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Reg No : .....

Name : .....

M Sc DEGREE (CSS) EXAMINATION, NOVEMBER 2021

First Semester

Faculty of Science

CORE - PH010103 - ELECTRODYNAMICS

M Sc PHYSICS,M.Sc.Space Science

2019 ADMISSION ONWARDS

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Time: 3 Hours Weightage: 30

Part A (Short Answer Questions)

*Answer any **eight** questions.*

*Weight **1** each.*

1. What is meant by induced dipoles?
2. In regions where there is no charge Poisson's equation reduces to Laplace's equation . Does it imply the electric potential is zero everywhere? Explain.
3. What is the current density J of a conductor of conductivity σ placed in an electromagnetic field?
4. Sketch the directions of incident, reflected and transmitted electric and magnetic fields of a monochromatic wave traveling in the **z** direction polarised in the **x** direction incident normally on the boundary separating two linear media.
5. Write a short note on potential formulation of electrodynamics.
6. What is Lienard's generalisation of Larmor formula?
7. List the approximations used in obtaining the power radiated by an arbitrary localized source and explain the physical basis of these approximations.
8. Explain proper time.
9. Discuss the validity of Newton's second law of motion with the principle of relativity.
10. Express continuity equation in covariant form.

(8×1=8 weightage)

Part B (Short Essay/Problems)

*Answer any **six** questions.*

*Weight **2** each.*

11. The magnetic field of an infinite uniform surface current, $\vec{K} = k\hat{x}$,where k is a constant, flowing over the $x - y$ plane. Show that the field is independent of the distance from the plane.
12. A phonograph record of radius R carrying a uniform surface charge σ is rotating at constant angular velocity ω. Find its magnetic dipole moment.
13. Calculate the reflection coefficient for the light at an air - silver interface of conductivity $6 \times 10^7 (\Omega . m)^{-1}$ at optical frequencies ($\omega = 4 \times 10^{15}/s$ assume $\mu = \mu_0$ and $\epsilon = \epsilon_0$)
14. Show that for plasma, frequencies greater than plasma frequency, the EM waves propagate without attenuation.
15. Show that the retarded potential $A(r, t)$ satisfy the inhomogeneous wave equation $\Box^2 \mathbf{A} = -\mu_0 \mathbf{J}$.
16. With the inclusion of the radiation reaction force, Newton's second law for a charged particle becomes $a = \tau \dot{a} + \frac{F}{m}$, where F is the external force acting on the particle. A particle is subjected to a constant force F , beginning at time $t = 0$ and lasting until time T. Find the most general solution $a(t)$ to the equation of motion in each of the two periods $(i)\ t < 0,\ (ii)\ 0 < t < T$.
17. Show that $\Lambda g \Lambda^T = g$, where Λ is the Lorentz transformation matrix in x direction and g (metric tensor) is a 4×4 diagonal matrix with first diagonal element -1 and all other diagonal elements 1.
18. Show that $E.B$ is invariant under Lorentz transformations.

(6×2=12 weightage)

Part C (Essay Type Questions)

*Answer any **two** questions.*

*Weight **5** each.*

19. Discuss the conservation of energy in electrodynamics.
20. Show that the electric and magnetic field vectors are perpendicular to each other and also perpendicular to the direction of propagation of the wave. Calculate
    1. average value of power density transported,
    2. average value of momentum density stored,
    3. radiation pressure exerted on a perfect reflector by the electromagnetic fields.
21. Calculate the electric and magnetic fields of a moving point charge q moving in a specified trajectory starting from Lienard-Wiechert potentials.
22. Discuss the propagation of TE waves through a rectangular waveguide and obtain an expression for the cut-off frequency.

(2×5=10 weightage)