing the comprehensive examination, he/she will continue research towards completion of the doctoral thesis. Students are encouraged to carry out discussions and consultations with the department faculty members about the field of research and should identify their thesis supervisor by the time of their comprehensive examination.

### M.Tech. Programme

M.Tech. students are required to take 3 core courses and 6 elective courses. Students in the M.Tech Programme take a minimum of four courses per semester during the first two semesters and one course in the third semester. The last two semesters are dedicated mostly to a thesis. A student can select courses based on his/her area of interest. Courses lay foundation for thesis work. Thesis can be done in any of the areas of management that include Services Management, Management of Technology, Innovation and Entrepreneurship, Marketing Management, Manufacturing, Operations and Supply Chain, Quantitative Methods & Decision Making, Organizational Behaviour, Human Resource Management, Business Economics, Infrastructure and Public Systems, Corporate Governance, Finance and Control Systems, Financial Markets and Models, Enterprise Information and Knowledge Systems, Leadership, Ethics, Strategic Management, Business Policy, etc.

### MBA Programme

Students in the MBA program are required to take a set of compulsory courses. Along with that they are also supposed to do the requisite number of specialization and elective courses. In the III and IV semesters the students are supposed to do

two special studies courses with an aim to give them an in-depth understanding in areas of management which is in line with the student's interests.

### Facilities

The Department has state-of-the art facilities for computational business modelling and simulation, design prototyping, SAP, Primavera, PFI (Project Finance International), Real Options SLS, Risk Simulator, DEA-Solver-Pro 8.0, SHAZAM Professional Edition 11, Product Lifecycle Management (PLM) software, graphics software like NX 7.5, also known as NX Unigraphics, Simulation and Automation Software like Arena 13, Stella 9.1 and DTS (Data Transformation Services), Statistical Software like SPSS 18 (Statistical Package for the Social Sciences), SAS 10 (Statistical Analysis System), MATLAB, MINITab and UML diagramming applications like ArgoUML digital innovation & investigating and all spheres of business systems in an integrated smart building. The various laboratories provide, computational support both for academic teaching and for research. Different academic databases are also available for research as well as teaching purposes. Furthermore the department also has the state of the art class rooms, lecture rooms, video-conferencing facilities, etc.

### Faculty

1. **Veena Bansal, Ph.D. (IIT Kanpur):** Information Technology and Management, ERP systems, E-Commerce.
2. **Devlina Chatterjee, Ph.D. (IISc Bangalore):** Business Economics, Applied Economics, Empirical Finance, Rural Economics.
3. **Jayanta Chatterjee, Ph.D. (IIT Delhi):** Marketing, Entrepreneurship, Services Management, Management of Technology & Innovation, Management of Design and Media.
4. **Shashi Shekhar Mishra, Fellow in Management (IIM Lucknow):** Marketing Strategy, New Product Development, Marketing Research.
5. **Subhas Chandra Misra, Ph.D. (Carleton University, Canada):** Information Systems, Analytics and Business Process Management.
6. **A. K. Mittal, Ph.D. (Case Western University, USA):** Operations Research, Operations Management, TQM, IPR & Services Management.
7. **B. V. Phani, Fellow in Management (IIM Calcutta):** Entrepreneurship, Accounting & Finance, Financial Governance.
8. **Deepu Philip, Ph.D. (MSU Bozeman, USA):** Operations Management, Decision Sciences, Business Games, System Simulation, Digital Innovation.
9. **Puneet Prakash, Ph.D. (GSU, Atlanta):** Financial Risk Management, Finance, Insurance, Quantitative Finance.
10. **Uday S. Racherla, Ph.D. (Purdue University, USA):** Innovation & Intellectual Property Management, Sustainability and Technology Transfer & Commercialization.
11. **R. N. Sengupta, Fellow in Management (IIM Calcutta):** Statistical Analysis, Risk Management, Quantitative Decision Techniques.
12. **Kripa Shanker, Ph.D. (Cornell University, USA):** Production/Operations Management, FMS/CIMS; Quantitative Decision Modelling.

13. **N. K. Sharma, Ph.D. (Delhi University):** Consumer Behaviour, Marketing Management, Marketing Research.
14. **R. R. K. Sharma, Fellow in Management (IIM Ahmedabad):** Quantitative Methods for Management, Manufacturing Policy, Strategic Management.
15. **Anoop Singh, Ph.D. (IGIDR, Mumbai):** Infrastructure Policy & Regulations, Energy & Environment, Managerial Economics, Project Financing, Energy Economics. Arun P. Sinha, Fellow in Management (IIM Ahmedabad): Strategic Management, Business Policy, International Business, Services Management.
16. **S. V. Va namalla, Ph.D. (IISc Bangalore):** Applied Operations Research, Optimization and Game Theory.
17. **Rahul Varman, Fellow in Management (IIM Ahmedabad):** Personnel Management and Industrial Relations, Organizational Theory and Social, Political, Legal issues in Business.

### Courses

Accounting for Management; Economic Analysis for Management; Financial Management; Measuring and Driving Corporate Performance; Financial Intermediates, Financial Institutions and Regulators; Financial Engineering; Management of Risk in Financial Systems; Commercial Banking, Risk Modeling & Risk Management; Entrepreneurial Finance; Security Analysis, Derivatives and Portfolio Management; Project Financing and Management; Energy & Carbon Markets: Economic Policy & Regulations; Power Sector Reform and Regulations: Theory & Practice, Financial Modeling; Infrastructure Regulation, Policy & Finance; Investment Valuation and Real Options; Organization Structure and Design; Managing Change in Organizations; Organizing for Services; Human Resources Management; Social Political and Legal Environment of Business; Globalization state & Corporations; Managerial Communication; Knowledge Strategies & Knowledge Systems; Manufacturing Strategy; Strategic Management; Corporate Innovation & Entrepreneurship, Management of Technology; Managing High Technology; International Business Management; Marketing Management; Strategic Marketing; Contemporary Issues; Design of e-Marketing; Marketing Research; Consumer Behaviour; Marketing of Services; Advertising and Marketing Strategy; Business to Business Marketing; Computing for Management; Database Management; Simulation of Business Systems; Management Information Systems; e-Commerce; Software Quality Management; Enterprise Information Integration; Software Project Management; Enterprise & Integration with IT; Business Process; Intellectual Property Management, Value Creation to Value Capture; Quantitative Methods for Decision Making; Production and Operations Management, Total Quality Management; Supply Chain Management; Manufacturing Planning and Control; Project Management; Managing Service Operations; Advanced Manufacturing Systems; Probability and Statistics; Introduction to Computing; Applied Design of Experiments; Operations Research for Management; Computer Aided Decision Systems; Network Flows; Production Systems; Operations Management; Algorithms; Combinatorial Optimization; Analysis and Control of Quality; Quality Assurance and Taguchi Methods; Stochastic Processes and their Applications; Software Engineering and Project Management; Computer Integrated Manufacturing Systems; Flexible Manufacturing Systems; Intelligent Manufacturing Systems; Advanced Statistical Methods for Business Analysis; Introduction to Game Theory; etc.

## MATERIALS SCIENCE & ENGINEERING

The department of Materials Science and Engineering at IIT Kanpur is world renowned for its exceptional quality of faculty, facilities and research. The department hosts a wide variety of state-of-the-art research facilities. In addition, the Advanced Center for Materials Sciences houses several advanced processing and characterization facilities. The department is involved in cutting edge computational as well as experimental research in both traditional as well as modern areas of materials science and engineering. The research activities of the department encompass a wide selection of materials including metals and alloys, semiconductors, ceramics, polymers, biomaterials and composites. The departmental research is directly relevant to various technologies such as Health, Renewable Energy, Transport and Automotive, Defense, Aerospace and Consumer Electronics.

### Major Research Areas

- ❖ Extractive, Process and Powder Metallurgy
- ❖ Physical Metallurgy
- ❖ Mechanical Behaviour of Materials
- ❖ Electrochemistry and Corrosion Science
- ❖ Computational Materials Science and Process Modelling
- ❖ Science and Engineering of Bio-materials
- ❖ Functional materials (e.g. Optical, Magnetic, Optoelectronic and Multiferroic) and Devices such as Memories, Displays and LEDs
- ❖ Energy and Environment Related Materials for Solar Cells, Fuel cells and Hydrogen Storage

### Career Opportunities

The postgraduate alumni of the department have an excellent placement record. Students of our department have become faculty members at premier institutions such as IISc, IITs, NITs and universities elsewhere in the world and scientists in several research labs such as ISRO, BARC, IGCAR, NML, DRDO, to name a few. Postgraduate alumni are also employed with leading industries like Tata Steel, Tata Motors, Ashok Leyland, Mahindra, GE, GM, SAIL, Moserbaer, BHEL etc. Our students also find opportunities in the IT and Finance sector.

### Academic Environment

In addition to pursuing research and education, our students are also actively involved in various professional society activities, such as Materials Science Advantage and Indian Institute of Metals, Kanpur. Institute provides ample opportunities and financial support to the PG students to present their research work at various conferences, in India and abroad. Students are also exposed to

various teaching opportunities in the form of teaching assistantships and tutorships. Students are encouraged and rewarded for publications in peer-reviewed journals. The institute offers ample opportunities for participation in a wide range of extracurricular activities for overall personality development.

### PG Admissions

For admission into the PhD program, students with M.Tech./M.E./B.Tech./B.E. degree in Metallurgical Engineering / Ceramic Engineering / Materials Science and Engineering / Mechanical Engineering and other appropriate engineering disciplines are eligible. Exceptionally bright students with M.Sc. degree in Materials Science / Physics / Chemistry / Biology (with Mathematics at B.Sc. level) are also eligible to apply for the PhD programme.

The minimum qualification for admission into the M.Tech. programme is B.E./B.Tech./B.S. degree in Metallurgical Engineering / Ceramic Engineering / Materials Science and Engineering / Mechanical Engineering and other appropriate engineering disciplines or M.Sc. degree in Materials Science / Physics / Chemistry. Candidates should also have qualified GATE with a valid score.

### Research Facilities

Synthesis and processing facilities include manufacturing units and facilities to fabricate materials in bulk and thin film form. Some of these facilities are specialty melting units and furnaces, physical and chemical thin film processing methods, mammalian and bacterial cell culture facilities, advanced sintering techniques such as spark plasma sintering, and conventional mechanical processing units such as rolling, swagging, and hot press. The department also has class 100 and 10000 clean rooms for the fabrication of devices.

Characterization facilities of the department include microscopy facilities consisting of optical and electron microscopes (SEM/ TEM/ FEG-SEM), atomic force microscope (AFM), powder and thin film X-ray diffractometer and thermogravimetric analysis instruments. Department also houses state-of-the-art testing facilities for measurement of complete array of mechanical, electrical, optical, magnetic and functional properties.

