Global Initiative of Academic Networks (GIAN) Programme

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GLOBAL INITIATIVE OF ACADEMIC NETWORKS

Ministry of Education
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भारतीय प्रौद्योगिकी संस्थान
भारतीय खनि विद्यापीठ
धनबाद

IIT INDIAN INSTITUTE OF TECHNOLOGY INDIAN SCHOOL OF MINES ISM DHANBAD

Legacy that Inspires the Future

Course ID: 2700047

Ref. No.: GIAN/S-24-25/242_rev_1 Dated: 16-01-2025

One Week GIAN Course On (in-virtual mode)

Memristor and its Applications in Neuromorphic Computations

Last Date for Registration June 16, 2025

IIT(ISM) Dhanbad (Virtual Mode)

June 23 – 27, 2025

Foreign Faculty: Prof. Sung-Mo Steve Kang

Name: Prof. Sung-Mo Steve Kang
Designation: Distinguished Professor Emeritus
Department: Electrical and Computer Engineering
University/Institute: Baskin School of Engineering, Santa Cruz, California
Email: skang@ucsc.edu
Mobile: (831) 706-5456

Sung-Mo Steve Kang is a Distinguished Chair Professor Emeritus of Engineering and Research Professor at the University of California, Santa Cruz. Briefly summarizing his background, he obtained his PhD from the University of California, Berkeley in 1975. He has worked over two decades at Rutgers University, AT&T Bell Laboratories at Murray Hill in NJ, and the University of Illinois at Urbana Champaign, before joining the University of California, Santa Cruz in 2001 as Dean of the School of Engineering. He has taken leaves of absence from UC Santa Cruz to become the President of the Korea Institute for Advanced Science and Technology (KAIST) from 2013 to 2017, and the Chancellor of the Nanomanufacturing Systems Center (NASCENT) University of California, Merced from 2007 to 2011. Throughout the career, his research interests centered on high-performance low power very large-scale integration (VLSI) circuits, computer-aided design (CAD) of such circuits, memristors, memristive devices, and their applications to neuromorphic computing. His work on these subjects has been published in over 600 peer-reviewed publications and major conference proceedings. Together, these works have been cited nearly 21,000 times by others in the computer science and electrical engineering. More recently, He has put much effort into memristor-technology-based neuromorphic circuits and systems to achieve higher energy efficiency while delivering higher throughput. This effort can be categorized as AI acceleration. In recognition of this work, he has received the best paper awards for the paper published in IEEE Trans. on Circuits and Systems I and also for the IEEE AICAS conference..

National Faculty & Course Coordinator: Prof. Rajeev Kumar Ranjan

Name: Prof. Rajeev Kumar Ranjan
Designation: Associate Professor
Department: Department of Electronics Engineering
University/Institute: Indian Institute of Technology(Indian School of Mines) Dhanbad
Email: rajeev@iitism.ac.in
Phone: (+91) 9471191517

Rajeev Kumar Ranjan completed his Ph.D. at the Indian Institute of Technology (Indian School of Mines Dhanbad). He worked as a Project Scientist at CSIR-CEERI, Pilani, Rajasthan from July 2004 – Aug 2005. He has also served as an assistant professor in the Department of Electronics and Communication Engineering, Sant Longowal Institute of Engineering and Technology, Longowal, Punjab, India (MHRD Funded Deemed University) from Aug 2007 - Nov 2010 before joining the Indian Institute of Technology (Indian School of Mines), Dhanbad, Jharkhand as a faculty in 2010. He is an associate professor with the Department of Electronics Engineering, IIT (ISM) Dhanbad. **Prof. Rajeev Kumar Ranjan has figured in the world's top 2% of scientists 2023 list compiled by Stanford University, US.** He is a passionate teacher as well as a researcher and holds more than 60 publications in reputed journals including IEEE Transactions on Circuits and Systems I, IEEE Transactions on Circuit and Systems II, IEEE Transactions on Nanotechnology, and IEEE Transactions on Very Large Scale Integration System. His research lab is primarily funded by the Ministry of Electronics and Information Technology, Govt. of India under the Chip to Startup Programme. Dr. Rajeev's current research work combines memristors for neuromorphic computing to understand the crosspoint arrays in object recognition and other learning applications.

