PHYSICS

Second Semester Unitwise Course Distribution

	PHY-HC-2016 Electricity and Magnetism Total Lectures: 60	**PHY-HC-2026** Waves and Optics Total Lectures: 60	**PHY-HG-2016** Electricity and Magnetism Total Lectures: 60	
NKD	Unit I: Electric Field and Electric Potential (Lectures 26) Unit II: Dielectric Properties of Matter (Lectures 08) Unit III: Magnetic Field (Lectures 09) Unit IV: Magnetic Properties of Matter (Lectures 04) Unit V: Electromagnetic Induction (Lectures 06)	---	Unit V : Maxwell's Equations and EM Wave (Lectures 10)	Total Lectures: 63
HB	-----	Unit I: Superposition of Collinear Harmonic Oscillations (Lectures 05) Unit II: Superposition of Two Perpendicular Harmonic Oscillations (Lectures 02) Unit III: Wave Motion (Lectures 04) Unit IV: Velocity of Waves (Lectures 06) Unit V: Superposition of Two Harmonic Waves (Lectures 07)	Unit I: Vector Analysis (Lectures 12) Unit II: Electrostatics (Lectures 22)	Total Lectures: 58
PB	Unit VI: Electrical Circuits (Lectures 04) Unit VII: Network Theorems (Lectures 03) Unit VIII: Ballistic Galvanometer (Lectures 03)	Unit VI: Wave Optics (Lectures 03) Unit VII: Interference (Lectures 09) Unit VIII: Interferometer (Lectures 04) Unit IX: Diffraction (Lectures 09) Unit X: Fraunhoffer Diffraction (Lectures 08) Unit X: Hollography (Lectures 03)	Unit III : Magnetism (Lectures 10) Unit IV : Electromagnetic Induction (Lectures 06)	Total Lectures: 62

PHY-HC-2016
Electricity & Magnetism
Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

Course Outcome: *After successful completion of this course, students will be able to Understand electric and magnetic fields in matter, Dilectric properties of matter magnetic properties of matter, electromagnetic induction, applications of Kirchhofff's law in different circuits, applications of network theorem in circuits.*

Theory

Unit I: Electric Field and Electric Potential (Lectures 26)

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Unique- ness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Unit II: Dielectric Properties of Matter (Lectures 08)

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector $\vec{D}$. Relations between $\vec{E}$, $\vec{P}$ and $\vec{D}$ Gauss' Law in dielectrics.

Unit III: Magnetic Field (Lectures 09)

Magnetic Force on a point charge, definition and properties of magnetic field $\vec{B}$. Curl and Divergence. Vector potential $\vec{A}$. Magnetic Force on (1) a current carrying wire (2) between current elements. Torque on a current loop in a uniform magnetic field. Biot-Savart's law and its simple application : straight wire and circular loop. Current loop as a magnetic dipole and its dipole moment (analogy with electric dipole) Ampere's circuital law and its application to (1) Solenoid (2) Torus.

Unit IV: Magnetic Properties of Matter (Lectures 04)

Magnetization vector ($\vec{M}$). Magnetic Intensity ($\vec{H}$). Magnetic Susceptibility and permeability. Relation between $\vec{B}$, $\vec{H}$, $\vec{M}$. Ferromagnetism. B-H curve and hysteresis.

Unit V: Electromagnetic Induction (Lectures 06)

Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

Unit VI: Electrical Circuits (Lectures 04)

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) 13 Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Unit VII: Network Theorems (Lectures 03)

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem. Norton theorem. Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Unit VIII: Ballistic Galvanometer (Lectures 03)

Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

NKD
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PB

Lab

A minimum of seven experiments to be done.

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. Measurement of field strength $\vec{B}$ and its variation in a solenoid (determine $\frac{dB}{dx}$).
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

Reference Books

[1] Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

[2] Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

[3] Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

[4] Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[5] Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.

[6] Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

PHY-HC-2026
Waves & Optics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *After successful completion of this course, students will be able to Understand superposition of harmonic oscillations, different types of wave motions, superposition of harmonic waves, interference and interferometer, diffraction, holography.*

Theory

Unit I: Superposition of Collinear Harmonic Oscillations (Lectures 05)

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Unit II: Superposition of Two Perpendicular Harmonic Oscillations (Lectures 02)

Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Unit III: Wave Motion (Lectures 04)

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

Unit IV: Velocity of Waves (Lectures 06)

Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit V: Superposition of Two Harmonic Waves (Lectures 07)

Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Unit VI: Wave Optics (Lectures 03)

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Unit VII: Interference (Lectures 09)

Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

Unit VIII: Interferometer (Lectures 04)

Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, (5) Visibility of fringes. Fabry-Perot interferometer.

Unit IX: Diffraction (Lectures 09)

Fresnel and Fraunhofer diffraction. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel diffraction pattern of a straight edge and at a circular aperture . Resolving Power of a telescope.

Unit X: Fraunhofer Diffraction (Lectures 08)

Single slit. Double slit. Multiple slits. Diffraction grating . Resolving power of grating.

Unit XI: Holography (Lectures 03)

Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

NKD
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PB

Lab

A minimum of seven experiments to be done.

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law.
2. To study Lissajous Figures.
3. Familiarization with: Schuster's focusing, determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

[1] Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

[2] Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill

[3] Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

[4] Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

[5] The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

[6] The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

[7] Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.

NKD
HB
PB

PHY-HG-2016 (PHY-RC-2016)
Electricity & Magnetism
Total Lectures: 60 Credits : 6 (Theory : 04, Lab : 02)

Course outcome: *Upon completion of this course, students are expected to apply Gauss's law of electrostatics to solve a variety of problems, calculate the magnetic forces that act on moving charges and the magnetic fields due to currents, have brief idea of magnetic materials, understand the concepts of induction, and apply them to solve variety of problems. In the Lab course, students will be able to measure resistance (high and low), Voltage, Current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different circuits RC, LCR etc.*

Theory

Unit I : Vector Analysis (Lectures 12)

Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Unit II : Electrostatics (Lectures 22)

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem – Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Unit III : Magnetism (Lectures 10)

Magnetostatics: Biot-Savart's law & its applications – straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia, para, and ferro-magnetic materials.

Unit IV : Electromagnetic Induction (Lectures 06)

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Unit V : Maxwell's Equations and EM Wave (Lectures 10)

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

NKD
HB
PB

Lab

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer
    (a) Measurement of charge and current sensitivity
    (b) Measurement of CDR
    (c) Determine a high resistance by Leakage Method
    (d) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q .
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem.
10. To verify the Superposition, and Maximum Power Transfer Theorem.

Reference Books

[1] Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

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