### Post Graduate Courses

PG students are free to choose from a number of fundamental and advanced postgraduate courses covering various aspects of material science and engineering. In addition to thesis requirements, PG students are required to complete minimum course requirement, depending upon their last degree and the background. A detailed list of courses, course requirement details and research interests of the faculty members are available on the department website (<http://www.iitk.ac.in/mse>).

**Kantesh Balani**  
Ph.D. (Florida Intl. University)

**Bikramjit Basu** (On leave)  
Ph.D. (KU Leuven, Belgium)

**Somnath Bhowmick**  
Ph.D. (IISc Bangalore)

**Krishanu Biswas**  
Ph.D. (IISc Bangalore)

**Ashish Garg**  
Ph.D. (Cambridge)

**Anshu Gaur**  
Ph.D. (UI Urbana-Champaign)

**Deepak Gupta**  
Ph.D. (UC Berkeley)

**Gouthama**  
Ph.D. (IISc Bangalore)

**Nilesh Gurao**  
Ph.D. (IISc Bangalore)

**Sarang Ingole**  
Ph.D. (Arizona State University)

**Monica Katiyar**  
Ph.D. (UI Urbana-Champaign)

**Kaustubh Kulkarni**  
Ph.D. (Purdue)

Biomaterials, Nanomechanics; Tribology, Ab-initio molecular modeling, Carbon nanotube (CNT) reinforced composites

Structural ceramics, Biomaterials, Tribology

Computational materials science, Size dependent properties of nanomaterials, Electronic structure calculations, Multiscale modeling

Nanomaterials, Solidification, Electron microscopy, Phase transformations, Graphene, Sintering

Structure-property correlations in multifunctional materials, Ferroic and multiferroic thin films and devices, Organic solar cells

Materials for electronic devices, Carbon based nanostructures, Device physics and simulation, Computational materials science

Organic Electronics (OLEDs, Displays, TFTs), Oxide and transparent semiconductors, Defects in semiconductors

Electron microscopy, Surfaces and interfaces, SPD Processing, Structure property correlations in materials, Shape memory alloys

Crystallographic texture, Thermo-mechanical processing and Mechanical Behaviour of materials

Inorganic Semiconductors for photovoltaics, Fabrication & applications of Nano Materials

Organic electronics, Solid state lighting, Printable electronics, Thin films, Electronic materials and devices: Characterization and processing

Light-weight alloys for automotive and aerospace applications, Multicomponent diffusion, Integrated computational materials engineering

<b>Tanmoy Maiti</b> <i>Ph.D. (Penn State)</i>	Nano-fabrication, Plasmonics, Renewable energy, Electronic materials and devices
<b>Indranil Manna</b> <i>Ph.D. (IIT Kharagpur)</i>	Structure-property correlations in materials, Synthesis and application of nano-materials, Surface engineering, Phase transitions and Fuel cells
<b>Dipak Mazumdar</b> <i>Ph.D. (McGill)</i>	Steelmaking, Process modeling, Heat, mass and momentum Transfer in materials processing
<b>Kallol Mondal</b> <i>Ph.D. (IIT Kharagpur)</i>	Phase transformations, Corrosion, Oxidation, Non-equilibrium processing, Metallic glasses, Nanocrystalline alloys
<b>Shobit Omar</b> <i>Ph. D. (University of Florida)</i>	Ceramic Processing, Solid state ionics, Solid oxide fuel cells, Electroceramics, Impedance spectroscopy, Sensors
<b>Sandeep Sangal</b> <i>Ph.D. (Manitoba)</i>	Mechanical properties of materials, Stereology, Computational materials science
<b>Romesh Chandra Sharma</b> <i>Ph.D. (McMaster)</i>	Phase equilibria, Thermodynamics and kinetics of phase transformations, Heat treatment of metals
<b>Rajiv Shekhar (On leave)</b> <i>Ph.D. (UC Berkeley)</i>	Electrochemical processing, Molten salt electrolysis, Aluminium electrolysis, Electrodeposition, Electrochemical remediation of soil
<b>Shashank Shekhar</b> <i>Ph. D. (Purdue)</i>	Grain boundaries and triple junctions, Severe plastic deformation, Machining and manufacturing, Structural nanomaterials
<b>Anandh Subramaniam</b> <i>Ph.D. (IISc Bangalore)</i>	Nanomaterials, Amorphous and metastable materials, Epitaxial systems, Defects and interfaces, TEM, Finite Element Modelling, Hydrogen storage.
<b>Anish Upadhyaya</b> <i>Ph.D. (Penn State)</i>	Materials processing, Liquid phase sintering, Structure-property correlations, Alloy design, Metal matrix composites, Nanocrystalline alloys
<b>Vivek Verma</b> <i>Ph. D. (Penn State)</i>	Protein micropatterning, Biosensor and biodevices, Fiber reinforced composites, Biomimetics

## MECHANICAL ENGINEERING

The Department of Mechanical Engineering is engaged in UG and PG teaching, research, developmental work and industrial consultancy. The PG program for M.Tech. and Ph.D. degree has four broad streams: Solid Mechanics and Design; Fluid Mechanics and Thermal Sciences; Manufacturing Science; and Robotics and Mechatronics (Ph.D only).

In the M.Tech. program, the emphasis is on the development of a broad background in a particular stream followed by a deeper study of a problem in the stream. Every student is required to take a minimum of 8 courses of which 3 or 4 (depending on the stream) are compulsory to be taken mostly in the first semester. In the second semester, the student takes mostly the elective courses and the remaining compulsory courses, if any. The elective courses are chosen in consultation with the thesis supervisor to match the student's interest as well as his thesis requirements. The third and fourth semesters are dedicated for the thesis work.

The minimum qualification for admission to the M.Tech. program is a Bachelor's degree in Mechanical Engineering\*. Candidates with a Bachelor's degree in Production Engineering\* are eligible for admission to the Manufacturing Science stream. At the time of admission, the candidates are ranked according to the merit depending on their previous educational background, GATE score and their performance in the interview/written test. The stream is allotted according to the rank and the preference of the candidate.

The Ph.D. program is designed to equip the student with general proficiency in a stream through the course work. The student then proceeds to do fundamental creative investigation of a topic in the stream. A Ph.D., student is required to take a minimum of 4 courses. After completion of the course work and before proceeding to the thesis work, he/she is required to pass the comprehensive examination. This examination is in both the written and the oral form and is designed to judge the overall comprehension of the student in his major field (the field of the thesis topic) and two minor fields (fields related to the thesis topics).

The minimum qualification for admission to the Ph.D. program is a Master's degree in Mechanical Engineering\*. In exceptional cases, candidates with B.Tech. (Mechanical)\*, Master's degree in other branches of engineering\* and M.Sc\*. will be considered. Interview/written test will be conducted by the department and the admissions would be made as per the procedure detailed at <http://www.iitk.ac.in/mech/>.

\*with minimum percentage/CPI specified by the Institute

### FACULTY

**Agarwal A.K, Ph.D. (IIT Delhi):** IC Engines, Alternate Fuels, Emissions, Laser Diagnostic Techniques, Micro-sensor Development, Lubricating Oil Tribology, Nano-particulates.

**Basu S, Ph.D. (IISc Bangalore):** Computational Micromechanics, Fracture Mechanics, Modeling of Materials across Length Scales, Finite Deformation Theories and Non-linear FEM.



**Bhattacharya B, Ph.D. (IISc Bangalore):** Smart Structures, Active and Passive Vibration Control, Flexible Manipulators and Smart Compliant Joints, Active Shape Control and Adaptive Structures.

**Bhattacharya S, Ph.D. (University of Missouri, Columbia):** Bio MEMS, Lab on Chip, Nano Technology, Microsystems Fabrication, MicroFluidics, Lithography processes, Nanoenergetics.

**Biswas G, Ph.D. (IIT/Kh):** Computational Fluid Mechanics and Heat Transfer, Turbulence.

**Chatterjee Anindya, Ph.D. (Cornell University):** Dynamics and Vibrations.

**Choudhury S.K, Ph.D. (PLPF Moscow):** Vibration Control of Machine Tools, Adaptive Control System, Metal Cutting, Hydraulic Control, Unconventional Machining.

**Dasgupta Bhaskar, Ph.D. (IISc Bangalore):** Robotics, CAD, Mechanisms, Machine Dynamics, Engineering Computation.

**Das M.K, Ph.D. (Penn State):** Electrochemical Energy Conversion, Chemically Reacting Systems.

**Das S.L, Ph.D. (Cornell):** Mechanics of Biological Membranes, Continuum Mechanics, Granular Mechanics.

**Deb Kalyanmoy, Ph.D. (Univ. of Alabama):** Optimization, Optimal Design, Computer Aided Design, Artificial Intelligence, Genetic Algorithms, Soft Computing.

**Dixit P.M, Ph.D. (Minnesota):** Metal Forming, Ductile Fracture, Elasto-plastic Impact/Contact Problems, Finite Element Method.

**Dutta Ashish, Ph.D. (Akita, Japan):** Robotics, Intelligent Control systems, Microsensors and actuators, Bio-robotics.

**Ghoshdastidar P.S, Ph.D. (South Carolina):** Computational Heat Transfer, Rotary Kiln modelling, Non-Newtonian Flow and Heat Transfer, Simulation of Boiling Heat Transfer. Modelling of Microscale and nanofluids heat transfer, food drying and chilling.

**Gupta A, Ph.D. (Berkeley):** Dynamics of Defects in Solids, Waves in Solids, Mechanics of Thin films.

**Gupta S.S, Ph.D. (Virginia Tech.):** Linear/Nonlinear Structural Mechanics, Mechanics of Nanomaterials and their Characterization using Molecular Simulations.

**Hatwal H, Ph.D. (IIT/K):** Vibrations, Dynamics of Ground Vehicles, Robotics.

**Jain V.K, Ph.D. (Roorkee):** Advanced Machining Processes, Accelerated Cutting, CAM Machining of Advanced Engineering Materials.

**Kumar Arvind, Ph.D (IISc Bangalore):** Manufacturing (casting, joining, welding, electron/laser beam melting/welding, layered and micro manufacturing, photovoltaic silicon growth); Heat transfer, Computational fluid dynamics (CFD); Multiscale and multiphysics modelling - coupling of heat transfer with electric/magnetic fields, thermal stress etc; Solid-Liquid phase change (Melting/

solidification); Laser/plasma assisted surface coating technologies; Phase change energy technologies; Flow interaction with cells and tissues.

**Kalra M.S, Sc D (MIT):** Nonlinear Dynamics and Control; Kinetic Simulation of Fusion Plasmas; Boundary Element Techniques.

**Kar K.K, Ph.D. (IIT/Kh):** Polymer, Polymer Blends, Alloys, & Composites, Polymer Processing & Rheology.

**Khandekar S, Ph.D. (Univ. Stuttgart, Germany):** Thermal Management, Passive heat Transfer, Heat Pipes, Energy systems.

