QP CODE: 23145384

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Reg No : .....

Name : .....

M Sc DEGREE (CSS) EXAMINATION, DECEMBER 2023

First Semester

CORE - PH010103 - ELECTRODYNAMICS

M Sc PHYSICS,M.Sc.Space Science

2019 ADMISSION ONWARDS

5A14521A

Time: 3 Hours | Weightage: 30

Part A (Short Answer Questions)

*Answer any **eight** questions.*

*Weight **1** each.*

1. What is the dipole moment of a distribution of charge?
2. A steady current is flowing down a long cylindrical wire of radius a. Find the magnetic field both inside and outside the wire if the current is uniformly distributed over the outside surface?
3. Show that for the auxiliary field H, $\oint H.dl = I_f$
4. Explain the reflection and transmission coefficients of an electromagnetic wave incident normally on a boundary separating two linear medium.
5. Obtain the time dependent generalisation of Coulomb's law.
6. For a point charge moving in a specified trajectory, establish that only one retarded point contribute to the potentials at one instant.
7. What are the terms in the electric field which will give a non-zero contribution to power radiated for a moving point charge.
8. Give the Lorentz transformation equations for electromagnetic fields.
9. Express continuity equation in covariant form.
10. What will be the dominant mode for a TE wave propagating in a rectangular waveguide? Justify your answer.

(8×1=8 weightage)

Part B (Short Essay/Problems)

*Answer any **six** questions.*

*Weight **2** each.*

11. Show that the potential energy and torque of a dipole placed in an electric field is given by $U = -p.E$ and $\tau = p \times E$ respectively.
12. Find the vector potential of an infinite solenoid with n turns per unit length of radius R and current I.
13. Write down the electric and magnetic fields for a monochromatic plane wave of amplitude E_0 and frequency ω and phase angle zero traveling in the direction from the origin to the point $(1, 1, 1)$ and with polarisation parallel to the $x - y$ plane. Sketch the wave.
14. Show that the index of refraction of plasma is $n = \sqrt{1 - \frac{\omega_p}{\omega}}$.
15. Find the fields, and the charge and current distributions, corresponding to $V(r, t) = 0$ and $\vec{A}(r, t) = -\frac{1}{4\pi\epsilon_0}\frac{qt}{r^2}\hat{r}$.
16. An insulating circular ring (radius b) lies in the $x - y$ plane, centered at the origin. It carries a linear charge density $\lambda = \lambda_0 \sin\phi$, where λ_0 is a constant and ϕ is the usual azimuthal angle. The ring is now set spinning at a constant angular velocity ω about the z- axis. Calculate the power radiated.
17. Describe the transformation of a second rank tensor under Lorentz transformation as a matrix equation.
18. Show that the (ordinary) acceleration of a particle of mass m and charge q, moving at velocity u under the influence of electromagnetic fields E and B, is given by $\vec{a} = \frac{q}{m}\gamma\left[\vec{E} + \vec{u} \times \vec{B} - \vec{u}(u.E)/c^2\right]$, where $\gamma = \sqrt{1 - u^2/c^2}$.

(6×2=12 weightage)

Part C (Essay Type Questions)

*Answer any **two** questions.*

*Weight **5** each.*

19. Discuss the necessity of modifying Ampere's law in electrodynamics.Deduce Maxwell's equation in a linear dielectric medium.
20. An electromagnetic plane wave is propagating inside a conductor . Comment on the nature of propagation constant. Compute the energy density and intensity of the wave inside the conductor.
21. Obtain Abraham- Lorentz formula for radiation reaction. Describe the physical basis of radiation reaction.
22. Explain proper time, four velocity and four momentum. Describe the transformation properties of ordinary velocity and four velocity. Obtain the energy momentum relation for a free relativistic particle.

(2×5=10 weightage)