Information Brochure

for

Post Graduate Admissions in

Ph.D./M.Tech./M.Des./MS (By Research) Programmes

January, 2021 (2020-21-II Semester)

Indian Institute of Technology Kanpur

Kanpur-208016, Uttar Pradesh (India)

AEROSPACE ENGINEERING

The Department of Aerospace Engineering offers comprehensive teaching and research programs at undergraduate (UG) and postgraduate (PG) levels leading to B Tech, B Tech-M Tech dual, M Tech, MS (research) and PhD degrees. The specializations associated to the PG programs are available in four major streams: (i) *Aerodynamics*, (ii) *Propulsion*, (iii) *Flight Mechanics*, (iv) *Structures*.

The Department is actively involved in sponsored R&D and consultancy projects funded by a range of defense and civil organizations. Some of them are,Aeronautics R&D Board, DRDO, ISRO, HAL, NAL, ADA, DST, Delhi Metro Railways Corporation, NAL, Indo-French Centre for the Promotion of Advanced Research (IFCPAR), TERI, PCRA, etc.

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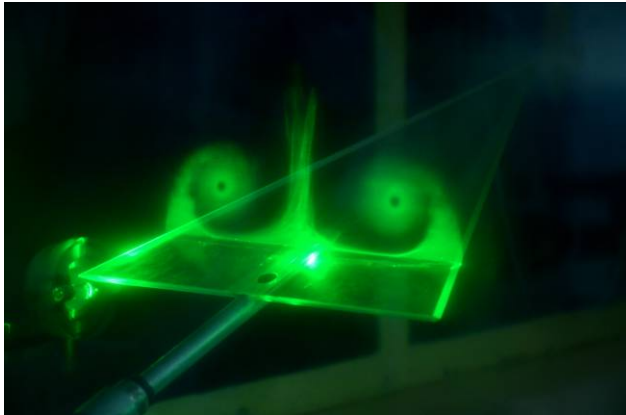
A. C. Mandal, *PhD (IISc Bangalore)*: Experimental Aerodynamics, Flow instability and transition, Turbulent Shear flow.

A. K. Ghosh, *PhD (IITK):* Flight Mechanics, Neural Networks, Flight Testing.

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

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

Abhishek, *PhD (University of Maryland, College Park):*Rotorcraft aeromechanics, futuristic VTOL/STOL systems, aerial vehicle design, Unmanned Aerial Systems, Inverse flight dynamics and wind turbines.

Ajay Vikram Singh, PhD (*University of Maryland, College Park*): Combustion and Reacting Flows, Combustion Generated Functional Nanoparticles, Soot Formation and Oxidation, Fire Dynamics, Detonations and Explosions.

Arnab Samanta , PhD (University of Illinois at Urbana-Champaign):Fluid Mechanics, Aeroacoustics, Hydrodynamic Stability, Flow Control,Wave Motion.

Arun Kumar P., *PhD (IIT Kanpur):* Subsonic and Supersonic jets, Flow control, Jet acoustics.

Ashoke De, *Ph.D(LSU):*CFD, Turbulent combustion, Gas turbine propulsion.

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

Debopam Das, *PhD (IISc Bangalore):* Theoretical and Experimental Fluid Dynamics, Aeroacoustics, Instability & transition, Vortex Dynamics. Unsteady Aerodynamics, Bird's and Insect's Flight.

G. M. Kamath, *PhD (University of Maryland, College Park):* Structural Health Monitoring, Composite Materials and Structures, Structural Dynamics, Condition Monitoring, Machine Learning, Aeroelasticity.

Kamal Poddar, *PhD (UC, San Diego)*: Aerodynamics, Turbulence, Low and High Speed Flows.

Mangal Kothari, *PhD (University of Leicester)*: Optimal Control, Nonlinear and Adaptive Control, Flight Vehicle Guidance and Control, State Estimation, Motion Planning and Cooperative Control.

Mohammed Ibrahim Sugarno, PhD (IISc Bangalore): Experimental Hypersonic Aerothermodynamics, High Enthalpy Test Facilities, Shock Waves.

Navrose, PhD (IIT Kanpur): Fluid Mechanics, Fluid-Structure Interaction, Optimization, Flow Stability and Control

Pritam Chakraborty, *PhD (Ohio State University)*: Mesoscale mechanics for plasticity, fatigue, creep and fracture; FEM; Multi-scale methods.

P. M. Mohite, *PhD (IIT Kanpur)*: Damage Mechanics of Laminated Composites, Composites, Finite Element Analysis.

R. Kitey, *PhD (Auburn University)*: Fracture Mechanics, Composite Materials, Experimental Stress Analysis, Optical Metrology, Thin Films, Finite Element Method.

Raghavendra P. Kukillaya , *PhD (Princeton University, New Jersey, USA):*Aircraft and Airship Flight Dynamics and Control, Systems Modelling, Simulation and Design, Optimal Control, Biomechanics.

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

S. Kamle, *PhD (Purdue)*: Experimental Stress Analysis, Smart Materials.

Sanjay Mittal, *PhD* (Minnesota): Unsteady Aerodynamics, CFD, FEM, Low speed Wind-Tunnel Testing, Bluff Body Flows, Shape Optimization, Sports Balls, Flows in air intakes.

Sanjay Kumar, *PhD (Caltech)*: Fluid Mechanics - bluff body wakes, shock-accelerated flows, shock waves, shock tubes.

Sathesh Mariappan, *PhD (IIT Madras)*: Fundamentals of thermoacoustic interactions, Application of dynamical systems' theory to thermo fluid systems, Optical flow diagnostics, Acoustic measurements.

S. Saderla, *PhD (IIT Kanpur)*: Online System Identification, UAV Design and Flight tests, Experimental Flight dynamics.

Tanmoy Mukhopadhyay, PhD (Swansea University, UK): Mechanical metamaterials, Advanced multi-functional composites, Deployable materials and structures, 2D materials and heterostructures, Multi-scale mechanics, Nano-mechanics, Stochastic analysis, Uncertainty quantification and reliability analysis, Surrogate modelling, Machine learning, Artificial intelligence, Computational additive manufacturing, Structural mechanics, Optimization, Homogenization

Vaibhav Arghode, *PhD (University of Maryland, College Park)*: Combustion, Heat Transfer, Fluid Mechanics, Experimental Methods, Computational Fluid Dynamics.

P. D. Mangalgiri, *PhD:* Composites, fracture and fatigue

Dipak K. Giri, *PhD (IIT Kharagpur)*: Spacecraft Dynamics and Control, Space Explorations: On-orbit Servicing, Space Debris Removal, Orbital Infrastructure Design in LEO,MEO,GEO.

PROGRAMS AND ADMISSION
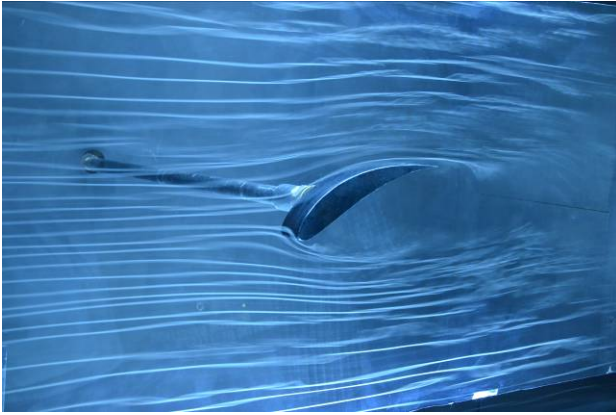
The masters programs are designed to impart students with various aspects of aerospace engineering through introductoryandadvanced level courses, followed by the researchwithin their field of specialization. The doctoral program is aimed at assisting students acquiring proficiency in their chosen area of research through comprehensive course work and extensive in-depth research. All PG programs culminate into thesis/dissertation.

The Department of Aerospace Engineering accepts students from various disciplines for its PG program. The detailed admission procedure along with the eligibility criteria is specified athttp://www.iitk.ac.in/doaa/admission-procedure.Some of the key information in regards to the application is mentioned below.

M.Tech: Candidates with a valid GATE score and the degree in one of the following disciplines can apply for the M Tech program.

Engineering: Bachelors degree in Aeronautical/Aerospace, Mechanical, Automobile, Production, Civil, Chemical, Naval Architecture, Electrical, Electronics/Electronics and Communication, Metallurgy /Metallurgy &Material Science, Instrumentation, Mechatronics
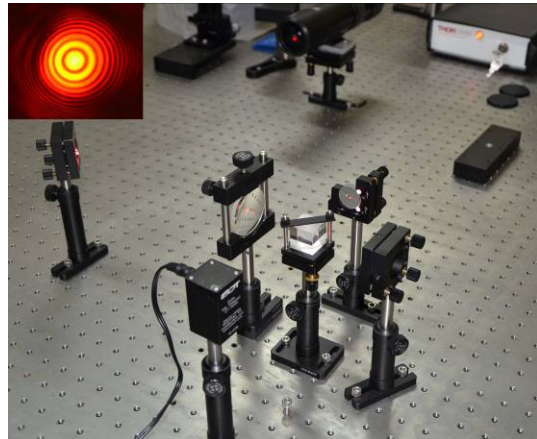
Science: Four years BS degree in Physics, Mathematics OR MSc degree in Physics, Mathematics and Engineering Physics with valid GATE score

The requirement of GATE score is waived off for the external and sponsored candidates.

M.S. (Research): Candidates with B Tech/BS (4-year)/M. Sc. degrees and a valid GATE score can apply for this program. The GATE score is waived off for the external and sponsored candidates.

B. Tech-M. Tech Dual: Students in B. Tech program at IITK can apply for B Tech-M Tech Dual degree program during his/her third year of the course work.

PhD:Candidates with following degree can apply for the PhD program.

- Masters degree in engineering

- Masters degree in science with a valid GATE/UGC/CSIR score

- Excellent academic record in B. Tech programand a valid GATE score (Application can be sent during the final year or after completing the B. Tech program).The GATE score is waived off for the students from CFTIs.

Sponsored/External/Part time candidate should have a minimum 2 years of R&D experience (or relevant) in the field of Aerospace Engineering.

COURSES
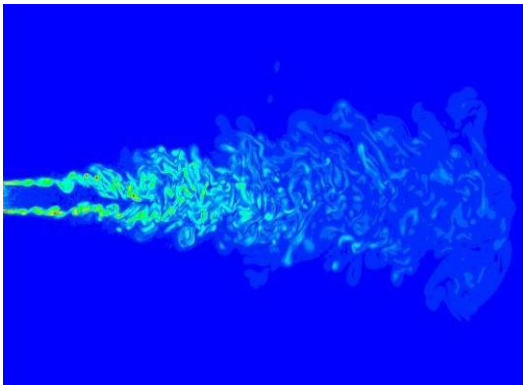
A student is admitted to thepost graduate program in one of the four major streams (Aerodynamics/Propulsion/Flight Mechanics/Structures). Based on the departmental policies the student will be allocated a thesis supervisor/s during the first semester of the program. In case the student is working on a multidisciplinary problem appropriate guidance/assistance will be provided by the department.

A student admitted in M. Tech program is required to complete a minimum 72 units of course work (equivalent of 8 courses) to a satisfactory level. The respective requirement for the M.S.(Research) students is 36 units. A student admitted in a PhD program is required to complete a minimum of 36 units of course work (equivalent of 4 courses) to a satisfactory level, followed by a comprehensive examination.Depending upon the area of specialization the student will be advised by DPGC/Thesis Supervisor to register for the required courses.

LABORATORIES AND 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, Advanced Combustion and Acoustics Lab, Fire Lab, Computational Propulsion Lab, Structures and Advanced Materials Characterization Lab, Structural Analysis Lab, Aeromodeling Lab, Unsteady Aerodynamics Lab, Helicopter Dynamics and Control Lab, CFD Lab, High Performance Computing Lab, Fluid Mechanics Lab, Flight Lab and National Wind Tunnel Facility (3 m x 2.25 m test section).
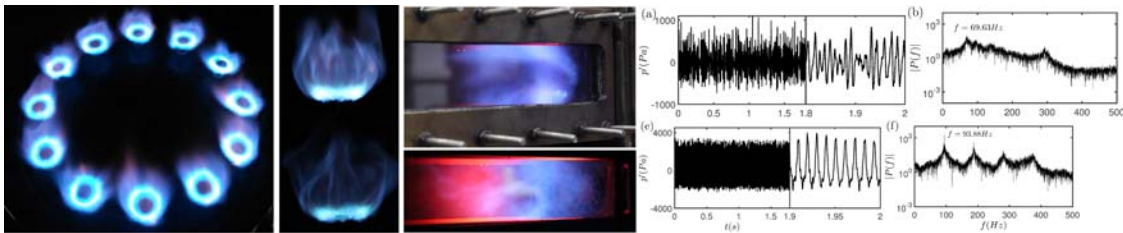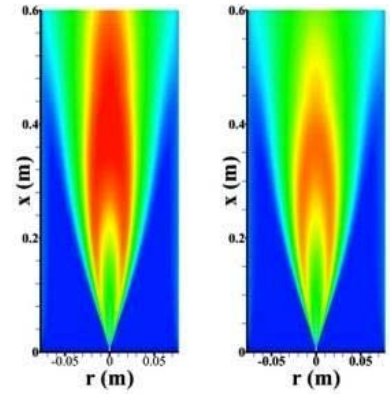
The experimental facilities in these labs include, low speed wind tunnels, high speed blow down tunnel, high speed jet facility, water tunnel, soap film tunnel, anechoic chamber for noise measurements, hot wire and laser Doppler anemometry, time resolved and stereoscopic PIV; cascade tunnel, continuous combustion unit and gas turbine test rig; Malvern Spraytech particle size analyzer, Gas Chromatograph; UTMs, Dynamic Impactor, DMA, DSC, TGA, TMA, Thermal evaporator, Spin coater, Phased Array Scanner, Autoclave, Prepreg forming, Laser spallation, Michelson Interferometer, multi-material 3D printing facility, Vicon Motion capture system, coaxial rotor hover test stand; Flight laboratory with four powered airplanes and several gliders with an operational aerodrome for flight research.

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. Ongoing research projects are spread in broadly three major domains that include (a) molecular, cellular and developmental biology, (b) structural and computational biology and (c) bioengineering. A major emphasis is on understanding the fundamental aspects of cell differentiation and growth, regenerative medicine, elucidating protein structure-function relationship, and engineering approaches to understand complex biological systems, providing economical detection methods and devices and generating new medicine systems. The department has attracted funding from major national and international agencies including the Wellcome-DBT India Alliance, Indo-UK Science bridge program, UKERI, Brain and Behavior Research Foundation, DBT, DST, CSIR, DAE, ICMR and DRDO to name a few. BSBE faculty and student members have received many awards and honors in recognition of their excellence in research.

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

FACULTY

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

Appu Kumar Singh, Ph.D. (Inst. of Microbial Tech., Chandigarh, India): Calcium signaling, ion channels, patch-clamp, electrophysiology, structural biology, X-ray crystallography, cryogenic electron microscopy.

Arun K. Shukla, PhD (Max Planck Institute of Biophysics, Frankfurt, Germany): Structural biology of membrane proteins, X-ray crystallography, cryo-EM, cellular signaling and combinatorial biology.

Arjun Ramakrishnan, PhD (National Brain Research Centre, Manesar, India):reward-based learning, decision making, human and nonhuman primate electrophysiology, eye tracking and pupillometry, computational modelling, wearable sensors.

Ashok Kumar, Ph.D. (IIT Roorkee, India): Biomaterials, tissue engineering, regenerative medicine, nanobiotechnology, stem cell research, drug screening and delivery, cryogel technology bioprocess engineering and environmental sciences.

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

Bushra Ateeq, Ph.D. (AMU, Aligarh, India): Molecular Oncology, Cancer Genomics, Drug targets, Mechanism of drug resistance in cancer, Cancer diagnostics, Cancer therapeutics.

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

Dibyendu K. Das, Ph.D. (IACS, Kolkata, India): Molecular Basis of Enveloped Virus Entry, Viral Genome organization and replication, Neutralizing antibody and Vaccine design, Single molecule fluorescence Imaging and High-resolution optical tweezers development.

Ganesh S, Ph.D. (BHU, Varanasi, India): Neurobiology of disorders, stress biology, and human genetics.

Hamim Zafar, Ph.D. (Rice University, Houston, USA): Computational biology, tumor heterogeneity and evolution, cell lineage tracing, genomics, single-cell multiomics.

Jayandharan G Rao, Ph.D. (Christian Medical College, Vellore, India): Gene therapy; human molecular genetics.

Jonaki Sen, Ph.D. (Albert Einstein College of Medicine, New York, USA): Morphogenesis, differentiation, migration and axonal guidance in the avian and mammalian brain, vertebrate developmental neurobiology.

Mainak Das, Ph.D. (Univ. of Central Florida, Orlando, USA): Bioelectronics, Green Energy, Physiology & Sensor.

Nitin Gupta, Ph.D. (University of California, San Diego, USA): Neuroscience, insect olfaction, computational biology, digital interventions for mental health.

Nitin Mohan, Ph.D. (Academia Sinica, Taiwan): Optical engineering, super-resolution microscopy, Intracellular transport and neurodegeneration, lysosome mediated nutrient sensing and dysregulations in diabetes, obesity.

Pradip Sinha, Ph.D. (BHU, Varanasi, India): Cancer genetics, cancer-induced paraneoplastic syndromes, metabolic disorders such as diabetes, and bio-entrepreneurial venture for drug discovery in the fruit fly, *Drosophila*, model

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

Saravanan M, Ph.D.(IISc, Bangalore, India): Chromatin remodeling, DNA repair and Stress biology.

Santosh Kumar Misra, Ph.D. (IISc, Bangalore, India): Biosensors, 3D-printed biomedical devices, Nanocomposites and Personalized medicine.

FACILITIES

BSBE offers its members with a wide variety of high-end equipments. Some of these include bioinformatics facility (servers, workstations, and software modules for high performance computing), material characterization facility (SEM, micro-CT, rheometer, mechanical testing and fabrication facilities), cell sorting and imaging facility (cell sorter, confocal microscope), genomic facility (DNA sequencer, microarray scanner and real-time PCR machines), centrifuge facility (ultra-speed, large volume and multipurpose centrifuges), sonication facility (bath sonicator, probe sonicator with micro and mini probes), gel imaging station, protein purification and characterization facility (Chromatography, HPLC and FPLC systems), protein crystallization facility (X-ray data collection facility with cryo cooling features), tissue culture facility (culture rooms for cell, organ and virus cultures), histopathology facility (tissue processing unit, automated microtome, and cryostat), electrophysiology facility, calcium imaging set-up, and a transgenic facility (transgenic facility for mouse, chicken, *Drosophila*, *C.elegans*, mosquitoes and zebra fish), human and nonhuman primate electrophysiology labs.

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 (**4-year program**) - 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 6.0 (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 course work covering diverse areas of biology and bioengineering for competence in both analytical and quantitative skills. We encourage students from any discipline (including non-biology background) to apply as they will be given a formal training in biology through a well formulated course work in basic biology.

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 (M.D.) 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) or Bachelor's degree (**4 year program**) 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. The requirement of GATE score is waived for candidates with bachelor's degree in engineering from the centrally funded technical institutes (CFTIs).

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.

The Department of Chemical Engineering is among the five departments established at the inception of IIT Kanpur in 1960. Along with the other pioneer departments, it ushered in a new paradigm in undergraduate engineering education that fosters the creative thinking process in a very open and vibrant academic environment. From an early emphasis on developing and perfecting the undergraduate curriculum to nurturing a fledgling post-graduate research program to significantly contributing to applied and fundamental ChE research, we have grown from strength-to-strength over the past five decades.

A hallmark of our Department is the emphasis on quality education as reflected in the over 36 "labor of love" textbooks written by our faculty, many receiving international acceptance. This is complemented by a strong research ethos, carefully nurtured by the pioneers and effectively passed on from one generation to the next. The significant post-liberalization research funding has brought in a critical mass of young, talented and motivated faculty immersed in research in the frontier areas of complex fluids, micro-reactors, nano-technology, adhesion, molecular simulations and biocomputation and energy systems. This is in addition to research in traditional areas of fluid dynamics, conventional/new separation processes, catalysis, polymer engineering and process design, control and intensification. The very diverse research portfolio is our core strength that effectively complements quality education.

ACADEMIC PROGRAMMES
The department offers undergraduate (B Tech) and postgraduate (M Tech, MS and PhD) degrees in Chemical Engineering. The admission process and graduation requirements are briefly summarized below.