**Kishore N.N, Ph.D. (IIT/K):** Composite Materials, FEM, Non-Destructive Testing.

**Mahesh Sivasambu, Ph.D. (Cornell):** Solid Mechanics, Composite Materials, Manufacturing Processes.

**Munshi P, Ph.D. (IIT/K):** Computer Tomography, Two-phase Flow, Non-destructive Testing.

**Muralidhar K, Ph.D. (Delaware):** Optical Techniques, Flow control, hierarchical transport phenomena, biological flows.

**Panigrahi P.K, (LSU):** Laser Based Instrumentation, Flow Control, CAD of Thermal Systems, Turbulence, Micro-fluidics and Heat Transfer.

**Ramkumar J, Ph.D. (IIT/M):** Micro/Nano-Fabrication & finishing, Nano Composites & Tribology.

**Reddy N.Venkata, Ph.D. (IIT/K):** Rapid Manufacturing, CAD/CAM, Metal Forming, Micro and Flexible Manufacturing Processes, Product and Process Design.

**Saha A.K, Ph.D. (IIT/K):** Turbulence, Chaos & Bifurcation, Vortex Dynamics, Hotwire Anemometry, Gas Hydrates, Experimental Fluid Dynamics and Heat Transfer, Computational Fluid Dynamics and Heat Transfer.

**Sarkar S (IIT/M):** Turbomachinery, Fluid Mechanics, Computational Fluid Flows, Turbulence, LES/DNS and Heat Transfer.

**Saxena Anupam Ph.D. (U Penn):** Compliant Mechanisms, Topology design, CAD, Robotics, MEMs, Optimization, Large Deformation Systems.

**Sharma B.L, Ph.D. (Cornell):** Continuum Mechanics and Thermodynamics, Lattice Dynamics, Dislocations and Solid-Solid Phase transformation.

**Sinha Sujeet K., Ph.D (Imperial College, London UK):** Nanotribology of microsystems, Tribological coatings, Lubrication, Polymer tribology, Bio-inspired surfaces for Tribology.

**Sharma Ishan, Ph.D. (Cornell):** Fluid/Solid mechanics; Contact mechanics; Granular media; Planetary/Space science; Waves and instabilities in continua; Fluid-structure interaction.

**Tiwari Nachiketa, Ph.D. (Virginia Tech):** Acoustics and Noise Control, Solid Mechanics, Composite Structures, Vibrations, Product Design, Automotive Systems, MEMS.

**Venkitanarayanan P, Ph.D. (U Rhode Island):** Experimental Solid Mechanics, Dynamic Fracture Mechanics, Functionally graded Composites.



**Vyas Nalinaksh S, Ph.D. (IIT/D):** Micro-Electro-Mechanical System (MEMS), Vibrations and Control, Rotor Dynamics, Instrumentation, Condition Monitoring

Wahi P, Ph.D. (IISc Bangalore): Nonlinear Dynamics, Vibrations.

## **COURSES**

The compulsory courses for M.Tech. Programs are as follows

**Solid Mechanics and Design:** Mathematics for Engineers, Introduction to Solid Mechanics, Applied Dynamics and Vibration

Fluid Mechanics and Thermal Sciences: Mathematics for Engineers, Viscous Flow Theory, Conduction and Radiation, Convective Heat and Mass Transfer

Manufacturing Science: Mathematics for Engineers, Metal Cutting, Non-traditional Machining Processes, Metal Forming

Elective courses for M.Tech. and Ph.D. students are listed at <http://www.iitk.ac.in/mech/>

## **FACILITIES**

The Department maintains the following laboratories for instruction and research: Experimental Stress Analysis, Vibration and Control, Material Testing, Machines and Mechanisms, Fluid Mechanics, Energy Conversion, Heat Transfer, Refrigeration and Air Conditioning and Manufacturing Science. There are many specialized research laboratories and facilities and their details can be seen on <http://www.iitk.ac.in/mech/>

## **DESIGN**

### **(Interdisciplinary programme)**

(An Interdisciplinary Courses-of-Study for the award of Master and PhD in Design)

Design Programme offers well-structured course-template for students to synthesize technology and aesthetics in the service of human-needs. The programme encourages creativity, innovation, craftsmanship, and personal expression leading to evolution of products and services in the field of engineering design and visual communications. A number of projects interspersed between the courses provide adequate opportunities for brain-storming yielding product and services to meet social, environmental and business need. The state-of-the-art technology-learning laboratories prepare the students for careers in industries and also higher studies through hands-on-experience. IIT Kanpur provides a broad-spectrum of courses and infrastructure in intense academic environment to achieve the above to build-in the students' adequate knowledge to make them stand tall in their professional and academic career.

### **Engineering design**

Engineering design projects are guided by faculty having close interactions with various product and service industries in India and abroad. The approach of concept-to-realization of functional prototype enables the learning of systematic and coherent way of engineering product development. This comprises product conceptualization, engineering design and design scheme leading to development of quality products which have great impact on social, environmental, business-strategy, defense, space etc due to their optimum design configuration and low life cycle costs achieved through concurrent engineering. IIT Kanpur provides excellent manufacturing facilities covering CNC turning and milling centers, Rapid Prototyping and also suitable test-benches for the product developed.

### **Communication Design**

Different courses and a wide spectrum of projects in Communication Design encourage students to explore the skills involved in this domain for creative expressions. Students are exposed to the fields of User Experience Design (UX), Visual Communication, Typography, Print Media, Interaction Design (UI), Film Making, New Media and Gaming. The electives offered in the stream help students realize the complexities of visual language, aesthetics, and usability. A strong component of Social Sciences and Management studies embedded in the form of elective courses further strengthen the communication design curriculum. Students extensively use the Media Technology Centre, which houses state of the art infrastructure to facilitate media research and aims to provide a meaningful platform for the students of the Design Programme to foster their creative potentials and merge it with their gradual process of acquiring and exchanging knowledge with technology based education at the institute.

## Life at Design Programme

The family of students at Design Programme is composed of people from varied backgrounds having unique talents. This diversity is threaded together by mutual understanding and cooperation, which characterizes the way of life here.

Creativity at Design Programme is not limited to academic projects. Students regularly take-up design projects outside their academic curriculum. Creative minds come together with enthusiasm to find innovative way of problem solving.

**Ph.D. in Design:** The applicant must have a master's degree in Engineering/ Technology/ Design with marks/CPI not below the specified minimum. Applicants with a bachelor's degree in Engineering/ Technology/ Design (four years programme) with a minimum of 75 percent marks / 7.5 CPI or Master's Degree in Science or an allied area satisfying each of the following criteria may also be considered.

- (a) A minimum of 65 percent marks/6.5 CPI in the Master's Degree
- (b) First division in Bachelor's Degree, and
- (c) Valid GATE/CEED score

## Faculty

**Ashutosh Sharma**, Ph.D (State University of New York at Buffalo)

- Soft nanofabrication, Mechanics, patterns and instabilities of soft visco-elastic interfaces and ultrathin films, Self-organized meso-patterning of polymers, carbon, ceramics and hydrogels, Functional and nano-materials: adhesive, catalytic, optical, super-wetting and nano-composites, Multiscale MEMS/NEMS & Microfluidic Systems: materials and platforms, Soft interfaces: Wetting, adhesion and friction, Carbon micro/nanostructures: fabrication and applications in environment, health and energy, Interfacial and colloidal interactions

**Bishakh Bhattacharya**, Ph.D (IISc, Bangalore): Professor & Head

- Axiomatic Design, Design of Embedded System, Intelligent System Design, Micro Electro Mechanical Systems (MEMS) and Multi-scale Design, Active and Passive Control, Smart Composites, Many-objective Optimization, Emergent System Design, Child Robot Interaction.

**Braj Bhusan**, Ph.D(BRAB University)

- Cognitive Factors in Design, Cognitive Neuropsychology

**Debabrata Goswami**, Ph.D (Princeton University)

- Photonics, Product Design Through Reverse Engineering

**Jayanta Chatterjee**, Ph.D (IIT Delhi)

- Design Management, Innovative Product Development

**Jhumkee Sengupta Iyengar**, Adjunct Faculty

- User Experience Design

**J Ramkumar** Ph.D., (IIT Madras)

- Micro / Nano- Fabrication and finishing, Nano Composites and Tribology, Product Design.

**Koumudi P Patil**, MFA (Visva Bharati University)

- Creative visualization, Communication Design, Form Development, Handicrafts

**Mainak Das**, PhD (University of Central Florida)

- Bioelectricity, Green energy, Bio-medical System Design

**Manindra Agarwal**, Ph.D (IIT Kanpur)

- Complexity Theory, Computational Number Theory, Peripheral Interest in Cryptography, Complex Analysis, and Combinatorics.

**Munmun Jha**, Ph.D(Glasgow)

- Social Anthropology, Indian Society.

**Nachiketa Tiwari Ph.D.**, (Virginia Tech); MBA, (Babson College)

- Acoustics and Noise control, Solid Mechanics, Composite Structures, Vibrations, Product Design, Automotive Systems, MEMS.

**P Sensarma**, Ph.D (Indian Institute of Science, Bangalore)

- Power Electronic Applications to Power Systems, Power Quality, FACTS devices, Power Supplies, Utility Interfaces for Renewable Generation.

**Satyaki Roy**, Ph.D (Visva Bharati Univ.)

- User Experience Design, New Media, Film Making

**Shatarupa Roy**, MFA (Visva Bharati Univ.)

- Design Theory, Visual Culture, Print Media and Graphics

**Sameer Khandekar** Ph.D (Uni-Stuttgart, Germany)

- Thermal Management, Passive Heat Transfer, Heat Pipes, Energy System.

**A K Varma**, PhD (IISc, Bangalore) : Visiting Professor

- Product Design, Development, Certification and Productionization, Management of Technology

## COURSES

Design Theory unveils the fundamental principles of design problem solving with special emphasis on the visual elements. It broadly covers the history, philosophy and cultural complexity concerning aesthetics and functionality of design.

Design Practice focuses on aspects like Axiomatic Design, Algorithmic Process of Design, Theory of Inventive Problem Solving, Product Planning and Specification, Benchmarking and Product Ramping.

Projects in Engineering Design & Visual Communication are designed to convert theoretical learning into Tangible Products & Services supplemented by Studies in Design, Interactive Design, Form & Style, 2D and 3D Visual Design, Elements & Principal of Design, Management of Design Innovation etc.

A number of courses are also available as electives from other departments such as Knowledge Strategies and Knowledge Systems, High Performance Polymers

& Composites, Composite Materials, Principles of Vibration Control, Material Selection for Mechanical Design, Multi-objective Optimization, Introduction to Virtual Instrumentation, Introduction to Polymer Science & Technology, Reliability Based System Design and Analysis, Introduction to mathematical modeling & Simulation, Fundamentals of Interactive Computer Graphics, Image Processing, Knowledge Based Man- Machine System, Ecological & Biological Principles, Ethics & Society, Consumer Psychology, Marketing Management, Organization Methods in Engineering Design, Finite Element Method, Composite Materials, Artificial Intelligence, Modern Art, Art Appreciation & Criticism, Art of Video Making, Communication Design etc.

