"ABC of Magnetic Data Storage: Backbone of the virtual world"

1st March to 5th March, 2025

Department of Physics, Motilal Nehru National Institute of Technology-Allahabad, Prayagraj, Uttar Pradesh-211004 (India)

1.0 Overview

Magnetic recording was invented by Valdemar Poulsen in the late 19th century. It took about 30 years after the magnetic tapes were commercialized. They were good for archival or sound recording, but they did not possess random access capability, and hence access times were longer compared to other forms of recording available during that period, such as punch cards. To overcome this issue, IBM invented first hard disk drive (HDD) which combined advantages of magnetic recording (multiple read/erase cycles) with random access capability, and suitably named it RAMAC (random access memory accounting system) or random-access method.

You will be surprised to know that the RAMAC (introduced in 1956) had a capacity of 5 MB, which was achieved using 50 magnetic disks with a diameter of 24 inch—each offering an areal density of 2 kilobits per square inch (kb/in^2). Since then, HDD technology have come a long way and one of the giant players, Western Digital's 22 TB HDD announced this year uses 10 disks with a diameter of 3.5 inch., each offering an areal density of over 1000 gigabits per square inch ($Gb/in.^2$) as of 2023. Such remarkable improvement has been possible due to the continuous advancement in nanomaterial fabrication as well as the discovery of quantum spin-based transport phenomena. The course attendees will learn through lectures; followed by hands-on training and tutorials on this essential field of magnetic data storage. The course will also provide an ample opportunity for the participants to interact with the experts throughout the course and explore career opportunities.

The foreign faculty Assoc. Prof. S. N. Piramanayagam from Nanyang Technological University, Singapore will deliver this course. He has been honoured with the prestigious IEEE Magnetics Society Distinguished Lecturers 2024 award for technical knowledge, experience, and ability in teaching, consultancy, research, and training in the field of spintronics, magnetic recording materials, and neuromorphic computing applications. The course is planned and offered as per the norms set by GIAN and Motilal Nehru National Institute of Technology Allahabad, Prayagraj (India).

2.0 Objectives

The objectives of the course are as follows:

i) Imparting a-to-z knowledge of basic components, material requirements and different sections of data storage system/devices.
ii) Exposing participants to the developments of magnetic storage media materials and the future roadmap.
iii) Providing in-depth understanding of the material aspect of magnetic storage devices and recent advancements in writing/reading technologies.
iv) Familier with the diversity in alternative storage systems used in Cloud computing, Data centres, Mobile phones and Space shuttles, Virtual platforms etc.

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Programme Schedule

Dates	March 01 to March 05, 2025	
Location	The course will be conducted via OFFLINE mode at Motilal Nehru National Institute of Technology (MNNIT) Allahabad, Prayagraj-211004, U.P. (India).	
Course Schedule	Day 1: March 01, 2025	**Inauguration: 9.00 AM-9.30 AM** (Physics of Magnetism and related effects) **Lecture 1: 1.5 hrs** Physics of Magnetism and related effects. **Lecture 2: 1.5 hrs** Introduction of Recording Media: Fundamentals, Longitudinal Recording Media, Measurement performance, Noise. **Tutorial 1 : 2 hrs** Problem Solving session, Practical Demonstration and and Continuous Improvement".
	Day 2: March 02, 2025	(Material Physics of Synthesis and Characterization) **Lecture 3: 1.5 hrs** Fundamentals of Magnetism, Deposition of magnetic thin film materials, Magnetization Process. **Lecture 4: 1.5 hrs** Nanostructuring, Deposition systems for magnetic nanomaterial synthesis, Advanced material characterizations. **Tutorial 2: 2 hrs** Demonstration on the growth and characterizations of various nanostructures, thin films used in recording media. **Tutorial 3: 2 hrs** Hand-on practice and demonstration of magnetic measurement system.
	Day 3: March 03, 2025	(Introduction to Advanced Recording Media) **Lecture 5: 1.5 hrs** Perpendicular recording media, Fabrication technique, function of multilayers, Noise issues, Basics of Read/Write heads. **Lecture 6: 1.5 hrs** Magnetoresistive Read Heads: Structure and Fundamentals, Evolution in Design and Functionality. **Tutorial 4 : 2 hrs** Heat Assisted and Heated Dot Recording media, Future roadmap, group discussion.
	Day 4: March 04, 2025	(Spin Transport Technologies) **Lecture 7: 1.5 hrs** Spin Transport Technologies, Detection of spin current generation, Applications of spin based devices. **Lecture 8: 1.5 hrs** Magnetic Random Access Memories (MRAM) based on spintronics, Spin transfter torque-MRAM. **Tutorial 5: 2 hrs** Problem solving session with examples: Anisotropic magnetoresistance, Types of magnetic sensors based on Hall effect, Spin Hall effct and Magnetoresistance. **Tutorial 6: 2 hrs** Hand-on practice, Assignments and demonstration of Micromagnetic Simulations Tools.

