

# Indian Institute of Technology, Kanpur



Department of Computer Science & Engineering  
Session: 2019-2020



## About Us:

The 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. Many of the nation's leading experts, educationists and consultants in computer science today are the alumni of this department. Currently, the department has a faculty of 35 whose research and teaching interests span almost all areas of Computer Science – including the newly initiated courses in **Parallel Computing** and **Blockchain Technology**. The department admits about 100 students every year in the **B.Tech.** Program and 75 students in the **M.Tech.** Some students convert their B.Tech. program into dual-degree program, which results in students getting both a B.Tech and an M.Tech. degree at the end of 5 years. There are about 12 students registered in **Ph.D.** program at a time. The department has recently started **M.S.** program, which is mainly focused in research in various domains of Computer Science. There is one software engineer and five other staff attached to the laboratory facilities. Besides, there are a number of research engineers working in various sponsored projects.

## Message from the Head:

The Computer Science and Engineering department at IIT Kanpur is the oldest Computer Science program in India, and it continues to excel in producing academic and industrial leaders of the future. In 2018, we are at the cross roads of the Computer Science as we have known in the last few decades, and the amazing new world of computing. This department offers a curriculum that is flexible for students to strengthen their basics in computing, and then dive into the advanced frontiers of computing in great depth. Students are well prepared to take on engineering as well as strategic visionary roles in the industry. Many of our students are doing extremely well in global companies such as Google, Microsoft, Intel, Facebook, Xilinx, Samsung etc. as well in financial software companies, algorithmic trading companies, E-commerce industry such as Amazon, Flipkart, Walmart etc. Many students have contributed, and built startup industries around the world.

Our research labs are also world class, and teaching labs are as well-equipped as any global university. The quality of teaching, learning, and experimentation are at par with any highly reputed American university. Students also do a lot of technology driven extra-curricular activities such as programming hackathons, capture-the-flag contests, pair programming, developing software for various institute level automation.

It is therefore, a premier place from where to hire your next engineer, your next leader, and your next technology visionary. On behalf of the department, I welcome all high tech industry to visit us, look at our curriculum, labs, research and talk to our faculty, and find a unique stimulating environment where your next hire is being nurtured for success.

**Dr. Sandeep K. Shukla**  
**Head, Computer Science and Engineering Department**  
**Indian Institute of Technology, Kanpur**

## Recent Research and Developments:

Researchers at the CSE department have achieved many milestones. Their research and initiatives have opened up new horizons.

### **Interdisciplinary Center for Cyber Security and Cyber Defense**

DST sanctioned 14.43 crores (~2.2 million USD) for the Interdisciplinary Center for Cyber Security and Cyber Defense of Critical Infrastructures. Prof. Sandeep Shukla and Prof. Manindra Agrawal will lead the group. This is the first center, set up in India, to pursue cyber security of critical infrastructures.

### **JEE Seat Allocation: An Algorithmic Perspective**

Prof. Surender Baswana proposed an algorithmic perspective for JEE seat allocation for CFTIs. This approach ensures each candidate submits a single choice list over all available programs, and receives no more than a single seat from the system, based on the choices and the ranks in the relevant merit lists.

### **Primality Testing in Polynomial Time**

One of the major problems in computational number theory was solved by Prof. Manindra Agrawal, Prof. Nitin Saxena. The problem was whether a number could be tested for primality in polynomial time.

### **Development of Air Quality Index(AQI) for Indian Cities**

An AQI translates individual air pollutant concentrations into a single number that reflects the status of air quality in simple terms. The scientific basis of developing AQI is the attainment of air quality standards and pollutant dose-response relationships. This was developed by Prof. Arnab Bhattacharya.

### **Fast Integer Multiplication Using Modular Arithmetic**

Prof. Piyush P. Kurur proposed an algorithm to multiply two N-bit integers that uses modular arithmetic for intermediate computations. This algorithm runs with the best known complexity.

### **MOOC and Agropedia Software Models**

MOOCs provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Agropedia, software as a service model, can be used to rapidly build agriculture portals for different communities.

### **Prutor: a Cloud based Web Application**

Prutor is a cloud-based web application that provides instant and useful feedback to students while solving programming problems. Prutor provides a view of the students' approach to solving programming problems, regardless of programming environments.

### **Smart Card Technology Development**

A standard for smart card operating system has been developed which is used by the government of India for all their smart card based applications. A smart card operating system has also been implemented which is compliant to this standard. This technology is in the process of being commercialized.

### **Language Technology**

Some path breaking contributions have been made in Indian language coding (ISCII), keyboard design, transliteration, OCR machine translation, Linux ware, NLP, Indian scripts on Linux, Web content creation and search. Some of our landmark achievement is: GIST multilingual technology, AGLABHARTI & ANUBHARTI MACHINE aided translation strategies and popular web sites such as Gita-supersite.