## **ENVIRONMENTAL ENGINEERING AND MANAGEMENT**

**(Interdisciplinary M. Tech. Programme)**

Recognizing the emerging challenges for environmentally sustainable economic development a broad based programme in Environmental Engineering and Management was started in 1997. This is primarily to meet the growing human resources requirements of high quality to provide leadership in various sectors such as, environmental policy and planning, implementation and legal aspects sustainable industrial development, environment friendly infrastructure management, resource cleanup through remediation of land, water and air resources, over and above the traditional “end-of-the-pipe” pollution control measures. The need for an integrated approach to environmental issues that transcend the boundaries of traditional disciplines in social sciences, physical sciences, engineering sciences and management sciences has been recognised. This programme builds on the past rich experience in environmental engineering, and the available expertise and infrastructure across various branches of engineering, sciences and humanities in the Institute. This interdisciplinary M. Tech Program is administered by the Department of Civil Engineering.

The programme offers M.Tech. (4 semesters) in Environmental Engineering and Management. A doctoral Programme in Environmental Engineering leading to a Ph. D degree is offered by the Civil Engineering Department. A bachelor's degree in the following branches of Engineering: civil, mechanical, chemical, agriculture, biotech, environmental or equivalent, or a Master's degree in most branches of sciences with mathematics till 10+2 level is the minimum requirement for admission to the M.Tech Programme.

The M.Tech. students take a minimum of four courses in first semester. In second semester, students take a minimum of four courses. The summer term and the third and fourth semester are fully devoted for working on a thesis. Admission to the M. Tech Programme is generally in the semester beginning July/August, while Ph.D. admissions are offered in both semesters.

### **COURSES**

Physiochemical Principles and Processes; Ecological and Biological Principles and Processes; Principal of Environmental Economics and Management; Environmental Quality and Pollution Monitoring Techniques; Principles and Design of Water supply and Treatment Systems; Principles and Design of Wastewater Treatment and Disposal systems; Air pollution and Its Control; Modelling of Natural systems. Environmental Management and Impact Assessment; Industrial Waste Management, Special topics in Environmental,

Engineering & Management, Environmental Audit and Atmospheric physics and chemistry. In addition, the students can take courses from other departments/ programmes depending on the background/ interest in consultation with programme advisor / thesis supervisor.

## FACILITIES

The environmental engineering laboratory is well equipped for routine and advanced analyses of water, air and solid samples. In addition, facilities are available for air, water and soil sampling, and for conducting laboratory, bench and pilot scale studies for water treatment and effluent/emission/ waste control, and air quality measurements.

## FACULTY

**Purnendu Bose, Ph.D. (Massachusetts, Amherst):** Environmental Engineering and Management: Physico-chemical processes for water and wastewater treatment, Advanced oxidation processes, Environmental Systems modelling and management.

**Saumyen Guha, Ph.D. (Princeton):** Fate and transport of pollutant in natural environment, Biological processes and kinetics, Heavy metals in the environment, Bioremediation of Hazardous substances

**Mukesh Sharma, Ph.D. (Waterloo):** Environmental Engineering and Management; Air Quality Modeling and Management, Fate Processes of Organic Pollutants and Parameter Estimation, Mitigation of Greenhouse Gases, Environmental Health and Risk Analysis.

**S N Tripathi, Ph.D. (Reading):** Environmental Engineering: Atmospheric Aerosol Modelling, Cloud Physics, Atmospheric Electricity, Fog Analysis, Aerosol Chemical and Optical Properties

**Vinod Tare, Ph.D. (IIT/K):** Environmental Engineering and Management: Water and Wastewater Treatment, Modelling and Simulation of Environmental Systems, Environmental Management - EIA and EA.

**Tarun Gupta, Sc.D. (Harvard):** Development of instruments for aerosol measurements, Physicochemical characterization of atmospheric pollutants, Personal exposure assessment and health effects of inhaled particles, source apportionment of air pollution and risk assessment.

**Anubha Goel, Ph.D. (Maryland):** Environmental engineering and management, Fate and Transport of Pollutants, Phase distribution of organic pollutants in atmospheres, Environmental modeling, Climate change.

## PHOTONICS SCIENCE AND ENGINEERING

### (Interdisciplinary Programme)

Since their invention in 1960s, LASERS are transforming the fields of science and technology. Laser activity started at IIT Kanpur in 1964 and by late 1960s IIT Kanpur distinguished itself in the fabrication of lasers of various kinds. The Laser Technology Programme (LTP) at IIT Kanpur started in July 1988 with the aim and objective of training young Engineering and Science graduates for providing skilled manpower in the specialised field of lasers and photonics. The name of the programme was changed to Photonics Science and Engineering in year, 2012. It is hard to imagine our lives without laser based optical communications and networks; compact disc players; laser printers, laser surgery; lasers-materials processing; and applications of laser spectroscopy in medicine and nano- materials. Today, IIT Kanpur has excellent facilities for research in the field of lasers and various laser applications. The curriculum has been designed to provide the necessary theoretical and experimental background in lasers, quantum optics, and various laser applications such as optical communications/ networks & switching, holography, material processing, materials and biomedical spectroscopy, flow/temperature & stress analysis, optical signal processing & computing and optoelectronic integration. Compulsory laboratory courses constitute an integral part of the curriculum. Each student is required to take- up a two semester long research project in any one of the laboratories associated with the laser technology programme. It is a unique interdisciplinary programme, which draws faculty from the departments of Aerospace Engineering, Chemistry, Electrical Engineering, Mechanical Engineering, Civil Engineering, and Physics to teach various core courses and guide/supervise M.Tech. thesis. The students make use of the facilities of the Centre for Lasers and Photonics, which consolidates the research and developmental activities in this field. In addition to the usual classroom teaching, emphasis is given to hands-on experience on lasers. The compulsory courses on Laser Technology Laboratory Techniques facilitate the process. Depending on the problem chosen, students carry out their M.Tech. projects in the laboratories of the centre for Lasers and Photonics (CELP) or in those of the departments stated above.

Candidates having a Bachelor's degree in all branches of engineering or Master's degree in Physics, Applied Physics, Applied Optics or Chemistry are eligible to apply for admission to the M.Tech. programme in Photonics Science and Engineering.

## FACULTY

**Ramesh C Budhani, Ph.D. (IIT/D):** Experimental Condensed Matter Physics (on leave).

**Debabrata Goswami, Ph.D. (Princeton):** Ultrafast Pulses, Non-linear Spectroscopy, Quantum Computing, Coherent Control



**Sudhir Kamle, Ph.D. (Purdue):** Holography, Stress Analysis, Smart Materials

**D.P. Mishra, Ph.D. (IISc. Bangalore):** CFD of Chemically Reacting Flows.

**K Muralidhar, Ph.D. (Delaware):** Fluid Mechanics, Heat Transfer

**Pradipta K Panigrahi, Ph.D (Louisiana State):** Holography, Laser Schlieren, Particle image velocimetry.

**Asima Pradhan, Ph.D. (CUNY, N Y):** Laser Spectroscopy, Medical Applications.

**Raj K Thareja, Ph.D. (Delhi):** Laser Physics, Laser Plasma Interaction

**Harshawardhan Wanare, Ph.D. (Hyderabad):** Non-linear Optics, Quantum Optics, Light Interaction in Biological Tissues.

**Pradeep K. Kumar (IIT, Chennai):** Quantum cryptography, Quantum optics, Non-linear Fiber optics, optical fiber communication.

**R. Vijaya (IIT Madras):** Fibre optics, non linear optics, photonic band gap structures.

**B. Lohani (ESSC,UK):** Laser ranging, Flash scanning Laser applications, Laser imaging and cross section.

**Utpal Das, Ph.D. (Michigan):** Quantum structures, Semiconductor Optoelectronic Integration.

### **Compulsory Courses:**

Introduction to Lasers, Introduction to Coherent and Laser Optics, Laser Systems and Applications, Laser Technology Laboratory Techniques, One Course on Electronics, M.Tech. Thesis Research.

### **Electives:**

Lasers and their Applications, Fourier Optics and Optical Information Processing, Lasers in industry, Laser induced Processes in Spectroscopy, Fiber Optic Systems I & II, Semiconductor Lasers, Optical Communication Systems, Optical Computing, and Optical networks & Switching.

### **Facilities:**

Besides the central facilities at the Institute level, the Centre for Laser Technology has its own precision machine shop and library, which supports the Laser Technology Programme. Various state of the art facilities i.e. Ti-sapphire laser, CCD spectrograph system, micro-Raman facility, spectro Fluorimeter, Polarimetry system, PIV, Interferometry, holography, schlieren, CO<sub>2</sub> laser, confocal microcopy, Tunable laser, optical bench and optical wave guiding setup, pulsed laser sources, MCT detectors and Lock-in-amplifier etc. are available.

## **MATERIALS SCIENCE**

### **(Interdisciplinary Programme)**

Materials are at the root of man's progress in the modern world. Advances in technology today are limited by the availability of newer materials with superior properties. Thus, the development of new solar cell materials would make greater use of solar energy feasible, new ceramic materials would make automobile and other engines lighter and more fuel efficient, new optoelectronic materials would revolutionize the communication industry, etc. For this, a thorough study of the existing materials and tailoring of new materials have to continue with ever increasing vigour. Such a task, however, requires an integrated approach to the subject employing established disciplines of science and engineering. Keeping this very objective in view and to provide focus and coordination for teaching, research and development, the Institute offers an Interdisciplinary Programme in Materials Science at the post-graduate level leading to M.Tech. and Ph.D. degrees. This provides an opportunity to young engineers and scientists to undergo an extensive training in different aspects of materials science and engineering. The courses of study are designed to demonstrate the application of fundamental principles to understand and utilize the properties of broad range of materials including metals and alloys, semiconductors, ceramics, glasses, composites, polymers, etc. Emphasis is given to various aspects of preparation, structural properties and applications of materials. Each student, besides undertaking course work, participates in research activities and submits his/her individual contribution in the form of a thesis to fulfil the requirements of the degree.

About two thirds of the graduates of the programme are placed in industries and research establishments in the country while others pursue doctoral or postdoctoral work at universities in India or abroad. Excellent infrastructure has been established for materials research at the Advanced Centre for Materials Science and at various other laboratories in the Institute. It includes a large number of modern sophisticated equipment for preparation, processing and characterization of materials.

Specialisation of the faculty members who are currently engaged on full time or half time basis in the activities of the Programme are given below. Besides these, several other faculty members from the engineering and the science departments of the Institute participate in the academic activities. Research is being conducted in the broad areas of electronic materials, ceramics, metals, composites, thin films, nano-materials, ferroelectrics, opto-electronic materials, solid state ionics, energy storage materials, polymers, magnetic materials, magneto-reology, fuel cells, photovoltaics, phosphors and specialised techniques.