	Day 5: March 05, 2025	(Alternative Magnetic Memories) **Lecture 9: 1.5 hrs** Thin-film media lubricants, Characterizations and advanced testing of HDD, Overcoat materials for recording media. **Lecture 10: 1.5 hrs** Introduction to Skyrmion & Racetrack memories. **Tutorial 7: 2 hrs** Magnetism for emerging computing technologies – Neuromorphic computing etc. **Feedback Session & Certificate Distribution**
Who can attend?	• Physicists, scientists, engineers, and researchers involved with development of nanomagnetic/magnetic/functional materials required in data storage media and are interested to explore the related fundamentals. • Student at all levels (B.Sc/B. Tech./M. Sc./M. Tech./Ph. D.) or Faculty from academic and technical institutions.	
Attendance and Evaluation	• Minimum 90% attendance is necessary for certificate of participation. • Appearing for evaluations/examinations during the course is necessary for certificate of grades in the course. • Regular assignments and quizzes will be conducted.	

Registration	**Last Date of Registration: 31st January 2025**
Course Fee	**First Step:** Fill the Google Form and register for course entitled "ABC of Magnetic Data Storage: Backbone of the Virtual World". **Second Step:** Pay the participation fees for attending the course as follows in the bank account "SNFCE MNNIT Allahabad" • Uplaod the copy of Transaction Receipt in the google form and email the same copy to sgupta@mnnit.ac.in • The above fees include only instructional materials, assignments (if any) and free internet facility. Participants are encouarged to bring their own laptop. • Meal and accommodation (in-campus) can be provided on payment basis. The accommodation will be subject to availability and on 'first come first serve' basis.
Bank Account Details	**Account Name**: SNFCE MNNIT Allahabad **Account No**.: 10424975574 **Bank Name**: State Bank of India (SBI) **Branch**: MNNIT Allahabad, Prayagraj-211004, Uttar Pradesh, India. **IFSC Code**: SBIN0002580

Participants from abroad	USD ($) 200/- + 18% GST
Industry/Research Organization	INR(Rs) 5000/- + 18% GST
Academic Institutions (Faculty Members)	INR(Rs) 3000/- + 18% GST
Academic Institutions (Students/Research Scholars)	INR (Rs) 1000/- + 18% GST

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International Expert

Dr. S. N. Piramanayagam is an Associate Professor in Division of Physics and Applied Physics, School of Physical and Mathematical Science, Nanyang Technological University, Singapore. He is experimental physicst and technological leader with 30+ years of experience in magnetic materials, magnetic recording media, spintronics, nanostructures fabriction and neuromorphic computing applications. He focuses on technologies transfer in form of advanced products that can benefit the people. He has published more than 200 research papers in journals of international repute and has filed several patent applications. He serves as an editor of IEEE Transactions on Magnetics and as editor-in-chief of Nano (World Scientific).

Host Faculty

Principal Course Coordinator

Dr. Surbhi Gupta is Assistant Professor in Department of Physics, Motilal Nehru National Institute of Technology-Allahabad, Prayagraj. Her major research fields include Spin-transport behavior, magneto-dynamics studies, ferroelectric photovoltaics and multiferroics. She completed her Ph.D in condense matter physics from Department of Physics and Astrophysics, University of Delhi. Before joining as faculty in MNNIT, she worked as post-doc in different institutes including University of Puerto Rico, USA, Kyushu Institute of Technology, Japan and Nanyang Technological University, Singapore. She has published around 50 research papers in journals of international repute and served as Guest Editor in Applied Surface Sciece Advances (Elsevier).

Course Coordinator

Dr. Naresh Kumar is Full Professor in Department of Physics, MNNIT Allahabad, Prayagraj. He obtained his Ph. D. in Physics from IIT Bombay. Dr. Kumar had been Brain Korea Post-Doctoral Fellow at Inha University Incheon South Korea, Visiting scientist Centre INRS-EMT(Énergie, Matériaux, Télécommunications) Varennes (Québec Canada). Dr. Kumar has an interest in functional oxide nano materials, magnetic and multiferroic materials and understanding of their Physical (structural, electrical, magnetic and optical) properties. He has published more than 80 research papers in journals of international repute and organised several international/national conferences in India.

Contact Details

Principal Course Coordinator	Course Coordinator	Local GIAN Coordinator
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