MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

DEPARTMENT OF PHYSICS

DETAILS OF THE COURSE

Course Type	Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
PC	24PHTXXX	Electromagnetic Theory	3	3	0	0	0

PREREQUISITE
None

COURSE OBJECTIVE(s)
This course aims to gain a deep understanding of the fundamental principles governing electrostatics, magnetostatics, and electrodynamics. Also, students learn how to develop problem-solving skills to analyze and solve complex problems in various practical scenarios, including applications in engineering, physics, and other fields.

COURSE OUTCOMES:

CO1	To understand the fundamental laws governing electric and magnetic fields.
CO2	Apply mathematical tools to analyze and solve electrodynamics problems.
CO3	Apply the knowledge of electrostatics, magnetostatics, and electrodynamics to real-world engineering applications.

COURSE ASSESSMENT
The Course Assessment (culminating to the final grade) will be made up of the following three components;

S. No.	Component	Weightage
a)	Internal assessment (based upon assignments, quizzes and attendance)	20%
b)	Mid-term examination	30%
c)	End Semester Examination	50%

COURSE CONTENTS

Overview of Electrostatics, Poisson and Laplace's equations, Boundary conditions and Uniqueness theorems, Electrostatic boundary value problems, Method of images, Multipole expansion, Approximate potentials at large distances, Electric field of a dipole, Polarization, field of a polarized object, Bound charges and its physical interpretation, Gauss's law in dielectrics and boundary conditions, Susceptibility, Permittivity, Applications of dielectric materials in capacitor.

(No. of lectures- 13)

Overview of Magnetostatics, Magnetization, Effect of a Magnetic Field on Atomic Orbits, Field of a Magnetized Object, Bound currents, Physical Interpretation of Bound Currents, Magnetic Field Inside Matter, Ampère's Law in Magnetized Materials, Magnetic Susceptibility and Permeability, Magnetic levitation.

(No. of lectures- 08)

Electromagnetic wave equation, Electromagnetic waves in vacuum, Energy and Momentum in Electromagnetic Waves, Electromagnetic waves in matter, Reflection and Transmission at normal and oblique incidence, Electromagnetic waves in conductors, Frequency dependence of permittivity, Wave guides, TE modes in a Rectangular Wave Guide, Optical fibers.

(No. of lectures- 08)

Scalar and vector potentials, Potential formulation of Maxwell's equations, Gauge transformations, Coulomb and Lorentz gauges, Retarded potentials, Dipole radiation, Electric dipole radiation, magnetic dipole radiation, Power radiated by a point charge, Introduction to antenna

(No. of lectures- 10)

TEXT BOOKS/ REFERENCE BOOKS: -

1. Introduction to Electrodynamics: David J. Griffiths, (Prentice Hall of India).
2. Classical Electrodynamics: J.D. Jackson, (John Wiley and Sons).
3. Elements of Electrodynamics: Matthew N. O. Sadiku (Oxford University Press)
4. Modern Electrodynamics, Andrew Zangwill (Cambridge University Press)
5. The Classical Theory of Fields: L.D. Landau, E.M. Lifshitz (Pergamon Press, Oxford).
6. Foundations of Electromagnetic Theory: J. Reitz and F.J. Milford (Addison-Wesley).
7. Electromagnetic Waves and Radiating Systems: E.C. Jordan (Prentice Hall of India).

Lecture Plan

Lecture No.	Topics to be covered
1	Overview of Electrostatics
2	Poisson and Laplace's equations
3	Boundary Conditions and Uniqueness theorems
4	Electrostatic boundary value problems
5	Method of images
6	Multipole expansion
7	Approximate potentials at large distances

8	Electric field of a dipole
9	Polarization, field of a polarized object
10	Bound charges and its physical interpretation
11	Gauss's law in dielectrics and boundary conditions
12	Susceptibility, Permittivity
13	Applications of dielectric materials in capacitor
14	Overview of Magnetostatics
15	Magnetization, Effect of a Magnetic Field on Atomic Orbits
16	Field of a Magnetized Object
17	Bound currents, Physical Interpretation of Bound Currents
18	Magnetic Field Inside Matter
19	Ampère's Law in Magnetized Materials
20	Magnetic Susceptibility and Permeability
21	Magnetic levitation
22	Electromagnetic wave equation
23	Electromagnetic waves in vacuum
24	Energy and Momentum in Electromagnetic Waves
25	Electromagnetic waves in matter
26	Reflection and Transmission at normal and oblique incidence
27	Electromagnetic waves in conductors
28	Frequency dependence of permittivity
29	Wave guides, TE modes in a Rectangular Wave Guide
30	Optical fiber
31	Scalar and vector potentials
32	Potential formulation of Maxwell's equations
33	Gauge transformations, Coulomb and Lorentz gauges
34	Retarded potentials
35	Dipole radiation, electric dipole radiation
36	Magnetic dipole radiation
37-38	Power radiated by a point charge
39	Introduction to antenna

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DEPARTMENT OF PHYSICS

Course Type	Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
PC	24PHTXXX	Quantum Mechanics	3	3	0	0	0

