Course: Core Paper XIII–HPHCR6132T & HPHCR6132P

Semester	VI
Paper Number	HPHCR6132T & HPHCR6132P
Paper Title	ELECTROMAGNETIC THEORY
No. of Credits	06 (Theory – 4, Lab – 2)
Theory/ Composite	Composite
No. of periods assigned	Th:4 periods/week Pr:3 periods/week
Name of Faculty member(s)	
Course description/ objective	1) In this course the Maxwell's equations are reviewed, and obtained in the general form for electrodynamics. The potential formulation is also introduced here which will be beneficial to the student in future courses in classical electrodynamics. 2) The wave equation and the plane wave solutions are studied. The concept of an electromagnetic wave is hence introduced with a study of its properties. 3) The study of conservation principles in electrodynamics leads to the understanding of the energy and momentum carried by electromagnetic field. 4) This is followed by the study of propagation of electromagnetic waves in free space, dielectrics, conductors and the behaviour of the waves at boundaries. This includes the understanding of several important parameters which decide the optical properties of the medium. 5) To discuss quantitatively the propagation of electromagnetic waves in anisotropic media. 6) To teach the principles of production of polarized light. 7) To discuss the principles of analysis of polarized light using waveplates and retarders. 8) To discuss quantitatively optical activity and principles of operation of polarimeters. 9) To discuss quantitatively the propagation of electromagnetic waves in optical fibers. 10) To introduce different types of optical fibers.
Syllabus	As enclosed
Texts	As enclosed
Reading/ Reference Lists	As enclosed

Evaluation	Total – 100 (Theory – 60, Practical – 40) Theory – CIA – 10 Semester Examination – 50 Group A (25 marks) Group B (25 marks) One 10 marks qs out of two qs One 10 mark qs out of two qs Three 5 mark qs out of five qs Three 5 mark qs out of five qs

Syllabus:

HPHCR6132T - ELECTROMAGNETIC THEORY (Credits – Theory – 4, Practicals – 2))

Module A [26 Lectures]

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density. **[11 Lectures]**

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. **[7Lectures]**

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients.**[8 Lectures]**

Module B [26 Lectures]

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism.

Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Analysis of Polarized Light. **[12 Lectures**]

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Specific rotation. Laurent's half-shade polarimeter**[4 Lectures]**

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves.**[7 Lectures]**

Optical Fibres :-Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). **[3 Lectures]**

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
3. Classical Electrodynamics, J. D. Jackson
4. Optics, Eugene Hecht, Pearson.
5. Optical Electronics, A.K. Ghatak&K.Thyagarajan, Cambridge University Press
6. Introduction to Fiber Optics, A.K. Ghatak& K. Thyagarajan, Cambridge University Press

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HPHCR6132P - Electromagnetic Theory Lab; Credits – 2 (39 periods)

1. To determine the specific rotation of sugar solution using Polarimeter.
2. To analyze elliptically polarized light by using a Babinet's compensator.
3. To determine the refractive index of glass & liquid by total internal reflection using a Gaussian eyepiece.
4. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
5. To verify the Stefan`s law of radiation and to determine Stefan's constant.
6. To determine the Boltzmann constant using V-I characteristics of PN junction diode.
7. To verify Brewster's law & Fresnel's equation.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
5. Advanced Practical Physics, B. Ghosh& K.G. Majumdar, Sreedhar Publishers

Paper Structure for laboratory

(a) Marks for experiment : **30 marks**
   - (i) Class performance on any one expt. – 8
   - (ii) Lab. Viva on the same experiment as (i) - 7
   - (iii) LNB for each of the three experiments - 5 x 3 = 15

(b) Grand Viva – **8 marks**

(c) Attendance – **2 marks**

[Students are to complete 3 experiments]