24P108 (Pages: 2) Name: .....

Reg.No: .....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2024

(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 are potentials? Write the expressions connecting fields and potentials.
2. Give the electromagnetic boundary conditions for a general interface.
3. What are the monopole and dipole terms in a multipole expansion?
4. Define propagation constant, attenuation constant and phase constant.
5. Write expressions for capacitance and inductance per unit length of a parallel plate transmission line.
6. Draw the equivalent circuit of a differential length of a two-conductor tranmission line.
7. Explain the characteristics of plasma.
8. Write the Boltzmann and Vlasov equations. Give its physical significance.

(8 × 1 = 8 Weightage)

Section B

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

9. Derive the non-homogenous wave equation for scalar potential and obtain the retarded scalar potential as a solution to this wave equation.
10. State the boundary conditions for electromagnetic fields across a conducting boundary. Give a brief analysis of the normal reflection of plane waves from a conducting boundary.
11. Discuss the propagation of TM waves in a rectangular waveguide and write the instantaneous field expressions for (TM_{11}) mode.
12. Derive the transformation of electric and magnetic fields under Lorentz transformation?

(2 × 5 = 10 Weightage)

Section C

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

13. Obtain the time-harmonic Maxwell's equations for source free simple media. Then show that if $(\mathbf{E}, \mathbf{H})$ are solutions to these equations, so is $(\mathbf{E}' = \eta\mathbf{H}, \mathbf{H}' = -\mathbf{E}/\eta)$, where $\eta = \sqrt{\mu/\epsilon}$ is the intrinsic impedance of medium.

14. A narrow-band signal propagates in a lossy dielectic medium which has a loss tangent 0.2 at 550kHz as the carrier signal firequency. The dielectric constant of a medium is 2.5. (a) Determine α and β. (b) Determine the group velocity and phase velocity.

15. Determine the amplitudes of the reflected and transmitted E and H in the case of normal reflection at the interface of region in which $\epsilon_{r2} = 8.5, \mu_{r2} = 1, \sigma = 0$ and E_{io}=1.5x10^{-3} V/m. Region 1 is free space.

16. Prove that the following wavelength relation holds for a uniform waveguide $(\frac{1}{\lambda_g^2}) = (\frac{1}{\lambda^2}) - (\frac{1}{\lambda_c^2})$. (λ_g) is the guide wavelength, (λ) is the wavelength in in-bound dielectric medium, and (λ_c) is the cut-off wavelength.

17. Obtain Ampere's law with Maxwell's correction from the relativistic Maxwell's equation.

18. Compute the Larmor radius for the following cases, when $v_{parallel}$ is neglible: (a) A 10keV electron in the earth's magnetic field of strength 5 x 10^{-5} T. (b) A solar wind proton with velocity 300km/s and B = 5 x 10^{-9} T.

19. For an plasma of density 10^{18} m^{-3}, find the value of magnetic field at which the plasma frequency for an electron is equal its cylclotron frequency.

(4 × 3 = 12 Weightage)

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