PREREQUISITE COURSES
None

COURSE OBJECTIVES
Students will learn basic principles of Quantum Mechanics, and learn to study quantum mechanical systems

COURSE ASSESSMENT

S. No.	Component	Weightage
a)	Internal assessment (based upon assignments, quizzes and attendance)	20%
b)	Mid-term examination	30%
c)	End Semester Examination	50%

COURSE CONTENTS

Introduction - Inner product spaces and generalization to functions, operators, failures of classical physics, postulates of Quantum Mechanics, measurement process, uncertainty relations, Ehrenfest theorem and classical correspondence, continuity equation for probability **(No. of lectures-9)**

Simple one-dimensional quantum mechanical systems - Free particles, delta potential well, recap of particle in a box, scattering by a step barrier, harmonic oscillator using both Hermite polynomials and Dirac's method, Double well potential **(No. of lectures - 12)**

More complicated systems - Angular momentum eigenvalues and eigenstates, angular momentum in position basis, hydrogen atom, basic overview of spin and statistics potential **(No. of lectures - 11)**

Approximate methods - Variational method, time-independent non-degenerate perturbation theory potential **(No. of lectures - 7)**

TEXT / REFERENCE BOOKS

1. Principles of Quantum Mechanics (Second Edition), R. Shankar (Springer)
2. Introduction to Quantum Mechanics (Second Edition), D. J. Griffiths (Cambridge India)
3. Quantum Mechanics (Fourth Edition), Leonard Schiff (McGraw Hill Education)
4. Quantum Mechanics (Third Edition), Eugen Merzbacher (John Wiley & Sons)

Lecture No.	Topics to be covered
1.	Inner product spaces and generalization to functions
2.	Operators
3.	Operators contd.
4.	Failures of classical physics
5.	Postulates of Quantum Mechanics
6.	Postulates of Quantum Mechanics contd. - measurement process
7.	Uncertainty relations
8.	Ehrenfest theorem and classical correspondence
9.	Continuity equation for probability
10.	Free particles
11.	Free particles contd.
12.	Delta potential well
13.	Delta potential well contd.
14.	Recap of particle in a box
15.	Scattering by an infinite step barrier
16.	Scattering by an infinite step barrier contd. – interpretation of results
17.	Scattering by a finite step barrier
18.	Harmonic oscillator in energy basis (Dirac's method)
19.	Harmonic oscillator in position basis (Hermite polynomials)
20.	Harmonic oscillator – further discussion
21.	Outlook
22.	Angular momentum in one direction only
23.	Angular momentum – general properties
24.	Angular momentum – eigenstates and eigenvalues
25.	Angular momentum in position basis
26.	Angular momentum in position basis contd.
27.	Hydrogen atom – setting up the problem
28.	Hydrogen atom – energy states
29.	Hydrogen atom – further discussion
30.	Basic overview of spin and statistics, symmetric and anti-symmetric states
31.	Energy-time uncertainty relation
32.	Outlook
33.	Variational Method
34.	Variational Method – more examples
35.	Perturbation theory (time independent, non-degenerate) – setting up
36.	Perturbation theory (time independent, non-degenerate) - derivation
37.	Perturbation theory (time independent, non-degenerate) - examples
38.	Perturbation theory (time independent, non-degenerate) – more examples
39.	Outlook

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DEPARTMENT OF PHYSICS

DETAILS OF THE COURSE

Course Type	Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
PC	24PHTXXX	Condensed Matter Physics	3	3	0	0	0

PREREQUISITE – Quantum Mechanics

COURSE OBJECTIVE(s)
This course aims to equip the students with fundamental knowledge of condensed matter physics. To explain structural, electrical, and magnetic behavior of different types of condensed phases.

COURSE ASSESSMENT
The Course Assessment (culminating to the final grade), will be made up of the following three components;

S. No.	Component	Weightage
d)	Internal assessment (based upon assignments, quizzes and attendance)	20%
e)	Mid-term examination	30%
f)	End Semester Examination	50%

COURSE CONTENTS

Crystal Physics - Classification of condensed matter-crystalline and noncrystalline solids, bonding in solids - ionic, covalent and metallic solids, crystal symmetry, point groups, space groups, lattices and basis, typical crystal structures, reciprocal lattice, Brillouin zone, structure factor. Bragg's law of diffraction. **(No. of lectures- 10)**

Lattice Vibrations and Thermal Properties - Monoatomic and diatomic lattices, normal modes of lattice vibration, phonons and density of states, dispersion curves, specific heat – classical, Einstein and Debye models. thermal expansion and thermal conductivity, normal and Umklapp processes. **(No. of lectures- 9)**

Band theory of solids - Free electron theory of metals, density of states, origin of energy bands, Fermi energy, Bloch Theorem, Kronig-Penney Model, distinction between metals, semiconductors, and insulators, Intrinsic and extrinsic semiconductors and carrier concentration, Hall effect in metals and semiconductors. **(No. of lectures- 9)**

