Approval: 8th senate meeting

Course Name: Magnetism and Magnetic Materials

Course Number: PH 508

Credits: 3-0-0-3

Prerequisites: PH 301 Quantum Mechanics

Intended for: UG/PG

Distribution: Elective

Semester: Odd/Even

Course Preamble: Magnetism is an open field where engineers, material scientists, physicists and others work together. This course is proposed for undergraduate/postgraduate level students. It starts with the fundamentals of magnetism and proceeds to explain magnetic materials and their applications.

Course Outline: The course will cover a thorough study about different types of magnetism along with the types of magnetic interactions. Also various types of glassy magnetism and magnetism in low dimensions will be covered. A detailed study about novel magnetic materials which are used for technological application will be carried out. Further, the course will introduce various measurement techniques used for measuring magnetization.

Modules:

Introduction [3 Lectures]

History of magnetism, Magnetic units, Classical and quantum mechanical model of magnetic moment of electrons, magnetic properties of free atoms.

Types of magnetism [8 lectures]

Classification of magnetic materials, Theories of Diamagnetism, Paramagnetism, Theories of ordered magnetism, Quantum theory of magnetism: electron-electron interactions, localized electron theory, itinerant electron theory.

Magnetic interactions [5 lectures]

Origin of crystal field, Jahn Teller effect, Magnetic dipolar interaction, Origin of exchange interaction, Direct exchange interactions, Indirect exchange interactions in ionic solid and metals, double and anisotropic exchange interaction.

Magnetic domains [5 Lectures]

Development of domain theory, Block and Neel Wall, Domain wall pinning, Magnons, Bloch's law, Magnetic anisotropy, magnetorestriction.

Competing interactions and low dimensionality [4 lectures]

Frustration, Spin glass, superparamagnetism, one and two dimensional magnets, Thin film and multilayers, Heisenberg and Ising models

Novel magnetic materials [7 lectures]

Colossal and giant magnetoresistive materials, magnetic refrigerant materials, Shape memory alloys, multiferroics, spintronics devices and their application in magnetic storage.

Measurements techniques [8 lectures]

Production and measurement of field, magnetic shielding, Faraday balance, AC susceptometer, Vibration sample magnetometer, torque magnetometer, SQUID magnetometer, Experimental method in low temperature.

Text books:

1. B. D. Cullity and C. D. Graham, Introduction to magnetic materials. John Wily & Sons, Inc, 2011

2. D. Jiles, Introduction to magnetism and magnetic materials. Taylor and Francis, CRC Press 1998.

Reference books:

1. K. H. J. Buschow and F. R. de Boer, Physics of Magnetism and Magnetic Materials. Kluwer Academic Publishers, 2003.
2. Stephen Blundell, Magnetism in Condensed Matter. Oxford University Press (2001).
3. Mathias Getzlaff, Fundamentals of Magnetism, Springer, 2008.