Department of Computer Science & Engineering

Indian Institute of Technology Kharagpur, India

# DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

## INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

The Department of Computer Science & Engineering was initiated in 1980 and the first B. Tech. batch graduated in 1982. Apart from being the department producing the first batch of graduates in Computer Science and Engineering amongst the Indian Institutes of Technology, this is one of the most reputed centres for Computer Science education and research in the country.

The hallmarks of the Department are in the breadth of its academic curricula and diversity in fundamental research and industrial collaborations. Collaborative research is ongoing with researchers in internationally acclaimed universities and research institutions abroad and in India. The Department has long-term funded research projects from leading multinational companies such as Intel, National Semiconductors, Microsoft, General Motors, Synopsys, Sun Microsystems and Texas Instruments. The alumni of this Department are well established all over the globe – achieving excellence in industry, academics and research, holding positions of rare distinction in leading industries and academic institutions of the world.

The Department offers the following degree programmes:

### B.Tech. in Computer Sc. & Engg.
An exciting blend of Computer Science and Computer Engineering with equal emphasis on software, hardware, systems and theory.

### M.Tech. in Computer Sc. & Engg.
This is a 24-months time-bound programme including two semesters of course work and an opportunity to work on a research project and thesis for a full year.

### B.Tech. + M.Tech. Dual Degree in Computer Sc. & Engg.
Both degrees are offered at the end of the fifth year with exciting opportunities to work on research problems over two years.

### MS (Research) in Comp. Sc. & Engg.
This two-year programme gives the opportunity to only those working in funded research projects or consultancy projects, and for institute staff members to work towards a master's research degree.

### PhD in Computer Sc. & Engg.
The Department and the Institute offer numerous high value fellowships for deserving doctoral candidates.

## THRUST AREAS

In order to meet challenges of rapid strides in technology and the diversity of emerging career opportunities, the Department has identified these thrust areas of research and development:

Algorithms and Complexity
Artificial Intelligence and NLP
Distributed Computing
Embedded Systems
Multimedia Systems
Cryptography and Information Security
Software and Systems Engineering
VLSI Design, Verification and Test
Sensor Networks

The Department has demonstrated considerable strengths in areas such as digital geometry, computational topology, computational and combinatorial geometry, and algorithm design and analysis. Collaborative research of combinatorial flavour has been conducted with TIFR Mumbai on hypergraph theory, and with RRI Bangalore on multipartite quantum entanglement. Research on graph and geometric algorithms is ongoing in collaboration with TIFR Mumbai, Carleton University, ISI kolkata and other reputed universities. The Department has major contributions in the design of efficient algorithms for curve and surface reconstruction, K-sets, robust geometric computations, regions visible by multiple reflections, diffuse reflection paths, hypertree coding, etc.

Areas of established strength in Artificial Intelligence include heuristic search, deduction, machine learning, and combinatorial optimization. Recent focus includes ambient intelligence, natural language processing, emotion recognition and formal verification.

Distributed computing is an area of emerging strength in the Department. Research facilities include the Microsoft Lab and a Beowulf cluster of workstations.

Studies on average latency for scalable and large scale WAN downloads for streaming data have been done by developing of the notion of "virtual web caching".

The Department has played a pivotal role in developing and deploying the technology behind one of the largest telemedicine networks in the country. The Department also has considerable strength in medical imaging, digital image processing, medical informatics and multimedia databases.

The Department has gained national level leadership on R&D on assistive learning for the physically challenged.

Cryptography and information security are areas of emerging focus in the Department. The Department has facilitated the inception of a Centre of Excellence in Security Research in the Institute with support from the Ministry of Defence.

Software Engineering research has been a traditional area of strength in the Department. Systems related areas of strength include databases, networks and embedded systems applications.

The Department is one of the world leaders in developing technology for VLSI CAD. Areas of strength include CAD for design verification and test. The Department has industrial collaborations in these areas with leading chip design and EDA companies.

# TECHNOLOGY DEVELOPMENT

This Section highlights some of the major areas of R&D in the Department.