UNDERGRADUATE

Bachelor of Technology (B Tech)

Duration: 4 years

Admission: Through the Joint Entrance Examination (JEE) + advanced JEE.

Courses: The ChE B Tech program comprises a four semester "core" program of courses in basic sciences, engineering sciences, humanities and computer programming, followed by a two year professional program, consisting of departmental professional courses and several electives. The full load for a semester is roughly 5 courses (50 credits). At least 405 credits must be completed for graduation with the option of additional research credits.

Research: In addition to course work, our students have the option of carrying out research with a faculty mentor in their last three semesters.

Double Major: Students can also opt to do a double major with an additional year of coursework. Thus for example, by appropriate planning of his/her program, a student admitted to ChE may graduate with a double major in Chemical Engineering and Computer Science in five years.

B Tech - M Tech (Dual Degree)

Duration: 5 years

Admission: Undergraduate students can opt to convert to dual degree after completion of their 5th, 6th or 7th semester.

Courses: The first four years of the program are almost identical to the B Tech course

work.

Research: The last two semesters and two summer terms are devoted entirely to research work. Students work under a faculty research supervisor on a challenging research problem. In the fifth year, a scholarship currently at Rs 12,400 per month is given subject to a minimum CPI of 8 or attaining more than 60 percentile GATE score.

POSTGRADUATE

The Department offers a Master of Technology (M Tech), a MS (Research) and a Doctorate (PhD) degree in Chemical Engineering. These programs are research centric and prepare the student for a productive research career. The rigorous coursework and research provide a healthy balance of breadth in ChE fundamentals and depth in their chosen research field.

Master of Technology (M Tech)

Duration: 2 years

Admission: Through Graduate Aptitude Test in Engineering (GATE). The examination is usually announced in the month of August and held in February across the country. Sponsored candidates from the industries as well as research organizations with appropriate experience need not have qualified GATE.

Course requirements: The students take six courses (of which at least three are in compulsory areas of Reaction Engineering, Thermodynamics, Transport Phenomena and Mathematics or Numerical Methods, the remaining from among several state-of-art electives).

Research: Students have usually do 10-12 course units (including summer term) of research. In their research project, students often work on research problems with individual faculty members, or are involved in sponsored projects from industry or government funding agencies. MHRD offers scholarships to students getting admission through GATE currently at Rs 12,400 per month. Scholarships from research projects are also available.

Master of Science by Research (MS Research)

Duration: 2 years

Admission: Admission is generally made in both the semesters in a year, i.e., July and December. Selection is done through a written test followed by interview. Candidates with a B Tech/MSc background and a minimum of 55% marks in their qualifying exam are eligible to apply. A valid GATE score (for B Tech degree holders) or valid CSIR-NET score (for MSc degree holders)is also required. Sponsored candidate should possess a minimum of 55% marks in their qualifying exam (no gate score needed).

Course requirements: The students take four courses (of which at least three are in compulsory areas of Reaction Engineering, Thermodynamics, Transport Phenomena and Mathematics or Numerical Methods, the remaining from among several state-of-art electives).

Research: Students usually do 12-14 course units (including summer) of research. In their research project, students often work on research problems with individual faculty members, or are involved in sponsored projects from industry or government funding agencies. They must be sponsored through project funding from their thesis supervisors (or) financial sponsorship must come from their parent industrial organization.

Doctor of Philosophy (PhD)

Duration: 4-5 years

Admission: Admission to the PhD programme is generally made in both the semesters in a year, i.e., July and December. Selection is done through a written test followed by interview. Industries and research organizations may also sponsor a candidate for admission to the PhD program.

Course requirements: The students take a minimum of four courses (out of which two are in the compulsory areas) to develop expertise in ChE fundamentals as well as to complement their research work.

Research: Post coursework (up to 1 year), students work on a research problem of their interest under the guidance of a faculty mentor(s). Working on a particular problem for 3-4 years is a unique experience that helps in developing a scientific temper along with the associated technical communication skills. The typical norm for graduation is 3-5 publications (submitted or accepted) in reputed peer-reviewed journals. MHRD offers scholarships currently at Rs 31-35,000 per month to full time PhD students. Scholarships from research projects are also available.

ELECTIVE COURSES

A range of graduate-level elective courses are developed and offered by the faculty. These cover fundamentals at an advanced and more abstract level and also help keep abreast with the latest developments and the state-of-the-art in niche specialized research areas. These courses prepare and enable the students to probe deeper into their research problems. A sample of the electives currently on offer is provided.

> New Separation Processes, Thermodynamics of Fluids and Mixtures, Principles of Heterogeneous Catalysis, Applied Statistics for Chemical Engineers, Optimization, Mechanics of Soft Materials, Introduction to Nanoscience and Technology, Polymer Science and Technology. Reaction Engineering of Polymers, Principles of Polymer Processing, Molecular Theories of Polymeric Systems, Environmental Pollution and Control, Engineering, Applications of Rheology, Advanced Process Dynamics and Control, Two-Phase Flow and Heat Transfer, Design of Fluid-Particle Systems, Colloids and Interface Science, Engineering Modelling and Simulation in Chemical Engineering, Introduction to Polymer Physics, Rheology of Soft Matter, Introduction to Molecular Simulation, Analytical and Material Characterization Techniques for Engineers, Introduction to Hydrodynamic Stability, 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

The department houses state-of the-art facilities and equipment to support research at the cutting edge. Besides the central facilities at the Institute level, we have our own workshop for fabrication of customized experimental set-ups; sophisticated analytical instruments such as SEM, XRD, FACS, BET, GLCS, GPC, AAS, AFM, HPLC, FT-IR, UV-VIS, ion-chromatograph, GC-MS, TGA etc; catalyst characterization equipment; membrane separations facilities (RO, ultrafiltration, electrodialysis etc); complex fluids characterization instruments such as goniometers, viscometers and rheometers; a dedicated nano-technology/fabrication unit with state-of-art equipment; and multi-node clusters for molecular simulations and computational fluid dynamic studies. For more details, visit https://www.iitk.ac.in/che/index.html

FACULTY

The department faculty, listed below, are recognized both nationally and internationally as leaders in their fields with prestigious awards and honours to their credit for research excellence (e.g. Infosys Prize, JC Bose Fellowship, Shanti Swarup Bhatnagar prize, Herdillia, Amar Dye Chem and NOCIL awards of IIChE, Fellowships of Academies of Sciences and Engineering, etc.)

1. *Vishal Agarwal*: Catalysis, reaction rate theory, biofuels, molecular simulations
2. *Pankaj Apte*: Statistical mechanics, interfacial thermodynamics, nucleation.
3. *Goutam Deo*: Heterogeneous catalysis, kinetics, transport phenomena
4. *Sanjeev Garg*: Bio-informatics, computer aided molecular design, flexibility analysis
5. *Animangsu Ghatak*: Adhesion and friction on soft interfaces, fracture of soft materials, bio-inspired design of reusable surfaces.
6. *Raju K Gupta*: Nanomaterials, self-assembly, nanostructures for energy applications.
7. *Yogesh M Joshi*: Rheology, polymer science and engineering, fluid mechanics
8. *Nitin Kaistha*: Integrated process design, plantwide control and intensification
9. *Rahul Mangal*: Polymer physics, colloids, complex fluids, nanocomposites, active matter, liquid crystals
10. *Raj Ganesh S Pala*: Sustainable energy, heterogeneous catalysis, Photo-chemical analysis, quantum and classical simulation of condensed matter systems.
11. *Siddharth Panda*: Chemical sensors, micro/ nano fabrication, processing of electronic materials, microfluidics, lab-on-a-chip.
12. *Indranil Saha Dalal*: Modelling and simulation of the dynamics of polymer chains in flow, complex fluids, flow induced effects in biomolecules.
13. *V Shankar*: Stability of fluid flows, dynamics and rheology of complex fluids.
14. *Ashutosh Sharma*: Colloid and interface engineering, nanotechnology, thin films.
15. *Jayant K Singh*: Molecular simulation, statistical thermodynamics, complex fluid structure, dynamics and phase behaviour.
16. *Sri Sivakumar*: Synthesis and characterization of nanomaterials, layer-by-layer assembly of polymer capsules, thin films, drug delivery and photonic crystals
17. *Raghavendra Singh*: Computational biology, gene therapy, embryonic andadult stem cells, tissue engineering, biomaterials.
18. *Naveen Tiwari*: Transport phenomena, instabilities in micro-scale free surface flows, flow through porous media.
19. *Anurag Tripathi*: Mechanics and rheology of granular flows and complex fluids.
20. *Nishith Verma*: Adsorption, environmental pollution control, mathematical modelling and simulation.

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 programs 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 in Civil Engineering and related fields.

FACULTY

Abhas Singh, Ph.D. (Washington University, St. Louis): Environmental geochemistry of heavy metals and inorganic contaminants, Inorganic contaminant fate and transport in groundwater, Contaminant remediation in natural as well as engineered environments, Recycling and stabilization of municipal and hazardous solid waste

Abhishek Chaudhary, Ph.D. (ETH Zurich): Sustainable Development, Environmental Modeling, Life Cycle Assessment

Amar Nath Roy Chowdhury, Ph.D. (National University of Singapore):Thin-Walled Structures, Stability of Structures, Nonlinear Finite Element Analysis, Structural Form Finding and Optimization, Plate and Shell Theories, Sandwich Structures, Particle-Based Methods.

Animesh Das, Ph.D. (IIT Kharagpur): Pavement design, Pavement materials, Pavement evaluation and maintenance.

Anubha Goel, Ph.D. (University of Maryland): Characterization of emissions from combustion sources for source identification a selection of mitigation strategies, technical interventions, indoor environmental quality, emission factors for pollutants from vehicular exhaust, impact of inhaled particles on human health, agricultural activity and climate change, management of solid waste for sustainable development.

Arghya Das, Ph.D. (University of Sydney): Constitutive modeling of Geomaterials. Micromechanics of granular materials. Bifurcation & instability analysis in Geomaterials. Numerical & physical modeling in Geotechnical Engineering.

Bipin Kumar Gupta, PhD (University of Waterloo): Foundations for Offshore Wind Turbines, Soil-structure interaction analysis and design, Numerical and Analytical Methods in Geomechanics

B. Nagarajan, Ph.D. (The Ohio State University): Geodesy, Satellite altimetric and gravimetric studies, Earth rotation and polar motion, photogrammetry and remote sensing, Topographical surveying and mapping, Regional Geoidal models

Balaji Devaraju, Ph.D. (University of Stuttgart):— Polar form of spherical harmonics as a diagnostic tool for GRACE/GRACE-FO temporal gravity field data Regularization of GRACE/GRACE-FO data with cyclo-stationary signal variances Parameterization strategies for mitigating aliasing errors in GRACE like gravity mission architectures

Bharat Lohani, Ph.D. (University of Reading): Terrestrial, Mobile and airborne laser scanning, Remote sensing, GIS, GPS, Electronic surveying, Algorithm development, Terrain modeling, Geodata visualization, and Applications.

Chinmoy Kolay, Ph.D. (Lehigh University): Behaviour of structures under extreme load events (e.g., earthquake, windstorm, and blast), Real-time hybrid (pseudo-dynamic) simulation, Structural dynamics and control, Nonlinear structural analysis, Numerical techniques and Soil-structure interaction.

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

Gourabananda Pahar, Ph.D. (IIT Kharagpur): Computational and experimental hydraulics, Lagrangian particle methods.

Gaurav Tiwari, Ph.D. (IISc Bangalore): Geotechnical engineering, rock mechanics and rock engineering, experimental rock mechanics, probabilistic rock engineering.

Harish K Venkatanarayanan, Ph.D. (Clemson University): Microstructure of cement-based material, Material characterization techniques, Advanced cementitious materials, Sustainable construction materials, Repair and rehabilitation of concrete structures.

Jagdish Prasad Sahoo, Ph.D. (IISc Bangalore): Foundation Engineering, Reinforced earth structures, stability of tunnels, underground openings and slopes, Pavement geotechnics, Strength behavior of rocks

Mukesh Sharma, Ph.D. (University of Waterloo): Air quality modeling and management, Fate processes of organic pollutants and parameter estimation, GHG emissions and mitigation.

Nihar R Patra, Ph.D. (IIT Kharagpur): Pile foundations, Soil-structure interactions, Ground engineering, Soil arching, Liquefaction potential evaluation.

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

Partha Chakroborty, Ph.D. (University of Delaware): Traffic flow theory and traffic engineering, Optimal transit system design, Transport system evaluation and management.

Pranamesh Chakraborty, PhD (Iowa State University): Intelligent Transportation Systems, Machine Learning, Big Data Analytics, Naturalistic Driving Studies

Prishati Raychowdhury, Ph.D. (University of California, San Diego): Soil dynamics, Geotectnical Earthquake Engineering, Seismic soil-structure interaction.

Priyanka Ghosh, Ph.D. (IISc Bangalore): 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.

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

Rajesh Sathiyamoorthy, Ph.D. (IIT Bombay): Numerical and Physical modeling, Geo-Environmental Engineering, Geosynthetics, Unsaturated soil mechanics, Railway Geotechnology.

Rajesh Srivastava, Ph.D. (University of Arizona, Tucson): Flow and transport through variably saturated porous media.

Richa Ojha, Ph.D. (Purdue University): Flow and transport through unsaturated porous media

Sachchida Nand Tripathi, Ph.D. (University of Reading): 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.

Salil Goel, Ph.D. (University of Melbourne and IIT Kanpur): Indoor/Outdoor Navigation, Cooperative Localization, LiDAR, Photogrammetry, Sensor fusion, Filtering and estimation theory, Integrated navigation/mapping systems, UAV applications

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

Saumyen Guha, Ph.D. (Princeton University): Subsurface Flow and Transport; Bioremediation of Toxic Organics in Natural Systems; Fate and Transport of Pesticides and Heavy Metals in the Natural Systems; Metal Uptake in Plants; Natural Isotopes.

Shivam Tripathi, Ph.D. (Purdue University): Statistical hydrology, Sediment transport, Eco-hydrology.

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

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

Suparno Mukhopadhyay, Ph.D (Columbia University): Structural Identification and Health Monitoring, Structural Dynamics, Earthquake Engineering

Syam Nair, Ph.D. (Texas A&M): Stabilization of pavement subgrade soils and base materials, Post-stabilization swelling in expansive soils, Characterization and performance prediction of cementitious materials, Use of recycled materials and by-products in pavement construction, Surface properties of aggregates and interaction with binding materials.

Tarun Gupta, Sc.D. (Harvard University): 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.

Venkatesan Kanagaraj, Ph.D. (IIT Madras):Traffic Flow Theory, Crowd Dynamics, Connected and Autonomous Vehicles.

Vinay K Gupta, Ph.D. (University of Southern California): Random vibrations, Earthquake engineering.

Vinod Tare, Ph.D. (IIT Kanpur): Water and wastewater treatment, modelling and simulation of environmental systems.

Vinod Vasudevan, Ph.D. (University of Nevada, Las Vegas): Traffic safety, Road user behavior, Non-motorized road user, Highway financing and policy analysis.

1. PROGRAMMES

We offer postgraduate programs in several specializations of Civil Engineering, leading to the degrees of Master of Technology (M.Tech.), MS by Research (MSR*) and Doctor of Philosophy (Ph.D.). The specializations offered are, Environmental Engineering (EE), Geoinformatics (GI), Geotechnical Engineering (GTE), Hydraulics & Water Resources Engineering (HWRE), Infrastructure Engineering and Management (IEM), Structural Engineering (STR) and Transportation Engineering (TE)

Admissions to M.Tech and MS by Research (MSR*) program in the above disciplines are offered generally in the July semester of each academic year. However, admissions to the

Ph.D. program are offered in both semesters. Admissions to Ph.D. program are also offered throughout the year on walk-in-interview basis subject to availability of seats.

NOTE (*):To learn about the specialization(s), that will / may be admitting MSR students please visit the website http://www.iitk.ac.in/ce/pg-admissions before applying and only after March 16, 2020.

2. ELIGIBILITY REQUIREMENTS

As per institute requirements, to be considered for admission all candidates must have at least 55 percent marks or 5.5/10 CPI in their B.Tech/BS (4-year)/M.Sc or equivalent. The departmental eligibility criteria are as follows:

2.1 M.Tech. Programme

Environmental Engineering (EE): Bachelor's degree preferably in Civil Engineering / Chemical Engineering / Mechanical Engineering / Agricultural Engineering or Master of Science in all areas. All candidates must have mathematics as a subject at least up to 10+2 level.

Geoinformatics (GI): Bachelor's degree in Civil/Mining/Electrical/Computer Science/ Electronics Engineering/Information Technology/Geoinformatics, or Master of Science in Earth Science and related areas 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: Bachelor's degree in Civil Engineering.

Hydraulics & Water Resources Engineering: Bachelor's degree in Civil/Agriculture Engineering. The candidates must have taken at least one mathematics course at the undergraduate level.

Infrastructure Engineering and Management: Bachelor's degree in Civil Engineering. Some candidates with Bachelor's degree in Building Construction and allied subjects may also be considered.

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

Transportation Engineering: Bachelor's 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.

4. More information giving other important details such as whether or not a written test will be held, whether direct admission (without any test or interview) will be offered, the number of choices for the different streams in the different programmes which will be considered for shortlisting of candidates for possible admissions, syllabus for the written test etc. will be provided at the following link: *http://www.iitk.ac.in/ce/pg-admissions*

2.2 M.S. by Research Programme

Same as in M. Tech program

2.3 Ph.D. Programme

EnvironmentalEngineering: Master's degree in Civil/Environmental/Chemical/Mechanical Engineering or in related engineering branch[*].

Geoinformatics: Master's degree in Civil/Mining/Electrical/Computer Science/ Electronics Engineering/Information Technology, or Master's degree in Earth Science and related areas or Geography/Physics/Mathematics/Environmental Sciences[$].

Geotechnical Engineering: Master's degree in Civil Engineering.

Hydraulics & Water Resources Engineering: Master's degree in Civil/Aerospace/ Agriculture Engineering.

Infrastructure Engineering and Management: Master's degree in Civil Engineering (Please see the Note 3 below).

Structural Engineering: Master's degree in Civil Engineering. Some candidates with Master's degree in Architecture, Building Construction and allied subjects may also be considered.

Transportation Engineering: Master's 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. For Ph.D. in Infrastructure Engineering and Management, candidates with Bachelor's degree having an excellent academic record and 5 years of relevant industrial experience, may also be considered.

GRADUATION REQUIREMENTS

For M.Tech. degree, a minimum of 72 credits should be earned through coursework, while maintaining a minimum CPI of 6.5, and a minimum of 72 credits through research work.

For MS (Research) degree, a minimum of 36 credits should be earned through coursework, while maintaining a minimum CPI of 6.5, and a minimum of 72 credits through research work. Total minimum credits required are 144.

The minimum total credits requirement for a Ph.D. student with a master's degree in engineering is 144. Out of this, a minimum of 36 credits should be earned through coursework while maintaining a minimum CPI of 7.0 and a minimum of 72 credits through research.

The minimum credits requirement for a Ph.D. student with bachelor's degree in engineering or master's degree in science is 216. Out of this, a minimum of 54 credits should be earned through coursework while maintaining a minimum CPI of 7.0 and a minimum of 72 credits through research.

COURSES

The courses offered from time to time and subject to periodic revisions in each area of specialization are listed below:

<u>Environmental Engineering:</u> Physico-Chemical Principles and Processes; Ecological and Biological Principles and Processes; Air Pollution and its Control; Principles of Environmental Management; Environmental Quality and Pollution Measurement Techniques; Atmospheric Physics and Chemistry; Surface Water Quality Modeling; Subsurface Pollutant Fate and Transport; Atmospheric Modeling; Solid and Hazardous Waste Management; Environmental Toxicology and Risk Assessment; Industrial Waste Management.

<u>Geoinformatics:</u> Introduction to Remote Sensing; Machine Processing of Remotely Sensed Data; Instrumentation, Laboratory and Field Practices in Geoinformatics; Global Navigation Satellite System; Geographical Information System; Laser Scanning and Photogrammetry; Geospatial Data Processing, Introduction to Inertial and Multi-Sensor Navigation, Physical Geodesy, Environmental Geodesy, Signal Processing on Sphere.

<u>Geotechnical Engineering</u>: 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.

