TM241314S

Reg. No :.....

Name :.....

MASTER'S DEGREE (C.S.S) EXAMINATION, NOVEMBER 2024

2024 ADMISSIONS REGULAR

SEMESTER I - CORE COURSE PHYSICS

PH1C03TM20 - Electrodynamics

Time : 3 Hours **Maximum Weight : 30**

Part A

I. Answer any Eight questions. Each question carries 1 weight **(8x1=8)**

1. Comment on the relation between magnetization M, magnetic flux density B and auxiliary field H.
2. Define polarization of a material.
3. State Biot-Savart's law.
4. What are monochromatic plane waves? Write the equations of electric and magnetic fields of a monochromatic plane wave.
5. State the reason behind the feature of excellent conductors as good mirrors.
6. From potential formulations of fields, deduce the time-dependent generalization of Coulomb Law.
7. Reframe Gauss's law and Ampere/Maxwell law in potential formulation.
8. Briefly explain the concept of radiation and state Larmor formula. Is it applicable to a relativistic particle?
9. Explain (i) current density 4- vector (ii) dual tensor
10. Express the field tensor in terms of 4- vector potential. Rewrite Lorentz gauge in relativistic tensor notations.

Part B

II. Answer any Six questions. Each question carries 2 weight **(6x2=12)**

11. Comment on the momentum conservation in electrodynamics.
12. Sea water at frequency $\nu = 4 \times 10^8 Hz$ has a permittivity $\epsilon = 81\epsilon_0$, permeability $\mu = \mu = \mu_0$, and resistivity $\rho = 0.23\ \Omega m$. What is the ratio of conduction current to displacement current? Assume a parallel plate capacitor immersed in sea water and driven by a voltage $V_0 cos(2\pi\nu t)$.
13. Find the wavelength and propagation speed in copper of conductivity $\sigma = 6 \times 10^7$ for radio waves at 1MHz.
14. Show that electromagnetic waves are transverse in nature.
15. Based on the total power radiated by a dipole, write an explanation for the blueness of the sky.
16. Convince that retarded potential V satisfies the inhomogeneous wave equation, $\nabla^2 V - \frac{1}{c^2}\frac{\partial^2 V}{\partial t^2} = -\frac{\rho}{\varepsilon_0}$.
17. The lowest frequency of an electromagnetic wave that can pass through an air-filled rectangular waveguide is fixed at 3000 Hz. What would be the dimensions of the rectangular waveguide?
18. An air-filled rectangular waveguide has dimensions a = 8 cm and b = 4 cm. Calculate the cut off frequencies for the following modes TE_{10}, TE_{20} and TE_{11}.

Part C

III. Answer any Two questions. Each question carries 5 weight **(2x5=10)**

19. Explain Maxwell's equations in matter and derive the boundary conditions of electric and magnetic fields.
20. Discuss the reflection of electromagnetic waves at a conducting surface.
21. Deduce the Larmor formula for a point charge in arbitrary motion
22. Reformulate Maxwell's equations and Lorentz force law using the relativistic tensor notation of fields.