## VLSI DESIGN, VERIFICATION, TEST

The Department is recognized world-wide for its strengths in the area of VLSI design. Areas of strength include:

VLSI chip design
CAD for design, testing and verification
Low-power VLSI circuit synthesis
System-on-chip testing

Using the resources and the fabrication support received through the Advanced VLSI Design Laboratory at IIT Kharagpur, the Department has successfully designed and taped out several VLSI chips.

The Department has significant strength in Low Power Design, CAD for timing and power analysis, Design for Testability, Built-in Self Test and SOC Testing.

The Formal Verification research group is a prominent research group in its area in the world. Verification is a major problem in all types of engineering design. The formal verification research group focuses on providing industrially relevant formal methods for the verification of various designs – ranging from digital and mixed-signal chip designs to complex software and embedded systems such as automotive control systems. Areas of strength include:

Design Intent Verification
Formal Verification Coverage
Formal Specification Refinement

Mixed-signal Design Verification
Coverage-driven Semi-Formal Verification
Verification of UML models

Research conducted by this group has been recognized world-wide in terms of research publications, and transfer of technology by industry partners.

**Research partners and sponsors**:
Intel, Synopsys, General Motors, National Semiconductors, Sun Microsystems, Interra Systems, Dept. of Sc & Tech: Govt. of India.

**Home:** [http://www.facweb.iitkgp.ernet.in/~pallab/forverif.html](http://www.facweb.iitkgp.ernet.in/~pallab/forverif.html)

## INTELLIGENT INTERFACES

Research in this area concentrates on the development of natural and versatile interfaces that enable a large segment of users to access the benefits of computers. Systems being developed include access mechanisms and communication tools for the physically challenged as well as systems with natural language and speech interfaces. The *Communication Empowerment Laboratory*, germinated from the above research, also works towards the development of adaptive tutoring systems. Major products resulting from this research include:

*Sparsha* -  An Educational Toolset for the blind

*Sanyog*  - An Iconic Communication System for the Children with Cerebral Palsy and Speech Impairment  (Winner of the Da-Vinci Award)

*Shruti* – A Text to Speech System for Bengali and Hindi

The NLP research group has been working on various aspects of language processing, especially various technologies for the processing of Indian languages. National level projects on Indian language machine translation and cross-language information access are being executed.

Beside the large number of quality publications in international journals and conferences, and several PhD and MS students produced, a salient outcome of these activities is real products that are deployed and are being used by several organizations. The PhD and MS students have joined leading companies.

**Research partners and sponsors**:
Media Lab Asia, Microsoft Research, Texas Instruments, Indian Institute of Cerebral Palsy, Ministry of Comm. and Information Tech, Ministry of Social Justice and Empowerment.

Home:   http://www.cel.iitkgp.ernet.in

A company, Minekey Inc., founded by an alumni of IIT Kharagpur has been incubated with the participation of some students and faculty of IIT Kharagpur. Minekey provides a recommendation service that lets online publishers deliver highly personalized content recommendations to their target audience.

Home: http://www.minekey.com

## TELEMEDICINE

The Telemedicine Laboratory in the Department has been a premier centre for Telemedicine research in India for the last several years. Sponsored by the Ministry of Information Technology, Govt. of India and WEBEL ECS, Kolkata, the research programs undertaken in this laboratory

have led to the development of the ***TelemediK*** software which is currently being used in more than 20 hospitals in the states of West Bengal and Tripura. This project has received a number of National awards and has been recognized as one of the best eGovernance related activities by the Government of India.

Recently a Linux based telemedicine solution named ***TelemediX,*** which can be accessed from any operating system using Java compatible web browsers, has been developed. Current efforts are focused on the development of a secure multi-tier inter-operable e-healthcare solution that will be accessible over the Internet. Other emerging R&D efforts include:

Development of tools and technologies for medical data access over handheld devices

Medical instrumentation

Transmission and visualization of medical data over wireless media

The Telemedicine Laboratory works in close coordination with the School of Medical Science and Technology and the G. S. Sanyal School of Telecommunication at IIT Kharagpur.

