I	Course Code	PH 227001
II	Course Title	Advanced Magnetic Materials and Applications
III	Credits	L T P C 3 1 0 4
IV	Prerequisites (if any)	A first course on modern physics and electromagnetics
V	Course Coordinator	Brajesh Tiwari
VI	Learning Outcome	After completion of the course students are expected to have learned the fundamentals of magnetism and processes governing the physical properties of magnetic materials. Various magnetic measurement techniques and their functioning are essential part of the course. Students will also learn different applications of advanced magnetic materials based on their applications. From this course student can gain working knowledge of magnetism and various applications of magnetic materials.
VII	Course Contents	I. Basics of Magnetism: Para and diamagnetism, metals and insulators, spin and orbital contributions, paramagnetism of 3d and 4f ions. Magnetic measurements: Faraday balance, Vibrating sample magnetometer (VSM), Superconducting Quantum Interferometer Devise (SQUID) magnetometer II. Various forms of interactions: Direct exchange, superexchange, double exchange, RKKY interaction, dipolar interaction, Dzyaloshinskii-Moriya interaction III. Magnetic Ordering: Ferromagnetism, antiferromagnetism, ferrimagnetism: Curie-Weiss Law, Mean field theory, excitations from quantum states, spin waves/ magnons $\frac{\nabla M}{M(0)} \sim T^{3/2}$, Bloch $T^{3/2}$ Law IV. Different form of magnetic energy: Dipolar, demagnetization, magnetostatic, magnetocrystalline anisotropy, space anisotropy. Zeeman and exchange energy. Magnetostriction. Domain and domain walls, magnetic hysteresis. Superparamagnetism, Magnetoelectric coupling and multiferroics. V. Magnetoresistance: Spin dependent scattering/conduction. AMR, GMR CMR, TMR in multilayers/ thin films. Basics of magnetic recording, Spin valves, spin polarized transport/spintronics, spin Hall effect, magnetic skyrmions
VIII	Text books/ References	1. S. Blundell, Magnetism in Condensed Matter, Oxford University Press (2001) 2. B. D. Cullity and C. D. Graham, Introduction to Magnetic Materials, 2nd Edition, Wiley (2009) 3. J. M. D. Coey, Magnetism and Magnetic Materials, Cambridge (2010) 4. Nicola A. Spaldin, Magnetic Materials: Fundamentals and Applications, Cambridge 2nd edition (2011) 5. David Jiles, Introduction to Magnetism and Magnetic Materials, Chapman and Hall (1991). 6. C. Kittel, Introduction to Solid State Physics, Wiley, 8th edition 2012