<u>Hydraulics & Water Resources Engineering</u>: Advanced Hydrology, Engineering Hydraulics, Fluid Mechanics Laboratory, Computer Methods in Hydraulics and Hydrology, Stochastic Hydrology, Introduction to AI Techniques, Sediment Transportation, Advanced Modeling of Subsurface Flow and Transport, Vadose Zone Hydrology and Ecohydrology.

<u>Structural Engineering</u>: Structural Dynamics; Engineering Mechanics; Stability of Structures; Experimental Methods in Structural Engineering; Masonry Structures; Advanced Design of Steel Structures; Durability of Concrete Structures; Earthquake Analysis and Design of Structures; Random Vibrations; Finite Element Methods in Civil Engineering Applications; Reliability Analysis and Design of Structures, Vibration-based Structural Health Monitoring for CE Applications, Special Concretes

<u>Transportation Engineering</u>: Traffic Flow Modeling and Simulation, Characterization of Pavement Materials, Analysis of Pavement Structures, Traffic Engineering, Pavement Design, Urban Transportation, Transportation Economics, Traffic Safety, Airport Systems Planning and Design, Characterization and Use of Aggregates in Pavement Systems, Laboratory Course in Transportation Engineering

<u>Infrastructure Engineering and Management:</u> Infrastructure Asset Management; Project Management; Infrastructure Financing; Construction Economics and Finance; Construction Equipment and Techniques; Repair and Rehabilitation of Concrete Structures; Quality and Safety in Construction.

In addition, courses in mathematics, numerical methods, statistics, etc. are also offered by the department. At least two such courses are compulsory in the M.Tech. programme for all areas of specialization.

4. FACILITIES

a. 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:

- Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Atomic Emission Spectrometry (ICP-OES), Microwave Plasma Atomic Emission Spectrometry (MP-AES), Ion Chromatograph (IC), 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, Optical Particle Sizer, Micro Pulse Lidar, Sun photometer, Gas Analyzers (Ozone, Sulfur Dioxide, Carbon Mono Oxide, Nitrogen Oxides), Scanning Mobility Particle Sizer, High Performance Computing Clusters
- 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 lmagine, ERMapper, Arclnfo 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, Fluid friction apparatus, Momentum measurement apparatus, Apparatus to calculate sudden losses in expansion, Contraction and bends, Wind tunnels, Hydrology system, Tilting flumes, Acoustic Doppler flowmeter, Ultrasonic and Electromagnetic flowmeters, Hydro-meteorological observatories.

- 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, Equipment 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, Vacuum 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, State - of – the – art Instrumented vehicle, CBR testing, Light Weight Deflectometer, Universal Testing Machine for Asphaltic and Granular Materials, Vacuum Density Measurement for Mixes, Core Cutter.

b. **National Centre for Geodesy, IIT Kanpur**

A National Centre for Geodesy (NCG) has been setup at IIT Kanpur, with the support from Department of Science and Technology (DST). The objective of this centre is to nucleate and strengthen activities in the area of Geodesy education, capacity building and academic research and development by preparing well trained PG students, conducting state of the art research and development activities. This centre acts as the National Resource Center for extensive support (laboratory, equipment, training, library, SW, etc.) to students and researchers from various universities and institutions and advise state/central government departments on all issues related to Geodesy. NCG offers M.Tech, MSR and PhD programs in the areas of Geodesy/Geoinformation. The eligibility requirements are the same as those listed under Geoinformatics in the earlier section. (For information only: In addition, NCG offers a DIIT (Diploma of IIT) program specially meant for working professionals in academia or industry. This DIIT

program is currently offered in three broad areas, namely: Geodesy, Navigation & Mapping, Remote Sensing and GIS. The eligibility requirements for DIIT are the same as for M.Tech but only meant for working professionals).

The department offers academic programs leading to BTech, MTech, MTech dual degree (BTech and MTech), MS (Research) and PhD degrees in Computer Science and Engineering. These programs are flexible and allow students to choose courses from a number of elective courses offered by the department and do research on a wide range of topics in Computer Science and Engineering.

RESEARCH

The CSE department faculty are actively involved in research in various fields of Computer Science. The department provides an excellent research platform and nurtures and challenges students to solve real-world research problems. The research in the department can be broadly classified into the following areas.

THEORY

Algorithms and Data Structures: Algorithms in the domains of graphs and combinatorics, computational geometry, computational number theory, streaming data, algorithmic game theory, semidefinite programming, randomized algorithms, optimization and approximation algorithms, and fault tolerance.

Theoretical Computer Science: Complexity theory, logic in computer science, functional programming, algorithmic information theory, computational number theory, cryptography, computable real and complex analysis, computational algebraic-geometry, algebraic complexity theory, quantum computation, coding theory, streaming algorithms, and game theory.

SYSTEMS

Cyber Security: Building secure cyber systems, security of cyber-physical systems, cybersecurity for critical infrastructures, design crypto algorithms and protocols, Cyber Security with Machine Learning, Cyber Security of Cyber Physical Systems, Blockchains, and use of machine learning for anomaly detection to fight persistent threats in the critical infrastructure.

Cyber-Physical Systems: IoT, distributed multi-robot systems, formal verification of multi-robot systems.

Systems Security: Security issues related to Computer Architecture, Operating Systems, and Computer Networks. Side-channel attacks at caches and processor, side-channel attack proofs, formal guarantees, crypto engineering to vulnerability analysis of systems and application layer software, network and web security, cloud security through virtual machine hardening.

Formal Methods: Analysis of cyber-physical systems, prove security of systems.

High-Performance Computing: Topology-aware mapping, communication-aware job scheduling, effective parallelization strategies, high-performance optimizations for

different applications like deep learning networks, optimizing big data I/O and solving parallel I/O bottlenecks.

Operating Systems: ComputerArchitecture-operating systems interface, virtualization, cloud computing, operating system-computer network interface.

Programming Languages and Compilers: Program analysis, data flow analysis, heap analysis, code optimizations, compilation for functional languages, program profiling, formal techniques for automated debugging, program verification and synthesis, high-performance compiler optimizations, GPU algorithms, memory model analysis, automated memory management, and intelligent tutoring systems.

Computer Architecture: Computer architecture research in processor design with speculative techniques, memory hierarchy optimizations in the form of hardware prefetching, cache/DRAM content management, cache coherence protocols for client and server systems, and secure processor/memory systems.

Software Architecture: Develop design architectures such as tactics, reference architectures, and frameworks to build efficient and scalable software.

DATA SCIENCES

Machine Learning: Deep learning, probabilistic machine learning, computer vision, video analytics and surveillance, zero-shot learning, learning with millions of classes, adversarial machine learning, large-scale data mining, human-AI interface, cognitive and behavioral modeling, large scale optimization and inference

Databases, Big Data and Data Mining: Data analytics, data processing, indexing, querying, searching, data mining, data provenance, graph mining

Natural Language Processing and Information Retrieval: Question-answering, knowledge graph generation, dependency parsing, multimodal affect modeling, conversational systems, bio-medical NLP

Computational Biology: Probabilistic machine learning for cancer biology, algorithms for sequencing data, medical image mining, structure learning from single-cell sequencing

FACULTY

Ajai Jain, PhD (McGill University): Machine translation, VLSI testing, computer architecture, parallel computing.

Amey Karkare, PhD (IIT Bombay): Compilers, Program Analysis and Optimizations, Functional Programming, Intelligent Tutoring Systems.

Anil Seth, PhD (TIFR Mumbai): Logic in computer science, Automata theory and Games.

Arnab Bhattacharya, PhD (University of California, Santa Barbara): Databases, Data Mining, Information Retrieval, Natural Language Processing.

Ashutosh Modi, PhD (Saarland University, Germany): Natural Language Processing, Machine Learning, Affective Computing

Biswabandan Panda, PhD (IIT Madras): Computer Architecture, Security Aspects in Computer Architecture, Computer Architecture Operating system interface.

Debadatta Mishra, PhD (IIT Bombay): Operating Systems, Virtualization and Cloud Computing, Computer Networks, System Security, Technology in Education

Dheeraj Sanghi, PhD (University of Maryland): Computer networks, protocols at MAC/network/transport layers, Ipv6, wireless networks, internet applications, multimedia applications. **(on leave)**

Hamim Zafar, PhD (Rice University): Computational Biology, Machine Learning, Bioinformatics.

Indranil Saha, PhD (University of California, Los Angeles): Application of formal methods to embedded and cyber-physical systems and Robotics.

Mainak Chaudhuri, PhD (Cornell University): Computer architecture.

Manindra Agarwal, PhD (IIT Kanpur): Computational complexity theory, randomized algorithms, cryptography, computational number theory.

Nisheeth Srivastava, PhD (University of Minnesota): Cognitive science, cognitive computing, human-computer interaction.

Nitin Saxena, PhD (IIT Kanpur): Computational Complexity Theory, Algebra, Number theory, Algebraic-Geometry.

Piyush Rai, PhD (University of Utah): Machine Learning, Bayesian Statistics, Statistical NLP and Artificial Intelligence.

Pramod Subramanyan, PhD (Princeton University): Intersection of formal methods, security and systems.

Preeti Malakar, PhD (IISc, Bangalore): High-performance computing, Scalable parallel computing, Workflow optimization

Purushottam Kar, PhD (IIT Kanpur): Optimization, Statistical Learning Theory, Machine Learning Algorithms.

Raghunath Tewari, PhD (University of Nebraska): Computational complexity theory, graph theory.

Rajat Mittal, PhD (Rutgers University): Quantum computing, Complexity theory.

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

Sandeep Shukla, PhD (State University of New York at Albany): Cyber Security, Blockchain, Machine Learning for Intrusion/Anomaly Detection, Formal Methods for Cyber Physical Systems.

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

Satyadev Nandakumar, PhD (Iowa State University): Algorithmic information theory, computable real and complex analysis.

Subhajit Roy, PhD (IISc, Bangalore): Compilers, program analysis and optimization.

Sumit Ganguly, PhD (University of Texas, Austin): Data Streaming, Dimensionality Reduction for Big Data Analysis, Numerical Linear Algebra.

Sunil Simon, PhD (IMSc, Chennai): Algorithmic aspects of game theory, Logic, automata and games, theory of distributed systems.

Surender Baswana, PhD (IIT Delhi): Graph algorithms, dynamic algorithms, and randomized algorithms.

Swaprava Nath, PhD (IISc., Bangalore): Artificial Intelligence, Multi-Agent Systems, Game Theory, Mechanism Design, Computational Social Choice and Crowdsourcing.

Swarnendu Biswas, PhD (Ohio State University): Programming languages, program analysis, compilers and runtime systems, parallel computing, approximate computing.

T V Prabhakar, PhD (IIT Kanpur): Software architecture, Knowledge Engineering, Cloud Computing, Big Data Architectures.

Vinay P. Namboodiri, PhD (IIT Bombay): Computer Vision, Machine Learning, Image Processing, Computer Graphics. **(on leave)**

PROGRAMS

The department has a highly-regarded undergraduate program. The course curriculum for the undergraduate program gives 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.

B.Tech. Program

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. programs is available from the institute's JEE office.

M.Tech. Program

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. degree in computer science or equivalent degrees. A student needs to do at least seven courses with at least one course each from the theory, systems, and data science/application areas. There are no compulsory courses except a seminar course in the second semester of the program. Thesis work forms a major component of the program and begins after the first two semesters of the program. 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 in 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.

Eligible candidates may have to go through a test and/or interview conducted by the department for admission to the M.Tech. Program.

MS (Research) Type-I Program

This programme is meant for students who wish to pursue a masters degree while working on a project in the institute. The following are eligibility criteria.

- B.Tech/BE/BS(4yrs)(CS or IT)/MCA/MSc(CS) with CPI>= 6.00 or >=60%, valid GATE CS score.

- B.Tech/BE/BS(4yrs)(any discipline) with CPI>= 7.5 or >=75%, valid GATE CS score.

- B.Tech/BE/BS(4yrs)/MSc in EC/EE/Electronics/Math, GATE score in EE/EC/Math should be in top 1.0% and CPI>= 7.5 or >=75% in eligibility degree.

MS (Research) Type-II Program

This program is meant for students who have a 3-year or 4-year bachelor's degree in CS or related fields or in Mathematics or Physics. The eligibility criterion is as follows.

- 3-year or 4 year Bachelor's degree in CS/IT/Computer Applications/Math/Stat/Phy with a CPI>=7.5 or 75%

Both MS (Research) programs (Type I and Type II) involve a significant thesis research component. Students enrolled in the MS programs also need to do at least four courses.

Sponsored students admitted on a full-time basis and those admitted on a part-time basis (with a minimum of one year of project support from the date of admission, in the case of those employed on sponsored research projects in the Institute) will not be required to satisfy the GATE requirement. The (part-time) students employed on sponsored research projects in the Institute will not be supported by the Department, in case they fail to get project funding in their second year of the programme. Such students could be offered Institute Assistantship, as in the case of the M.Tech. students, for a maximum of one year, provided they have a valid GATE score and their case is considered favorably by the DPGC of the Department.

Applications for admission under the M.S. by Research programme will be invited independent of those for the M.Tech. programme and thus those interested to apply in both programmes will need to make separate applications. The merit list for admission in the proposed M.S. by Research programme will be prepared following the same process as that for the MTech programme, but the cut-off GATE scores (used for short-listing for the purpose of interview/written test) for the two programmes will be independent of each other.

Ph.D. program

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

All Ph. D. students are provided with a personal computer, personal 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 present their papers at conferences inside the country and abroad. A number of industry-supported fellowships are also available to Ph.D. Students.

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

RESEARCH AND COMPUTATIONAL FACILITIES

IIT Kanpur has one of the largest campus-wide networks among educational organizations in the nation with a 3Gbps connectivity to the Internet. All students of the institute get email, browsing, and other Internet facilities. Apart from a state-of-art Computer Center that is a central facility, the CSE department has its own well-equipped laboratories.

Research Centers

The CSE department is a leading center for research in cyber-security, cryptography, and cyber-physical systems research. The department is home to two research centers in this area, the Interdisciplinary Center for Cyber Security and Cyber Defense of Critical Infrastructures (C3I) (https://security.cse.iitk.ac.in) and the National Blockchain Project (https://blockchain.cse.iitk.ac.in).

Special Interest Groups (SIG): The CSE department is home to several reading groups in theory, data sciences and systems research. These are largely student-led activities and offer a unique platform to discuss not only one's own research but cutting-edge developments in the area as well.

1. SIG on Theoretical Aspects of Computer Science (SIGTACS): https://sigtacs.github.io
2. SIGs on Systems and Security Research
   a. Computer Architecture Research for Resilient, Secure, and Scalable Systems (CARS): https://www.cse.iitk.ac.in/users/biswap/CARS.html
   b. Computer Architecture, Operating Systems and Systems Security (CAOS): https://www.cse.iitk.ac.in/users/skmtr/CAOS.html
3. SIG on Natural Language Processing

STUDENT WELLNESS INITIATIVES

Association for Computing Activities (ACA): ACA is a student body of the CSE department and aims to make the student experience more enjoyable and well-rounded. This is achieved through various events, designed to increase interaction between students and faculty. The body organizes welcome and farewell events for various batches, summer schools for non-IITK UG students on various topics like machine learning, algorithm design, and cybersecurity, weekend programming contests and happy hours that include games, sports, and trivia quizzes, basically free food and fun.

You can read more about ACA at https://aca-cse-iitk.github.io/.

Counseling Initiatives: The department has a student well-being committee and arranges for student mentors to offer guidance and help students overcome difficulties in course and thesis work. The department counsellor offers help and advice to students on a variety of issues including but not restricted to academics.

COGNITIVE SCIENCE PROGRAMME

The Cognitive Science IDP at IIT Kanpur will be admitting students in the MS and PhD program for the semester starting July 2020. In order to apply for the MS or PhD program in Cognitive Science, the candidates should possess valid score/qualification in GATE/ CSIR/ JRF/ NET/ COGJET-2020 other equivalent exam.

Candidates will be shortlisted for interview based on COGJET scores in the qualifying exam. Candidates who did not appear in COGJET-2020 but have a valid score/qualification in GATE/ CSIR/ JRF/ NET/ other equivalent exam will have to appear for a written exam. They will be shortlisted for the interview on the basis of their score in the written exam.

The admission portal can be accessed using the link
https://oag.iitk.ac.in/cogjet

Details of the admission procedure are available at
https://www.iitk.ac.in/cogsci/docs/cogjet.pdf

For more details on the Ph.D program see:
https://www.cgs.iitk.ac.in/user/cgs/cgs/index.php/Cgs/PhdCourse

For more details on the MS program see:
https://www.cgs.iitk.ac.in/user/cgs/cgs/index.php/Cgs/MsCourse

The home page for the Cognitive Science program is:
https://www.cgs.iitk.ac.in/user/cgs/cgs/

Design Programme: An Interdisciplinary Courses-of-Study for the award of Master and PhD degree in Design

The Design Programme envisions itself as an interdisciplinary space for co-creation of design education, research and people-centric application. We believe in developing a collaborative environment between students, researchers, academicians and business practitioners. We aim at creating a working environment for enabling knowledge sharing and experience exchange. Pedagogically, we believe in 'learning by doing', experimentation, collaboration and innovation. We aim at creating the next generation of designers, design thinkers and design leaders who will conceptualize and develop design solutions for the challenges faced by industry and society. To do so, we foster a passion based and student centric learning culture. We constantly explore creative ways of working and enhancing interaction to support world-class development in education, research and practical application context. We strive to build on designers' ability to research, discover, invent, innovate, ideate, make decisions, evaluate and lead for the purpose of improving quality of life.

Our curriculum is based upon an interdisciplinary synthesis of design, technology, social sciences and management, while also adhering to the principles of sustainability. The programme inculcates the spirit of creativity, celebrates innovation, develops an appreciation for human values, fosters craftsmanship, and encourages personal expression leading to evolution of products and services for the betterment of society and people.

Our Students

Design at IIT Kanpur is a unique program in terms of its multidisciplinary approach and flexibility. This requires a certain maturity to be able to navigate, exploit it to its fullest and derive maximum benefit from it. Students comfortable with ambiguity & flexibility fit well and have a better head start in the unique environs for Design education at IIT Kanpur. At the Design Program, we seek problem solvers with a good academic record, interdisciplinary outlook, strong emotional and social intelligence, capable of thinking on their feet, and above all hard working and persistent.

Our Graduates

We have a strong Placement record since our inception in 2002. Our graduates have been joining the IT industry, organizations with a focus on media, product design and visual graphics, automobile industry, and we are proud of the myriad range of successful start ups launched by our alumni. A select few have also pursued research in Design towards a PhD and eventually opted an academic career.

Design Disciplines

In the first two semesters of the masters programme we offer students a holistic training in Design through the core courses and departmental electives in various different disciplines of Design. Students are also encouraged to take courses outside their own discipline. Students take up thesis project in the third and fourth semester of their masters programme in some of the following streams of study: Product/ industrial Design, Mobility Design, Visual Communication, Engineering Design, User Experience Design, Interaction Design, Film Making, Systems Design etc

Faculty

We have a multidisciplinary group of faculty drawn from many different departments, streams and discipline of study from across the institute who contribute in teaching as well as research in the Design Programme. Additionally, we have several adjunct and visiting faculty members from the industry and academia.

