



भारतीय प्रौद्योगिकी संस्थान कानपुर
Indian Institute of Technology Kanpur

COMPUTER SCIENCE & ENGINEERING

POST GRADUATE PROGRAM

Website: www.cse.iitk.ac.in

COMPUTER SCIENCE & ENGINEERING

Indian Institute of Technology Kanpur was the first Institute in India to start Computer Science education. The initial "computer-related" courses were started at IIT Kanpur in August 1963 on an IBM 1620 system installed in the nation's first "computer classroom," a novelty then even in many North American and European universities. Gradually, the Institute drew upon some of the brightest young Indians in Computer Science to serve on its faculty and initiated an independent academic program in 1971, leading to Ph.D. and M. Tech. degrees. The undergraduate program started later, with the first batch graduating in 1983. The department was formally established in 1984.

It attracts top quality BTech, MTech, MS, and PhD students to the respective degree programs. The department also has an MS program, which is mainly focused in research in various domains of Computer Science. The MTech, MS, and PhD programs require the students to conduct research leading to a thesis. Every year the research activities in the department lead to scientific publications in top-tier conferences and journals in all areas of Computer Science and Engineering. Our faculty members are also engaged in a large number of sponsored research and consultancy projects funded by the Government as well as the industry. Several engineers and post-doctoral fellows are relentlessly working to lead the department with cutting-edge technologies.

Over the years, our faculty have been honored with several prestigious national and international awards and fellowships. They are also actively participating in the editorial boards of top-quality journals and transactions. Moreover, both the undergraduate and postgraduate students have grabbed best paper awards on several occasions, whereas the PhD students have been awarded with Prime Minister Research Fellowships, Intel, Google, TCS and Qualcomm Innovation Fellowships. The department also has a very strong alumni network including many of the nation's leading experts, educationists and consultants in computer science today



POST-GRADUATE PROGRAMMES OFFERED

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. An appealing part of our M.Tech. program is that some of the top performing students (based on the evaluation done after the first semester) may be eligible to get a joint M.Tech. degree from IIT Kanpur and one of our partner universities outside India. As part of this joint degree program, such students will get a chance to spend a part of their M.Tech. program at the partner university and do their thesis work jointly with faculty from both the places.

MS (Research) Program

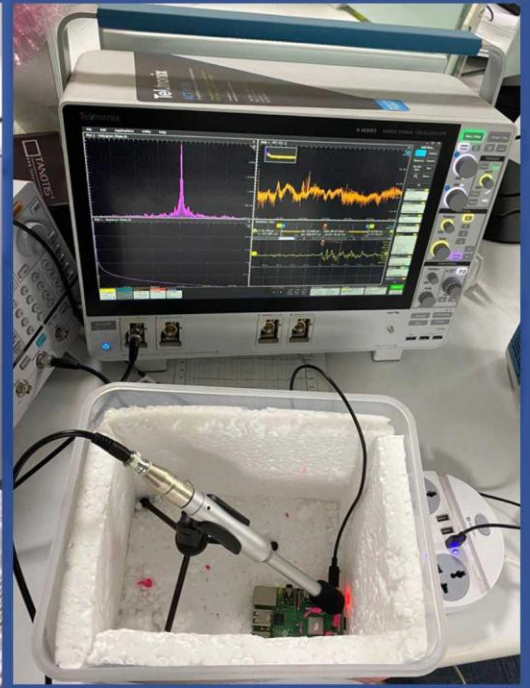
In the MS (Research) program, a student is required to complete the required courses chosen in consultation with the thesis advisor. The student is expected to carry out research work leading to a thesis. Students will work under a supervisor on industry-sponsored or other funded projects at IIT Kanpur and earn an MS (Research) degree, provided they meet all the program requirements. MS students can be funded by the Institute (Full-time) or through a project (Full-time/Sponsored/Part-time). The program's strong focus on research makes it exciting and provides students with in-depth knowledge in their area of study.

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 with a valid GATE/JRF score 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.

POST-GRADUATE PROGRAMMES OFFERED

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



LABS/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.

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.

- ❖ SIG on Theoretical Aspects of Computer Science (SIGTACS):
<https://sigtacs.github.io>
- ❖ SIGs on Systems and Security Research
 - Computer Architecture, Operating Systems and Systems Security (CAOS):
- ❖ SIG on Natural Language Processing
- ❖ SIG on Computational Genomics

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.