Organized by
Indian Institute of Technology (Indian School of Mines)
Dhanbad-826004 Jharkhand, INDIA
https://www.iitism.ac.in

Course Overview:

One Week GIAN Course On (in-virtual mode)
Memristor and its Applications in Neuromorphic Computations
June 23–27, 2025

This course delves into the revolutionary concept of memristors, their underlying principles, and their transformative role in the field of neuromorphic computations. Memristors, or memory resistors, are two-terminal nanoelectronic devices capable of retaining memory states based on their resistance, making them a cornerstone in the design of energy-efficient, brain-inspired computing systems.

The course begins by exploring the theoretical foundation and historical evolution of memristors, discussing their properties, fabrication techniques, and electrical characteristics. Participants will gain an understanding of how memristors emulate synaptic behavior, providing a bridge between conventional silicon-based technologies and brain-like computation.

Key topics include:

1) Introduction to nano-scaled technology: Fundamentals of Nano-Scaled MOS Devices and Circuits.

2) Introduction to Memristors: Fundamentals of memristive systems, mathematical modeling, and comparison with other passive electronic components.

3) Technology Impact: Future perspectives of memristive devices.

4) Fabrication Techniques : Fabrication techniques involved in the development of memristors, including challenges and advancements in nanoscale manufacturing.

5) Memristor-Based Circuits and Architectures: Integration of memristors into circuits, hybrid CMOS-memristor designs, and their role in memory, logic, and reconfigurable systems.

6) Neuromorphic Computation Fundamentals: Introduction to brain-inspired computing, the role of memristors in replicating neural networks, and their advantages over traditional von Neumann architectures.

7) Synaptic Behavior and Learning Mechanisms: Implementation of synaptic plasticity, long-term potentiation (LTP), and depression (LTD) using memristors, enabling real-time learning and adaptation.

8) Applications in Artificial Intelligence and Machine Learning: Memristor-based accelerators for AI workloads, edge computing, and energy-efficient training of neural networks.

9) Emerging Trends and Future Directions: Exploration of open research areas, challenges in large-scale adoption, and the potential for memristor-enabled technologies to revolutionize computing paradigms.

This workshop will incorporate tutorial sessions, case studies, and real-world examples to provide a holistic understanding of how memristors are poised to transform neuromorphic computing. By the end of the course, participants will acquire foundational knowledge and practical insights into designing and applying memristor-based systems in AI, robotics, IoT, and beyond.

Designed for students, researchers, and professionals, this course bridges the gap between theoretical knowledge and practical applications, equipping participants to contribute to the evolving landscape of brain-inspired technologies.

Objectives:

Semiconductor Design Technologies have gained immense popularity in the research community. The objective of this one week GIAN course is to provide research aspects and solutions to the various problems related to the Design, Simulation, and Fabrication of IC's in Analog VLSI domain.

- Focus on emerging concepts of Analog VLSI Design, Simulation, and Fabrication.
- To provide a comprehensive overview of the fundamental concepts.
- To expand the in-depth knowledge of participants.
- To generate more open problems for research in related areas.

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Schedule

One Week GIAN Course On (in-virtual mode)
Memristor and its Applications in Neuromorphic Computations

June 23–27, 2025

There are following lectures and tutorials mentioned below will be covered (sixty percent of the course schedule) by foreign faculty expert Prof. Sung-Mo Steve Kang, Santa Cruz, California, USA and rest of the course will be covered by IIT and Industry experts.

Day-1	Inaugural Function	
	Lecture-1	High-performance and low power very large-scale integration (VLSI) circuits.
	Lecture-2	Fundamentals of Nano-Scaled MOS Devices and Circuits.
	Lecture-3	Future perspectives of memristive devices.
Day-2	Lecture-4,	Fundamentals of memristors and memristive devices.
	Lecture-5	
	Lecture-6	Memristor emulator circuit design and its applications.
	Tutorial-1	Derivation of theoretical concept of memristor emulator circuits.
Day-3	Lecture-7	Fundamentals on Neuromorphic computations.
	Lecture-8	
	Tutorial-2	CMOS Design and Process Development.
Day-4	Lecture-9	Memristor integration with Memristive device.
	Lecture-10	
	Tutorial-3	SoC Issues and Challenges.
Day-5	Lecture-11	Memristive Devices and Their Applications in Neuromorphic Computing.
	Lecture-12	
	Test	Online test MCQ based of 60 min duration.