Braj Bhusan Ph.D (BRAB University)
Cognitive Neuropsychology, Cognitive Factors in Design

Deepu Philip Ph.D, (MSU Bozeman)
Production and operations management, Systems engineering and simulation, Local search and optimization

D. P. Mishra Ph.D (IISc Bangalore)
Combustion system Design, Thermal System, Pedal Power Devices, Design products for rural india

Ishan Sharma Ph.D (Cornell University)
Granular materials, Planetary science, Contact mechanics and adhesion, Soft materials, Dynamics, Structural vibrations, Wave propagation, Stability, Fluid-structure interaction

J Ramkumar Ph.D (IIT Madras)
Design products for inclusive society, Design products for rural india, Design products for children

Koumudi P Patil PhD (IDC, IITB)
Communication Design, Design Thinking and Research Methods, Frugal Innovation for creative Industry

Mainak Das PhD (University of Central Florida)
Bio-electricity, Green Energy, Physiology, Sensor

Manindra Agarwal Ph.D (IIT Kanpur)
Abstractions and Design

Munmun Jha Ph.D (Glasgow University)
Design Anthropology

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

Niraj Sinha Ph.D (University of Waterloo)
Prosthetic aids, Low cost machines

Satyaki Roy Ph.D (Visva Bharati University)
Folk Art and Crafts, Creativity, Cinema Studies

Shantanu Bhattacharya Ph.D (University of Missouri, Columbia)
Design of Dental Healthcare products, Design of Clinical Diagnostic Products, Design of products for water remediation

Shatarupa T Roy Ph.D (DOD, IIT Guwahati)
History of Art, Visual Culture, Design Theory

Tarun GuptaPh.D (Harvard University)
Environmental Engineering, Personal exposure assessment and health effects of inhaled
particles, Control of engine exhaust emissions, and risk assessment

Ritwij BhowmikPh.D. (National Chiao Tung University, Taiwan)
Art History, Art Education, Visual Culture, Film and Media Studies, Modern Art, Far-
Eastern Art, Chinese Calligraphy and Painting

Vimal Kumar Ph.D (University of California, Irvine)
Economics of Conflict, Microeconomic Theory, Political Economics, Economic Growth
and Technological Development, Game Theory

Vinay P Namboodiri (IIT Bombay)
Multimedia for intelligent interfaces, Machine learning for interface and content analysis,
Sketch based representation

Adjunct Faculty

Arvind Lodaya
Strategic Consulting, Branding, Industrial Design

Om Prakash
Material & Manufacturing Research

Shailendra Singh
Process & System Innovation

Admissions
M.Des: Masters programme in Design aims at attracting students from diverse
backgrounds who exhibit high levels of creativity, intellectual ability and maturity. To
ensure such a student profile, we admit those best suited to our program through a
rigorous selection process.

Admissions are made once a year, in July. The minimum academic qualification is that
candidates should hold a Bachelor's degree in Engineering, Design or Architecture from a
recognized University with not less than 55% marks or equivalent (no marks restriction
for SC/ST/PD candidates) as well as a valid CEED/GATE score. Candidates holding
degrees in Fine Arts or Interior Design are not eligible to apply for this program. Students
in the final year of the qualifying degree may also apply, but the admission would stand
cancelled if the final examination is not over at the time of admission, or if the proof of
minimum qualification is not submitted by September 30th in the year of admission. There
is no restriction on the age of the candidate or the number of attempts for CEED/GATE.
Shortlisted candidates will be called for another screening at the Institute, the details of
which will be intimated to the candidate with the call letter by Program and admission
will be granted based on the final results.

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 program) 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. Shortlisted candidates will be called for another screening at the Institute, the details of which will be intimated to the candidate with the call letter by Program and admission will be granted based on the final results.

(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

DEPARTMENT OF EARTH SCIENCES

The Department of Earth Sciences at IIT Kanpur is deeply engaged in interdisciplinary teaching and research programs of contemporary relevance in Earth Science. The department aims to provide trained manpower for sustainable development and resourcing India's future generations. The Department is active in studying various facets of the Earth and other planetary bodies, encompassing its evolution and internal dynamics, its surface processes, and natural and human-induced transformations of the terrestrial environment vis-a-vis sustainable development. Teaching and research programs in the department are adequately supported by well-equipped laboratory facilities. This program thus provides a sound, topical background in various aspects of Earth Sciences, and will form the foundation for pursuing further advanced studies as well as a wide range of employment opportunities in the mineral, energy, water, environmental and space sectors.

FACULTY LIST AND THEIR RESEARCH INTERESTS

Malik, Javed N.; (PhD, M. S. University of Baroda), *Professorand Head of the Department*

Active Tectonics, Paleoseismology, Paleo-tsunami, Natural Hazards.

Sinha, Rajiv; (PhD, University of Cambridge), *Professor*.

River science, Geomorphology, Remote Sensing and GIS, wetlands, Climate Change

Paul, Debajyoti; (PhD, Cornell University), *Professor*.

Mantle Dynamics, Crustal evolution, Applied Geochemistry.

Misra, Santanu; (PhD, Jadavpur University), *Associate Professor*.

Structural Geology, Tectonics, Geodynamics.

Sen, Indra Sekhar; (PhD, Florida International University), *Assistant Professor*.

River geochemistry, Himalayan cryosphere, Aerosol geochemistry.

Deepak Dhingra; (Ph.D., Brown University, USA), *Assistant Professor*

Planetary remote sensing, Lunar geology, Enceladus' plume research, Impact cratering research

Mandal, Animesh; (PhD, IIT Kharagpur), *Assistant Professor*.

Exploration geophysics, Potential field methods, Geophysical data processing and modelling.

Ghosal, Dibakar; (PhD, Institut de Physique du Globe de Paris), *Assistant Professor*.

Geophysics, Seismology, Poroelasticity.

Ishwar Kumar C.; (PhD, IISc Bangalore), *Assistant Professor*

Tectonics and crustal evolution, Petrology, Paleogeography, Remote sensing and GIS

Agrawal, Amar (PhD, IIT Roorkee), Assistant professor

Impact cratering, Tectonics, Rock magnetism

Explore further about the ES Faculty members here: http://iitk.ac.in/es/faculty

PROGRAMS

BSMS program in Earth Sciences (5 years):

BSMS program in Earth Sciences has a focus on basic sciences, computational and engineering sciences, and modern analytical tools (in geochemistry, geophysics, seismo-tectonics, remote sensing and GIS), and application-oriented teaching. Our BS-MS programme consists of a set of (a) core courses in basic sciences and engineering, (b) departmental compulsory courses, (c) electives, (d) undergraduate project and (e) independent research project. All students will be admitted for the 4-year BS programme as per the norms approved by the Senate and will be allowed to opt for the MS degree by extending the programme by two semesters. The proposed programme is designed with an objective to understand the interactions amongst earth's systems emphasizing on the earth surface processes, soil-atmosphere critical zone, deep earth processes, natural hazards, resource exploration, and climate change etc.

M.Tech. Program in Geological Technology (4 Semesters):

The M.Tech. program in Geological Technology has a focus on applied Earth sciences, specialized courses in Earth surface processes, River and climate sciences, Petrology and geochemistry, Petroleum studies, Solid Earth and Exploration Geophysics, Advanced Structural Geology, Rock Deformation; Remote Sensing-GIS and natural hazards. The program consists of 2 semesters of course work and two semesters of research. The M.Tech. students are expected to complete 8 courses in the first two semesters with a minimum CPI of 6.0 and then allowed to carry out research in one of the specialized areas for the next two semesters. A written thesis has to be submitted and defended at the end of the program.

The program aims to provide high quality manpower in Earth Sciences, where intellectual foundations and traditions are anchored in: (a) Integration of quantitative data across various Earth systems, and (b) Application of geological, geophysical and other related analytical methods. Some of our major research areas include river science, natural hazards, environmental geology, hydrocarbons, near surface geophysics (applied to natural resources exploration, as well as geologic, hydrologic, and engineering issues), water, soil and rock chemistry, and climate change. The Department encourages interdisciplinary research and innovative ideas in all possible areas of Earth Sciences.

Who Can Apply?

Students with M.Sc. degree in Earth Science, Physics, Chemistry or related streams or B.Tech./B.E. degree in Civil Engineering/Geosciences are eligible to apply for the

M.Tech. program. The applicant must have secured marks/CPI not below 65% marks (or Cumulative Performance Index (CPI) of 6.5 on a 10-point scale). Candidates belonging to the Scheduled Castes/Scheduled Tribes who have a bachelor's degree in engineering or a master's degree in science are eligible to apply irrespective of the marks/CPI. In addition, a valid GATE score is needed. The GATE requirement will be waived for the B.Tech. graduates from IITs with a minimum overall CPI of 6.5 and a minimum CPI of 8.0 in the last two semesters in B.Tech. However, such students are not entitled to Institute Assistantship if overall CPI is below 8.0.

Explore further about our M. Tech. Program here: http://iitk.ac.in/es/m-tech

PhD Program in Earth Sciences

The PhD program in Earth Sciences aims to develop high quality research programs in areas of Surface Processes, River Science, Climatology, Petrology and Geochemistry, Structural Geology, Rock Deformation, Solid Earth Dynamics, Exploration/near surface geophysics, Seismology, Palaeo-seismology, Natural Hazards, Energy etc. with an emphasis on interdisciplinary and quantitative approach. The PhD program also consists of a combination of course work and independent research.

All PhD students are expected to complete a minimum number of courses (4 courses for students with M.Tech. degree and 6 courses for students with M. Sc. or B.Tech. degree). After completing the course work, students must clear a comprehensive (written and oral) examination before he/she is admitted to the candidacy of the PhD program. Subsequently, the candidate is required to deliver a "State-of-the-Art Seminar" on his/her area of research. All PhD students are expected to carry out independent research and are 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.

Who Can Apply?

Students with M. Sc. / M.Tech. degree or equivalent in Earth Science streams with first division with CPI/marks not below 6.5 or 65% or Bachelor's degree in engineering with CPI/marks not below 7.5 or 75% are eligible to apply. Valid GATE/UGC/CSIR score is required for financial assistance, except for graduates from IITs with a minimum CGPA of 8.0.The candidates with DST INSPIRE fellowship for PhD are also eligible to apply. Candidates belonging to the Scheduled Castes/Scheduled Tribes who have a master's degree in engineering/sciences are eligible to apply irrespective of the marks/CPI.

Explore further about our PhD Program here: http://iitk.ac.in/es/ph-d

COURSES

Remote sensing and GIS for geo-resource evaluation, Geophysical methods, Geophysical field theory, Seismic exploration and subsurface imaging, Well logging, Instrumentation in Earth Sciences, Mathematics for Earth Sciences, Applied sedimentology and Basin analysis, Geology and Geochemistry of Petroleum, Advanced structural geology, Rock mechanics and rock physics, River Science, Isotope Geochemistry, Igneous and

metamorphic petrology, Aqueous Geochemistry, Natural hazards, Active Tectonics and Paleoseismology, Global climate change, Economic Geology etc.

Explore further about our course structure here: http://iitk.ac.in/es/course-structure-phd-m-tech

Explore further about our courses here: http://iitk.ac.in/es/list-of-courses-phd-m-tech

FACILITIES

General Facilities:

- Laboratory for X-Ray Diffraction
- Laboratory for Scanning Electron Microscopy
- Laboratory for Optical Microscopy with imaging and image processing facilities, Remote sensing and GIS lab with softwares Arc GIS, ERDAS Imagine and ENVI
- Laboratory for thin section and polished section preparation
- Mini-workshop
- All modern facilities for geological field investigations.

Specialized Laboratory Facilities:

- *Laboratory for Geochemical studies*: AAS, Q-ICP-MS, ICP-MS/MS, UV-VIS, water isotope analyzer (LGR), Nutrient Analyzer, Class 10,000 metal free clean laboratory, various hand-held water quality probes, ice coring facilities

- *Laboratory for Geophysical studies:* Remotely acquisition UNITES (RAU), Geophones, Weight drop hammer, Portable Engineering Seismograph, Ground Penetrating Radar (GPR), Well Logger, , Digital Gravimeter (Sintrex CG-6), Proton Precession Magnetometer (Overhausser), Four electrodes Resistivity Meter (Aquameter CRM500), Multi-electrode Resistivity Meter (SYSCAL R1 plus), Very Low Frequency electromagnetic station (VLF-EM), Geosoft, OpendTect, FOCUS, HRS Cable and cable-less (UNITE) systems for seismic data acquisition

- *Laboratory for Sedimentology*: Sedigraph, Vibratory Cup mill, SMZ- 100, CL Microscope, carbon analyzer, Hydrobios Gravity Corer, Sediment dredger, Core archive and Analysis facility, pollen analysis and microscopy.

- *Laboratory for Structural Geology and Rock Deformation*: Core drilling machine, Lathe Machine, Mini-Load Frame, Gas/Liquid Permeameter, Gas Pycnometer, High Velocity Pulsar/Receiver along with Oscilloscope, Deformation Table.

- *Laboratory for Palaeoseismology*: Optically Simulated Luminescence (OSL) and Thermoluminescence (TL) dating facilities, Engineering Seismograph.

- *Laboratory for Terrain Mapping and Survey*: Total Station, Differential Global Positioning System (DGPS) & GPS, Image Rover, Unmanned Airborne Vehicle (UAV), multispectral, hyperspectral and thermal cameras for UAVs, LIDAR

Terrestrial Scanner, Inflatable boat and engine, Acoustic Doppler Current Profiler (ADCDP), Echo sounder

Central Facilities:

WD-XRF, Stable isotope ratio mass spectrometry, Mechanical and electrical Workshops, Field Emission Scanning Electron Microscope (FE-SEM); Transmission Electron Microscopy (TEM); Electron Back-scatter Diffraction (EBSD), Electron Micro-probe Analyzer (EPMA), Fourier transform infrared spectroscopy (FTIR), Thermo-Gravimetric Analyzer (TGA) and Differential Scanning Calorimetry (DSC), Atomic Force Microscopy, Vibrating Sample Magnetometer (VSM).

With an ever-increasing emphasis on a technology-driven economy, interdisciplinary economic research has become the key to global economic prosperity. IIT Kanpur's Department of Economic Sciences – the first among all IITs – is a pioneer in economic research, teaching and outreach activities. With its rigorously trained and proficient faculty, the department is fast emerging as a prominent center for economic research in India.

DEPARTMENT FACULTY AND THEIR RESEARCH INTERESTS

Vimal Kumar; (Ph. D., University of California, Irvine, U. S. A.)

Professor andHead of the Department

<u>Research Interests</u>: Economics of Conflict, Microeconomic Theory, Political Economics, Economic Growth and Technological Development, and Game Theory.

Surajit Sinha; (Ph. D., McMaster University, Canada**)**

Professor

<u>Research Interests</u>: Money – Macro and Industrial Economics.

Joydeep Dutta; (Ph. D., I. I. T. Kharagpur, India)

Professor

<u>Research Interests</u>: Optimization Theory.

PraveenKulshreshtha; (Ph. D., Cornell University, U. S. A.**)**
Professor

<u>Research Interests</u>: Microeconomics, Industrial Economics, Economics of Corruption and Business Ethics.
Somesh K. Mathur; (Ph. D., Jawaharlal Nehru University, India)

Professor

<u>Research Interests</u>: Efficiency and Productivity Analysis, New Trade and Growth Theories, and WTO Issues such as TRIPS and IT policy.

P. Murali Prasad; (Ph. D., University of Hyderabad, India)

Professor

<u>Research Interests</u>: Microeconomics, Law and Economics, and Environmental Economics.

Sarani Saha; (Ph. D., University of California, Santa Barbara, U. S. A.)

Professor

<u>Research Interests</u>: Applied Microeconomics, Environmental Economics and Public Economics.

Sohini Sahu; (Ph. D., State University of New York at Albany, U. S. A.)
Associate Professor
Research Interests: Macroeconomics.
Mohammad Arshad Rahman; (Ph. D., University of California, Irvine, U. S. A.)
Associate Professor
Research Interests: Bayesian Econometrics, Econometrics and Applied Econometrics.
Deep Mukherjee; (Ph. D., University of Connecticut, U. S. A.)
Associate Professor
Research Interests: Agricultural Economics, Environmental Economics, Efficiency and Productivity Analysis, and Public Policy.
Debayan Pakrashi; (Ph. D., University of Queensland, Australia)
Assistant Professor
Research Interests: Behavioural Economics, Health Economics, Labour Economics and Economic Development.
Wasim Ahmad; (Ph. D., University of Delhi, India)
Assistant Professor
Research Interests: Macroeconomics, Financial Economics and Applied Econometrics.
Bikramaditya Datta; (Ph. D., Columbia University, U. S. A.)
Assistant Professor
Research Interests: Investment Timing, Moral Hazard and Overconfidence, Motivating Experts in Dynamic Settings.

PH. D. PROGRAMME IN ECONOMIC SCIENCES AT I. I. T. KANPUR

The Ph. D. Programme in Economic Sciences was introduced at IIT Kanpur in 1974, in the Department of Humanities and Social Sciences, IIT Kanpur. Till date, around 60 Ph. D. students have graduated from the programme. Various Ph. D. graduates of the programme, including many recent ones, have been placed at reputed academic institutions and private firms such as NIPFP Delhi, IIT Bombay, IIT Roorkee, IIM Kozhikode, BITS Pilani, IIT-ISM Dhanbad, IIM Jammu, IIM Ranchi, NIT Surathkal, RBI, Ernst & Young, HSBC and TCS.

Admission Cycle: Admissions are made twice in a year – in May (summer) and December (winter). *Eligible students face an Admission Test, which consists of a written examination and an interview, as a part of the selection procedure.*

Admission Test (written exam and interview) will be held at I. I. T. Kanpur in May 2020.
For further information, see I. I. T. Kanpur website:

http://www.iitk.ac.in/eco/admissions/postgraduate-admission

Walk-in-interviews are held throughout the year. Prospective students are encouraged to apply as soon as possible.

Eligibility Criteria for Ph. D. in Economic Sciences at I. I. T. Kanpur:

(a) The candidate must have a master's degree in economics, or a bachelor's degree in engineering or sciences (4 year programme), or a master's degree in sciences or an allied field of economics, with marks/CPI (Cumulative Performance Index) not below 55 percent marks/5.5 CPI (on a 10 point scale),

as long as these are not less than the minimum pass marks/CPI; otherwise, the minimum pass marks/CPI must be obtained. Note that *candidates belonging to the Scheduled Castes/Scheduled Tribes, who have <u>passed</u> the basic qualifying degree, are eligible to apply irrespective of the marks/CPI and will be considered for admission.*

(b) The candidate must either have a valid GATE score, or must have qualified JRF/NET. The requirement of GATE/JRF/NET is waived for candidates having a master's degree in sciences/arts from IITs with a minimum CPI of 8.0.

Ph. D. Programme Course Structure:

- Five-years programme, with a set of courses and high quality research opportunities.
- Two-semester coursework, followed by a comprehensive examination.

COURSES

The two-semester Ph. D. coursework will consist of compulsory courses in the following fields:

- Advanced Microeconomics
- Advanced Macroeconomics
- Econometrics
- Mathematical Analysis for Economics

Moreover, the students will be asked to choose a set of elective courses from the following basket of courses:

- Applied Econometrics
- Bayesian Data Analysis
- Bayesian Econometrics
- Contract Theory
- Development Economics
- Efficiency and Productivity Analysis
- Financial Econometrics
- Foundation of Finance
- Game Theory
- Labour Economics
- Law and Economics
- Monetary Economics
- Topics in Economic Growth

Contact:

Prof. Vimal Kumar	Office:
Head, Department of Economic Sciences	Department of Economic Sciences
IIT KANPUR	IIT KANPUR

Electrical Engineering

The Department of Electrical Engineering (www.iitk.ac.in/ee/) offers M.Tech, MS(R), and Ph.D programmes in almost all the sub-disciplines of Electrical Engineering. The areas include: Digital Communication Systems; Information and Coding Theory; Telecom and Wireless Networks; Peer-to-peer networks; Digital Switching Systems; 5G Wireless Communication Systems; Digital Signal and Image Processing; Computer Vision; Inverse Problems and Tomography; Signals and Systems Theory; Control Systems and Robotics; Networked Control and Electric Vehicle Control; Electronic and Virtual Instrumentation; Fuzzy Logic; Neural Networks and their applications; Power Systems; HVDC & FACTS, Power Quality; 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; Organic Electronics; Flexible Electronics; Photovoltaics; Electromagnetics; RF Engineering and Microwaves; Antennas, Metamaterials; MMIC; RF and Microwave Sensors; RFID; Microwave and Mm-wave Imaging; RF Energy Harvesting, Electromagnetic and Tomographic Imaging; Terahertz Imaging and Testing; Nanophotonics, Plasmonics, Quantum Dot based Devices; Optoelectronics; Signal processing for fiber-optics; Nonlinear fiber optics; Fiber-optic sensors; Quantum Cryptography and Quantum Optics; Spin waves; Photonic Networks and Systems.

Programmes

In the application form for M.Tech., the applicants must specify their choice of area(s) of specialization/code number mentioned above. Please note that the candidates have to use only those code numbers given at the end of this section while filling up application form for Ph.D. programme. 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 (www.iitk.ac.in/doaa/) . Candidates are also advised to refer the EE admissions web-page (http://www.iitk.ac.in/ee/admissions) for regular updates.

M.Tech.: In M.Tech. programme, a student takes eight courses, some of which may be compulsory for the area of specialization chosen, the rest being electives to be chosen in consultation with the programme advisors. The programme also includes a research/project component, which culminates in a thesis.

