

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2025
(Regular/Improvement/Supplementary)**

**PHYSICS
FPHY1C03- ELECTRODYNAMICS AND PLASMA PHYSICS**

Time: 3 Hours

Maximum Weightage: 30

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.

1. Explain the Lorentz gauge condition and write down the nonhomogeneous wave equation for vector and scalar potentials.
2. Define the reflection coefficient and transmission coefficient for the normal incidence of electromagnetic waves at a plane dielectric boundary. Obtain the relation between them.
3. What is meant by a distortionless transmission line? Give the condition for a lossy transmission line to be distortion less.
4. Explain the cutoff frequency of a waveguide.
5. Derive the relativistic transformation equation $\mathbf{E}^\perp = \gamma_0 \mathbf{E}_0^\perp$ for the perpendicular component of the electric field between two inertial frames with a relative velocity.
6. Show that the current density 4-vector is divergenceless.
7. Discuss the three conditions that a plasma must satisfy.
8. Write and explain Vlasov equation in kinetic theory of plasma.

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. Discuss the flow of energy in electromagnetic waves and arrive at the Poynting's theorem.
10. Obtain the general transmission line equations for arbitrary time dependence and hence obtain it for harmonic time dependence.
11. Discuss the potential formulation in relativistic electrodynamics and obtain the d'Alembertian of 4-vector potential.
12. Discuss the motion of a charged particle in a region filled with a uniform electric and magnetic field. Obtain the expression for the drift speed of the guiding center of the orbit.

(2 × 5 = 10 weightage)

(P.T.O.)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. With the help of a neat diagram derive the electromagnetic boundary conditions for the perpendicular component of electric displacement.
14. Show that if \mathbf{E} and \mathbf{H} solutions of source-free Maxwell's equations in a simple medium characterized by ϵ and μ then $\mathbf{E}' = \eta\mathbf{H}$ and $\mathbf{H}' = -\frac{\mathbf{E}}{\eta}$ are also solutions of Maxwell's equations. Here η is the intrinsic impedance of medium.
15. Calculate the magnetic dipole moment of a circular coil with radius 3 cm, number of turns per unit length 100 and carrying a current 2 A.
16. Calculate the attenuation constant and skin depth for electromagnetic waves in copper at 3 MHz. Copper is a diamagnetic material with conductivity 5.8×10^7 S/m.
17. Show that the conductance between two conductors separated by a dielectric medium with permittivity ϵ and conductivity σ is related to the capacitance of the arrangement by $G = \frac{\sigma}{\epsilon}C$.
18. Show that the tensor equation $\frac{\partial G^{\mu\nu}}{\partial x^\nu} = 0$ represents $\nabla \cdot \mathbf{B} = 0$.
19. Find the cyclotron frequency and Larmor radius of electrons moving with speed 3×10^4 m/s perpendicular to a magnetic field of strength 3×10^{-3} T.

(4 × 3 = 12 weightage)