Magnetism - Introduction to magnetism, quantum theory of dia- and para-magnetism, magnetic ordering, Weiss molecular theory of ferromagnetism and antiferromagnetism. Introduction to superconductivity, Meissner Effect, concept of Cooper pairs, BCS theory, Type-I and Tupe-II superconductors. **(No. of lectures- 12)**

TEXT/ REFERENCE BOOKS: -

1. Introduction to Solid State Physics, Kittel C, 8^{th} Ed. (Wiley Eastern Ltd. (2004))
2. Solid State Physics, Ashcroft N M and Mermin N D, 2^{nd} Ed. (Holt-Saunders (2004))
3. Solid State Physics, Hook J R and Hall H E (John Wiley and Sons (2001))
4. Magnetism in Condensed Matter, Blundell S (Oxford University press (2001))

Lecture Plan

Lecture No.	Topics to be covered
1.	Introduction and background
2.	Classification of condensed matter-crystalline and noncrystalline solids
3.	Bonding in solids - Ionic, covalent and metallic solids
4.	Bonding in solids - Ionic, covalent and metallic solids
5.	Crystal symmetry, point groups and space groups
6.	Lattices and basis
7.	Typical crystal structures,
8.	Introduction to reciprocal space and reciprocal lattice
9.	Brillouin zone, structure factor
10.	Bragg's law of diffraction
11.	Monoatomic and diatomic lattices
12.	Monoatomic and diatomic lattices
13.	Normal modes of lattice vibration
14.	Phonons, Density of states and dispersion curves
15.	Specific heat – classical, Einstein and Debye models.
16.	Specific heat – classical, Einstein and Debye models.
17.	Thermal expansion, thermal conductivity.
18.	Thermal expansion, thermal conductivity.
19.	Normal and Umklapp processes
20.	Free electron theory of metals
21.	density of states
22.	Origin of energy bands
23.	Fermi energy,
24.	Bloch Theorem, Kronig-Penney Model
25.	distinction between metals, semiconductors, and insulators
26.	Intrinsic and extrinsic semiconductors and carrier concentration
27.	Hall effect in metals and semiconductors.
28.	Introduction to magnetism
29.	Introduction to magnetism
30.	quantum theory of dia- and para-magnetism
31.	quantum theory of dia- and para-magnetism
32.	Weiss molecular theory of ferromagnetism and antiferromagnetism
33.	Weiss molecular theory of ferromagnetism and antiferromagnetism
34.	Introduction to superconductivity,
35.	Meissner Effect
36.	concept of Cooper pairs,
37.	BCS theory
38.	Type-I and Tupe-II superconductors.
39.	Course revision

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DETAILS OF THE COURSE

Course Type	Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
PC	24PHTXXX	Advanced Physics Lab	3	0	0	6	0

COURSE OBJECTIVES

To impart knowledge of advanced experimental concepts and techniques in undergraduate Physics

COURSE CONTENTS

1. To study the temperature dependence of Hall coefficient of a given material.
2. To study the Gaussian nature of laser beams and carry out the diffraction experiments.
3. To study the speed of ultrasonic velocity in liquids and measure elasticity parameters.
4. To record a Frank Hertz curve for Mercury and measure the energy emission of free electrons in a gas filled triode.
5. To measure the magnetic susceptibility of paramagnetic solution by Quincke's method and to find the ionic molecular susceptibility and magnetic moment.
6. To determine the Curie temperature of a given solid and study the magnetic transition.
7. To study Bragg's law by microwave diffraction.
8. Low temperature electrical resistivity measurements of metals and semiconductors
9. To study the performance characteristics of an analog PID controller and measurement of Temperature using Temperature Sensors/RTD
10. To observe and measure the forces and torques acting on a magnetic dipole placed in an external magnetic field.
11. To investigate the magnetic force between two current carrying wires.
12. To measure permittivity and permeability of free space, and then calculate the speed of light.
13. Measurement of thin film thickness and optical constants using ellipsometry/quartz crystal oscillator.
14. Determination of crystallite size, and crystal structure by X-ray diffraction.
15. Determination of band gap of optical materials by UV-visible spectroscopy.
16. Measurement of pressure, strain and torque using strain gauge.
17. Measurement of speed using photoelectric transducers and compass
18. Measurement of angular displacement using Potentiometer.
19. To perform Fourier analysis of complex waves

TEXT BOOKS/ REFERENCE BOOKS: -

1. Introduction to Solid State Physics: C. Kittel, 7th Ed. (John Wiley and Sons)
2. Solid State Physics: N. Ashcroft and N.D. Mermin (Holt, Rinehart and Winston).
3. Solid State Physics: A.J. Dekker (Prentice Hall of India, New Delhi).
4. Magnetism in Condensed Matter: Stephen Blundel (Oxford Master Series in Condensed Matter Physics).
5. Purcell E., Electricity and Magnetism Berkeley Physics course, vol 2.
6. Sadiku M N O, Elements of Engineering Electromagnetics, Oxford University Press, 3rd Edition
7. Rangan C S, Sharma G R and Mani V S V, "Instrumentation Devices and Systems", 2nd Ed., Tata McGraw-Hill (2008)
8. Anand M M S, "Electronic Instruments and Instrumentation Technology", Pearson Education (2008).