### **FACULTY**

**Jaleel Akhtar, PhD (University of Magdeburg):** Microwave Material Processing, Microwave Imaging and Non-Destructive Testing, Electromagnetic Characterization of Dielectric and Composite Materials, Electromagnetic Scattering, Computational Electromagnetics.

**Malay K. Das, PhD (Penn State):** Fuel Cell Degradation, Gas Hydrate, Hydrogen Generation, Hydrogen Safety, Symmetry-breaking, Nanofluid, Carbon Capture.

**Manas Ghorai, PhD (NCL, Pune):** Synthetic Organic Chemistry, Development of Novel Methodologies, Bioorganic Chemistry, Asymmetric Synthesis, PEM Fuel Cell.

**Rajeev Gupta, PhD (IISc Bangalore):** Probing Structure-property Correlations in Materials using Optical Spectroscopic Methods (Raman IR, Photoluminescence), Synthesis of Multiferroics and Nanomaterials, Phase Transitions in Materials, Alternate Battery Materials, Biomaterials, Nanotubes and Nanowires, Properties of Materials under Pressure.

**Kamal K. Kar, PhD (IIT-Kharagpur):** Carbon Nanotubes, Nanostructured Materials, Nanopolymer, Nanocomposites, Multifunctional and Functionally Graded Composites, Biomaterials, Carbon-Carbon Composites, Analysis and Applications in Field emission Devices, Solar Cell, Fuel Cell, High Energy Density Battery, High Performance Structural Composites.

**Jitendra Kumar, PhD (BHU):** Nanosize Particles, Inorganic Membrane, Electronic, Magnetic and Hydrogen Storage Materials, Thin Films, Electron Microscopy, Photovoltaics, Phosphors.

**Y.N. Mohapatra, PhD (IISc Bangalore):** Electronic and Optoelectronic Materials, Physics of Semiconductor Devices and Defects, Organic Semiconductors, Polymer Light-emitting Diodes and Photo-electronic Applications.

**Siddhartha Panda, PhD (University of Houston):** Chemical Sensors, Micro/Nano Fabrication, Microfluidics, Electronic Materials Processing, Plasma Processing.

**K.P. Rajeev, PhD (IISc Bangalore):** Condensed Matter Physics, Transition Metal Oxides, Nitrides and Nanophase Systems, Electronic Instrumentation.

**J. Ramkumar, PhD (IIT-Madras):** Micro / Nano-Fabrication and Finishing, Nano Composites and Tribology.

**K. Shahi, PhD (Gorakhpur):** Superionic/Fast-ion Conductors, Solid Electrolytes, High Energy Density Batteries.

**Sri Sivakumar, PhD (University of Victoria):** Synthesis and Characterization of Nanomaterials, Layer-by-Layer (LbL) Assembly, Polymer Capsules, Thin Films, Drug Delivery, Photonic Crystals.

## PROGRAMMES

The eligibility requirements for admission to M.Tech. and Ph.D. programmes are:

**M.Tech.:** Master's Degree in Physics, Applied Physics, Chemistry, Materials Science with Mathematics and Physics or Chemistry at Bachelors level or B.Tech./B.E./B. Sc. (Engg.) in Ceramic/Chemical/Electrical/Electronics and Communication/Materials/ Mechanical/ Metallurgical Engineering or any equivalent branch of engineering/technology.

**Ph.D.:** M.E., M.Tech. or M. Sc. (Engg.) Degree in Materials Science or any equivalent branch of engineering/technology. or

B.Tech./B.E/B.Sc. (Engg.) in relevant branch of engineering/ technology or Master's degree in Science in an allied area with exceptional academic records.

**The requirements for completion of the programmes are:**

**M.Tech.:** At least seven courses and a research project leading to a thesis.

**Ph.D.:** At least four/ten (if entering with Master's degree in engineering or technology/Bachelor's degree in engineering or technology or Master's degree in sciences) courses, passing a comprehensive examination and a research project leading to a thesis.

## COURSES

Structural and Magnetic Properties of Materials; Electrical and Dielectric Materials; Mechanical Properties of Materials; Characterization of Materials; Materials Engineering; Electronic Ceramics; Materials for Energy Conversion and Storage; Electron Microscopy and Microanalysis; Crystal Growth - Theory and Practice; Engineering Polymers; Principles of Ceramic Processing; Electronic Materials; High Performance Polymers and Composites, Introduction to nano-materials and nanotechnology; Any relevant course from other department/programme.

## NUCLEAR ENGINEERING TECHNOLOGY

### (Interdisciplinary Program)

Nuclear Engineering and Technology is an interdisciplinary postgraduate program offering M.Tech. and Ph.D. degrees. The interdisciplinary nature of the program is reflected in the eligibility of students for admission to M.Tech. Program: graduates in engineering, primarily Mechanical, Electrical, Electronics, Instrumentation, Chemical, and M.Sc. in Physics. M.Tech. in Nuclear Engineering (or a related area) is required for admission to Ph.D. programme. Selection of M.Tech. students is done through interview and scores in GATE and qualifying examination. Selection of Ph.D. students is done through interview and scores in qualifying examination.

### FACULTY

**M S Kalra, Sc.D. (MIT):** Nonlinear Dynamics, Fusion Plasmas, Boundary Element Methods.

**P Munshi, Ph.D. (IIT/K):** Radiation Imaging and Tomography, Safety Analysis

**S Qureshi, Ph.D. (Berkeley):** Radiation Detectors, VLSI

### ASSOCIATED FACULTY

**A Khanna, Ph.D. (IITK):** Nuclear Chemical Engineering.

**P Wahi, Ph.D. (IISc Bangalore):** Non-linear Dynamics

### VISITING FACULTY

**Om Pal Singh, Ph.D. (IIT Delhi):** Reactor Physics, Risk Analysis

**S. K. Gupta, Ph.D. (University of Mumbai):** Thermal Safety Analysis

### COMPULSORY COURSES

Mathematics for Engineers, Nuclear and Reactor Physics, Nuclear Power Engg I, Nuclear Power Engineering II, Nuclear Measurements Laboratory,

### ELECTIVE COURSES

Nondestructive Evaluation, Computerized Tomography, Nuclear Fusion, Nuclear Chemical Engg, Nuclear Fuel Cycles, Nuclear Materials, Fast Reactor Technology, Nuclear Power Engineering III, Advanced Reactor Physics, Neutron Transport Theory, Radioisotope Applications in Engineering, Interaction of Radiation with Matter

### FACILITIES

The nuclear engineering laboratory is well equipped with radiation detectors, radioisotope gauges, PC-based multi-channel analyzer, signal correlator, 5 Ci Pu-Be neutron source, 1.7 MeV Tandem accelerator, a nine-detector gamma-ray CT system using Cs-137 source and a Micro-focal X-ray CT scanner (7 microns).

### RESEARCH AREAS

Radiation Imaging and Tomography, Thermal Safety Analysis, Probabilistic Safety Analysis, Non-linear Dynamics (fusion and fission), nuclear chemical simulations, Severe Accident Analysis

## CHEMISTRY

The Department of Chemistry has a PhD program designed to train candidates to pursue research of both fundamental and applied nature, and also to interact with other programmes of this Institute in a meaningful manner. The Department believes that the training of the students to a high level of professional competence for academic and industrial careers can be done best only in an environment where active research of high quality is being carried out. Accordingly, research forms one of the major activities of the Department.

The department consists of twenty nine faculty members, about two hundred and thirty doctoral students, several post-doctoral and project research associates. In addition, the department has about 80 masters students and about 100 undergraduate students.

### FACULTY LIST AND THEIR RESEARCH INTERESTS:

**G Anantharaman, Ph.D. (Goettingen Univ.):** Organometallic Chemistry, Coordination Chemistry.

**Jitendra K Bera, Ph.D. (IISc Bangalore):** Coordination Chemistry, Inorganic Materials, Supramolecular chemistry, Electronic properties and theoretical calculations.

**P K Bharadwaj, Ph.D. (IIT, Kharagpur):** Supramolecular Chemistry, X-ray Crystallography.

**A Chandra, Ph.D. (IISc Bangalore):** Statistical Mechanics, Computer Simulations.

**V Chandrasekhar, Ph.D. (IISc Bangalore):** Polymers, Main Group Inorganic Chemistry.

**N S Gajbhiye, Ph.D. (IISc Bangalore):** Chemistry of Nanomaterials, Solid State Chemistry.

**M K Ghorai, Ph.D. (Univ. Poona):** Organic Asymmetric Synthesis, Bio-Organic Chemistry.

**M. Ranganathan, Ph.D. (Stanford Univ.):** Statistical Mechanics of Crystal Growth, Biochemistry and Bioinformatics.

**D Goswami, Ph.D. (Princeton Univ.):** Femto second pulse shaping, nonlinear spectroscopy, coherent control, multiphoton imaging, Quantum Computing.

**R Gurunath, Ph.D. (IISc Bangalore):** Bio-chemistry, Environmental biodegradation, fluorescence probes in biology.

**S Manogaran, Ph.D. (IISc, Bangalore):** Molecular Conformations, Electronic Structure and Spectroscopy calculations using Computational Methods.

**R N Mukherjee, Ph.D. (Calcutta Univ.):** Biomimetic Inorganic Chemistry: Synthesis, Structure and Reactivity.

**J Narasimha Moorthy, Ph.D. (IISc Bangalore):** Organic Photochemistry and Organic Supramolecular Chemistry.

**S P Rath, (IACS, Calcutta):** Bioinorganic Chemistry, Metalloporphyrin Chemistry, NMR of Paramagnetic Systems and X-ray Crystallography.

**N Sathyamurthy, Ph.D. (Oklahoma State Univ.):** Theoretical Molecular Reaction Dynamics.

**V K Singh, Ph.D. (M.S. Univ., Baroda):** Synthetic Organic Chemistry with Particular Emphasis on Enantio-selective Reactions, Synthesis of Biologically Active Molecules.

**S Sundar Manoharan, Ph.D. (IISc, Bangalore):** Nanomaterials, Spintronics, Organic L.Eds and Biodegradable Polymers for drug Delivery.

**Y D Vankar, Ph.D. (BHU):** Synthetic Carbohydrate Chemistry of Biological relevance, Asymmetric Synthesis, Total Synthesis of Natural Products.

**V K Yadav, Ph.D. (M.S. Univ., Baroda):** Synthetic Organic Chemistry with Particular Emphasis on (a) the Synthesis of Structurally and Biologically interesting Molecules (b) the Development of New Synthetic Protocols (c) Free Radical Cyclization and (d) the Use of Metals as Templates for Organic Reactions.

**K Srihari, Ph.D. (Univ. Calif., Berkeley):** Semi classical Methods in Chemistry (Theory).

**S Verma, Ph.D. (Univ. Illinois, Chicago):** Bioinspired Molecular Scaffolds for Nucleic Acid and Protein Cleavage, Modeling of Prebiotic Catalysis and Drug design.