### **Multipurpose Multimodal Human Identification System**

The primary aim is to design a robust system which is capable of handling problems like security, personal, verification/identification etc. The various traits that are considered are Face, Iris, Signature, Fingerprints and Ear.

### **Medical Application**

The medical applications group supported by media lab Asia developed a portable mobile model of printing healthcare delivery which uses ICT and digital devices to contact remotely located individuals requiring medical attention with doctors.





## CSE Lab Facilities:

### Network

The CSE lab is equipped with a 1 gbps switched network with a tree topology. All systems (servers & clients) are equipped with 1 gbps NICs. A CISCO Catalyst 3750G Series Layer-3 switch acts as a backbone switch. The lab is connected to the campus network through a router. The connectivity between CSE and the institute Computer Center is through fiber optic cable. A total of 50 switches (24 ports each) each having 1 gbps speed cover the both CSE buildings. Department has two server rooms which are full with different kinds of servers. These server rooms also have specific project based servers & systems.

### Cloud

Recently CSE lab has deployed one cloud "**Vyomkesh**" which has currently 20 compute nodes having dual Xeon 6 core CPUs with 48 GB RAM each. It supports 240 physical (480 logical) cores with 960 GB RAM. Soon

capacity will be enhanced. A system course having 125 students will use Vyomkesh first time.

### Hardware Lab

The hardware lab in the CSE department is the state of the art lab equipped for embedded computing. The lab provides several FPGA based stations for hardware programmability. The lab is used both for UG education and research.

### SCADA Cyber Security Test Bed

A flexible SCADA test bed has been installed of Schneider made industrial hardware and software to provide a facility for research scientists and engineers investigating cyber security of critical infrastructure. This test bed replicates of power distribution automation for both three phase and single phase power supply. This test bed is equipped with real field devices such as energy meters, protection relays, modular control system, IRIG-B based GPS time sync unit, IEC-61850 compliant Ethernet switches, unified threat management hardware, industrial grade HMI, SCADA system etc.

### **Robotics Lab**

Vicon Vero Motion Capture System for indoor robot localization has been installed in this Lab.

### **Sun Grid**

Sun grid has been established in the department with funding from Sun Microsystems, USA. The grid has 20 workstation based on Opteron (64 bit AMD processor) and it is available to all the users who want to do research and explore the area of High Performance Technical Computing. The department is recognized as the "Sun Regional Academic and Research Partner for Excellence in Grid Computing.

## **Research Areas and Faculties:**

The department provides an excellent research platform, and challenges the students' potential to solve tough problems.

### **Algorithms and Data Structures**

Faculties: Dr. Raghunath Tewari, Dr. Ratan K Ghosh, Dr. Sanjeev Saxena, Dr. Shashank Mehta, Dr. Sumit Ganguly, Dr. Surender Baswana

We are a group of faculty and students working on exciting problems on the recently very popular areas in algorithms

And data structures including dynamic graph algorithms, fault tolerance, streaming algorithms, computational geometry, graph theory and space bounded algorithms. We are interested primarily in the research problems and general directions given below, but are also adaptable and receptive to new interesting problems that may come up in the near future.

### **Biometrics**

Faculty: Dr. Phalguni Gupta  
Biometrics lab at IIT Kanpur is actively involved in the development of biometric based authentication systems that can handle multiple traits such as a face, fingerprint, palmprint, iris, ear, knuckleprint, hand geometry, hand vein, finger vein, signature etc. The idea is to use the physiological or behavioral characteristics of a person to identify him in an automated way. This lab also provides consultancy to various government agencies on these matters.

### **Compilers, Programming Languages and Analysis**

Faculties: Dr. Amey Karkare , Dr. Subhajit Roy  
The department has a focused interest on the theory and applications of programming languages and program analysis. The main research areas are compilers, data flow analysis, heap analysis, formal techniques for automated debugging, program verification and synthesis, program profiling, compiler optimizations, GPU algorithms. Of

particular interest is a recent project being executed by Prof. Amey Karkare, Prof. Subhajit Roy and Dr. Sumit Gulwani (adjunct faculty, MSR Redmond) on developing intelligent tutoring systems that are designed to adaptively guide students who are learning programming or other tools and tasks for the first time. The project has been successfully piloted with the introductory programming course at IIT Kanpur which graduates more than 800 students each year.

### **Computer Architecture and Operating Systems**

Faculties: Dr. Biswabandan Panda, Dr. Debadatta Mishra, Dr. Mainak Chaudhuri, Dr. Rajat Moona  
Currently the group focuses on designing memory systems for emerging application domains that are resilient to application behavior. The group also focuses on the interface between Operating Systems, Architecture, and Virtualization techniques.