Who can attend?

- Executives, engineers, scientists and researchers from Electronics Engineering, VLSI, Electrical Engineering, Computer Sciences, and service and government organizations including R&D laboratories.
- Students at all levels (B.Tech/M.Sc./M.Sc. Tech/M.Tech/PhD) or faculty from reputed academic institutions and technical institutions.

About the Dept. of Electronics Engineering

Department of Electronics Engineering initiated as a supporting department to ISM Dhanbad in 1976, the Department of Electronics Engineering incepted into a separate faculty department since 1998, offering B. Tech in Electronics and Communication Engineering to students admitted through IIT JEE. Strengthened with highly qualified faculty experts and in-housed with well-equipped state-of-the-art laboratories, ample computing resources and several research and development projects, the department has established itself in significantly contributing towards academics, research and building of brilliant careers for students. With a well-designed and constantly reviewed syllabus, in addition to the undergraduate program, the department offers a Master of Technology (M.Tech) in Electronics and Communication Engineering and runs a Ph.D. program in various fields of electronics engineering. Ongoing research projects include topics such as modeling of semiconductor nanostructured devices and fabrication of low-power analog IC's using memristor based neuromorphic architectures.
The department also hosts the Society of Electronics Engineers, which provides a platform for students to engage in extracurricular activities and stay updated with the latest developments in the field.

Important

- ❖ Participants for the course will be selected on first come first served basis.
- ❖ All the participants will be provided course certificates.

In case of any query, contact:
Mr. Tarun Kumar Sharma
Phone: +91-9504528026

Course Coordinator

Prof. Rajeev Kumar Ranjan
Associate Professor, Department of Electronics Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad-826004, INDIA.
Phone: +91-9471191517 **Email**: rajeev@iitism.ac.in

Local GIAN Coordinator

Prof. Sukha Ranjan Samadder
Associate Dean (Research & Development), Indian Institute of Technology (Indian School of Mines), Dhanbad-826004, INDIA.
Email: adrnd@iitism.ac.in

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About IIT(ISM) Dhanbad

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The Indian Institute of Technology (Indian School of Mines), Dhanbad, spans an expansive 393-acre campus in the heart of India's prime coking coal belt, about 260 km from Kolkata. Established on December 9, 1926, by Lord Irwin, the then Viceroy of India, the institution was founded to address the need for skilled professionals in mining and related fields, with a focus on disciplines such as Mining and Applied Geology. In 1967, the Indian School of Mines (ISM) gained the status of a deemed university under Section 3 of the UGC Act, 1956. Over the years, it expanded its academic scope to include core engineering disciplines, becoming a comprehensive institution of global repute for engineering, science, and management education. On September 6, 2016, the Government of India elevated ISM to the status of an Indian Institute of Technology (IIT), renaming it the Indian Institute of Technology (Indian School of Mines), Dhanbad. A fully residential campus with world-class facilities, IIT(ISM) Dhanbad offers a diverse range of academic programs. These include B.Tech. (4 years) courses across 12 major engineering disciplines, integrated M.Tech. (5 years) programs in Applied Geology, Applied Geophysics, and Mathematics & Computing, as well as M.Tech., M.Sc., M.Sc. Tech, MBA, and Ph.D. programs. The institute has made significant contributions to India's growth in mining, mineral exploration, petroleum, and groundwater sectors, solidifying its position as a premier technological institute.

Course Fee

S. No.	Category	Amount (including GST)
1.	Students B.Tech., B.A., B.Sc., M.Tech., M.A., M.Sc., Integrated M.Sc., M.Sc. (Tech.)	₹ 500/-
2.	Research Scholars, Post doctoral Fellows	
3.	Faculty and Teachers from Academic Institutions (Public and Private)	
4.	Participants from industry/Research organizations (Public and Private)	
5.	Students (Foreign)	
6.	Industry Sponsors	

Bank Details

Name of Bank: Canara Bank

Account Name: IIT ISM PROJECT AC

Account No.: 0986101009746

IFSC Code: CNRB0000986

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SCAN

31012626009746@cnrb

- **Last date for registration is 16th June 2025.**
- **All participant must fill Google Form for registration:**

Google Form Link:
https://docs.google.com/forms/d/1P1vwU6-M81sil2FuGTVsQo6gd_sQDLQ0EWkW6-fOOgo/edit