**M L N Rao, Ph.D. (Univ. Hyderabad):** Organometallic Method for Organic Synthesis, Green chemistry, Combinatorial Chemistry, Organic Synthesis, Heteroatom chemistry.

**Nisanth Nair (Univ.of Hanover, Germany):** Computational Chemistry.

**D. H. Dethe, Ph. D. (IISc Bangalore) :** Total Synthesis of bioactive natural synthesis new synthetic methods.

**Pratik Sen, Ph.D. (IACS Kolkata):** Ultrafast Laser Spectroscopy Fluorescence Spectroscopy, Interface selective non-linear Spectroscopy.

**Ramesh Ramapanicker, Ph. D. (IISc Bangalore):** Synthetic organic Chemistry, Bioorganic

Chemistry, Bioconjugation Chemistry.

**Shridhar R. Godre, Ph. D. (IIT Kanpur) :** Theoretical and computational quantum chemistry.

**Ashis K. Patra Ph. D. (IISc Bangalore):** Medicinal Inorganic Chemistry, Chemical Biology, bioconjugate chemistry, drug delivery.

**Raja Angamuthu, Ph. D. (Univ. of Leiden):**Inorganic synthesis and biomimetic chemistry

#### PH.D. PROGRAMME

The Ph.D. programme includes an integrated sequence of course work and research. Like most other Ph.D. programmes, a significant portion of the first year is spent taking courses, some compulsory and some electives. A student is admitted to the candidacy of the Ph.D. programme only after successful completion the comprehensive (written and oral) examinations, typically in the second year of the programme. Subsequently, the candidate is required to deliver a "State of the Art Seminar" on his/her area of research. Typically, a candidate completes Ph. D. between 4-6 years and the candidate is expected to carry out a significant amount of independent research. The candidate is also encouraged to present research findings in conferences and publications. Prior to completion, the candidate is required to deliver an "Open Seminar" following which he/she is allowed to submit the thesis and appear for the thesis oral examination.

#### COURSES

Each student is required to take a minimum of six courses, including compulsory and elective courses. The compulsory courses include one "Principles" course based on their stream of work i.e. Principles of Physical Chemistry/Principles of Inorganic chemistry/Principles of Organic Chemistry, and additional course, either "Modern Physical Methods in Chemistry" or "Introduction to Modern Instrumental Methods".

In addition to the compulsory courses, the student is required to take four additional courses in the form of electives with the consent of thesis guide. The department electives typically vary from one semester to another depending on the availability of suitable instructors.

Some of the department elective courses are: Scientific Instrumentation, Modern Instrumental Methods for Structure Determination, Principles of X-ray Crystallography, Advanced Organic Chemistry I & II, Chemical Binding, Chemical Thermo-dynamics, Physical Organic Chemistry, Electronics for Chemists, Advanced Inorganic Chemistry I & II, Basic Biological Chemistry, Mathematics for Chemistry, Chemistry of Natural Products, Organic Reaction Mechanisms, Stereochemistry, Organic Photochemistry, Electrocyclic Reactions, Chemistry of Organometallic Compounds, Frontiers in Molecular Biology, Molecular Reaction Dynamics, Chemical Kinetics, Valence Bond and Molecular Orbital Theories, Chemistry of Ionized Gases, Solid State Chemistry, Quantum Chemistry I & II, Ligand Field Theory, Enzyme Reaction Mechanisms and Enzyme Kinetics, Symmetry and Molecular Structure, Physical Photo-chemistry, Physical Inorganic Chemistry, Bio-



inorganic Chemistry, Statistical Mechanics and its Application to Chemistry, Molecular Modelling in Chemistry, Computer Programming in Chemistry, Lasers in Chemistry and Biology, Chemistry of Drug Design and Metabolism, Supramolecular Chemistry, Special Topics of Current Interest in Organic, Physical and Inorganic Chemistry.

### **FACILITIES**

The Department is equipped with excellent instrumental facilities normally required for research and training. These include infrared, ultra-violet/visible and near infrared spectrophotometer, various solid-state dye lasers, supersonic jet fluorescence spectrometer, magnetic resonance equipment (nuclear, electron-spin), and single crystal X-ray diffractometer with liquid nitrogen facility, various types of chromatographs, polarographs, light scattering photometer, cyclic voltammetric equipment, steady-state spectrofluorimeter, time-correlated single photon counting spectrofluorimeter, stopped flow-spectrometer, high speed centrifuge, ultracentrifuge, electrophoretic equipment facilities for doing protein and model chemistry and photochemistry reactors. The department has acquired a state-of-the-art 400 and 500 MHz multinuclear NMR spectrometers, ESI Mass spectrometers, Resonance Raman spectrophotometer, Bruker EPR spectrometer, FT-IR spectrometer, CHNSO analyser and CCD diffractometer to augment research activities. The department has also recently acquired thin film deposition chamber for Nanostructured devices and CEM microwave reactor for organic scale-up processes. A Molecular Modelling Laboratory and PC clusters are also now available in the department. Some equipment like the powder X-ray diffractometer, DTA & TGA etc. are also available.

The department also has access to the Institute's Computational facility, low-temperature laboratory, glass blowing and machine shops and various other analytical facilities in the institute.

### **SEMINARS AND CONFERENCES:**

In order to keep abreast of the latest developments in chemistry and allied subjects, and also to provide a forum for discussions about research in progress, the department holds weekly lectures/seminars, where active researchers are invited to deliver lectures on topics of current interest. In addition, various national and international symposia are periodically organized by the department.

## **HUMANITIES AND SOCIAL SCIENCES**

The Department consists of five major disciplines Economics, English Literature and Linguistics, Philosophy, Psychology and Sociology. Each of these disciplines has a Ph.D. programme. The Department has a Fine Arts component as well which offers only undergraduate courses. The Ph.D. programme of the department is committed to producing research work of high quality in theoretical and applied fields and in interdisciplinary areas. Several doctoral dissertations produced in the Department have received encomiums in India and abroad. The Department has an under graduate programme in Economics.

### **FACULTY**

**Bagad, Prashant, Ph.D. (Southampton)** : Aesthetics, Philosophy of Literature, Plato, Existentialism.

**Bhushan, Braj, Ph.D. (BRAB Univ. )** : Cognitive Neuropsychology, Cognitive Factors in Design, Trauma Psychology

**Chakrabarti, Anindita, Ph.D. (Delhi University.)**: Sociology of Religion, Social Movements, and Urban Sociology.

**Chakraborty Tanika Ph. D. (Washington University)** : Development Economics, Labor, Applied Micro-economics, Decision making

**Chandran Mini, Ph.D. (Kerala)**: Modern British Literature, European Literature, Indian Literature & Aesthetics.

**Dixit, Shikha, Ph.D. (Agra)**: Cognitive Psychology, Social Cognition, Application of Psychology to Armed Forces and Health Psychology.

**Jha Munmun, Ph.D. (Glasgow)**: Indian Society, Human Rights, Social Movements, Design Anthropology.

**Krishnan, Lilavati, Ph.D. (McMaster, Canada)**: Experimental Social Psychology, and Cross-Cultural Psychology.

**Kulshreshtha Praveen, Ph.D. (Cornell)**: Microeconomics, Industrial & Financial Economics, Econometrics, Governance and Business Ethics.

**Kumar Vimal, Ph. D. (Univ. of California, Irvine)** . : Game Theory, Growth & Technology, Political Economics.

**Mathur Somesh K, Ph.D. (JNU)**: Quantitative Methods, International Economics, Efficiency and Productivity Analysis, New Trade and Growth Theories, WTO issues like TRIPS and IT Policy, Evaluating Economic Agreements, Convergence Issues and Econometrics.

**Mathur Suchitra, Ph.D. (Wayne State, USA)**: Indo-Anglian Literature, Postcolonial Theory and Literature, Women's Studies, Cultural Studies.

Mukherjee, Anirban, Ph. D. (University of British Columbia, Canada) Economic History, Development Economics, Institutional Economics.

**Neelakantan G, Ph.D. (IIT Kanpur):** Twentieth-Century American Literature, Modernism and Post-Modernism, American Jewish Literature, Literary Theory.

**Prasad, P.M. Ph.D. (Univ. Hyderabad):** Law and Economics, Microeconomic Theory, Environmental Economics, Intellectual Property Rights.

**Patil Koumudi, MFA (Visva-Bharati Univ.):** Art history, Installation Art, Participatory/ Community Arts.

**Pattnaik B K, Ph.D. (Pune Univ):** Social Studies in Science and Technology, Sociology of Development, Sociology of Voluntary Sector and Social Movements.

**Priya, Kumar Ravi, Ph.D. (Delhi Univ.):** Disaster Psychology and Disaster Management, Cultural Psychology, Health Psychology and Alternative Paradigms of Psychology.

**Puttaswamy, Chaithra, Ph.D. (SOAS, London) :** Language Documentation and Description, Historical Linguistics, Language Typology, Language contact, Dravidian Linguistics.

**Raina A.M., Ph.D. (IIT Kanpur):** Cognitive Linguistics, Natural Language Semantics in theoretical and computational perspectives, Language Acquisition and Learning.

**Ravichandran T, Ph.D. (Pondicherry Univ.):** Postmodern American Literature, Literary Theory, Cyberpunk Literature, Indian Writing in English, English Language Teaching.

**Roy Satyaki, Ph.D. (Visva Bharati University.):** Art History, Visual Communication, Graphics, Media Studies.

Saha, Sarani, Ph.D. (Univ. of California, Santa Barbara) Environmental Economics, Public Economics, Political Economy, Applied Micro-economics.

**Sarma, A V Ravishankar, Ph.D. (IIT Bombay):** Formal and Philosophical Logic, General Philosophy of Science, Formal Epistemology.

Saxena K K, Ph.D. (Udaipur): Input-Output Analysis, Regional Economics, Macroeconomic Analysis.

**Sharma A K, Ph.D. (IIT Bombay):** Social Demography, Rural Development, Sociology of Health and Illness, HIV Studies.

**Sinha, Arvind K, Ph.D. (Patna):** Organizational Behaviour and Social Psychology

**Sinha, Surajit, Ph.D. (McMaster):** Macro-Money, Money and Banking.

**Sahu Sohini, Ph.D. (State University of New York at Albany):** Macroeconomics, Econometrics.

**Sahu Vineet, Ph.D. (University of Hyderabad):** Philosophy of Mind, Ethics in the Western Tradition.

**Shatarupa Thakurta Roy, MFA (Visva-Bharti Univ.) :** History of Art, Graphics, Design Theory.

## PH.D. PROGRAMME

The Ph.D. programme includes both course work and dissertation. The two-semester course work consists of a minimum of six advanced level courses. The courses are designed to enhance the students' knowledge of their own disciplines and to expose them to new areas. After successful completion of the course work, but not later than the fifth semester, a student has to pass the Comprehensive Examination which is a necessary requirement for submission of the Ph.D. dissertation. The entire programme is expected to extend over eight to nine semesters. The following are among the important areas of specialisation offered by the department.

