19P108 (Pages: 2) Name: …….……

Reg. No…….……...

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2019

(CUCSS PG)

CC19P PHY1 C03 – ELECTRODYNAMICS AND PLASMA PHYSICS

(Physics)

(2019 Admission Regular)

Time: Three Hours Maximum: 30 Weightage

Part A

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

1. Give the electromagnetic boundary conditions in a time varying case for an interface between a dielectric medium and a perfect conducting medium.
2. Write a short note on plasma. What is the significance of plasma frequency?
3. Define Brewster angle. When does it exist at an interface of two non magnetic media?
4. What is meant by a quarter wave transformer? Why is it not useful for matching a complex load impedance to a low-loss line?
5. Single conductor waveguides cannot support TEM waves. Why?
6. Prove that $E^2 - c^2B^2$ is relativistically invariant.
7. Plasma can have several temperatures at the same time. Why?
8. Justify the statement that 'Plasma is quasi-neutral'.

(8 x 1 = 8 Weightage)

Part B

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

9. Discuss in detail, the reflection and transmission of an e.m. wave incident normally at a plane dielectric boundary. Mention the important theoretical observations.
10. Obtain the time harmonic transmission line equations. Discuss the wave characteristics on an infinite transmission line and hence, analyze the three cases of lossless line, low loss line and distortion less line.
11. Formulate Maxwell's equations and Lorentz force law in relativistic notations.
12. Discuss the motion of charged particles in uniform electric and magnetic fields and obtain the expression for drift velocity. Hence establish that current cannot flow in neutral plasma subjected to uniform electric and magnetic fields.

(2 x 5 = 10 Weightage)

Part C

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

13. A circular ring in the x − y plane (radius R, centered at the origin) carries a uniform line charge λ. Find the first three terms (n = 0, 1, 2) in the multipole expansion for V (r, θ)
14. Prove that the sum of the Brewster angle and the angle of refraction is π/2 for perpendicular polarization ($\mu_1 \neq \mu_2$) under the condition of no reflection at an interface.
15. Consider a transmission line made of two parallel brass strips of σ_c = 1.7 x 10^7 S/m of width 25 mm and separated by a lossy dielectric slab of $\mu = \mu_0$, ε_r = 3, $\sigma = 10^{-3}$ S/m of thickness 2.0 mm. The operating frequency is 500 MHz Calculate the R, L, G, and C per unit length.
16. Write the electric and magnetic field components for TE waves in a rectangular waveguide. Hence prove that the TE_{10} mode is the dominant mode of a rectangular waveguide with a > b where a and b are the length and breadth of the rectangular cross section.
17. Prove that the relativistic transformation rules for the electric and magnetic field components of a moving system constitute an antisymmetric second rank field tensor.
18. Show that $\frac{\partial G^{\mu\nu}}{\partial x^{\nu}} = 0$ can be expressed in terms of field tensor $F^{\mu\gamma}$ as

$$\frac{\partial F_{\mu\nu}}{\partial x^{\lambda}} + \frac{\partial F_{\nu\lambda}}{\partial x^{\mu}} + \frac{\partial F_{\lambda\mu}}{\partial x^{\nu}} = 0$$

19. For a low density plasma, the dispersion relation is given by $\omega^2 = \omega_0^2 + c^2k^2$, where k is the wave vector and ω_0 the plasma frequency. Derive a relation between the phase velocity and group velocity of the plasma.

(4 x 3 = 12 Weightage)

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