

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2017**

(CUCSS)

Physics

**PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS**

(2017 Admissions)

Time : Three Hours

Maximum : 36 Weightage

**Section A***Answer all questions.**Each carries weightage 1.*

1. Write down the Lorentz gauge for potentials.
2. Write down the boundary conditions between two lossless media.
3. Define the intrinsic impedance of a medium. What is the value of intrinsic impedance at free space ?
4. Explain the skin depth of a conductor.
5. Explain the different guiding structures that support TEM waves.
6. Distinguish between the surface resistance and the resistance per unit length of a parallel plate transmission line ?
7. Define the quality factor of a resonator ?
8. Define a 4 - vector current density ?
9. Give the Lorentz force law in relativistic notation.
10. Explain the significance of Debye length.
11. Define the term 'armor radius'
12. Give the importance of Vlasov equation.

(12 × 1 = 12 weightage)

**Turn over**

## Section B

Answer any two questions.

Each carries weightage 6.

13. Obtain the behaviour of electric and magnetic field components of a uniform plane wave incident normally on a plane conducting boundary ?
14. Explain the propagation of TM modes for a rectangular waveguide. Find the ratio of the lowest TM cut off frequency to the lowest TE cut off frequency ?
15. Obtain the electromagnetic field tensor ? Derive the equation of continuity in tensor notation ?
16. Explain the motion of charged particles in uniform magnetic and electric fields. Derive an expression for drift velocity ?

(2 × 6 = 12 weightage)

## Section C

Answer any four questions.

Each carries weightage 3.

17. Find the electric field at a height  $z$  above the center of a square sheet of side ' $a$ ' and carrying a uniform surface charge  $\sigma$ . Deduce the result for the limiting cases when ' $a$ ' tends to infinity and  $z \gg a$ .
18. A sinusoidal electric intensity of amplitude 25V/m and frequency 5GHz exists in a lossy dielectric medium that has a relative permittivity of 1.5 and a loss tangent of 0.001. Find the effective conductivity and the average power density dissipated in the medium ?
19. Find the Poynting vector on the surface of a long, straight conducting wire (of radius  $b$  and conductivity  $\sigma$ ) that carries a direct current  $I$ . Verify Poynting's theorem.
20. A  $100 \Omega$  lossless transmission line of 5 m long is connected to a signal generator having an internal resistance  $0.5 \Omega$  and an open-circuit voltage  $v_g = 0.2 \cos 2\pi 10^9 t$ . The velocity of wave propagation on the line is  $2 \times 10^9$  m/s. Assuming the matched load, find the values of: (i) instantaneous voltage and current at an arbitrary point on the line, and (ii) the average power transmitted to the load ?
21. Prove that the expressions, (i)  $(\mathbf{E} \cdot \mathbf{B})$  and (ii)  $(\mathbf{E}^2 - c^2 \mathbf{B}^2)$  are relativistically invariant.
22. (a) In a Fusion reactor, the ions are compressed to a density of  $10^{36}/\text{m}^3$  at a temperature of  $5 \times 10^8$  K. Compute the values of  $N_0$  and  $\lambda_D$  ?  
(b) Compute the larmor radius for a 5KeV electron in the earth's magnetic field of strength  $5 \times 10^{-4}$  T ?

(4 × 3 = 12 weightage)