22P108 (Pages: 2) Name: ....

Reg.No: ....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2022

(CBCSS - PG)

(Regular/Supplementary/Improvement)

CC19P PHY1 C03 - ELECTRODYNAMICS AND PLASMA PHYSICS

(Physics)

(2019 Admission onwards)

Time : 3 Hours Maximum : 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. What is displacement current?
2. Give the electromagnetic boundary conditions for an interface between two lossless linear media.
3. Write down the Maxwell's equations expressed in terms of phasors for a linear, isotropic and homogenous medium.
4. Define group velocity. Explain the case in which the group velocity is different from the phase velocity.
5. What is the input impedance of a short-circuited loss-less transmission line if the length of the line is (a) $\lambda/2$ (b)$\lambda/4$
6. Why is the TE_{10} mode in a rectangular waveguide is of particular practical importance?
7. What are the conditions for an ionized gas to become Plasma?
8. Explain why the group velocity for a plasma oscillation is zero.

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. Derive the non-homogenous wave equation for vector potential and then, obtain the retarded vector potential as a solution to this wave equation.
10. Give the boundary conditions for electromagnetic fields across a conducting boundary. Analyse the normal reflection of plane waves from a conducting boundary.
11. Obtain the time-harmonic transmission line equations. Discuss the wave characteristics on an infinite transmission line and hence analyse the cases of loss-less line, low-loss line and distortion-less line.
12. Show explicitly how the relativistic formulation of electrodynamics includes all four Maxwell's equations.

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage.

13. A circular ring in the x-y plane (radius R, centered at the origin) carries a uniform line charge λ. Find the first three terms (n = 0,1,2) in the multipole expansion for $V(r,\theta)$.

14. Use Maxwell's equations to show that for a harmonic wave propagating in a simple medium, the electric field and magnetic field are perpendicular to the direction of propagation of wave and both of these fields are perpendicular to each other.

15. Deduce the law of reflection and Snell's law by considering the incidence of electromagnetic waves on a plane dielectric boundary.

16. A distortion-less line has $Z_0 = 60\Omega, \alpha = 20mNp/m, u = 0.6c$ where c is the speed of light in vacuum. Find R, L, G and C.

17. A point charge q is at rest at the origin of a coordinate system S_o. What is the electric field of this charge in a system S moving along the positive x-axis with a speed v_o relative to S_o?

18. Compute the Larmor radius and cyclotron frequency for a 10keV electron in the earth's magnetic field of strength 5×10^{-5} T. Assume the $v_{parallel}$ to be neglible.

19. Compute number of particles and Debye length in Debye sphere for $n = 10^{19}\ m^3$.

(4 × 3 = 12 Weightage)