MS(R): In MS(R) programme, a student has to complete a minimum of four courses in the area chosen by the student in consultation with the thesis advisor. After completing the course work, the student is expected to do research work leading to a thesis. Focus on research makes this program exciting and provides in-depth knowledge to the student.

Ph.D.: In the Ph.D. programme, a student with M.Tech qualification has to complete minimum of four courses and a student with B.Tech. qualification has to complete minimum of ten courses. The most important part of the doctoral programme is the

research work leading to a thesis. Student works on exciting research problems to come up with innovative/original ideas.

Specialization in the M.Tech/MS(R)/Ph.D. Programmes is available in any of the following broad areas:

Microelectronics and VLSI **(Code: 01)**

Power Engineering **(Code: 02)**

RF and Microwaves **(Code: 03)**

Signal Processing, Communications and Networks **(Code: 04)**

Control and Automation **(Code: 05)**

Photonics **(Code: 06)**

OPPORTUNITIES IN SPONSORED RESEARCH

Sponsored research and development activities are actively 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 MEMBERS

Akhtar M J, Ph.D. (Magdeburg): Microwave, mm-wave and THz imaging and nondestructive testing, RF Sensors, Artificial dielectrics and metamaterials, Wideband microwave absorbers, Microwave material processing, UWB antennas, Microwave filters, Electromagnetic and multi-physics modelling, RF energy harvesting, Interaction of electromagnetic waves with biological tissues.

Anand S, Ph.D. (IITB): Renewable sources based DC microgrid and power electronic converters for solar PV systems.

Arora V, Ph.D. (IITK): Audio signal processing, machine learning, automatic speech recognition, music information retrieval

Balasubramanian K B, Ph.D. (IISc): Nanoscale electro-optics, superconducting qubits and sensors, low-dimensional electron transport

Banerjee A, Ph.D. (Notre Dame): Green communications, Cognitive radio, Error control coding, Wireless communications and Visible light 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

Budhiraja R Ph.D. (IITM): Applications of linear algebra, information theory and optimization to study problems in wireless communications, massive MIMO, cooperative communications, 5G algorithm design, building communication systems

Chakrabarti 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; Low and high frequency electrical characterization; Atomistic Simulation; RF Circuit Design.

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

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

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

Gupta A K, Ph. D. (UT Austin): Wireless Communications, Stochastic Geometry and Numerical Methods.

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. (UMCP): Nanophotonics; Plasmonics; Quantum optics; Quantum dot based Devices.

Gupta T D, Ph.D.: Wearable electronics, Optics for health monitoring, Sensing, Energy harvesting and robotics, Metasurfaces, Stretchable electronics.

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): 5G Wireless Technologies, Massive MIMO, mmWave MIMO, Non-Orthogonal Multiple Access (NOMA), FBMC, IoT and Full Duplex Wireless

Karandikar A, Ph.D. (IITK): Quality of Service and Resource Allocation in Wired/Wireless Networks, Frugal 5G and Rural Broadband, Resource Allocation, Mobility Management and Dual Connectivity in Heterogeneous Wireless Network, Device to Device Communication, Software Defined Networking, TV White Space and its Potential for Affordable Broadband Access in India

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

Mondal I, Ph.D. (IITM): Analog Integrated Circuit Design

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

Mohapatra A, Ph.D. (IITD): Power system security; Uncertainty modelling; Stochastic analysis and optimization; Robust and efficient system operation and planning; Renewable integration in power systems; Deregulation.

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

Potluri R, Ph.D. (Kentucky): Control system theory; Practical applications of control theory; Electric vehicles; Networked control systems; Consensus and Cooperation.

Pradeep Kumar K, Ph.D. (IITM): Signal processing for Optical Communications, Non-linear fiber optics; Quantum cryptography; Fiber-optic sensors, Spin Waves.

Rajawat K, Ph.D. (Minnesota): Optimization Algorithms, Network Optimization, Signal Processing in Networks, Online Machine Learning..

Rajshekhar G, Ph.D. (EPFL): Biomedical Optics; Light Microscopy; Optical Metrology; Digital Holography.

Sahoo S R, Ph.D. (IITB): Linear and Nonlinear systems, Adaptive Control, Time-delay systems, Control of unmanned vehicles, Multi-agent systems and coordinated control, AC and DC Microgrids.

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

Sharma A, Ph.D. (IITK): Power Systems, Smart Grid Technology, State Estimation, IT Application into Power Systems, Smart City, Multi-Agent Systems, Wide Area Monitoring & Control of Power System, Energy Market, Demand Response Management, Internet of Things.

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; Optical networks; Digital switching systems; Wireless networks; Wireless sensor networks; P2P networks.

Srivastava K V, Ph.D. (IITK): Metamaterials, Microwave Antennas, Printed Antennas, MIMO Antennas, Microwave Metamaterial Absorbers, Microwave Cloaking, Finite-Difference Time-Domain (FD-TD) Technique.

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 A, (Notre Dame): Epitaxial growth and characterization of semiconductor thin films, Semiconductor Device Design and Fabrication, Electron Transport measurements and modelling.
Verma, A R, Ph.D. (IISC): High Voltage Engineering, Dielectrics and Electrical Insulation, Computational Electrostatics, Polymeric Insulation for High Voltage Application, Over-voltages in Power Systems
Verma N K, Ph.D. (IITD): Big Data; Internet of Things/Cyber physical systems; Intelligent Data Mining Algorithms and Applications; Diagnosis and Prognosis of Rotating Machines; Soft-Computing in Modelling and Control; Machine Learning Algorithms; Computer Vision; Bioinformatics; Smart Grid; Intelligent Agents and their Applications; Intelligent Informatics; Fuzzy Controllers; Image frame generation; Brain Computer/Machine Interface.

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; Solar photovoltaic technologies; 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; Smart Grid Technology; Smart Grid Technology Applications.

Basics of Modern Control Systems; Control System Design; Optimal Control; Digital Control; Robust Control Systems; Nonlinear Systems; Linear Stochastic Dynamical Systems; Industrial Automation and Control; Neuro-Fuzzy Control.

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; Advanced Antennas; Microwave measurement and Design; Microwave Circuits; Monolithic Microwave Integrated Circuits; Microwave Imaging, Characterization and Non-destructive Testing; Electromagnetic Interference and Compatibility Techniques, Computational Tomography

Semiconductor Optical Devices; Optical Communications; Photonic Networks and Switching; Quantum and Wave Phenomena; Optical Coherent Imaging; Nonlinear Fiber Optics; Fiber-Optics I and II; Quantum Cryptography

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; Topics in Stochastic Processes; Topics in Cryptography and Coding; Digital Switching; Wireless Communications; Digital Communication Networks; Convex Optimization; Simulation of Communication Systems, Wireless Communication, 5G Wireless Technologies.

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 microprocessor-based control of PMDC motors, multi-motor coordination, networked control and control of electric vehicles.

Distributed Systems and Control (DiSCo) Lab is equipped with quadcopters, fixed wing UAVs, flight simulator, processor-in-loop testing facility for quadcopters, simulation of multi-agent systems.

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 static control laboratory with solid state control of electric drives; Power systems simulation laboratory equipped with Six Racks Real Time Digital Simulation (RTDS), Opal-RT and other modern simulation tools; 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 analyzers 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 (600 nm-2000 nm) and interface development facility for fiber optic links, clean room for semiconductor optoelectronic device fabrication and photonic measurement laboratory.

In addition, Advanced Fiber optics laboratory has WDM optical components, semiconductor optical amplifiers, single-mode standard and nonlinear fibers, Sampling oscilloscope (optical 40 GHz and electrical 65 GHz bandwidth), electronics to enable experiments on 40-100G optical links.

Networks laboratory with scalable and configurable test-bed for simulating complex network topologies, 802.11 WiFi links, software radio, multiservice network and QoS, etc. Wireless Communications laboratory is equipped with NI USRPs platform.

Quantum Photonics Research Laboratory is equipped with optical characterization facility, comprising of a home-built microscope attached to a high-resolution spectrometer and a

CCD camera, for testing nanophotonic and plasmonic devices, and FDTD simulation tools for designing these devices.

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; Communications laboratory equipped with USRPs and WARP boards. 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.

5G testbed Lab is developed to build the testbed that closely resembles a real-world 5G deployment. The testbed will deliver an end-to-end 5G testbed comprising of 5G BS and UE nodes that support enhanced mobile broadband (eMBB), Ultra low latency communication (URLLC) and massive MTC including NBIoT services. This testbed could become a basis for many commercial deployments.

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 starting 1988, was consummated with the introduction of MBA programme in the year 2001.

The department focuses 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 Industrial Engineering and Management that include Industrial Engineering, Operations Research, Operations Management, Supply Chain Management, Services Management, Business Economics and Policy, Infrastructure and Public Systems, Finance and Control Systems, Financial Markets and Models, Marketing Management, Organizational Behaviour, Human Resource Management, Innovation and Entrepreneurship, Enterprise Information & Knowledge Systems, Social Media Analytics, Decision Theory, Optimization, Applied Statistics, etc.

Ph.D. Programme

Students in the Ph.D. program are required to take 8 courses. A student may be required to take additional courses depending on his/her background and research interests. 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 are expected to identify their thesis supervisor by the time of their comprehensive examination.

M.Tech. Programme

M.Tech. students are required to take 3 compulsory courses and 6 elective courses. Students in the M.Tech. Programme take 4 courses per semester during the first two semesters and 1 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 Industrial Engineering and Management.

MBA Programme

Students in the MBA program are required to take 7 compulsory courses, five in the first semester and one each in the second and fourth semesters, and at least 10 elective courses. There is an emphasis on hands-on training and application of class room learning and that is met first by a two-month long industrial internship during the summer break after first year and then an integrative capstone project that spans over the second year.

Facilities

The Department has state-of-the art facilities for teaching and research. Apart from modern classrooms, the department has dedicated lab-space for students with computing facilities for data analysis, optimization, simulation, etc. All relevant software like MATLAB, SPSS, SAS, Arena, Primavera, PLM, GAMS, etc are subscribed and maintained. Different academic databases, such as CMIE and IndiaStat databases, are also available. The Department subscribes all major academic research journals published by Informs, Elsevier, Springer, Wiley, Taylor & Francis, etc. There are laboratories for dedicated research in thrust areas like renewable energy, simulation and control, etc.

Faculty

1) Amit Shukla, FPM (IIM Lucknow, India): Organizational Behaviour, Human Resource Management, Positive OB, Academic Excellence.

2) Anoop Singh, Ph.D. (IGIDR Mumbai, India): Power Sector Regulation & Policy, Infrastructure Project Financing, Energy & Environment, Managerial Economics, Energy Economics & Policy Modelling.

3) Avijit Khanra, FPM (IIM Ahmedabad, India): Production Planning, Inventory Control, Supply Chain and Logistics, Scheduling, Analysis of Queues, Mathematical Modelling and Optimization.

4) B. V. Phani, FPM (IIM Calcutta, India): Entrepreneurship, Accounting and Finance, Financial Governance.

5) Deepu Philip, Ph.D. (MSU Bozeman, USA): Operations Management, Decision Sciences, System Simulation, Systems Engineering, Defense Systems.

6) Devlina Chatterjee, Ph.D. (IISc Bangalore, India): Empirical Finance, Insurance Economics, Tourism Economics, Consumer Finance, Consumer Behavior.

7) Faiz Hamid, FPM (IIM Lucknow, India): Combinatorial Optimization, Network Optimization, Fuzzy Logic, Data Mining, Recommender Systems.

8) R. N. Sengupta, FPM (IIM Calcutta, India): Statistical Analysis, Risk Management, Quantitative Decision Techniques, Optimization, Metaheuristics Techniques.

9) R. R. K. Sharma, FPM (IIM Ahmedabad, India): Quantitative Methods for Management, Manufacturing Policy, Strategic Management.

10) Rahul Varman, FPM (IIM Ahmedabad, India): Personnel Management and Industrial Relations, Organizational Theory and Social, Political, Legal issues in Business.

11) S. C. Misra, Ph.D. (Carleton University, Canada): Business Process Management, Project Management, Supply Chain Management, Quality Management, Enterprise Resource Planning (ERP), Business Analytics/Data Analysis, E-Governance, and Information Systems.

12) Shankar Prawesh, Ph.D. (University of South Florida, USA): Social Media, Recommender Systems, Data Mining, Evolutionary Computation and Agent Based Modelling.

13) Sri Vanamalla V, Ph.D. (IISc Bangalore, India): Applied Operations Research, Optimization and Game Theory.

14) Subhankar Mukherjee, FPM (IIM Calcutta, India): Development Economics, Applied Microeconomics.

15) Suman Saurabh, FPM (IIM Ahmedabad, India): Corporate Finance, Financial Derivatives, Mergers and Acquisition, Behavioral Finance.

16) Veena Bansal, Ph.D. (IIT Kanpur, India): Information Technology and Management, ERP systems, E-Commerce.

17) Vipin B., Ph.D. (IIT Madras, India): Decision Theory, Inventory Theory, and Supply Chain Management.

Courses

Quantitative Methods: Probability and Statistics, Operations Research, Introduction to Computing, Simulation of Business Systems, Introduction to Game Theory, Introduction to Stochastic Processes, Advanced Decision Models, Computer aided Decision Systems, Management Decision Analysis, Advanced Statistical Methods for Business Analytics, Data Mining and Knowledge Discovery, Applied Machine Learning, Social Media Analytics, Quantitative Methods for Decision Making, Statistical Modelling for Business Analytics, Research Methodology.

Operations & Information: Design of Production Systems, Operations Management, Production and Operations Management, Supply Chain Management, Manufacturing Planning and Control, Managing Service Operations, Manufacturing Strategy, Project Management, Managing Software Projects, Total Quality Management, Software Quality Management, Management Information Systems, Business Process Management, Enterprise Integration with Information Technology, E-Commerce.

Economics & Finance: Economic Analysis for Management, Macroeconomic Analysis for Management, Economics of Business Policy, Infrastructure Regulation: Policy and Finance, Project Financing and Management, Energy and Carbon Markets: Economics Policy and Regulations, Accounting and Finance, Investment Valuation and Real Options, Advanced Valuation, Security Analysis & Portfolio Management, Derivative Contracts, Mergers and Acquisitions, Advanced Corporate Finance, Financial Modeling, Advanced Financial Modeling, Financial Institutions and Commercial Banking, Credit Risk Modelling, Management of Risk in Financial System, Financial Engineering.

Management: Marketing Management, Consumer Behaviour, Marketing Research, Brand Management, E-Marketing, Marketing of Service, Business to Business Marketing, Product Strategy and Management, Strategic Marketing, Managerial Communication, Organization Structure and Design, Human Resources Management, Strategic Management, Socio-Political and Ethical Aspects of Business, International Business Management, Corporate Innovation & Entrepreneurship, Management of Technology, Intellectual Property Management.

Detailed information of the department and related information can be accessed at

Department: http://www.iitk.ac.in/ime
Faculty: http://www.iitk.ac.in/ime/faculty.html

Research: http://www.iitk.ac.in/ime/research.html
Ph.D. scholar: http://www.iitk.ac.in/ime/research.html

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

The Department of Materials Science and Engineering at IIT Kanpur is world renowned for its excellence in research, teaching (undergraduate and postgraduate) and state-of-the-art research and teaching infrastructure. The departmental facilities are well aided by the Advanced Center for Materials Sciences housing several advanced processing and characterization facilities. The research landscape of the Department encompasses the cutting edge computational as well as experimental research in both traditional as well as modern areas of materials science and engineering on a wide selection of materials including metals and alloys, semiconductors, electronic and structural ceramics, polymers, biomaterials and composites. The Department's research is directly relevant to various technology sectors such as Ferrous and Nonferrous Industry, Health, Renewable Energy, Transport and Automotive, Defense, Aerospace and Consumer Electronics.

Major Research Areas

➢ Extractive, Process and Powder Metallurgy
➢ Physical and Mechanical Metallurgy of Materials
➢ Electrochemistry and Corrosion Science
➢ Materials for Automobiles, Aerospace and Nuclear Applications
➢ Computational Materials Science and Process Modelling
➢ Biomaterials
➢ Functional materials (e.g. Optical, Magnetic, Optoelectronic, Ferroic and Multiferroic) and Devices such as Memories, Displays and LEDs
➢ Energy and Environment Related Materials for Solar Photovoltaics, Thermoelectric Power Generation, Batteries, Fuel Cells and Hydrogen Storage
➢ Integrated Computational Materials Engineering

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, NFTDC to name a few. Postgraduate alumni are also employed with leading industries like Tata Steel, Tata Motors, Ashok Leyland, Mahindra, GE, GM, SAIL, Moser Baer, BHEL,JSW, Saint Gobain 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 the activities of various professional bodies, such as Materials Advantage and Indian Institute of Metals. 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.

First Class throughout the academic career (UG and PG) is expected for admission into M.Tech. or PhD.

Financial Assistance

Financial support (in the form of Institute Assistantship) is available to the regular (non-sponsored) students of M.Tech./M. Des./MS (By Research) and Ph.D. Programmes.

The student is expected to carry out the assigned duties during the programme. The M.Tech./MS (By Research) students are currently entitled to a monthly stipend of Rs.12,400/- for 8 hours of work per week. For Ph.D. students the corresponding financial support amounts to Rs.31,000/- for the first two years, and thereafter, it is raised to Rs.35,000/- for another three years.

PhD Admissions Scheme

The goal of Doctor of Philosophy (PhD) programme of the department is to create future teachers, scientists, innovators, incubators, and engineers with strong analytical skills and in-depth training in theoretical concepts as well as experimental skills. The core philosophy of programme is to develop an enquiring attitude in the student enabling him/her to contribute to the scientific and engineering innovations and develop new paradigms. These objectives are achieved by offering a large number of courses in various areas of specialisation followed by training the students in the scientific method of investigation of their research topics. Department encourages students towards an interdisciplinary course work and research to develop an overall understanding of the science and technology. Further to the course work, submission of a PhD thesis on original research topic is an integral part of the programme.

Financial Assistantship

Full Institute assistantship is available for a period of 4 years.**Rs.31,000/- for the first two years and there after it is raised to Rs.35,000/- respectively for another two years.**After that, on the recommendation of SPGC after submission of a detailed progress report duly commented and signed by the supervisors and Peer Review Committee (PRC), the scholarship can be extended for another year on full assistantship. Subsequent extensions are made on case to case basis upon the recommendation of PRC and SPGC

with assistantship provided at a reduce rate. A student can also be funded (assistantship) by other agencies such as CSIR during his/her PhD.

Coursework

Students with M. Tech. background:

The student should complete a minimum of 16 units/credits of courses (4 courses or more). A minimum CGPA of 7.0 should be maintained throughout the programme.

Students with B. Tech./M. Sc. Background:

The student should complete a minimum of 40 units/credits of courses (10 courses or more). A minimum CGPA of 7.0 should be maintained throughout the programme. A student can also opt for an additional M. Tech. degree (we strongly encourage to do so). A student has to take four compulsory courses for the M. Tech. programme in order to get the additional M. Tech. degree.

All the PG students will have to compulsorily register for the seminar courses before the completion of programme:

> ➢ MSE690-Seminar Participation in II semester and
>
> ➢ MSE691- Seminar Presentation in III semester

It is compulsory for all the new PhD students to registered for four courses in the first semester i.e. without any thesis credits. For the selection of the courses students can seek advice of DPGC or supervisor if they have already identified one. Students with little or no background in materials science fundamental courses are recommended to take M. Tech. compulsory courses which can be discussed with DPGC or the thesis supervisor. Students without a strong materials science background are encouraged to do more basic courses such as compulsory M. Tech. courses to hone up their fundamentals. Students can also audit (i.e. without registering) certain courses, if permitted by the instructors. A student can also opt for a course where grades will be given in terms of S/X (satisfactory/unsatisfactory) and will not be counted towards final CPI calculation.

Coursework has to be completed before the student can appear for comprehensive exam.

Teaching Assistant (TA) duty

PG Students on institute assistantship will have to put in 8 hours of TA work/week. The DPGC will assign TA work every semester.

Choice of Advisor/Guide

The student will be assigned Thesis Advisor as per extant department policy. The guide allocation is done within a period of 2 months of joining the program. A list of available faculty members is circulated to students and a student is required to submit preferences from the list. While all efforts are made to ensure that a student gets a guide from his /her preferences, it might not be always possible. A student can also chose a co-guide in consultation with the guide, if necessary.

