

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2024
(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. What is meant by loss tangent of a lossy medium? Explain the origin of complex permittivity.
2. Define group velocity and phase velocity. Obtain the general relation between them.
3. Name the four distributed parameters of a general transmission line. Express the propagation constant and characteristic impedance in terms of these parameters.
4. What is meant by a cavity resonator?
5. Define current density 4-vector and obtain the continuity equation in relativistic form.
6. Write down the expression for the Minkowski force on a point charge q and explain the terms involved.
7. Discuss Debye Shielding.
8. Derive the expression for cyclotron frequency.

(8 × 1 = 8 weightage)

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

9. Discuss the reflection of electromagnetic waves at oblique incidence at a plane conducting boundary with the electric field perpendicular to the plane of incidence.
10. Discuss the transmission of TM waves in rectangular waveguides and obtain the expression for cutoff frequency.
11. Write down the Maxwell's equations in tensor form. From the tensor form derive the divergence and curl of electric and magnetic fields.
12. Derive the Vlasov equation for a sufficiently hot plasma.

(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 parallel component of magnetic field H .
14. A time harmonic electric field of amplitude 200 V/m and frequency 1 GHz exists in a lossy dielectric medium with a relative permittivity of 2.25 and a loss tangent of 0.001. Find the average power dissipated in the medium per cubic metre.
15. Three charges $1\ \mu C$, $2\ \mu C$ and $-3\ \mu C$ are placed respectively at the points (0,0), (3,0) and (3,4) on the xy plane (in meters). Calculate the electric dipole moment of the arrangement.
16. Find the Poynting vector on the surface of a long, straight conducting wire of radius a and conductivity σ that carries a direct current I .
17. The attenuation on $50\ \Omega$ distortionless lossy transmission line is 0.01 dB/m. The line has a capacitance of 0.1 nF/m. Find resistance per metre, inductance per metre and conductance per metre of the line.
18. What is the electric field of a point charge q in a system S which moves with a speed v_0 with respect to reference system S_0 ? The point charge is assumed to be at rest in the system S_0 .
19. Calculate the plasma frequency and maximum penetration depth for a plasma density of 10^{16} electrons/ m^3 .

(4 × 3 = 12 weightage)