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Total No. of Pages : 03

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M.Sc.(Physics) (2015 to 2017) (Sem.–3)

# ELECTRODYNAMICS

Subject Code : MPH-302

Paper ID : [72615]

Time : 3 Hrs. Max. Marks : 100

**INSTRUCTIONS TO CANDIDATES :**

1. **Attempt FIVE questions in all including the compulsory question no.9.**
2. **Symbols used have their usual meaning.**

Q1. a) State Dirichlet's theorem and discuss its use for the solution of boundary value problems with method of separation of variables. (8)

b) How orthogonality is guaranteed by Dirichlet's theorem? (4)

c) A point charge q is situated at distance 'a' from the centre of a grounded conducting sphere of radius R. Find the potential outside the sphere using method of images. (8)

Q2. a) Write the Maxwell's electrodynamics equations and show how the inconsistency in the new formulation of these equations was overcome. (5)

b) Derive the Gauge transformations for A and V. (5)

c) What is Coulomb Gauge and its application? (5)

d) What is Lorentz Gauge, use it to derive two important equations in terms of d' Alembertian? (5)

Q3. a) Derive the general expression for the electromagnetic field energy. (4)

b) Derive the differential form of Poynting's theorem and compare it with continuity equation for charge. (8)

c) Define Poynting vector and give its importance/significance and units. (4)

d) Explain the conservation of momentum in terms of Maxwell's stress tensor. (4)

Q4. a) Derive the electromagnetic wave equation in terms of E and B in an isotropic dielectric. (6)

b) Derive the relations for energy (Poynting's theorem for a complex vector field) and momentum in electromagnetic waves. (6)

c) Explain the terms for a linear and homogeneous medium : index of refraction, Poynting vector, Intensity of field, skin depth. (2×4=8)

Q5. a) Derive the expression for the reflection (R) and transmission (T) coefficient when wave passes from one medium into another at oblique incidence. (6)

b) Invoke the boundary conditions for oblique incidence of electromagnetic wave to derive the Fresnel's amplitude relations and Brewster' angle. (6)

c) Derive the reflection and transmission coefficients for waves polarized parallel to the plane of incidence. (8)

Q6. a) Starting from Maxwell's equations for an electromagnetic wave propagating between a pair of parallel conducting planes of infinite extent, derive the expression and conditions for TE, TM and TEM modes of EM wave propagation. (12)

b) Explain TE wave propagation in a rectangular wave guide and derive the condition for its cutoff frequency. (8)

Q7. a) Explain Lienard-Wiechert potentials and their importance. (4)

b) By using the Lienard-Wiechert potentials, derive the epression for electric and magnetic fields of a point charge in arbitrary motion. (12)

c) Write a short note on centre fed linear antenna. (4)

Q8. a) Derive the position vector for the motion of single charged particle under the influence of uniform electric and magnetic field. (8)

b) Using appropriate equation of motions for a particle in a varying magnetic field, derive the expression for the average force acting on the particle as well as magnetic moment of the particle. (6)

c) Show that magnetic moment of a charged particle in a non-uniform magnetic field is equivalent to the magnetic moment of a current loop. (6)

**Q9. Answer briefly :**

a) State first and second uniqueness theorems and differentiate about their applicability.

b) State Faraday's laws of induction and also write it in integral and differential forms.

c) Show, how the potential representation fulfills two (Gauss's law in magneto-statics and Faraday's law) homogeneous Maxwell equations.

d) Show how the relationship ($B = \nabla \times A$) between magnetic field (B) and magnetic vector potential (A) satisfy the desired property of magnetic field.

e) Explain how Newton's third law is valid in electrostatics and magnetostatics but not in electrodynamics.

f) Write the Maxwell's equations inside matter but in regions where there is no free charge or free current.

g) Write the boundary conditions when a wave passes transparent medium into another.

h) What do you mean by boundary conditions and explain the boundary conditions for electrodynamics in the case i) linear media and ii) there is no charge or free current at interface?

i) Define a linear and homogeneous medium and write Maxwell's equations for it.

j) Explain total internal reflection and Stoke's parameters. (2×10=20)