## ECONOMICS

Industrial Economics, Project Evaluation/Appraisal, Input-output Economics, Development Economics, Environmental Economics, Macroeconomic analysis, Econometrics, Microeconomic Theory, Energy Economics, Monetary Economics, Law and Economics, Environmental Impact Assessment, Game Theory, Political Economics, International Economics.

## ENGLISH (Qualifying degree: Masters in English Literature/Linguistics)

British and American Literature, Postcolonial Literature, Indian Literature, Feminist Theory and Literature, Postmodern Theory and Literature, Indian Writing in English, Critical Theory, Linguistic Theory, Cognitive Linguistics, Communication,

Computational Linguistics, Sociolinguistics, Language Documentation and description, Language Typology.

## PHILOSOPHY

Ethics, Social & Political Philosophy, Philosophy of Mind, Metaphysics, Philosophical Aesthetics, Existentialism & Phenomenology, Hermeneutics, Philosophy of Social Sciences, Philosophy of Language, Philosophy of Cognitive Science, Philosophy of Science, formal and Philosophical Logic.

## PSYCHOLOGY

Cognitive Psychology, Engineering Psychology, Organizational Behaviour, Personality and Developmental Psychology, Social Psychology, Consumer Psychology, Social Cognition, Organizational Cognition, Health Psychology,

Neuropsychology, Disaster Psychology and Disaster Management, (Cross) Cultural Psychology, Alternative Paradigms of Psychology, Applications of Psychology to Armed Forces.

### **SOCIOLOGY**

Sociological Theories, Research Methods and Social Statistics, Social Stratification and Social Change, Sociology of Development and Underdevelopment, Social Demography, Urban Sociology, Industrial Sociology, Sociology of Environment, Participatory Rural appraisal, Sociology of Science and Technology, Rural Sociology, Human Rights, Third sector (NGO) Research, Sociology of Religion, Political Sociology.

### **FACILITIES**

The Department has full access to the Computer Centre of the Institute. In the Department there are four academic laboratories. The Language Laboratory is a sophisticated one containing 32 booths. The Economics Laboratory has the latest databases and software. The Psychology Laboratory is well equipped for demonstration of various experiments and also has a good collection of psychological tests. The Fine Arts Studio provides facilities to the students to develop their artistic creativity. It has adequate equipment and studio space for this purpose. The Studio has built an infrastructure in the area of design development and design and aesthetics. Continuous modernization of these laboratories ensures that these are provided with latest equipment and facilities.

### **Eligibility Requirements for Ph.D.**

Ph.D. in HSS: A Master's degree in the relevant subject or in sciences or a Bachelor's degree in Engineering with marks/CPI not below the prescribed minimum and a valid JRF/NET/GATE/UGC/CSIR score.

## **MATHEMATICS & STATISTICS**

The department, which started as the Department of Mathematics in 1960, got its new name as the Department of Mathematics and Statistics in 2004. It has always shared the vision of the Institute in striving for excellence in research and teaching and has succeeded in this endeavor to a large extent. Over the years, the department has evolved as one of the premier departments in the country providing excellent teaching and research in Mathematical Sciences and Statistics. The vibrant academic environment is nurtured by strongly motivated faculty and provides an opportunity to pursue research in frontline areas of basic sciences as well as in interdisciplinary areas of science and technology.

The department currently has 32 faculty members who are engaged in research and teaching in various areas of Pure Mathematics, Applied Mathematics and Statistics. The faculty of the department aims to achieve high quality research and teaching standards in various disciplines of Mathematics and Statistics with flavor of unified approach towards both pure and applied aspects. The faculty of the department has also responded enthusiastically to the growing demands of research and teaching. As Mathematics and Statistics have penetrated many areas of human endeavors, an updating of the curricula is regularly undertaken to keep abreast with the latest developments and to bring innovations. The contributions by the faculty of the department in research and teaching have won recognition by the scientific community in the form of various prestigious awards and distinctions. A number of sponsored research projects funded by national agencies are under taken by the faculty.

### **FACILITIES**

The Computer Centre of the institute provides E-mail, Web, DNS, FTP, Internet access, high performance computing and other services 24 hours and 365 days a year. Computer Centre has a number of state of the art servers, high end Linux and Windows labs and application software. The state of the art parallel and multi-processor computer servers cater to the computational needs of the academic community. In addition, the department also has its own high-end Linux and Windows labs that provide computing and remote access facilities exclusively to the department students. Apart from this, the department has one Parallel Computing laboratory and an Advanced Digital Imaging Solution (ADIS) laboratory.

IIT Kanpur has a large Central Library named after late Professor P.K. Kelkar, the founding director of the institute. This library is one of the best libraries of its kind in India, with an excellent collection of books and periodicals. There is a generous allocation from the Institute towards Library funding for Mathematics and Statistics. The library is fully automated and provides CD-Rom computer aided referral services. In addition, the Central Library has the special status of being an NBHM (National Board of Higher Mathematics) Regional Library, thereby looking after the needs of mathematicians in the geographic region. Towards this, NBHM has

been providing us with a sizeable annual grant. The Department maintains its own library with a good collection of text books and reference books. It is run by the students of the department and the collection in this library has come from retired faculty members, gifts from visitors, and complimentary copies of books from publishers.

### Ph.D. PROGRAMME

In addition to a five year integrated M. Sc. Program in Mathematics & Scientific Computing (From the academic session 2011-12, Five Year M.Sc. (Integrated) programme in Mathematics and Scientific Computing has been replaced by a more flexible Four Year BS programme in Mathematics and Scientific Computing) and two parallel two-year M.Sc. programs in Mathematics and in Statistics, the department also offers two parallel Ph.D. programs in Mathematics and in Statistics. Admissions to these Ph.D. programmes require a valid GATE score or a JRF from UGC/CSIR/NBHM. The admissions are done through a written test & interview. These programs attract good students from all over India. Research work leading to the Doctorate Degree in Mathematics/Statistics is carried out in various areas indicated under faculty specialization. In the first two semesters, every Ph.D. student is required to do at least six courses. These courses are intended to familiarize the students with the modern aspects of Mathematics/Statistics and initiate the students to the chosen area of research. Apart from training related to the fundamental principles of Mathematics and Statistics, the scope of these comprehensive and flexible programs includes interaction with allied areas from other departments of the Institute. Such an interaction, while maintaining the identity of the department, is unique to the curricula. The doctoral programs aim to prepare motivated researchers in frontline areas. The department has so far produced over 300 Ph.D. students who are now associated with reputed educational institutes and R&D organizations across the globe. Many of our Ph.D. students are also doing extremely well placed in private sector industries. Currently the department has about 60 research scholars working in state of the art research areas. Regular seminars keep everyone charged and updated. The Ph.D. students also actively participate in the teaching of core courses of U.G. Program (B. Tech, B.Tech-M.Tech Dual Degree, M.Sc. Integrated and Four Year BS programmes). This helps them in tuning their communication and teaching skills.

### FACULTY AND THEIR AREAS OF RESEARCH SPECIALIZATIONS

**Akash Anand, Ph.D. (Univ. of Minnesota, Twin Cities):** Numerical analysis, Scientific computing, Partial differential and integral equations.

**D. Bahuguna, Ph.D. (IIT/K):** Differential Equations, Non-linear Analysis, Theory of Semi-groups.

**Malay Banerjee, Ph.D. (Calcutta Univ):** Mathematical Ecology and Eco-Epidemiology, Stochastic Stability Analysis and Chaos in Related Areas, Nonlinear Dynamics.

**Mohua Banerjee, Ph.D. (Calcutta Univ):** Mathematical Logic and Rough Set Theory.

**Peeyush Chandra, Ph.D. (IIT/K):** Mathematical Modeling, Fluid Mechanics, lubrication, Biomechanics.

**Sameer Chavan, Ph.D. (Pune Univ):** Operator Theory, Subnormals and Operators Close to Isometrics.

**Aparna Dar, Ph.D. (SUNY Stonybrook):** Differential Geometry, Algebraic Topology, Knot Theory.

**I. D. Dhariyal, Ph.D. (Ohio State):** Estimation, Ranking and Selection Procedures

**Pravir K. Dutt, Ph.D. (UC Los Angeles):** Numerical Analysis, Fluid Mechanics

**Joydeep Dutta, Ph.D. (IIT/Kgp):** Non-smooth Optimization/Abstract Convexity and Global Optimization.

**Sudipta Dutta, Ph.D. (ISI Kolkata):** Functional Analysis.

**S. Ghorai, Ph.D. (Univ. of Leeds):** Computational Fluid Dynamics, Mathematical Biology, Adaptive Unstructured grid.

**Manjul Gupta, Ph.D. (IIT/K):** Functional Analysis, Operator Theory.

**M. K. Kadalbajoo, Ph.D. (IIT/B):** Numerical Analysis.

**G. P. Kapoor, Ph.D. (IIT/K):** Convex Analytic Dynamics and Fractals, Computational Complex Analysis.

**B. V. Rathish Kumar, Ph.D. (Sri Sathya Sai Instt.):** Computational Fluid Dynamics, Finite Element Analysis, Parallel Numerical Algorithms.

**Debasis Kundu, Ph.D. (Penn State Univ):** Statistical Signal Processing, Non-linear

Regression, Survival Analysis, Statistical Computing.

**Arbind Kumar Lal, Ph.D. (ISI Delhi):** Coding Theory.

**Shobha Madan, Ph.D. (IIT/K):** Harmonic Analysis, Hp-Spaces, Wavelets.

**Alok Kumar Maloo, Ph.D. (Bombay Univ./TIFR):** Commutative Algebra.

**Neeraj Misra Ph.D. (IIT/K):** Statistical Inference, Reliability Theory, Ranking & Selection Problems, Nonparametric Entropy Estimation.

**Amit Mitra, Ph.D. (IIT/K):** Statistical Signal Processing, Data Mining of Financial/Economic Time Series.



**Sharmishtha Mitra, Ph.D. (IIT/K):** Order Statistics, Survival Analysis, Econometrics.

**Parasar Mohanty, Ph.D. (IIT/K):** Harmonic Analysis.

**T. Muthukumar, Ph. D. (IISc, B'lore) :** Homogenization and variational methods for PDE's, Elliptic PDE's, Optimal Controls.

**Nandini Nilakantan, Ph.D. (IISc B'lore):** Combinatorial Theory, Computational Geometry.

**R. K. S. Rathore, Ph.D. (IIT/D; D Sc (Delft)) :** Approximation Theory, Numerical Analysis, Computer Aided Tomography.

**Rama Rawat, Ph.D. (ISI B'lore):** Harmonic Analysis.

**G. Santhanam, Ph.D. (IITB/TIFR):** Differential Geometry.

**Shalabh, Ph.D. (Lucknow Univ):** Econometrics, Regression Modelling, Statistical Inference, Sample Surveys.

**P. Shunmugaraj, Ph.D. (IIT/B):** Functional Analysis, Approximation and Optimization.

**Prawal Sinha, Ph.D. (IIT/B):** Lubrication Theory, Biomechanics, Environmental Pollution, Epidemiology.

## PHYSICS

The Department of Physics at IIT Kanpur is reputed for its high quality academic programme and research in front-line areas of both fundamental and applied importance. The Department has at present 36 members in the Faculty, and is assisted by a team of Research Associates and Postdoctoral Fellows as part of the academic staff. There are around 100 Ph.D. scholars engaged in doctoral research.

