

PHY 624: Magnetism in Materials (2025-26-II)

Instructor: Dr. Anjan K. Gupta (off: SL217F, email: anjankg@iitk.ac.in, Ph. 7549)

Time Table: MW 17:15 – 18:30 (each slot is equivalent to 1.5 lectures), **Venue:** TBA

Office Hour: On appointment (by email)

Course Web page: TBA

Detailed description (40 Lectures):

This is a first course in magnetism in order to provide a detailed background to an undergraduate/graduate student in order to understand the state-of-the-art research in this area. A background in electromagnetism (at Phy103 level) and quantum mechanics (at Phy431/PSO201 level) is required and some exposure to thermal/statistical/condensed-matter physics is desirable. A special emphasis will be given to the nano-magnetism as it a focus of current research of many researchers.

S. No.	Topic	Lects.
1	Introduction: review of magneto-statics; magnetic moments and angular momentum; Bohr-van Leeuwen theorem; quantum mechanics of spin; Bohr magneton; classical mechanics of magnetic moments;	6
2	Physics of isolated magnetic moments: Diamagnetism and para-magnetism; Adiabatic demagnetization, nuclear spins, hyperfine structure	5
3	Crystal fields and Magnetic resonance techniques	5
4	Interactions: Dipolar and exchange interactions	3
5	Magnetic Ordering: Ferromagnetism; Antiferromagnetism; Ferrimagnetism; Spin glasses and other random orders; Nuclear ordering; Measurements of magnetic ordering	5
6	Models of magnetic ordering: Landau theory; Heisenberg and Ising Hamiltonians; Weiss model; Symmetry breaking and phase transitions; Excitations; Domain structure and magneto-crystalline anisotropy;	6
7	(Ferro-)Magnetism in low dimensional systems: nano-particle magnetism; one- and two-dimensional magnets; spin waves and magnonics	10

Recommended books:

- 1) "Magnetism in Condensed Matter" by Stephen Blundell, Oxford 2001.
- 2) "Introduction to magnetic materials" by Cullity and Graham, Willey 2009.
- 3) "The theory of Magnetism made Simple" by Daniel C. Mattis, World Scientific 2006.
- 4) "Introduction to the theory of Ferromagnetism", A. Aharoni, Oxford, 1996.

Grading: (out of 250)

Home-Works + Attendance: 50

Mid-Sem: 40 (1 hour)

End-Sem: 120

Term paper: 40