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Derive electromagnetic wave equation for a conducting medium Derive vector Helmholtz equation.

Unit - V

- What is frequency dispersive propagation?
- Define phase velocity and group velocity?
- What is magnetic vector potential?
- Give mathematical analysis of Brewster's angle?

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Give mathematical analysis for reflection at the surface of a conductive medium of e.m. waves.

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EC - 402**B.E. IV Semester**

Examination, June 2016

Electro-Magnetic Theory**Time : Three Hours****Maximum Marks : 70**

- Note:** i) Answer five questions. In each question part A, B, C is compulsory and D part has internal choice.
 ii) All parts of each question are to be attempted at one place.
 iii) All questions carry equal marks, out of which part A and B (Max. 50 words) carry 2 marks, part C (Max. 100 words) carry 3 marks, part D (Max. 400 words) carry 7 marks.
 iv) Except numericals, Derivation, Design and Drawing etc.

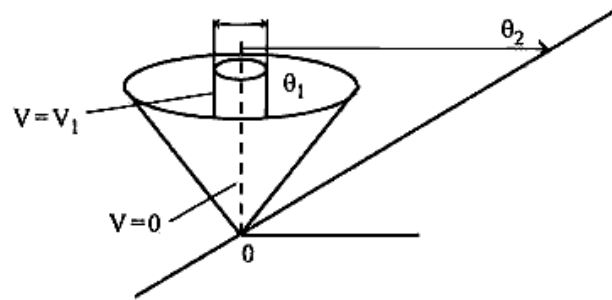
Unit - I

- Write formula for divergence in cartesian, cylindrical and spherical co-ordinate systems?
 - What is electric field intensity?
 - Find the work done in moving a point charge $Q = -20 \mu\text{C}$ from the origin to (4, 0, 0) m in the field $\vec{E} = \left(\frac{x}{2} + 2y \right) \vec{a}_x + \partial \tau \cdot \vec{a}_y \text{ V/m}$.
 - Calculate the potential at a point
 - Outside
 - Inside a uniformly charged sphere of radius = (a).

[2]

OR

Solve Laplace's equation for the region between co-axial cones. Given at $\theta = \theta_1$, $V = V_1$ and $\theta = \theta_2$, $V = 0$. The cone vertices are insulated at $r = 0$.



Define potential function and potential difference?

Unit - II

2. a) Write expression for capacitance of an isolated sphere.
- b) Derive Poisson's equation and Laplace's equation.
- c) Calculate the potential at $r_A = 3\text{m}$ w.r.t $r_B = 9\text{m}$ due to a point charge $Q = 500\text{ PC}$ at the origin and zero reference at infinity.
- d) Derive expression for energy stored and energy density in a magnetic field? Calculate the magnetic flux density at the centre of a current carrying loop when the loop radius is 2 cm loop current is 1 mA and the loop is placed in air.

OR

Derive expressions for inductance of

- i) Solenoid
- ii) Toroid of circular cross-section
- iii) Toroid of rectangular cross-section
- iv) Co-axial cable.

[3]

Unit - III

3. a) Calculate the skin depth in copper at 10 GHz . Assume conductivity of copper $\sigma = 5.8 \times 10^7\text{ mhos/m}$ and permeability equal to that of free space?
- b) Derive expressions for Instantaneous poynting vector.
- c) Derive expressions for energy stored and energy density in static electric field.
- d) Derive wave equations for non-conducting medium?

OR

- Give a general solution of Maxwell's equations w.r.t. uniform plane waves?

Unit - IV

4. a) Calculate the phase velocity and the magnitude of the attenuation constant of plane wave at a frequency of 10 GHz in polyethene. It is given that $\mu = \mu_0$, $\epsilon_r = 2.3$ and $\sigma = 2.56 \times 10^{-4}\text{ mhos/m}$.
- b) What do you mean by horizontal polarization?
- c) If a parallel polarized electromagnetic wave is incident from air on to the surface of
 - i) Paraffin with $\mu_r = 1$, $\epsilon_r = 2.1$
 - ii) Flint glass with $\mu_r = 1$, $\epsilon_r = 10$
 - iii) Distilled water with $\mu_r = 1$, $\epsilon_r = 81$. Find the Brewster angle θ_{IB} in each of the cases.
- d) Give mathematical analysis of elliptical polarization.