The Department participates in the undergraduate Core Courses in the B.Tech. Programme, and has started a new Five-year BS + MS Programme in Physics (making effective use of the flexibility in the new credit-based undergraduate Programme, with options for minor and double major in different disciplines) which includes basic and engineering sciences, workshop practices, courses on computation as well as courses on humanities and social sciences. The Department has a Two-year M.Sc. programme as well as a Ph.D. Programme with specialization in many major areas of Physics. The Physics Department also offers a unique time-saving M.Sc. - Ph.D. (Dual Degree) Programme for those seeking to take advantage of our M.Sc. training to accelerate their progress in doctoral work. Further, there is a large variety of courses offered by the Physics Faculty that are of interest to a number of inter-disciplinary programmes of the Institute. The Physics Department also participates in the Laser Technology and the Materials Science Programmes of the Institute. A brief description of the course structure for various Programmes and courses is given in this bulletin.

The Department actively participates in front-line research in several major areas of Physics. The largest group is working in the physics of Condensed Matter in all its aspects, viz. strongly-correlated systems, biophysics, the physics of plasmas. Interests are more or less evenly divided between theoretical and experimental work, with strong cross-pollination of ideas between theory and experiment. This is particularly true in the developing fields of Nanotechnology, Bio-materials and Biological systems. There is an active group involved in applying Nuclear Physics techniques to the study of materials and applications of ion beams in science and engineering. The High Energy Physics group has a wide-range of expertise ranging from the subtleties of renormalization in quantum field theories to numerical simulation of experimental processes and the analysis of vast quantities of statistical data. The Laser Physics and Quantum Optics group has interests ranging from laser ablation and laser synthesis of materials to quantum optics, and medical applications of lasers.

### FACULTY

**S Banerjee, Ph.D. (TIFR, Mumbai),** Condensed Matter Physics (Experiment)

**S Bhattacharjee, Ph.D. (RIKEN, Japan),** Condensed Matter Physics (Experiment)

**K Bhattacharya, Ph.D. (SINP, Kolkata),** Cosmology and Quantum Field Theory

**R C Budhani, Ph.D. (IIT, Delhi),** Condensed Matter Physics (Experiment)

**D Chakrabarti, Ph.D. (Jadavpur, Kolkata)**, High Energy Physics, QCD (Theory)

**S Chakraborty, Ph.D. (SNBNCBS, Kolkata)**, Non-Linear Dynamics (Theory)

**D Chowdhury, Ph.D. (IIT Kanpur)**, Condensed Matter & Statistical Physics (Theory)

**A K Agarwal, Ph.D. (IISc, Bangalore)**, Condensed Matter Physics (Theory)

**A Dutta, Ph.D. (SINP, Kolkata)**, Condensed Matter Physics (Theory)

**S Ghosh, Ph.D. (Cornell)**, Quantum Optics, Condensed Matter Physics (Experiments)

**T K Ghosh, Ph.D. (IMSc, Chennai)**, Condensed Matter Physics (Theory)

**A K Gupta, Ph.D. (Kentucky)**, Condensed Matter Physics (Experiment)

**R Gupta, Ph.D. (IISc Bangalore)** Condensed Matter Physics (Experiment)

**M K Harbola, Ph.D. (CUNY)**, Condensed Matter Physics (Theory)

**Z Hossain, Ph.D. (TIFR, Mumbai)**, Condensed Matter Physics (Experiment)

**P Jain, Ph.D. (Syracuse)**, High Energy Physics (Theory)

**K Krishnacharya, Ph.D. (MPI Goettingen)**, Condensed Matter Physics (Experiment)

**Y N Mohapatra, Ph.D. (IISc, Bangalore)**, Condensed Matter Physics (Experiment)

**S Mukherji, Ph.D. (IOP, Bhubaneswar)**, Cond Matter & Statistical Physics (Theory)

**S Mukhopadhyay, Ph.D. (SINP, Kolkata)**, Condensed Matter Physics (Experiment)

**A Pradhan, Ph.D. (CUNY)**, Laser Spectroscopy & Medical Applications (Experiment)

**R Prasad, Ph.D. (Roorkee)**, Condensed Matter Physics (Theory)

**K P Rajeev, Ph.D. (IISc, Bangalore)**, Condensed Matter Physics (Experiment)

**S A Ramakrishna, (RRI, Bangalore)**, Condensed Matter Physics & Optics (Theory)

**V Ravishankar, Ph.D. (Mysore)**, High Energy Physics (Theory)

**D Sahdev, Ph.D. (Case Western)**, High Energy Physics (Theory)

**T Sarkar, Ph.D. (IMSc, Chennai)**, High Energy Physics (Theory)

**G Sengupta, Ph.D. (IOP, Bhubaneswar)**, High Energy Physics (Theory)

**K Shahi, Ph.D. (Gorakhpur)**, Condensed Matter Physics (Experiment)

**A Singh, Ph.D. (Urbana-Champaign)**, Condensed Matter Physics (Theory)

**V Subrahmanyam, Ph.D. (TIFR, Mumbai)**, Condensed Matter Physics (Theory)

**R K Thareja, Ph.D. (Delhi)**, Laser Physics (Experiment)

**H C Verma, Ph.D. (IIT, Kanpur)**, Nuclear Physics (Experiment)

**M K Verma, Ph.D. (Maryland)**, Turbulence & Plasma Physics (Theory)

**H Wanare, Ph.D. (Hyderabad)**, Nonlinear Optics (Theory)

**R Vijaya, Ph.D. (IIT Madras)**, Laser Physics (Experiment)

### PH.D. PROGRAMME

The Department of Physics offers many subdisciplines in the Ph.D. programme. The requirements in the various programmes are prescribed to ensure that the scholars acquire enough professional maturity to enable them to deal with a wide range of research problems in their respective fields of specialization.

The research interests of the department include topics in Condensed Matter Physics, Ion Beams and Nuclear Physics techniques, Dynamical Systems and Statistical Physics, Quantum Field Theory, High Energy Physics, Lasers and Laser Spectroscopy imaging and Bio-physics and a substantial degree of Inter-Disciplinary activity.

Students with good academic record and strong motivation for a career in Physics after earning Master's degree can apply for admission to the Ph.D. programme. The programme combines course work, guided research, independent study and teaching assignments, all designed with a view to making the scholar a professional physicist. The compulsory courses consist of review of mathematical physics, classical mechanics, quantum mechanics, statistical mechanics, solid state physics and nuclear physics while the elective courses cover the ongoing research areas in the department.

### ELECTIVE COURSES

Advanced Quantum Mechanics, Group Theory and Application to Quantum mechanics, Advanced Statistical Mechanics, Special Topics in Quantum Mechanics, Non-equilibrium Statistical Mechanics, Physics of Soft and Bio-materials, Condensed Matter II, Magnetism in Materials, Computational Methods in Physical Sciences, Computer Simulations in Physics, Electronic Structure of Materials, Topics in Semiconductor Physics and Technology of Thin Films, Disordered Systems, Physics of Semiconductor Nanostructures, Low Temperature Physics, Nuclear Techniques in Solid State Studies, Elements of Bio and Medical Physics,

Lasers and Laser Spectra, Quantum Electronics, Coherence Optics, Nuclear Physics I, Quarks, Nucleons and Nuclei, General Relativity and Cosmology, Atmospheric Science I, Particle Physics, Special Topics in Field Theory and Particle Physics, String Theory, Special Topics in Physics, Measurement Techniques, Digital Electronics for Scientists, Mean Field Theories in Random Alloys, Advanced Low Temperature Physics, High Energy Physics II.

## **FACILITIES**

Condensed Matter Physics: Nitrogen and Helium Liquefiers, Superconducting magnets (up to 14 Tesla), Closed cycle Helium Refrigerators (down to 1.3 K), Experimental Setup for Resistivity, Hall Effect and Magnetic Susceptibility, Magnetoresistance, Specific Heat, Thermoelectric Power, Tunneling Conductance, Magnetostriction, Ultra high vacuum scanning probe microscope, superconducting quantum interference device (SQUID) based Magnetic Properties Measurement System (MPMS) with  $10^{-6}$  emu resolution and 1.7K - 350K temperature range and magnetic field up to 5 Tesla. We also have a Physical Properties Measurements System (PPMS) with a 14 tesla superconducting magnet and helium-3 fridge with 300 mK base temperature. Scanning electron microscope (SEM) with electron beam lithography facilities for nano-scale patterning have been installed recently.

Some homemade facilities like variable temperature (8K - 300K) scanning tunneling microscope (STM) with atomic resolution and conductance imaging, magneto-optic Kerr effect (MOKE) imaging of magnetic surfaces, Pulsed Excimer Laser ablation facility for synthesis of magnetic, superconducting and dielectric superlattices, high frequency measurements of vortex dynamics in superconductors, Raman and micro-Raman Spectroscopy set-up for correlated systems.

Well equipped facilities have been setup for opto-electronic characterization of semiconductor materials and devices. State of the art research facilities for organic semiconductors are available. The Department participates in major projects on Organic Electronics through Samtel Centre for display Technologies. For microfluidics, we have contact angle goniometer, fluorescent microscope and high speed (10,000 fps) camera.

Laser Laboratories: ND:YAG lasers, Excimer Laser, Double Monochromators, Photon Counters, Box Car Averagers, Vibration free tables. Facilities exist for High Resolution Spectroscopy, Raman and Micro-Raman Spectroscopy, Laser based pump-probe measurements, Laser-Plasma Studies and Nonlinear Optics, diode Lasers, Biological imaging system, optical spectrum analyzers and fibre optics system, optical lithography set-up.

Ion Beam and Nuclear Techniques Laboratory: Mossbauer Spectrometer, Tandem particle accelerator, focused ion beam (FIB) with SEM column (Nova Lab 600) for Nano Microfabrication down to nm scales, modern 1.7 MeV Tandatron accelerator with capabilities of producing ion beams of almost all elemental species. The facility is equipped with a nuclear microprobe station for science and engineering

applications such as proton and heavy ion beam writing, RBS, PIXE and ion Channeling E-beam deposition, Positron Annihilation, Mossbauer Studies at Low Temperatures.

Computational Facility: CHAOS cluster (264 cores and 1/2 Terabytes of RAM), Several high-end graphics workstations with three-dimensional visualization capabilities, GPU workstations, a new cluster with 396 cores and 1 Terabytes of RAM will also be installed soon. In addition the Computer Centre, a central facility at the Institute also has two super computers (IBM-SP2, PARAM) accessible to the department.