Programme	BS Solid State Physics	Course Code	SSP-309	Credit Hours	3 (2-1)
Course Title	**Introduction to Magnetism**				

Course Introduction

This course provides a comprehensive introduction to the fundamental principles of magnetism, covering the origin of magnetic moments, types of magnetic materials, and the behavior of materials in magnetic fields. The course explores both classical and quantum mechanical aspects of magnetism, with applications to modern technology such as magnetic storage, sensors, and medical imaging.

Learning Outcomes

By the end of this course, students will:

1. Understand the basic concepts of magnetism, including magnetic fields, magnetic moments, and the origins of magnetism.
2. Learn about the different types of magnetic materials and their properties.
3. Explore the quantum mechanical foundation of magnetism and its implications for material behavior.
4. Study the interaction of materials with magnetic fields and the resulting phenomena.
5. Apply the principles of magnetism to real-world technologies and devices.

	Course Content	**Assignments/Readings**
Week 1	**Unit-I** 1.1 Introduction to Magnetism 1.1.1 Historical background and significance of magnetism 1.1.2 Overview of magnetic phenomena and applications 1.1.3 Basic concepts: magnetic fields, magnetic forces, and magnetic moments 1.1.4 Magnetic dipoles and the magnetic dipole moment	What is the significance of magnetism?
Week 2	**Unit-II** 2.1 Magnetic Fields and Their Sources 2.1.1 The Biot-Savart Law and Ampère's Law 2.1.2 Magnetic field due to a current-carrying wire, loop, and solenoid	Review related articles

Week 3	**Unit-III** 3.1 The concept of magnetic flux and Gauss's Law for magnetism 3.1.1 The vector potential and its relationship to the magnetic field	What is magnetic flux?
Week 4	**Unit-IV** 4.1 Types of Magnetic Materials 4.1.1 Classification of magnetic materials: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism 4.1.2 Magnetic susceptibility and permeability	Differentiate types of magnetic materials
Week 5	**Unit-V** 5.1 Temperature dependence of magnetic behavior: Curie and Néel temperatures 5.1.1 Magnetic hysteresis and domains in ferromagnetic materials	What is the hysteresis loop?
Week 6	**Unit-VI** 6.1 The Quantum Mechanics of Magnetism 6.1.1 Quantum mechanical origin of magnetic moments: orbital and spin angular momentum 6.1.2 The Bohr magneton and the gyromagnetic ratio	Practice
Week 7	**Unit-VII** 7.1 Quantum theory of paramagnetism: the Langevin model and the Curie Law 7.1.1 Exchange interaction and its role in ferromagnetism and antiferromagnetism 7.1.2 The Heisenberg model and the concept of spin waves (magnons)	What are magnons?
Week 8	Mid Term Exams	
Week 9	**Unit-VIII** 8.1 Ferromagnetism and Magnetic Domains 8.1.1 Spontaneous magnetization	What are magnetic domains?

	and the origin of ferromagnetism 8.1.2 Weiss molecular field theory and the concept of the Curie temperature	
Week 10	**Unit-IX** 9.1 Domain theory of ferromagnetism: domain walls and their movement 9.1.1 Magnetic anisotropy and magnetostriction 9.1.2 Hard and soft magnetic materials and their applications	Review some papers and articles
Week 11	**Unit-X** 10.1 Magnetic Circuits and Materials in Magnetic Fields 10.1.1 Magnetic circuits: analogy to electrical circuits 10.1.2 Magnetomotive force, magnetic reluctance, and permeability	What is magnetic permeability?
Week 12	**Unit-XI** 11.1 Magnetic hysteresis loops and energy loss in magnetic materials 11.1.1 The demagnetizing field and its effects on magnetic behavior	Review
Week 13	**Unit-XII** 12.1 Advanced Topics in Magnetism 12.1.1 Superparamagnetism and its occurrence in nanoparticles 12.1.2 Magnetic resonance: nuclear magnetic resonance (NMR) and electron spin resonance (ESR)	What are the applications of superparamagnetic materials?
Week 14	**Unit-XIII** 13.1 Introduction to spintronics and magnetoresistance 13.1.1 Magnetic materials in technology: magnetic storage (hard drives), magnetic sensors (Hall effect sensors), and medical imaging (MRI)	Practice
Week 15	**Unit-XIV** 14.1 Applications of Magnetism 14.1.1 Magnetic storage devices: principles of data	Revision

	storage and retrieval 14.1.2 Magnetic levitation and its applications in transportation 14.1.3 Magnetohydrodynamics and applications in energy generation 14.1.4 Magnetic materials in electric motors and transformers 14.1.5 Applications in biomedicine: magnetic nanoparticles for drug delivery and hyperthermia treatment	
Week 16	Final Term Exams	

Textbooks and Reading Material

1. "Introduction to Magnetic Materials" by B. D. Cullity and C. D. Graham
2. "Foundations of Magnetism" by Friedrich Herlach and Noboru Miura
3. "Magnetism in Condensed Matter" by Stephen Blundell
4. "Principles of Magnetism" by A. F. J. Levi
5. "Magnetism and Magnetic Materials" by J. M. D. Coey
6. "Concepts in Spin Electronics" edited by Sadamichi Maekawa
7. "Modern Magnetic Materials: Principles and Applications" by Robert C. O'Handley

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assignments: Types and Number with Calendar

1.
2.
3.
4.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.