1. For Prospective Ph.D. Students

MSE Department invites bright candidates to pursue PhD. The applications are accepted throughout the year. Following are the eligibility criterion (any one of the following):

Those possessing a B.E./B.Tech. degree in Metallurgical or Materials Engineering,

Materials Science or other engineering disciplines must have

- Minimum 75% marks or a CPI of 7.5/10 in B.E./B.Tech. &
- Valid GATE score required in order to avail institute assistantship
       OR

- Those with a M.Sc. degree in Physics, Chemistry, Life Sciences, Materials Science, Nanoscience, Nanotechnology or other appropriate areas must have
- Minimum 65% marks or a CPI of 6.5/10 in M.Sc. &
- Ist Division in B.Sc. &
- Minimum valid 95 percentile score in GATE or qualified CSIR-NET JRF &
- taken Mathematics as one of the courses at undergraduate level (for example B.Sc.) and passed it with first class (60%)
       OR

- Those possessing a B.E./B.Tech. degree and a M.E./M.Tech. degree in Metallurgical or Materials Engineering, Materials Science, Ceramic Engineering, Nanoscience, Nanotechnology or other appropriate engineering disciplines must have
- Minimum 60% marks or a CPI of 6.0/10 in B.E./B.Tech. &
- Minimum 70% marks or a CPI of 7.0/10 in M.E./M.Tech.
       OR

Those possessing a M.Sc. degree and a M.E./M.Tech. degree in Metallurgical or Materials Engg., Materials Science, Ceramic Engineering, Nanoscience, Nanotechnology or any other appropriate engineering disciplines must have

- Minimum 60% marks or a CPI of 6.0/10 in B.Sc. and M.Sc. &
- Minimum 70% marks or a CPI of 7.0/10 in M.E./M.Tech.

Selection Procedure (applicable only for the candidates applying for PhD programme)

Shortlisted candidates will be invited for appearing into a written-test/interview. which will be carried out over a day or two. Hence, candidates are advised to be prepared to spend two days at IIT Kanpur. The broad areas to be covered in written test will include

1. Section 1: Elementary Mathematics and aptitude test
2. Section 2: Basics of metallurgy (physical metallurgy, mechanical metallurgy, process metallurgy)
3. Section 3: Basics of materials science (physics and chemistry of materials, biomaterials)

   Section 1 is compulsory for all the students and the shortlisting for interview will be done based the marks obtained in this section. A student has to opt for either section 2 or section 3 and marks obtained will be counted while preparing the final merit list. Depending on their choice of written paper, candidates shortlisted for interview will have to appear before an interview board related to either metallurgy or materials science.

Based on the performance of the candidate in the written test/interview, the candidate will be offered admission into the PhD programme of the Department of Materials Science and Engineering at IIT Kanpur.

2. For Prospective M.Tech. Students

MSE Department invites bright candidates to pursue M.Tech. degree in Materials Science and Engineering. The applications are accepted via an advertisement made in the Feb/March of each year. Following are the eligibility criterion (any one of the following):

Those with a B.E/B.Tech. degree in Metallurgical or Materials Engg., Materials Science, Ceramic Engg., Chemical Engg., Mechanical Engg. or other engineering disciplines must have

- Minimum 60% marks or a CPI of 6.0/10 in B.E./B.Tech. &
- Qualified GATE with a valid GATE score

OR

Those with a M.Sc. degree in Physics, Chemistry, Life Sciences, Materials Science, Nanoscience/Nanotechnology or appropriate areas (with Mathematics at B.Sc level) must have

- Minimum 60% marks or a CPI of 6.0/10 in B.Sc. &
- Minimum 60% marks or a CPI of 6.0/10 in M.Sc. &
- Qualified GATE with a valid GATE score or qualified CSIR-NET JRF

Research Areas @ MSE, IIT Kanpur

Prospective candidates may visit Faculty and their research areas on http://www.iitk.ac.in/mseold/pages/select.php

Important note: PhD admissions are open throughout the year and when online applications are closed, application can be made by sending a hardcopy version to the department.

For Notice/details regarding admissions click here

Address for communications (including sending filled hardcopy of off-line application forms):

The Convener, DPGC
Department of Materials Science and Engineering
I.I.T. Kanpur, Kanpur-208016

Further details can be found at http://www.iitk.ac.in/mse/academics

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 and temperature dependent modern X-ray diffractometers, Raman spectroscope 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. The research infrastructure is well supported by advanced state-of-the-art infrastructure at Advanced Center for Materials Science (ACMS) housing facilities such as Auger Electron Spectroscopy, X-ray Photoelectron Spectroscopy, SQUID and VSM , to name a few.

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).

Faculty Profiles

Kantesh Balani *Ph.D.* (Florida Intl. University)	Biomaterials, Nanomechanics; Ultra High Temperature Ceramics, Tribology, Ab-Initio Molecular Modeling, Carbon Nanotube (CNT) Reinforced Composites
Somnath Bhowmick *Ph.D.* (IISc Bangalore)	Computational Materials Science, Size Dependent Properties Of Nanomaterials, Electronic Structure Calculations, Multiscale Modeling
Krishanu Biswas *Ph.D.* (IISc Bangalore)	Nanomaterials, Solidification, Electron Microscopy, Phase Transformations, Graphene, Sintering
Ashish Garg *Ph.D.* (Cambridge University)	Structure-Property Correlations in Materials, FerroicandMultiferroic Materials, Thin Films and Devices, Solar Photovoltaic Materials and devices, Materials for Energy Generation, Harvesting and Conversion
Anshu Gaur *Ph.D.* (UI Urbana-Champaign)	Materials For Electronic Devices, Carbon Based Nanostructures, Device Physics And Simulation, Computational Materials Science
Deepak Gupta *Ph.D.* (UC Berkeley)	Organic Electronics (Oleds, Displays, Tfts), Oxide And Transparent Semiconductors, Defects In Semiconductors
Gouthama *Ph.D.* (IISc Bangalore)	Electron Microscopy, Surfaces And Interfaces, SPD Processing, Structure Property Correlations In Materials, Shape Memory Alloys
Nilesh Gurao *Ph.D.* (IISc Bangalore)	Crystallographic Texture, Thermo-Mechanical Processing And Mechanical Behaviour Of Materials
Sarang Ingole *Ph. D.* (Arizona State University)	Inorganic Semiconductors For Photovoltaics, Fabrication & Applications Of Nano Materials
ShikharJha	**Thermodynamics of phase transformations, Structure of material, Interfaces, and Solid state physics**
Monica Katiyar *Ph.D.* (UI Urbana-	Organic Electronics, Solid State Lighting, Printable Electronics, Thin Films, Electronic Materials And Devices: Characterization

Champaign)	And Processing
Kaustubh Kulkarni *Ph.D.* (Purdue University)	Light-Weight Alloys For Automotive And Aerospace Applications, Multicomponent Diffusion, Integrated Computational Materials Engineering
Tanmoy Maiti *Ph.D.*(Penn State University)	Thermolelectrics, Perovskite Solar Cell, Oxide electronics, Plasmonics and RenewableEnergy.
Dipak Mazumdar *Ph.D.* (McGill University)	Steelmaking, Process Modeling, Heat, Mass And Momentum Transfer In Materials Processing
Kallol Mondal *Ph.D.* (IIT Kharagpur)	Phase Transformations, Corrosion, Oxidation, Non-Equilibrium Processing, Metallic Glasses, Nanocrystalline Alloys
Rajdip Mukherjee *Ph.D.* (IISc Bangalore)	Phase-field Modelling, Multiscale Modelling, Phase Transformations
K. S. Nalwa	**Organic and inorganic semiconductors, nanomaterials, thinfilms, material interfaces, Perovskite based solar cells, all organic multifunctional Biochemical sensors.**
Shobit Omar *Ph. D.* (University of Florida)	Ionic Conductors, Mixed Ionic-Electronic Conductors,Na-ion Batteries, Solid Oxide Fuel Cells, Thermal Barrier Coatings, Ceramic Processing
Sandeep Sangal *Ph.D.* (Manitoba University)	Mechanical Properties Of Materials, Stereology, Computational Materials Science
Rajiv Shekhar *Ph.D.* (UC Berkeley)	Electrochemical Processing, Molten Salt Electrolysis, Aluminium Electrolysis, Electrodeposition, Electrochemical Remediation Of Soil
Shashank Shekhar *Ph. D.* (Purdue University)	Grain Boundaries And Triple Junctions, Severe Plastic Deformation, Machining And Manufacturing, Structural Nanomaterials
Anandh Subramaniam *Ph.D.* (IISc Bangalore)	Nanocrystals and Nanostructures, Defects And Interfaces, Simulations at the Nanoscale using Finite Element Method, Hydrogen storage in Nano-hybrids, Transmission Electron

	Microscopy.
Anish Upadhyaya *Ph.D.* (Penn State University)	Materials Processing, Liquid Phase Sintering, Structure-Property Correlations, Alloy Design, Metal Matrix Composites, Nanocrystalline Alloys
Vivek Verma *Ph. D.* (Penn State University)	Protein Micropatterning, Biomaterials, FiberReinforced Composites, Bioplastics
Amarendra K Singh *Ph. D. (*IIT Kanpur)	Steel Refining and Casting, Extractive Metallurgy, Integrated Computational Materials Engineering, Solidification Processing, Sustainable Manufacturing
Sudhanshu Shekhar *Ph.D.* (Arizona State University)	3D/4D Materials Science, Nanoindentation, Micro-mechanical testing, Lightweight alloys, Deformation behavior of alloys

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

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 in different streams is a Bachelor's degree in Mechanical Engineering or in any of the following branches for different streams.

Manufacturing Sciences: Aero Engg, Chem Engg,   Metallurgy/MatSc Engg, Prod/Manuf Engg.
Fluid and Thermal Sciences: Aero Engg, Chem Engg.
Solid Mechanics and Design: Aero Engg, Civil Engg, Metallurgy/MatSc Engg, Chem Engg.
Robotics and Automation: Aero Engg, Comp Sc, Elect/Electro/Comm Engg, Mechatronics/Instrum Engg.

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, eligibility (as above) 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 6 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 has a written and an oral parts, and is designed to judge overall comprehension of the student in his/her field.

The required 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 will be made as per the procedure detailed at http://www.iitk.ac.in/me/.

*with minimum percentage/CPI specified by the Institute

MS (Research):
Who can apply: B.Tech in Mech. Engg with 55% marks / 5.5 CPI, and a valid GATE Score (to be waived for candidates working in sponsored projects). B.Tech. in other branches of Engg may also be considered.

Minimum course requirements for this program will be five including two compulsory courses. Mathematics for Engineers is compulsory for all students. The other compulsory course will be stream specific.

Minimum research credit for the MS by research program will be 72 credits.

Remaining credits have to be obtained either form the course or research works.

The candidates not working in sponsored projects and admitted on full-time basis will be required to have a valid GATE score (unless they have graduated from an IIT with a minimum CPI of 8.0). Some of them may be offered Institute or Project Assistantships, as in the case of the M.Tech students. The candidates working in sponsored projects and admitted on full-time basis and the students admitted on part-time basis (with a minimum of one year of project support from the date of admission) will not be required to satisfy the GATE requirement. The part-time students employed in sponsored research projects in the Institute will have to get project funding in their second year of the programme too. Such students may be offered Institute Assistantship, as in the case of the M.Tech students, for a maximum of one year, provided they have a valid GATE score by that time, and their case is considered favourably by the department.

For details about our department admission procedure, the candidates can visit our website: http://www.iitk.ac.in/me/.

FACULTY

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

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

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

Bhattacharya Jishnu, Ph.D. (University of Michigan, Ann Arbor): Thermodynamics, Heat Transfer, Energy Storage Materials, Atomic Scale Computation, Multi-scale Modeling.

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

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

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

Chindam Chandraprakash, Ph.D. (Penn State University): Thermomechanics, Biomimetic design, Acoustic materials, Multifunctionality of thin films.
Choudhury Sounak 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, Optimization.
Das Malay K., Ph.D. (Penn State): Electrochemical Energy Conversion, Chemically Reacting Systems.
De Santanu, Ph.D. (IISc Bangalore): CFD of reactive flows; advanced turbulent combustion modeling; droplet and spray combustion; flame stabilization, extinction/re-ignition, auto-ignition; coal and biomass combustion; soot formation and emission
Dutta Ashish, Ph.D. (Akita, Japan): Robotics, Intelligent Control systems, Microsensors and actuators, Bio-robotics.
Ghoshdastidar Partha 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 Anurag, Ph.D. (Berkeley): Dynamics of Defects in Solids, Waves in Solids, Mechanics of Thin films.
Gupta Shakti S., Ph.D. (Virginia Tech.): Linear/Nonlinear Structural Mechanics, Mechanics of Nanomaterials and their Characterization using Molecular Simulations.

Kumar Arvind, Ph.D (IISc Bangalore): Solidification processing; Heat transfer in manufacturing; Additive manufacturing; Laser materials processing; Thermal energy storage; Thermal spray coating.

Joshi Pranav (PhD, Johns Hopkins University), Experimental fluid mechanics, turbulent flows and heat transfer

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

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

Law Mohit, Ph.D. (UBC Vancouver): Machine Tool Dynamics, Vibration Control, Dynamic Substructuring, High Performance Machining.

Mimani Akhilesh. Ph. D, (IISc Bangalore): Array processing methods for acoustic source localization, Computational acoustics and aeroacoustics, Duct and muffler acoustics, Mechanical vibration.

Mukhopadhyay Supratik, Ph.D, (University of Bristol) : Mechanics of composites, Theory of Damage and failure, Numerical simulation of strain localization and fracture, Finite element method, Meshindependent and mesh-free methods, Numerical simulation of manufacturing processes.

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

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

Pal Anikesh, Ph.D (PhD, University of California San Diego): Turbulence, Machine Learning, Computational Fluid Dynamics (CFD), Atmospheric and Oceanic flows and Climate dynamics.

PanigrahiPradipta K., Ph.D. (LSU): Laser Based Instrumentation, Flow Control, CAD of Thermal Systems, Turbulence, Micro-fluidics and Heat Transfer.

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

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

Sarkar Subrata (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.

Saurab Aditya, Ph.D, (Technical University Berlin), Dynamics of gas turbine (GT) combustors, flame dynamics, atomization of liquid fuels, alternative and biofuels in GT engines, suppression of noise and instabilities in combustors

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

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

Singh Manjesh K., Ph.D:(PhD, Swiss Federal Institute of Technology (ETH Zurich), Switzerland): Soft Matter, tribology and rheology.

Shinde Sachin Y, Ph.D. (IISc Bangalore): Experimental Fluid Mechanics, Biofluid Dynamics, Swimming and Flying, Fluid Structure Interaction.

Sinha Niraj, Ph.D. (Waterloo): Nanotechnology, Bioengineering, Manufacturing Systems.

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

Venkitanarayanan Parameswaran, 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 Pankaj, Ph.D. (IISc Bangalore): Nonlinear Dynamics, Vibrations.

COURSES

The compulsory courses for M.Tech. Programs can be found at the department website http://www.iitk.ac.in/me/.

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, Robotics and Automation, and Manufacturing Science. There are many specialized research laboratories and facilities and their details can be found on the website of individual faculty members.

to be seen on http://www.iitk.ac.in/me/.

Materials Science Programme

Faculty

Jaleel Akhtar, PhD (University of Magdeburg, Germany): Microwave Material Processing; Microwave Imaging and Non-Destructive Testing; Electromagnetic Characterization of Artificial Dielectrics, Nano-Composites and Metamaterials; Microwave Material Interaction and Multiphysics Modeling; Design of Microwave Devices Using Electromagnetic Inverse Scattering.

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, 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.

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.

R. G. S. Pala, PhD (University of Utah): Electrochemical and reaction engineering, Sustainable energy and environment, Photoelectrochemical systems, CO_2 capture, Fuel cells, Catalysis using nanostructured metal oxides.

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

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

PHOTONICS SCIENCE AND ENGINEERING
(Inter-disciplinary Programme)

Since their invention in 1960s, lasers have transformed most 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 the year 2012 which would be housed at the Center for Lasers and Photonics (CELP).

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 Ph.D., M.Tech. and MS theses. 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 (for M.Tech. students) courseon Photonics Science & Engineering Laboratory Techniques facilitates the process.

It is hard to imagine our lives without laser-based optical communications and networks; compact disc payers; laser printers, laser surgery; lasers-based 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, tomographic imaging, flow/temperature & stress analysis, optical signal processing & computing and optoelectronic integration. Laboratory courses constitute an integral part of the curriculum.

Candidates having relevant background from 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. and MS programmes in Photonics Science and Engineering. Each M. Tech student is required to take up a two-semester long research thesis after the completion of his/her coursework with any one of the faculty members associated with the center for lasers and photonics. The admission into the M.Tech program is by virtue of GATE and a written screening and interview process.

The MS program is a research predominant masters stream that has been recently introduced at the IIT-K and students enrolling are expected to take up challenging research projects as their thesis. The entry is either in project mode wherein the students join on a designated sponsored research project ongoing in the department (based upon their compatibility with the project requirements and preferably a valid GATE score) or in

the institute mode wherein they join on an institute scholarship (based on GATE score and interview).

Candidates having relevant background and exceptional performance in Bachelor's degree in Engineering or a first-class in Master's degree in Engineering, Physics, Applied Physics, Applied Optics or Chemistry are eligible to apply for the Ph.D programme in Photonics Science and Engineering. Seats are limited and subject to availability of vacancy in the sub-area preferred by the candidate. A Statement of Purpose should be attached with the application for Ph.D programme indicating the area of interest and the reasons for its choice.

FACULTY

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

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

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

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

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

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

Naren Naik, Ph.D. (IISc. Bangalore): Development and analysis of tomographic reconstruction and tracking algorithms; Fluorescence optical tomography; Numerical solutions for wave propagation and radiation transfer; Biomedical and sub-surface multimodal tomographic imaging.

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

Asima Pradhan, Ph.D. (CUNY, N Y): Biophotonics, Laser Spectroscopy and Imaging

G. Rajshekhar, Ph.D (EPFL Switzerland): Optical Metrology, Digital Holography,

Biomedical Imaging, Applied Signal Processing

Saurabh Mani Tripathi, PhD (IIT-Delhi): Fiber and integrated optics, development of biological and chemical sensors operating on the infrared and terahertz frequencies, plasmonics and metamaterials.

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

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

Compulsory Courses (M.Tech.):

Introduction to Photonics, Principles of Lasers and Detectors, Photonic Systems and Applications, Photonics Laboratory Techniques, Research in Photonics and Lasers.

Electives:

Numerical methods in Optics, Laser Spectroscopy, Fiber Optic Systems I & II, Semiconductor Lasers, Optical Communication Systems, Optical Computing, and Optical networks & Switching, Quantum Optics, Computational methods in tomographic imaging, Introduction to biophotonics.

Facilities:

Besides the central facilities at the Institute level, the Centre for Lasers and Photonics (CELP) has its own precision machine shop and library, which support the Photonic Science and Engineering Programme. Various state-of-the-art facilities i.e. Femto-second laser, Ti-sapphire laser, picoseconds- and nanosecond-lasers, CCD-spectrograph system, micro-Raman facility, spectrofluorimeter, Polarimetry system, PIV, Interferometry, Holography, Schlieren, CO_2 laser, confocal microscopy, Tunable laser, optical wave guiding setup, pulsed laser sources, diode lasers, MCT detectors, laser scanners, Photon counters and Lock-in amplifier are available. The programme also shares a semiconductor optoelectronic device fabrication facility with other departments.

The Department of Chemical Engineering is among the five departments established at the inception of IIT Kanpur in 1960. Along with the other pioneer departments, it ushered in a new paradigm in undergraduate engineering education that fosters the creative thinking process in a very open and vibrant academic environment. From an early emphasis on developing and perfecting the undergraduate curriculum to nurturing a fledgling post-graduate research program to significantly contributing to applied and fundamental ChE research, we have grown from strength-to-strength over the past five decades.

A hallmark of our Department is the emphasis on quality education as reflected in the over 36 "labor of love" textbooks written by our faculty, many receiving international acceptance. This is complemented by a strong research ethos, carefully nurtured by the pioneers and effectively passed on from one generation to the next. The significant post-liberalization research funding has brought in a critical mass of young, talented and motivated faculty immersed in research in the frontier areas of complex fluids, micro-reactors, nano-technology, adhesion, molecular simulations and biocomputation and energy systems. This is in addition to research in traditional areas of fluid dynamics, conventional/new separation processes, catalysis, polymer engineering and process design, control and intensification. The very diverse research portfolio is our core strength that effectively complements quality education.

