M SC DEGREE END SEMESTER EXAMINATION 2014 -15
SEMESTER -1: PHYSICS
COURSE: P1PHYT03 - ELECTRODYNAMICS

Time: 3 Hours   Max. Marks: 75

Part A
Answer **all** questions.

1. Which of these statements is not characteristic of a static magnetic field?
    a. It is solenoidal   b. It is conservative
    c. It has no sinks or source   d. They are always closed

2. The flux through each turn of a 100 turn coil is (t^3 – 2t) mWb, where t is in seconds is
    a.1V   b. -1V   c. 4mV   d. 0.4V

3. Which is the main factor for determining whether a medium is free space, lossless dielectric, lossy dielectric, or a good conductor?
    a. Attenuation Constant   b. Constitutive parameters (σ, ε, μ)
    c. Loss Tangent   d. Reflection Coefficient

4. The dominant mode in a rectangular waveguide is
    a. TE_{11} b. TM_{11} c. TE_{01} d. TE_{10}

5. A Quarter wave monopole antenna operating in air at a frequency 1MHz must have an overall length of
    a. 300m   b. 150m   c. 75m   d. 100m

(5 x 1 = 5)

Part B (Short Answer)
Answer any **Five** of the following

6. Explain Maxwell's stress Tensor.
7. Distinguish between Coulomb Gauge and Lorentz Gauge.
8. What is meant by loss tangent and loss angle of a medium?
9. What is Radiation Resistance?
10. Explain the Directivity and gain of an antenna.
11. What is meant by characteristic impedance of a transmission line?
12. What are Reflection and Transmission coefficients? How they are related?
13. In what respects a waveguide is different from a transmission line?

(5 x 2 = 10)

Part C
Answer any **three** of the following

14. For a conducting medium obeying Ohm's law, $J = \sigma E$, show that $\dfrac{\partial \rho}{\partial t} + \dfrac{\sigma \rho}{\varepsilon} = 0$. Also prove that if initially there is charge density at any point inside the conducting medium, then the charge density at a later time is given by $\rho = \rho_0 \exp\left\{ -\sigma / \varepsilon \right\} t$, where σ is the conductivity and $\dfrac{\varepsilon}{\sigma}$ is the relaxation time.

15. The magnetic field of the TE_{11} mode in a rectangular waveguide of dimensions a x b is given by $H_z = H_0 \cos(0.3 \pi x) \cos(0.4 \pi y)$, where x and y are in cm. Determine the waveguide dimensions and the cutoff frequency.

16. Find the skin depth δ and the wave velocity at a frequency of 1.6 MHz in Aluminium, where σ = 38.2 MS/m and $\mu_r = 1$.

17. A magnetic field strength of 5µA/m is required at a point on θ = π/2 which is 2 Km from an antenna in air. Neglecting ohmic loss, how much power must an antenna transmit if it is a half wave dipole?

18. Show that the velocity of propagation of an electromagnetic wave along a parallel plate transmission line $v_p = \dfrac{1}{\sqrt{LC}}$.

(3 x 4 = 12)

Part D
Answer all questions. Each question carries 12 Marks

19. (a)Discuss with relevant theory the reflection and transmission of a plane electromagnetic wave in the z-direction, incident normally on a boundary in x-y plane between two linear media with indices of refraction n_1 and n_2.

OR

(b)Obtain expressions for the energy and momentum of a plane electromagnetic wave and derive the relation between them.

20. (a)Write a note on: i) Current density 4-vector

ii) 4-vector potential

iii) Electromagnetic field tensor

OR

(b) Derive the Maxwell's equations in the Tensor form.

21. (a) Derive an expression for the energy radiated by an oscillating electric dipole.

OR

(b) Assuming Lienard-Wiechert potentials, find the field vectors of an accelerated point charge.

22. (a) Discuss the propagation of TE waves in a rectangular waveguide and derive the expression for the cut-off frequency.

OR

(b)Derive the general transmission line equation for a two conductor parallel transmission line.   (4 x 12 = 48)