### **Cyber-Physical Systems**

Faculties: Dr. Indranil Saha , Dr. Sandeep Shukla  
The CPS Group at the CSE Department of IIT Kanpur is working on developing principled approaches for robust implementation of cyber-physical systems. A cyber-physical system is a collection of interconnected computing devices interacting with the physical world to regulate its behavior.

world to regulate its behavior. The group is working on several exciting problems in the area of CPS, more specifically in distributed multi-robot systems and internet-of-things. The focus of this group is to develop cyber-physical systems with correctness guarantee through the application of formal verification/synthesis techniques.

### **Cyber Security / System Security**

Faculties: Dr. Biswabandan Panda, Dr. Manindra Agrawal, Dr. Rajat Moona, Dr. P Subramanyam, Dr. Sandeep Shukla  
At IIT Kanpur, leveraging the expertise in multiple areas of Computer Science and Engineering we initiated such a comprehensive program within our center for cyber-security. We have a multi-disciplinary national project to carry out research, training and education in cyber security of the national cyber space including information infrastructure, and other critical infrastructures such as banking, power grid, industrial manufacturing, defense tactical communication networks, and various information assets of the country. The group also focuses on Side-channel and Covert-channel attacks through the processor, caches, and memory system.

### **Databases, Big Data and Data Mining**

Faculties: Dr. Arnab Bhattacharya, Dr. Medha Atre, Dr. Sumit Ganguly  
Databases are ubiquitous and form the backbones of almost all the modern

systems. While traditional databases are relational, the NoSQL paradigm has proved itself useful in various applications and situations, especially in the realm of big data. The research in this field encompasses data analytics, data processing, indexing, querying, searching and information retrieval. It also includes data mining in the form of graphs, text, multimedia, strings, etc.

### **Machine Learning and Computer**

#### **Vision**

Faculties: Dr. Harish Karnick, Dr. Nisheeth Srivastava, Dr. Piyush Rai, Dr. Purushottam Kar, Dr. Vinay P. Nambodiri  
This is an area where the department has had a recent surge in terms of strength, as well as diversity. We cover nearly all the challenging areas of machine learning and computer vision. In ML, it focuses on theoretical probabilistic machine learning, deep learning, optimisation, natural language processing etc. In vision, it mostly works on language and facial analysis, graphics, human attributes prediction, pose estimation, action/activity prediction, human-centered computing, human factors in computing, Computational Cognitive Science etc.

### **Software Architecture**

Faculty: Dr. T. V. Prabhakar  
In the era of Internet-scale applications, the success of a software application greatly depends on its quality attributes

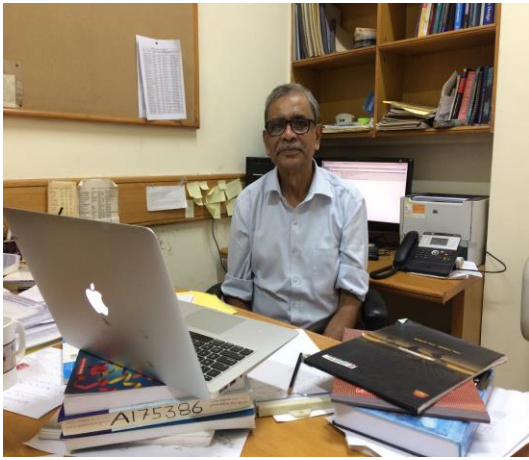
such as performance and scalability. To ensure the quality attributes desired by an application, the architect has to design a suitable architecture -- which is a very complex task. Software architecture community tries to abstract out the experiential knowledge from various domains and presents tools to design architectures such as tactics, reference architectures, and frameworks.

### **Theoretical Computer Science**

Faculties: Dr. Anil Seth, Dr. Manindra Agrawal, Dr. Nitin Saxena, Dr. Piyush Kurur, Dr. Raghunath Tewari, Dr. Rajat Mittal, Dr. Satyadev Nandakumar, Dr. Somnath Biswas, Dr. Sumit Ganguly, Dr. Sunil Simon  
The department continues to be one of the best places to engage in cutting edge research in all areas of complexity theory, logic, game theory etc. Our graduate students and alumni have performed marvelously at arriving at path-breaking results on the very fundamentals of computer science.

Thrust areas in the department include streaming algorithms (Prof. Sumit Ganguly), information theory (Prof. Satyadev Nandakumar), quantum algorithms and cryptography (Prof. Piyush Kurur and Prof. Rajat Mittal), game theory (Prof. Sunil Simon), logic (Prof. Anil Seth) and computational complexity theory (Prof. Somnath Biswas, Prof. Manindra Agrawal, Prof. Nitin Saxena, Prof. Raghunath Tewari).





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