ACADEMIC PROGRAMMES
The department offers undergraduate (B Tech) and postgraduate (M Tech, MS and PhD) degrees in Chemical Engineering. The admission process and graduation requirements are briefly summarized below.

UNDERGRADUATE

Bachelor of Technology (B Tech)

Duration: 4 years

Admission: Through the Joint Entrance Examination (JEE) + advanced JEE.

Courses: The ChE B Tech program comprises a four semester "core" program of courses in basic sciences, engineering sciences, humanities and computer programming, followed by a two year professional program, consisting of departmental professional courses and several electives. The full load for a semester is roughly 5 courses (50 credits). At least 405 credits must be completed for graduation with the option of additional research credits.

Research: In addition to course work, our students have the option of carrying out research with a faculty mentor in their last three semesters.

Double Major: Students can also opt to do a double major with an additional year of coursework. Thus for example, by appropriate planning of his/her program, a student admitted to ChE may graduate with a double major in Chemical Engineering and Computer Science in five years.

B Tech - M Tech (Dual Degree)

Duration: 5 years

Admission: Undergraduate students can opt to convert to dual degree after completion of their 5th, 6th or 7th semester.

Courses: The first four years of the program are almost identical to the B Tech course work.

Research: The last two semesters and two summer terms are devoted entirely to research work. Students work under a faculty research supervisor on a challenging research problem. In the fifth year, a scholarship currently at Rs 12,400 per month is given subject to a minimum CPI of 8 or attaining more than 60 percentile GATE score.

POSTGRADUATE

The Department offers a Master of Technology (M Tech), a MS (Research) and a Doctorate (PhD) degree in Chemical Engineering. These programs are research centric and prepare the student for a productive research career. The rigorous coursework and research provide a healthy balance of breadth in ChE fundamentals and depth in their chosen research field.

Master of Technology (M Tech)

Duration: 2 years

Admission: Through Graduate Aptitude Test in Engineering (GATE). The examination is usually announced in the month of August and held in February across the country. Sponsored candidates from the industries as well as research organizations with appropriate experience need not have qualified GATE.

Course requirements: The students take six courses (of which at least three are in compulsory areas of Reaction Engineering, Thermodynamics, Transport Phenomena and Mathematics or Numerical Methods, the remaining from among several state-of-art electives).

Research: Students have usually do 10-12 course units (including summer term) of research. In their research project, students often work on research problems with individual faculty members, or are involved in sponsored projects from industry or government funding agencies. MHRD offers scholarships to students getting admission through GATE currently at Rs 12,400 per month. Scholarships from research projects are also available.

Master of Science by Research (MS Research)

Duration: 2 years

Admission: Admission is generally made in both the semesters in a year, i.e., July and December. Selection is done through a written test followed by interview. Candidates with a B Tech/MSc background and a minimum of 55% marks in their qualifying exam are eligible to apply. A valid GATE score (for B Tech degree holders) or valid CSIR-NET score (for MSc degree holders)is also required. Sponsored candidate should possess a minimum of 55% marks in their qualifying exam (no gate score needed).

Course requirements: The students take four courses (of which at least three are in compulsory areas of Reaction Engineering, Thermodynamics, Transport Phenomena and Mathematics or Numerical Methods, the remaining from among several state-of-art electives).

Research: Students usually do 12-14 course units (including summer) of research. In their research project, students often work on research problems with individual faculty members, or are involved in sponsored projects from industry or government funding agencies. They must be sponsored through project funding from their thesis supervisors (or) financial sponsorship must come from their parent industrial organization.

Doctor of Philosophy (PhD)

Duration: 4-5 years

Admission: Admission to the PhD programme is generally made in both the semesters in a year, i.e., July and December. Selection is done through a written test followed by interview. Industries and research organizations may also sponsor a candidate for admission to the PhD program.

Course requirements: The students take a minimum of four courses (out of which two are in the compulsory areas) to develop expertise in ChE fundamentals as well as to complement their research work.

Research: Post coursework (up to 1 year), students work on a research problem of their interest under the guidance of a faculty mentor(s). Working on a particular problem for 3-4 years is a unique experience that helps in developing a scientific temper along with the associated technical communication skills. The typical norm for graduation is 3-5 publications (submitted or accepted) in reputed peer-reviewed journals. MHRD offers scholarships currently at Rs 31-35,000 per month to full time PhD students. Scholarships from research projects are also available.

ELECTIVE COURSES

A range of graduate-level elective courses are developed and offered by the faculty. These cover fundamentals at an advanced and more abstract level and also help keep abreast with the latest developments and the state-of-the-art in niche specialized research areas. These courses prepare and enable the students to probe deeper into their research problems. A sample of the electives currently on offer is provided.

> New Separation Processes, Thermodynamics of Fluids and Mixtures, Principles of Heterogeneous Catalysis, Applied Statistics for Chemical Engineers, Optimization, Mechanics of Soft Materials, Introduction to Nanoscience and Technology, Polymer Science and Technology. Reaction Engineering of Polymers, Principles of Polymer Processing, Molecular Theories of Polymeric Systems, Environmental Pollution and Control, Engineering, Applications of Rheology, Advanced Process Dynamics and Control, Two-Phase Flow and Heat Transfer, Design of Fluid-Particle Systems, Colloids and Interface Science, Engineering Modelling and Simulation in Chemical Engineering, Introduction to Polymer Physics, Rheology of Soft Matter, Introduction to Molecular Simulation, Analytical and Material Characterization Techniques for Engineers, Introduction to Hydrodynamic Stability, 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

The department houses state-of the-art facilities and equipment to support research at the cutting edge. Besides the central facilities at the Institute level, we have our own workshop for fabrication of customized experimental set-ups; sophisticated analytical instruments such as SEM, XRD, FACS, BET, GLCS, GPC, AAS, AFM, HPLC, FT-IR, UV-VIS, ion-chromatograph, GC-MS, TGA etc; catalyst characterization equipment; membrane separations facilities (RO, ultrafiltration, electrodialysis etc); complex fluids characterization instruments such as goniometers, viscometers and rheometers; a dedicated nano-technology/fabrication unit with state-of-art equipment; and multi-node clusters for molecular simulations and computational fluid dynamic studies. For more details, visit https://www.iitk.ac.in/che/index.html

FACULTY

The department faculty, listed below, are recognized both nationally and internationally as leaders in their fields with prestigious awards and honours to their credit for research excellence (e.g. Infosys Prize, JC Bose Fellowship, Shanti Swarup Bhatnagar prize, Herdillia, Amar Dye Chem and NOCIL awards of IIChE, Fellowships of Academies of Sciences and Engineering, etc.)

21. *Vishal Agarwal*: Catalysis, reaction rate theory, biofuels, molecular simulations
22. *Pankaj Apte*: Statistical mechanics, interfacial thermodynamics, nucleation.
23. *Goutam Deo*: Heterogeneous catalysis, kinetics, transport phenomena
24. *Sanjeev Garg*: Bio-informatics, computer aided molecular design, flexibility analysis
25. *Animangsu Ghatak*: Adhesion and friction on soft interfaces, fracture of soft materials, bio-inspired design of reusable surfaces.
26. *Raju K Gupta*: Nanomaterials, self-assembly, nanostructures for energy applications.
27. *Yogesh M Joshi*: Rheology, polymer science and engineering, fluid mechanics
28. *Nitin Kaistha*: Integrated process design, plantwide control and intensification
29. *Rahul Mangal*: Polymer physics, colloids, complex fluids, nanocomposites, active matter, liquid crystals
30. *Raj Ganesh S Pala*: Sustainable energy, heterogeneous catalysis, Photo-chemical analysis, quantum and classical simulation of condensed matter systems.
31. *Siddharth Panda*: Chemical sensors, micro/ nano fabrication, processing of electronic materials, microfluidics, lab-on-a-chip.
32. *Indranil Saha Dalal*: Modelling and simulation of the dynamics of polymer chains in flow, complex fluids, flow induced effects in biomolecules.
33. *V Shankar*: Stability of fluid flows, dynamics and rheology of complex fluids.
34. *Ashutosh Sharma*: Colloid and interface engineering, nanotechnology, thin films.
35. *Jayant K Singh*: Molecular simulation, statistical thermodynamics, complex fluid structure, dynamics and phase behaviour.
36. *Sri Sivakumar*: Synthesis and characterization of nanomaterials, layer-by-layer assembly of polymer capsules, thin films, drug delivery and photonic crystals
37. *Raghavendra Singh*: Computational biology, gene therapy, embryonic andadult stem cells, tissue engineering, biomaterials.
38. *Naveen Tiwari*: Transport phenomena, instabilities in micro-scale free surface flows, flow through porous media.
39. *Anurag Tripathi*: Mechanics and rheology of granular flows and complex fluids.
40. *Nishith Verma*: Adsorption, environmental pollution control, mathematical modelling and simulation.

HUMANITIES AND SOCIAL SCIENCES

The Department consists of five major disciplines: English, Fine Arts, Philosophy, Psychology and Sociology. Each of these disciplines has a Ph.D. programme. 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.

FACULTY

Bagad, Prashant (University of Southampton): Aesthetics, Philosophy and Literature, Existentialism, Gandhian Studies, Plato.

Bhushan, Braj (Babasaheb Bhimrao Ambedkar Bihar University): Cognitive Neuropsychology, Cognitive Factors in Design, Trauma Psychology.

Bhowmik, Ritwij (National Chiao Tung University): Art-History, Art Education, Visual Culture, Far-Eastern Art, Modern and Post-Modern Art and Cinema studies

Chakrabarti, Anindita (University of Delhi): Sociology of Religion, Social Movements, Urban Sociology, Sociology of Law, Economic Sociology

Chandran, Mini (University of Kerala): Modern British Literature, European Literature, Indian Literature & Aesthetics, Translation Studies.

Chattopadhyay, Sayan (University of Cambridge): Indian Writings in English, Postcolonial Studies, Life Writings, Literature of Colonial Bengal.

Dixit, Shikha (Agra University): Social Cognition, Organizational Cognition, Cognitive Psychology, Health Psychology, Illness Narratives.

Hassan, Feroz (University of Michigan): History of Film Theory, Aesthetic Politics, Cinema of the Global South, Indian Cinema in the World, French and Francophone Cinemas, Cinema in the age of New Media.

Jha, Munmun (University of Glasgow): Indian Society, Human Rights, Social Movements, Design Anthropology.

Kumar, Devpriya (University of Allahabad): Cognitive Psychology, Neuropsychology, Human-Computer Interaction, Control System Approach to Human Cognition, Sense of Agency, Emotion Perception, Time Perception.

Mathur, Suchitra (Wayne State University): Indian Writing in English, Postcolonial Theory and Literature, Women's Studies, Cultural Studies.

Neelakantan, G. (IIT Kanpur): Twentieth and Twenty-first Century American Literature, Modernism and Post-Modernism, American Jewish Literature, Memory Studies, Trauma Studies, and Literary Theory.

Patil, Koumudi (IIT Bombay): Art history, Installation Art, Participatory/Community Arts, Visual culture, Craft theory & practice, Design thinking.

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

Priya, Kumar Ravi (University of Delhi): Disaster Psychology and Disaster Management, Cultural Psychology, Health Psychology and Alternative Paradigms of Psychology.

Puttaswamy, Chaithra (SOAS, University of London): Language Documentation and Description, Historical Linguistics, Language Typology, Language contact, Dravidian Linguistics.

Raina, Achla M. (IIT Kanpur): Cognitive Linguistics, Pragmatics, Lexical Semantics, Sign Linguistics, Indo-Aryan and Dardic Linguistics.

Ravichandran, T. (Pondicherry University): Postmodern American Literature, Literary Theory, Ecocriticism, Posthumanism, Climate Fiction, Cyberpunk Literature, Indian Writing in English, English Language Teaching.

Roy, Satyaki (Visva Bharati University): Visual Culture, Folk and Minor Art and Film Making

Roy, Shatarupa Thakurta (IIT Guwahati): Art History, Design Theory, Art criticism, Folk and Tribal Art, Research Methodology in Visual Art and Visual Culture.

Sam, Jillet Sarah (University of Maryland, College Park): New Media Studies, Sociology of Money, Social Geography, Sociology of Consumption.

Saraswat, Lalit (IIT Bombay): Philosophy of Science (Biology), the relevance of Evolutionary Biological Theories for understanding the nature and origins of Perception, Cognition, the notion of Emergence, Causation (multi-level), Creativity, along with interests in the conceptual issues in Neurophilosophy, Neuroethics, and Genetics

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

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

Sahu, Vineet (University of Hyderabad): Philosophy of Mind, Ethics, Political Philosophy, Philosophy of Social Sciences and Philosophical Anthropology.

Sudharshana, N. P. (English and Foreign Languages University, Hyderabad): Second Language Acquisition, ELT, Language Testing, Applied Cognitive Linguistics.

Swarnakar, Pradip (IIT Kanpur): Environmental Sociology, Social Network Analysis.

Udaar, Usha (IIT Delhi) : Indo-Aryan Linguistics, Linguistic Variation, Syntax.

Verma, Ark (Ghent University): Cognitive Psychology, Cognitive Behavioral Sciences, Cognitive Neuroscience, Neuropsychology, Psycholinguistics.

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 candidacy into PhD programme. The entire programme is expected to extend over eight to nine semesters. The following are among the important areas of specialization offered by the department.

ENGLISH

British and American Literature, Postcolonial Literature, Indian Literature, Feminist Theory and Literature, Postmodern Theory and Literature, Posthumanism, Literature and the Environment, Indian Writing in English, Critical Theory, Cultural Studies, Linguistic Theory, Cognitive Linguistics, Computational Linguistics, Sociolinguistics, Language Documentation and Description, Language Typology, Lexical Semantics, Sign Linguistics, Teaching English as a Second Language, Second Language Acquisition, Language Testing, Applied Linguistics, Cinema studies, Translation Studies

FINE ARTS

Visual culture, , Art and Aesthetics, Folk and Tribal Art, , Film Making, Film Appreciation, Participatory/Community Arts, Craft theory and practice, , Far-Eastern Art, Indian Art and Western Art.

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, Epistemology, Gandhian Studies, Philosophy and Literature, Plato, Aesthetics, Philosophy and Literature, Phenomenology, Existentialism, Hermeneutics, Gandhi studies, Evolutionary Epistemology (Cognitive Perceptual Mechanisms/ Theories)

PSYCHOLOGY

Cognitive Psychology, Engineering Psychology, Organizational Behavior, 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

Sociology of Health and Illness, Social Demography, Sociology of Religion, Sociology of Work, Urban Sociology, Sociology of Science and Technology, Sociology of

Development, Social Movements, Design Culture, Human Rights, Social Geography, New Media Studies, Digital Sociology, Sociology of money, Social Geography, Sociology of Consumption, Environmental Sociology and Social Network Analysis, Sociology of Law, Economic Sociology

FACILITIES

The Department has full access to the Computer Centre of the Institute. In the Department, there are three academic laboratories. The Language Laboratory is a language teaching and testing laboratory containing 50 booths. 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. In addition to these discipline-specific laboratories, theDepartment also has a general Research Laboratory facility for the administration and execution of sponsored research projects undertaken by the Faculty from time to time. Continuous modernization of the laboratories ensures that these are provided with latest equipment and facilities. For more on facilities, visit: http://www.iitk.ac.in/hss/

Eligibility Requirements for Ph.D. in HSS

A Master's degree in a relevant discipline or MS/BS/B.Tech/M.F.A./M.A./M.Arch/ M.Des/PG Diploma in Craft degree with marks/CPI not below the prescribed minimum and a valid UGC JRF/UGC NET/CSIR JRF/CSIR NET/GATE score.

MATHEMATICS & STATISTICS

The Department, which started as the Department of Mathematics in 1960, got its new name - 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 great extent. Over the years, the Department has evolved as one of the premier seats of learning in the country providing excellent teaching and research in Mathematical Sciences and Statistics. The vibrant academic environment is nurtured by strongly motivated members of the faculty and provides an opportunity to pursue research in frontline areas of basic as well as interdisciplinary areas of science and technology.

The Department currently has 47 faculty members who are engaged in research and teaching in various areas of Pure Mathematics, Applied Mathematics and Statistics. The faculty members of the Department aim to achieve high quality research and teaching standards in various disciplines of Mathematics and Statistics with a flavor of unified approach towards both pure and applied aspects and are ever responsive towards the growing demands of new and emerging areas of research and teaching. As Mathematics and Statistics have penetrated into 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 members 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 and international agencies are also undertaken by them.

FACILITIES

The Computer Centre of the Institute provides E-mail, Web, DNS, FTP, Internet access, high performance computing and other services for 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.

The department has its own computing facilities for students, faculty members and staffs of the department.

These include: Two clusters installed in centralized Data Centre; one with (17+3) 20 nodes (IBM X3650 M4 Cluster), and the other with 4 nodes; Advanced GPU, Non-GPU workstations and high-end servers for computational and simulations; A Linux lab having 48 high end desktops with remote access facility; Big UPS' systems for entire department

computers; MATLAB server with network license., Department web server / FTP server for circulating the faculty position data and other confidential data and sync with advanced Apple i-Pads which is used in departmental faculty meetings.

Department has Linux Lab is well equipped with 48 desktop computers. This lab is available from 8 AM to 2 AM., One lab is also available for department and IITK placement online exams., Department has 5 Research Scholar room each Scholar facilitated with Hi-end personal Computer and personal cubical.

All the PCs have advanced configurations (Core i7 and Core i5 processor) and all advanced and latest software. These labs are running and fully maintained under supervision of our technical staff.

Three seminar rooms equipped with projectors and screen and multimedia facility;Polycom/Skype video conferencing setup with two 55 inch TV screens. Printing Facility

We have B/W Laser printers to all the PhD students for their research use. For UG and PG students it is on request basis., Our Office is on the 5th Floor of the Faculty Building [right from the lift], and on the 3rd Floor of the New Core Lab Building, and one of us can usually be found around our office

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 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 Ph.D. students of the Department. The Department provides B/W Laser printing facility to all PhD students for their research use and to all UG and other PG students on request basis. The departmental seminar room is well-equipped with Top-mounted, Handnote and OHP projectors, cordless Microphone and other Audio-Visual support. The Department has three separate labs only for our research scholars. Every research scholar has his own cabin with advanced core i7 computer.

Ph.D. PROGRAMME

In addition to a flexible four-year BS programme in Mathematics and Scientific Computing andtwo 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. Admission to these Ph.D. programs require a valid GATE score in MA paper (for Ph.D. in Mathematics), and in MA/ST paper (for Ph.D. in Statistics), or a valid UGC/CSIR JRF rank in Mathematical Sciences, or a qualifying certificate of NBHM / INSPIRE fellowship. The admissions are done through a written test and/or interview. The programs attract good students from all over India. Research work leading to the Ph.D. 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 tofamiliarize the students with the fundamental aspects of Mathematics / Statistics befitting to a Ph.D. level and initiate the students to the chosen area of research. Apart from training related tothe fundamental principles of Mathematics andStatistics, the scope of these comprehensive and flexible programs include 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 hasso far produced over 380Ph.D. students who are now associated with reputededucational institutes and R&D organizations across the globe. Many of our Ph.D. students are also doing extremely well in private sector industries. Currently the Department has about 55 research scholars working in state of the art research areas. Regular seminars keep everyone charged and updated. Ph.D. students are required to actively participate in the tutoring of U.G. students (from B. Tech, B. Tech - M. Tech Dual, four-year BS and two-year M. Sc. programs) in core and professional courses. They also conduct voluntary helping sessions for the benefit of the U.G. students. This helps them in tuning their communication and teaching skills.

FACULTY WITH AREA OF RESEARCH SPECIALIZATION

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

D. Bahuguna, Ph.D. (IITKanpur): Differential Equations, Non-linear Analysis, Theory of Semi-groups.

Kaushik Bal, Ph.D. (Universite de Pau et des Pays de l'Adour, France): Elliptic and Parabolic Partial Differential Equations

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

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

Suprio Bhar, Ph.D. (**ISI Bangalore**): Stochastic Partial Differential Equations in infinite dimensional spaces, Hilbert valued Stochastic Processes, Rough paths and Regularity Structures.

