D1APH2303 **(2 Pages)** **Name.....**
Reg.No.....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023
(Regular/Improvement/Supplementary)

PHYSICS
FPHY1C03-ELECTRODYNAMICS AND PLASMA PHYSICS

Time: 3 Hours **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.

1. Write down four Maxwell's equations in differential and integral forms. Also mention its significance.
2. Define phasors and explain briefly its importance in electromagnetism.
3. What are evanescent waves?
4. What is meant by a "distortionless line"? When does a transmission line become a distortionless line?
5. Define Impedance matching of transmission line.
6. Define 4-vector potentials. Also write down the relation which connects the field tensor and 4- vector potential's.
7. Define plasma.
8. Write a short note on Debye shielding.

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. Derive the expansion for the potential at large distance due to a localised charge distribution. Also show that if the total charge is zero, dipole moment is independent of the origin of the coordinate system.
10. An electromagnetic wave in dielectric medium 1 (ϵ_1, μ_0) impinges obliquely on a boundary plane with dielectric medium 2 (ϵ_2, μ_0). Let θ_i and θ_t denote the incident and refraction angels respectively, then derive the following relation for parallel polarisation $\Gamma \parallel = \frac{sin2\theta_t - sin2\theta_i}{sin2\theta_t + sin2\theta_i}$ and $\tau \parallel = \frac{4sin\theta_t cos\theta_i}{sin2\theta_t + sin2\theta_i}$
11. Prove that, when a finite transmission line is matched, its voltage and current distributions are exactly same as though the line has been extended to infinity.
12. Explain the motion of charged particle in uniform electric and magnetic fields. Derive the expression for drift velocity.

(2 × 5 = 10 weightage)

(P.T.O.)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. Show that the magnetic field of a dipole can be written in coordinate free form as $B_{dip}(r) = \frac{\mu_0[3(\hat{m}.\hat{r})\hat{r}-m]}{4\pi r^3}$.

14. The electric filed intensity of a linearly polarised uniform plane propagating in the +z direction in sea water ($\epsilon_r = 72, \mu_r = 1$) is $E = a_x 100cos(10^7\pi t)(\frac{V}{m})$ at z= 0. The conductivity of the sea water is $\sigma = 4(\frac{S}{m})$. Determine: attenuation constant, intrinsic impedance, phase velocity and $H(z,t)$.

15. It is found that the attenuation on a 50 (Ω) distortionless transmission line is 0.01 (dB/m). The line has capacitance of 0.1 (nF/m).

    i) Find the resistance, inductance and capacitance per meter of the line.

    ii) Find the velocity of propagation.

    iii) Determine the percentage to which the amplitude of voltage of a travelling wave decreases in 1 (km) and in 5 (km).

16. Show that $E.B$ is relativistically invariant.

17. Calculate the electric field of a point charge in uniform motion.

18. Compute the tensor invariant quantity $F^{\mu\nu}.G_{\mu\nu}$.

19. A distant galaxy contains a cloud of protons and anti-protons each with density $10^5\ m^{-3}$ and temperature 1000 K. What is the Debye length?

(4 × 3 = 12 weightage)