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

FACULTY LIST

- ❖ **Abhranil Chatterjee**, PhD (The Institute of Mathematical Sciences, Chennai): Complexity Theory and Designing algorithms with algebraic techniques
- ❖ **Adithya Vadapalli**, PhD (Indiana University Bloomington): Applied Cryptography, Private Information Retrieval, Secure Multiparty Computation, Zero-Knowledge Proofs and Oblivious RAMs
- ❖ **Amey Karkare**, PhD (IIT Bombay): Compilers, Program Analysis and Optimizations, Functional Programming, Intelligent Tutoring Systems.
- ❖ **Amitangshu Pal**, PhD (University of North Carolina Charlotte): Wireless and Sensor Networks, Sensing and Communication for Internet of Things (IoTs), Building IoT Solutions for Smart Cities.
- ❖ **Angshuman Karmakar**, PhD (KU Leuven): Post Quantum Cryptography, Side Channel Attacks, Computation on Encrypted Data (Homomorphic encryption, Functional encryption and multi-party computation), and Cryptology
- ❖ **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
- ❖ **Debadatta Mishra**, PhD (IIT Bombay): Operating Systems, Virtualization and Cloud Computing, Computer Networks, System Security, Technology in Education
- ❖ **Debapriya Basu Roy**, PhD (IIT Kharagpur): Hardware Security, VLSI for Cryptography, Post Quantum Cryptography
- ❖ **Gunjan Kumar**, PhD (TIFR Mumbai): Sublinear Algorithms, Approximation Algorithms, Statistical Learning Theory and Information Theory
- ❖ **Hamim Zafar**, PhD (Rice University): Computational Genomics, 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.
- ❖ **Preeti Malakar**, PhD (IISc, Bangalore): High-performance computing, Scalable parallel computing, Workflow optimization
- ❖ **Pritam Choudhury PhD (University of Pennsylvania)**: Programming Languages, Type Theory, Language-Based Security, Formal Verification, Logic and Formal Methods in Indian Knowledge Traditions.

FACULTY LIST

- ❖ **Priyanka Bagade**, PhD (Arizona State University): Internet of things (IoT), Sensors, Mobile computing, cyber-physical systems, deep learning.
- ❖ **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).
- ❖ **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
- ❖ **Sayak Ray Chowdhury**, PhD (IISc Bangalore): Reinforcement Learning, Multi-armed bandits, Differential Privacy and Language Model Alignment
- ❖ **Soumya Dutta**, PhD (Ohio State University): Machine Learning, Data Science, Visual Computing, Scientific Computing, Data Visualization, Explainable and Interpretable AI, and Big Data Visual Analytics.
- ❖ **Sruti Srinivasa Ragavan**, PhD (Oregon State University): Human Factor in Computing, Software Engineering and End-User Computing
- ❖ **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.
- ❖ **Sutanu Gayen**, PhD (University of Nebraska-Lincoln): Foundation of Machine Learning and Probabilistic Algorithms
- ❖ **Swarnendu Biswas**, PhD (Ohio State University): Programming languages, program analysis, compilers and runtime systems, parallel computing, approximate computing.
- ❖ **Urbi Chatterjee** (PhD, IIT Kharagpur): Hardware security, Physically unclonable functions, Secure authentication protocol design, Internet of things security

BROAD RESEARCH AREAS

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: Computer Architecture-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.

BROAD RESEARCH AREAS

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. **Internet of things:** Sensors, embedded systems, mobile computing, context aware computing, cyber-physical systems, and applications of deep learning to cyber-physical systems and internet of things.

Computer communication and networks: Computer networking research at MAC/network/transport layers, wireless networks, rechargeable sensor networks, exploring communication and networking in challenging environments like underground, underwater or inside body area networks.

Hardware Security: side-channel (power, EM, and timing) and fault attacks and countermeasures, secure hardware design for novel cryptographic algorithms in FPGA/ ASIC, physically unclonable functions, hardware trojan detection, IP protection, FPGA based hardware accelerator for ML/AI, secure protocol design, unmanned air vehicle security, hardware implementation of post-quantum cryptography.

Cryptography: Design and analysis of cryptographic schemes such as post-quantum cryptography, homomorphic and multi-party computation schemes, blockchains etc., protocol design, Algorithmic optimizations, efficient implementation, Practical applications of cryptographic schemes.

DATA SCIENCES

Machine Learning: Deep learning, probabilistic machine learning, 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.

Computer Vision: Video analytics and surveillance, medical image analysis, scene understanding, 3D vision and geometry, multimodal vision, vision for robotics / embodied AI, adversarial robustness and security, self-supervised and unsupervised learning in vision, generative models for vision, cognitive and behavioral modeling via vision.

Data Analytics, Visual Computing, Scientific Computing, and Data Visualization: Machine learning for visual computing, scientific and information visualization, interactive data exploration, high-dimensional data, image analysis, explainable and interpretable AI, and big data analytics.



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