Sameer L. Chavan, Ph.D. (Pune University): Function-theoretic and graph-theoretic operatortheory

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

DebrajDas, Ph.D. (North Carolina State University) Asymptotic Theory of Statistics (Rates of convergence to CLT, Edgeworth Expansions), Bootstrap and Higher order corrections, Time Series, Statistical Analysis of Networks.

Subhra Sankar Dhar, Ph.D. (ISI Kolkata): Non-parametric function estimation, Non-parametric and Robust Statistical Methods, Statistical Pattern Recognition, Statistical Signal Processing, Applications of Statistics in Interdisciplinary Subjects like Economics.

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

Subhajit Dutta, Ph.D. (ISIKolkata): Discriminant Analysis, Inference based on Data Depth, Characterization of Multivariate Distributions, Classification of Sequence Data

Arijit Ganguly Ph.D. (TIFR Mumbai): Diophantine approximation, Dynamical systems and Random walks.

S. Ghorai, Ph.D. (University of Leeds, UK): Mathematical Biology, Scientific Computing.

Satyajit Guin Ph.D. (**IMSc, Chennai**): Noncommutative Geometry, Operator Algebra.

Somnath Jha, Ph.D (TIFR, Mumbai): Number Theory and Arithmetic Geometry.

Amit S. Kuber, Ph.D (University of Manchester, UK): Category theory, Model theory, Categorical logic, Representation theory of finite dimensional algebras

Debasis Kundu, Ph.D. (Penn State University): Statistical Signal Processing, Non-linearRegression, Survival Analysis, Statistical Computing.

Kumar, **Ashutosh**,**Ph.D**.(**University of Wisconsin-Madison**)

Mathematical Logic, Set Theory and its application to real Analysis, Measure Theory and Topology

Arbind Kumar Lal, Ph.D. (ISIDelhi): Algebraic Graph Theory.

Alok Kumar Maloo, Ph.D. (Bombay University/TIFR Mumbai): Commutative Algebra.

Ashis Mandal, Ph.D. (ISl Kolkata): Algebraic Topology; Deformation of Algebraic Structures, Higher Structures and Related Fields.

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

Amit Mitra, Ph.D. (IITKanpur): Statistical Signal Processing, Robust Model Selection & Parameter Estimation, Data Mining in Finance

Sharmishtha Mitra, Ph.D. (IITKanpur): Order Statistics, Reliability Models, Robust Estimation in Non-linear Models, Econometrics

Minerva Mukhopadhyay, Ph.D. (ISI Kolkata): Asymptotic Statistics, Bayesian Variable Selection, Nonparametric Inference.

Parasar Mohanty, Ph.D. (IITKanpur): Harmonic Analysis.

T. Muthukumar, Ph. D. (IMSc Chennai): Homogenization and variational methods for PDE's, Elliptic PDE's, Optimal Controls.

Santosh V R N Nadimpalli, Ph. D. (Universitè Paris-XI,OrsayandUniversityof Leiden) Representation theory and Local Langlands program.

Nandini Nilakantan, Ph.D. (IISc Bangalore): Combinatorial Theory, Computational Geometry.

Abhijit Pal, Ph.D. (ISI Kolkata): Geometric Group Theory, Relatively Hyperbolic Groups, Mapping Class Groups.

Sasmita Patnaik, Ph.D. (Univ. of Cincinnati): Operator Theory

S. K. Pattanayak, Ph.D. (CMI Chennai): Algebraic Groups and Invariant Theory, Lie Algebras and Representation Theory.

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

Rama Rawat, Ph.D. (ISI Bangalore): Harmonic Analysis.

Prosenjit Roy, Ph.D (University of Zürich, Switzerland): Partial Differential Equations.

Preena Samuel, Ph.D (IMSc Chennai): Algebraic Groups.

Bidyut Sanki, Ph.D. (**IISc Bangalore**): Topology and Geometry.

G. Santhanam, Ph.D. (IITBombay/TIFR Mumbai): Differential Geometry.

Debasis Sen, Ph.D. (ISI Kolkata): Homotopy theory, Group actions.

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

Sachin S. Sharma, Ph.D (IMSc Chennai): Representation Theory of Kac-Moody Algebras, extended affine Lie Algebras.

Sudhanshu Shekhar, Ph.D (TIFR Mumbai): Algebraic Number Theory, Arithmetic Geometry.

P. Shunmugaraj, Ph.D. (IIT Bombay): Functional Analysis.

Saurabh Kumar Singh, PhD. (TIFR, Mumbai) :

Analytic Number Theory, L-functions, sub-convexity bounds,

Riemann zeta function, Sieve methods

Ajay Singh Ramdin Thakur, Ph.D (IMSc Chennai): Topology of Complex manifolds, Algebraic Topology.

Dootika Vats, PhD (University of Minnesota, Twin-Cities, USA): Markov chain Monte Carlo, Bayesian Computation, Covariance Matrix Estimation, Bayesian Variable Selection, Intractable Likelihood Problems

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 41 members in the Faculty and is assisted by a team of DST-Inspire Faculty Fellows and Postdoctoral Fellows as part of the academic staff. There are around 120 research scholars engaged in doctoral research.

The Department participates in the undergraduate Core Courses in the B.Tech. Programme, and BS (4 yr) + MS (1 yr) 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 M.Sc. (2 yr) 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.

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 Systems in all its aspects, with interests more or less evenly divided between theoretical and experimental work, with strong cross-pollination of ideas between theory and experiment.

Other moderate-size groups include High Energy Physics and Optics. The Plasma Physics Group is involved in investigation of both fundamental and applied aspects of plasma physics research with good emphasis on interdisciplinary research, the Ion-Beam group applies Nuclear Physics Techniques to the study of materials and applications of Ion Beams in Science and Engineering. Other groups include Biological and Statistical Physics, and Nonlinear Dynamics.

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 Atomic and Molecular Physics, Plasma Physics, Biological and Statistical Physics, Condensed Matter Physics, Computational Physics, Dynamical Systems, Turbulence and Non-linear Physics, Particle Physics, Beyond Standard Model phenomenology, QCD, Lattice Gauge Theories, Quantum Field Theory, Astrophysics, Cosmology, String Theory and Quantum Gravity - AdS/CFT - Hydrodynamics, Biophotonics, Light-Matter Interaction, Photonics of Micro

and Nano Structured Materials, Non-linear Optics, Fiber Optics, Quantum Optics, Laser Cooling and Trapping, Ion Beams and Nuclear Physics Techniques, with a substantial degree of Inter-Disciplinary activity.

Students with good academic record and strong motivation for a career in Physics can apply for admission to the Ph.D. Programme after earning Master's degree (or the new BS 4-yr degree). 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 Ph.D course work consist of several subjects such as review of mathematical physics, classical mechanics, quantum mechanics, classical electrodynamics, 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, Non-equilibrium Statistical Mechanics, Physics of Soft and Bio-materials, Condensed Matter II, Magnetism in Materials, Computational Methods in Physical Sciences, Electronic Structure of Materials, Topics in Semiconductor Physics and Technology of Thin Films, Disordered Systems, Physics of Semiconductor Nanostructures, Low Temperature Physics, Quantum Electronics, Coherence Optics, General Relativity and Cosmology, 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, High Energy Physics II, Spintronics, Non-linear Systems and Dynamics, Concepts of Plasma Physics, Physics of Turbulence, Electromagnetic Metamaterials and Plasmonics, Transport in Mesoscopic Systems, Soft Matter Physics, Introduction to Biophotonics, Physics of Natural Nanomachines, Physics of Semiconductor Nanostructures, Condensed Matter Phenomena in Low Dimensional Systems, The Standard Model of Fundamental Physics, and large number of Special Topics Courses.

Major Research 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 micro-fluidics, we have contact angle Goniometer, fluorescent microscope and high speed (10,000 fps) camera.

Optics Laboratories:

ND:YAG lasers, Excimer Laser, Double Monochromators, Photon Counters, Spectrofluorimeter, Box Car Averagers, Vibration free tables. Facilities exist for High Resolution Spectroscopy, Micro-Raman Spectroscopy, Laser based pump-probe measurements, Laser-Plasma Studies and Nonlinear Optics, Diode Lasers, spectrograph-CCD system, Optical Spectrum Analyzers and Fibre Optics System, Optical Lithography Set-up, Atomic Force Microscopy Facility (Park XE 70 machine with a 100micron X 100 micron scanner head and a liquid cell). Two new Labs - Quantum and Nano-Optics, Quantum Optics and Entanglement Lab. are being set up.

lon 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 Tandetron 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 Facilities:

Physics cluster (Newton): 396 cores, 1.5 TB memory, Infiband switch. Chaos I: 256 cores, ½ TB RAM, Gigabit switch. Chaos II: 128 cores, ½ TB RAM, Two K10 GPU cards, Infiband switch. Many workstations including 3D capable visualisation stations. Dirac cluster for electronic structure calculations, 96 cores, 768 GB RAM. In addition, there are the following Institute facilities : hpc Cluster 1: 2994 cores, 100 TB storage, Peak rating 34.5 Tflops (Ranked 369 in June 2010 Top500 ranking). hpc Cluster II: 15,360 cores, 98TB RAM, Peak rating 316 Tflops (Ranked 130 in Nov 2013 Top500 ranking).

The Department organizes a yearly "Jagadishwar Mahanty Distinguished Lecture" (since the year 2005) by an eminent scientist which provides unique opportunity of interaction

with faculty and students, and a "Research Scholars Day" involving short talks and poster presentations by research scholars in the department apart from the weekly colloquium and seminars.

Faculty Members

1. Amit Agarwal, *Ph.D. Indian Institute of Science, Bangalore, 2009*

Area of research: quantum many-body effects, low-dimensional quantum systems

2. *Arjun Bagchi, Ph.D. Harish chandra Research Institute, 2009*

Area of research: Theoretical High Energy Physics, String Theory

3. Satyajit Banerjee, *Ph.D. Tata Institute of Fundamental Research, 2000*

    Area of research: Superconductivity, Magneto-optics

4. Supratik Banerjee, Ph.D. *Universite Paris-Sud, France 2014*

    Area of research: Turbulence in fluids, Physics of space and astrophysical plasmas

5. Sudeep Bhattacharjee, *Ph.D. RIKEN, Japan,* 1999

    Area of research: Plasma Physics, Focused ion beams from intense plasmas,

    Interaction of multi-element ion beams with matter, Physics of nano-scale systems

6. Kaushik Bhattacharya, *Ph.D. Saha Institute of Nuclear Physics, 2005*

    Area of research: Cosmology, Particle Physics

7. Dipankar Chakrabarti, *Ph.D. Saha Institute of Nuclear Physics, 2004*

    Area of research: Quantum Chromodynamics, Lattice Gauge Theory, Lightcone Field Theories

8. Joydeep Chakrabortty*, Ph.D. Harishchandra Research Instiute, 2011*

    Area of research: Particle Physics (Theory and Phenomenology); Main interest: Unification of fundamental forces, Supersymmetry, Supergravity

9. Sagar Chakraborty, *Ph.D. S N Bose National Centre for Basic Sciences, 2008*

    Area of research: Nonlinear Dynamics, Chaos Theory, Evolutionary Game Theory, Turbulence

10. Debashish Chowdhury, *Ph.D. I I T Kanpur, 1984*

    Area of research: Statistical and Biological Physics

11. *Debtosh Chowdhury, Ph.D. IISc, Bangalore, 2013*

    Area of research: Theoretical Particle Physics, Beyond the Standard Model phenomenology, Cosmology and Astroparticle physics

12. Diptarka Das, Ph.D. *University of Kentucky, 2014*

    Area of research: Conformal field theories, Non-equilibrium physics, String theory

13. Amit Dutta, *Ph.D. Saha Institute of Nuclear Physics, 2000*

Area of research: Quantum phase transitions

14. Saikat Ghosh,   *Ph.D. Cornell University, 2008*

    Area of research: Quantum Optics

15. Tarun Kanti Ghosh,   *Ph.D. Institute of Mathematical Sciences, 2003*

    Area of research: Utra-cold atomic gases, Nanoscopic physics

16. Anjan Kumar Gupta,   *Ph.D. University of Kentucky, 2001*

    Area of research: Scanning Tunneling Microscopy, Superconductivity

17. Rajeev Gupta,   *Ph.D. Indian Institute of Science, 2001*

    Area of research: Optical spectroscopy and phases

18. Manoj Harbola,   *Ph.D. City University of New York, 1989*

    Area of research: Atomic and Molecular Physics

19. Zakir Hossain,   *Ph.D. Tata Institute of Fundamental Research, 1997*

    Area of research: Superconductivity, Strongly-correlated electron systems

20. Pankaj Jain,   *Ph.D. Syracuse University, 1988*

    Area of research: Cosmology, Particle Physics

21. Anand Kumar Jha,   *Ph.D. University of Rochester, 2009*

    Area of research: Quantum-optics

22. Aditya Kelkar   *Ph.D. Tata Institute of Fundamental Research, 2009*

    Area of research: Experimental atomic collision physics, heavy ions and electron collisions, accelerator physics

23. Manas Khan,   *Ph.D. Indian Institute of Science, Bangalore, 2011*

    Area of research: Statistical Physics of Soft and Active Matter (Experiment, Modeling and Computation), Optical Trapping and Micromanipulation, Brownian dynamics simulation

24. Krishnacharya,   *Ph.D. Max Planck Institute, 2007*

    Area of research: Soft Matter Physics

25. Arijit Kundu, *Ph.D. Heinrich-Heine University, Germany, 2012*

    Area of research: Equilibrium and non-equilibrium quantum transport. Topological systems in condensed matter.

26. Nilay Kundu, *Ph.D. Tata Institute of Fundamental Research, 2014*

    Area of research: Theoretical High Energy Physics, String Theory

27. Y N Mohapatra, *Ph.D. Indian Institute of Science, Bangalore, 1989*

    Area of research: Semiconductor Physics, Material Science

28. Soumik Mukhpadhyay,   *Ph.D. Saha Institute of Nuclear Physics, 2009*

    Area of research: Spintronics, Nanomagnetism, Physics of complex oxide materials

29. Jayita Nayak, Ph.D. Devi Ahilya Viswavidyalaya, Indore, 2015

    Area of research: Angle resolved photoemission spectroscopy of topological insulators, high Tc superconductors, and hard X-ray photoelectron spectroscopy of quasicrystals and Heusler alloys

30. Asima Pradhan, *Ph.D. City University of New York, 1991*

    Area of research: Medical Applications of Lasers

31. K P Rajeev, *Ph.D. Indian Institute of Science, Bangalore, 1992*

    Area of research: Low Temperature Physics

32. S A Ramakrishna, *Ph.D. Raman Research Institute, 2001*

    Area of research: Photonics & Waves in Random Media

33. Tapobrata Sarkar, *Ph.D. Institute of Mathematical Sciences, 2001*

    Area of research: String Theory & Quantum Gravity

34. Gautam Sengupta, *Ph.D. Institute of Physics, Bhubaneswar, 1992*

    Area of research: String Theory & Quantum Gravity

35. Avinash Singh, *Ph.D. University of Illinois at Urbana-Champaign, 1987*

    Area of research: Strongly-correlated Systems

36. *Chanchal Sow, Ph.D. Indian Institute of Science, Bangalore, 2014*

    Area of research: Magnetism in Complex Oxides, Interplay between Ferromagnetism and Superconductivity, Single Crystal and Thin Film Growth of Novel Quantum Materials, Strongly Correlated Electron Systems under Non Equilibrium Steady State (SCESness).

37. *V Subrahmanyam, Ph.D. Tata Institute of Fundamental Research, 1991*

    Area of research: Strongly-correlated Systems, Quantum Computation

38. Saurabh Mani Tripathi, *Ph.D. IIT Delhi 2010*

    Area of research: Fiber and Integrated Optics

39. Mahendra K Verma *Ph.D. University of Maryland, 1994*

    Area of research: Nonlinear Physics, Magnetohydrodynamics

40. R Vijaya (HOD), *Ph.D. IIT Madras, 1991*

    Area of research: Fiber optics, Nonlinear optics and Photonic band gap structures

41. Harshwardhan Wanare, *Ph.D. University of Hyderabad, 1998*

    Area of research: Non-linear optics, imaging

The major research groups and active research areas are listed below:
Condensed Matter Experiments

- *Magneto-Optical Imaging*
- *Nanostructures of Superconducting and Magnetic Materials*
- *Intense Laser-Matter Interaction*

- *Non-Equilibrium Transitions in Driven Vortex States of Superconductors*
- *Interplay between Magnetism and Superconductivity*
- *Magnetic and Transport behaviour of Heavy Fermion Compounds*
- *Electronic, Magnetic, Optical Properties of Surfaces using Scanning Probe Microscopy*
- *Electronic and Magnetic Properties of Transition Metal Oxides*
- *Charge Ordered State of Transition Metal Oxide Thin Films*
- *Spintronics, Spin-Polarized Tunneling in Transition Metal Oxides*
- *Strongly Correlated Electron Systems in Low Dimensions*
- *Photonic and Electronic Materials*
- *Printable Electronics, Organic LED and Lighting*
- *Defects and Disorder in Semiconductors*
- *Effects of Localized States on Electrical and Optical Properties*
- *Hybrid Inorganic/Organic Devices*
- *Amorphous and Porous Silicon*
- *Electronic Properties of Crystalline Semiconductors*

Condensed Matter Theory

- *Electronic Structure of Disordered Systems*
- *Molecular Dynamics Simulations and Genetic Algorithms*
- *Topological Insulators*
- *Applications of Density Functional Theory*
- *Electronic Structure of Atoms, Molecules, and Solids*
- *Correlated Electrons and Quantum Magnetism*
- *Spin, Charge, Orbital Correlations in Transition Metal Oxides*
- *Antiferromagnetism, Superconductivity, BE Condensation and Disordered Systems*
- *Low Dimensional Electronic Systems, Graphene, Spintronics*
- *Quantum Many Body Effects in Low Dimensional Systems*
- *Transport Properties of Hybrid Structures*
- *One-Dimensional and Quasi-One Dimensional Spin and Electron Systems*
- *Classical and Quantum Phase Transitions in Random Systems*
- *Non-Equilibrium Dynamics of Magnetic and Non-Magnetic Systems*
- *Statistical and Theoretical Biophysics*
- *Natural Nano Machines, Complex Adaptive Biological networks*
- *Driven-Dissipative Systems, Self-Assembled Soft and Bio-Materials*
- *Phase Transitions in Driven Diffusive Systems*
- *Non-equilibrium Dynamics of Spin Systems*
- *Physics of Biopolymers and Molecular Motors*
- *Nonlinear Dynamics, Fluid Dynamics, Turbulence*
- *Magnetohydrodynamics, Turbulence, and Dynamo*
- *Structured Photonic Materials and Negative Refractive Materials*
- *Plasmonic Properties of Metallic Structures*
- *Quantum Entanglement and Quantum Computation*

Photonics and Quantum Optics

- *Laser Raman Spectroscopy*
- *Laser-Plasma Studies*
- *Bio-Medical Applications*
- *Nonlinear Optics, Fiber Optics*
- *Photonic Band Gap Structures*
- *Imaging in Complex Media & Biological Tissues*

- *Photonics and Waves in Random Media*
- *Coherent Control of Light-Matter Interaction*
- *Non-Linear Optics, Quantum Optics*
- *Quantum Optics, Quantum Information, Precision Spectroscopy*
- *Cold-Atom Systems, Foundations of Quantum Mechanics*
- *Using Cold-Atom Systems to Probe Nano-Materials and Molecules.*

High-Energy Physics

- *Quantum Field Theory*
- *Astrophysics, Cosmology, Astroparticle Physics*
- *Particle Physics, Beyond Standard Model Phenomenology*
- *Quantum Chromodynamics, Lattice Gauge Theory*
- *Classical and Quantum Gravity,*
- *String Theory, AdS-CFT and AdS-Condensed Matter correspondence.*
- *Black Holes Thermodynamics.*
- *Hydrodynamics from charged black branes, fluid dynamics and gravity*

Plasma Physics and Ion beam Physics

- *Experimental plasma physics*
- *Wave Interaction with plasmas confined in multi-cusp magnetic fields*
- *Physics of plasmas confined by a dipole magnet*
- *Atomically heterogeneous systems created with low energy ion beams*
- *Atmospheric pressure low temperature micro-plasmas*
- *Plasma based multielement focused ion beams*
- *Research using focused ion beams*
- *Ion-Beams for science, engineering and technology*