PH-8201 **Classical Electrodynamics**

L	T	P	C
4	1	0	5

Course outcomes:

After successful completion of the course, the students should be able to

CO1: Understanding and using (skill of solving problems, calculating) electrostatics and magnetostatics, in vaccum, in the presence of conductors and linear dielectrics by using methods of electrodynamics.

CO2: Elaborate on the physical implications of Maxwell's equations

CO3: Do multipole expansions of electrostatic and magnetostatic fields

CO4: Explain and use conservation laws for energy, Poyinting vector, Momentum, Maxwell stress tensor.

CO5: Understanding and using (skill of solving problems, calculating) electrodynamics in media, macroscopic fields, susceptibilities, dielectrics and conductors, boundary conditions, radiation.

CO6: Understanding and using (skill of solving problems, calculating) retarded potentials and gauge transformations.

CO7: Analyze propagation, reflection and transmission of plane waves at interface and through wave guides

CO8: Understanding (basic) theory of relativity and its connection to electrodynamics, calculating elementary problems in relativistic mechanics and electrodynamics.

CO/PO Mapping

S-strong, M-medium and W-weak indicate the strength of correlation

COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	M	M	W	W			S	M	S
CO2	S	S	S	M	M	M	W			S		M
CO3	M	S	M	M	S	S	W			M	S	S
CO4	W	M	M	M	W	M	W			S	W	W
CO5	S	S	S	W	M	M	W			S	M	W
CO6	S	S	S	M	M	M	W			S	M	W
CO7	S	S	S	W	M	M	W			S	M	W
CO8	S	S	S	M	M	M	W			S		M

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UNIT-I

Electrostatics: Coulomb's law, Gauss law, scalar potential (with problems), Laplace and Poisson's equations, Electrostatic potential and energy density of the electromagnetic field, static fields in material media, Polarization vector, macroscopic equations, classification of dielectric media, Molecular polarizability and electrical susceptibility, Clausius-Mossetti relation, Models of Molecular polarizability, energy of charges in dielectric media. **8 Hrs**

Magneto-statics: The differential equations of magnetostatics, vector potential (with problems), magnetic fields of a localized current distribution, Singularity in dipole field, Force and torque on a localized current distribution. **6 Hrs**

Boundary Value Problems: Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Methods of images with examples, magnetostatic boundary value problems (derivation of equation for H and M, some special cases), energy in the magnetic field. **10 Hrs**

Multipole Expansion: Multipole expansion of the scalar potential of a charge distribution, dipole moment, quadrupole moment, Multipole expansion of the energy of a charge distribution in an external field. **6 Hrs**

UNIT-II

Time Varying fields and Maxwell equations: Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem (with problems), Conservation of momentum. **8 Hrs**

Electromagnetic Waves: Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, EM wave guides, Cavity resonators, Dielectric waveguide, optical fibre waveguide. **10 Hrs**

Radiation from Localized Time varying sources:
Solution of the inhomogeneous wave equation in the absence of boundaries, Fields and radiation of a localized oscillating source, electric dipole and electric quadrupole fields, center fed antenna **6 Hrs**

Charged Particle Dynamics:
Non-relativistic motion in uniform constant fields and in a slowly varying magnetic field, cross electrostatic and magnetic fields and applications, Relativistic motion of a charged particle. **6 Hrs**

Total: 60 Hrs

Theory: 60 Hrs

BOOKS:

1. Introduction to Electrodynamics: D.J. Griffiths, (Prentice Hall India, New Delhi).
2. Classical Electrodynamics: J.D. Jackson, (Wiley Eastern, New Delhi).
3. Classical Electrodynamics: S.P. Puri (Tata McGraw Hill, New Delhi).
4. Classical Electromagnetic Radiation: J.B. Marion and M.A. Heald, (Academic Press, San Diego).
5. Foundations for Microwave Engineering: RE *Collin* (McGraw-Hill, New York)

c/BOS

Head
Department of Physics
Sant Longowal Inst. of Engg. & Tech.
LONGOWAL (Sangrur)