

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2021
(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. When did a transformation become Gauge transformation? Mention Lorentz gauge condition.
2. What is meant by Debye shielding?
3. Explain the origin of complex permittivity in good conductors.
4. Traffic police always prefer straight road to check the speed of a moving vehicle. Justify your answer.
5. What do you mean by impedance matching of a transmission lines?
6. Can a wave guide have more than one cut off frequency? Explain.
7. Suppose that in one inertial frame $B=0$ but $E \neq 0$ (at some point A). Is it possible to find another system in which the electric field is zero at A?
8. Explain the concept of temperature in plasma.

(8 × 1 = 8 weightage)

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

9. Obtain the relation between reflection coefficient and transmission coefficient when a uniform plane wave with parallel polarization is incident obliquely on a plane conducting boundary. Also find the relation between the critical angle θ_c and Brewster angle $\theta_{B||}$ for non magnetic media.
10. Explain the relativistic transformation equation for electric and magnetic fields.
11. Derive the expression for Debye length. Also explain the criteria for plasma.
12. Describe the propagation of TE modes for rectangular wave guide. Find the ratio of the lowest TM cut-off frequency to the lowest TE cut-off frequency.

(2 × 5 = 10 weightage)

(P.T.O.)

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

13. Consider a solenoid of radius 'R' with n turns per unit length in which time dependant current $I = I_0 \sin \omega t$ flows. Calculate the electric field at a perpendicular distance $r < R$ from the axis of symmetry of the solenoid ($\frac{\omega R}{c} \ll 1$).
14. A straight wire along the z axis carries charge density λ travelling in the positive Z direction at speed V. Construct the field tensor and dual tensor at (x,0,0).
15. A sphere of radius R centered at the origin carries charge density $\rho(r, \theta) = k \frac{R}{r^2} (R - 2r) \sin \theta$ where k is a constant. Find the approximate potential for points on the Z axis far from the sphere.
16. A plane polarized electromagnetic wave in free space at a time $t = 0$, is given by $E(x, y) = 10a_y e^{i(6x+8z)}$. Calculate the magnetic field $B(x, z, t)$.
17. Demonstrate the analogy between the wave characteristics on a transmission line and uniform plane wave in a lossy medium.
18. Show that $E^2 - c^2 B^2$ is relativistically invariant.
19. A distant galaxy contains a cloud of protons and anti protons each with density $10^6 m^{-3}$ and temperature 100K. What is the Debye length?

(4 × 3 = 12 weightage)