

**21P108**

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Name: .....

Reg.No: .....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2021**

(CBCSS - PG)

(Regular/Supplementary/Improvement)

**CC19P PHY1 C03 - ELECTRODYNAMICS AND PLASMA PHYSICS**

(Physics)

(2019 Admission onwards)

Time : 3 Hours

Maximum : 30 Weightage

**Section A**

Answer *all* questions. Each question carries 1 weightage.

1. Explain how the definition of loss tangent is used to classify conductivity of a material?
2. What do you mean by time-harmonic fields?
3. Discuss the effect of choice of origin of coordinates on the monopole and dipole terms of multipole expansion.
4. Explain the kinematic properties of reflection and refraction of electromagnetic waves.
5. What is the essential difference between transmission lines and ordinary electric networks?
6. What is meant by quarter wave transformer?
7. Show that in a plasma oscillation disturbance do not propagate.
8. Explain why the group velocity for a plasma oscillation is zero.

**(8 × 1 = 8 Weightage)**

**Section B**

Answer any *two* questions. Each question carries 5 weightage.

9. Derive the relation connecting the three electric vectors E, P and D and discuss the electromagnetic boundary conditions for a dielectric boundary.
10. Analyse the propagation of EM waves in a conducting medium and obtain an expression for the skin depth.
11. Discuss the propagation of TM waves in a rectangular waveguide and obtain an expression for the cut-off frequency and phase velocity.

12. Show explicitly how the relativistic formulation of electrodynamics includes all four Maxwell's equations.

**(2 × 5 = 10 Weightage)**

### Section C

Answer any *four* questions. Each question carries 3 weightage.

13. Obtain an expression for displacement current for a capacitor. A parallel plate capacitor with circular plates of radius 4 cm is charged with a change in electric field of  $10^{10}$  V/m-s. Calculate the displacement current.
14. Derive the relation between group velocity and phase velocity. Specify how they are related for anomalous dispersion and normal dispersion.
15. A y-polarized uniform plane wave with a frequency 200MHz propagates in air and is incident normally on a conducting plane at  $x=0$ . Assuming the amplitude for electric field is 10 V/m, write the phasor expression for (a) incident electric and magnetic field (b) reflected electric and magnetic field (c) total electric and magnetic field in the air (d) determine the location nearest to the conductor in the air medium, where the total electric field is zero.
16. Determine the wave impedance and guide wavelength at a frequency equal to one-third the cutoff frequency in a waveguide for TEM, TM and TE modes. Identify the characteristic mode of the waveguide for this frequency for TEM, TM and TE waves.
17. Prove that the symmetry (or anti symmetry) of a tensor is preserved by Lorentz transformation.
18. Find the debye length and the number of particles in Debye sphere for a typical radiofrequency plasma where particle density is  $10^{17}$  m<sup>-3</sup> and  $KT_e = 1.5$  eV.
19. Compute the Larmor radius for the following cases, when  $v_{\text{parallel}}$  is negligible:  
(a) A 10keV electron in the earth's magnetic field of strength  $5 \times 10^{-5}$  T.  
(b) A solar wind proton with velocity 300km/s and  $B = 5 \times 10^{-9}$  T.

**(4 × 3 = 12 Weightage)**

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