**Home:**   www.telemedik.iitkgp.ernet.in

## STUDENT ACTIVITIES

The students of the Department actively participate in the R&D activities in the Department and in numerous design, programming and project contests. The students also organize an annual online programming contest called **Bitwise**, which has become a recognized and well contested international event with significant industrial sponsorship and a few hundred teams contesting each year from across the globe.

## FACULTY

**Anupam Basu,** Ph.D (IIT Kharagpur)
*Speech and Language Processing, Embedded Systems, Assistive Technology*

**Partha Bhowmick,** Ph.D (ISI Kolkata)
*Digital Geometry, Image Processing, Approximate Pattern Matching, Biometrics, Shape Analysis*

**Goutam Biswas**
*Theoretical Computer Science, Compilers*

**Partha Pratim Chakrabarti,** Ph.D (IIT Kharagpur)
*Artificial Intelligence, CAD for VLSI, Algorithms, Formal Verification*

**Rajat Subhra Chakraborty,** Ph.D. (Case Western Reserve University, Cleveland, USA)
*Hardware Security, VLSI Design*

**Abhijit Das,** Ph.D (IISc Bangalore)
*Cryptography & Network Security, Algebraic & Number Theoretic Computation*

**Pallab Dasgupta,** Ph.D (IIT Kharagpur)
*Formal Verification, CAD for VLSI, Artificial Intelligence*

**Partha Sarathi Dey,** M.Tech (IIT Kharagpur)
*Digital Logic Design, Data Structures, Computer Org. & Arch.*

**Niloy Ganguly,** Ph.D (BESU, Calcutta)
*Peer-to-peer Networks, Complex Network Theory, Social Network Modelling*

**Sujoy Ghose,** Ph.D (IIT Kharagpur)
*Networks, Algorithms, Artificial Intelligence, Information Systems*

**Arobinda Gupta,** Ph.D (Univ. of Iowa)
*Distributed Systems, Fault Tolerance, Adaptive Systems*

**Gaurav Harit,** Ph.D (IIT Delhi)
*Document Image Analysis, Video Analysis, Pattern Recognition.*

**Rajeev Kumar,** Ph.D (Univ of Sheffield)
*Programming Language & Software Engineering, Evolutionary Algorithms and Combinatorial Optimization, Multimedia & Embedded Systems*

**Arun Kumar Majumder,** Ph.D (Univ. of Calcutta), Ph.D (Univ. of Florida)
*Data and Knowledge based Systems, Information Security, Medical Informatics, Design Automation*

**Rajib Mall,** Ph.D (IISc Bangalore)
*Software Engineering, Real-Time Systems*

**Chitta Ranjan Mandal,** Ph.D (IIT Kharagpur)
*Digital System Synthesis, Internet Technologies, VLSI, System Verification*

**Pabitra Mitra,** Ph.D (ISI Kolkata)
*Machine Learning, Data Mining, Artificial Intelligence*

**Debdeep Mukhopadhyay,** Ph.D (IIT Kharagpur)
*Cryptography, VLSI, Cellular Automata*

**Jayanta Mukhopadhyay,** Ph.D (IIT Kharagpur)
*Image Processing, Computer Vision, Pattern Recognition, Medical Informatics*

**Ajit Pal,** Ph.D (Univ. of Calcutta)
*Low-power VLSI Design, Embedded Systems, Networking*

**Sudebkumar Prasant Pal,** Ph.D (IISc Bangalore)
*Design and Analysis of Algorithms, Computational and Combinatorial Geometry, Quantum Information Processing.*

**Dipanwita Roy Choudhury,** Ph.D (IIT Kharagpur)
*Cellular Automata, VLSI Design and Test, Cryptography and Network Security*

**Dipankar Sarkar,** Ph.D (IIT Kharagpur)
*Formal Verification, Symbolic Logic and Automated Reasoning*

**Sudeshna Sarkar,** Ph.D (IIT Kharagpur)
*Artificial Intelligence, Machine Learning, Information Retrieval, Natural Language Processing*

**Indranil Sengupta,** Ph.D (Univ. of Calcutta)
*VLSI Design and Test, Cryptography and Network Security, Mobile Computing*

## Contact:

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