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10EE44

Fourth Semester B.E. Degree Examination, June/July 2013
Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. State and explain Coulomb's law of force between the two point charges. Also indicate the units of quantities in the force equation. **(05 Marks)**

b. State and apply Gauss law to obtain an expression for the electric field intensity due to an infinite sheet of charge with a surface charge density ρ_s C/m^2 and area A m^2. **(10 Marks)**

c. Find : i) Electric field intensity and ii) Electric flux density at the origin due to $Q_1 = 0.35\,\mu C$ at (0, 4, 0) m and $Q_2 = -0.55\,\mu C$ at (3, 0, 0) m. **(05 Marks)**

2 a. Explain with mathematical expressions: i) Potential difference ii) Absolute potential iii) Potential gradient. **(06 Marks)**

b. Derive an expression for the equation of continuity of current. **(06 Marks)**

c. At the boundary between glass ($\epsilon_r = 4$) and air, the lines of electric field make an angle of 40° with normal to the boundary. If electric flux density in air is 0.25 μC/m^2, determine the orientation and magnitude of, i) Electric flux density and ii) Electric field intensity, in glass. **(08 Marks)**

3 a. Derive Poisson's and Laplace equations starting from point form of Gauss law. **(06 Marks)**

b. Using Laplace equation derive an expression for the capacitance of a concentric spherical capacitor. The inner spherical conductor is of radius 'a' and potential V, while outer conductor is of radius 'b' and potential zero. **(08 Marks)**

c. Determine whether or not the following potential fields satisfy Laplace's equation :
i) $V = 2x^2 - 3y^2 + z^2$ ii) $V = r^2 + z^2$ **(06 Marks)**

4 a. Write an explanatory note on Biot Savarts law. **(04 Marks)**

b. Discuss the concept of scalar and vector magnetic potential and arrive at the expressions for Poissons equation in magnetostatics. **(08 Marks)**

c. State and prove ampere's circuital law and apply it to a straight solid conductor to calculate the magnetic field intensity. **(08 Marks)**

PART – B

5 a. Find the expression for the force on differential current carrying elements. **(06 Marks)**

b. Define Lorentz force equation and mention the application of its solution. **(06 Marks)**

c. Calculate the inductance of a Solenoid of 200 turns wound tightly on a cylindrical tube of length 60 cm and of diameter 6 cm, with air as media. Derive the expression used. **(08 Marks)**

6 a. With necessary relationships, explain Faradays law of electromagnetic induction for both static and time varying conditions. **(10 Marks)**

b. Starting from Faradays law of electromagnetic induction derive $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$. **(06 Marks)**

c. Find the frequency at which conduction current density and displacement current density are equal in a medium with $\sigma = 2 \times 10^{-4}$ s/m and $\epsilon_r = 81$. **(04 Marks)**

7 a. What is uniform plane wave? Explain its propagation in free space with necessary equation. **(08 Marks)**

b. Define skin depth and depth of penetration. **(08 Marks)**

c. For copper the conductivity is 58 mega-s/m. Find the skin depth at a frequency of 10 MHz. **(04 Marks)**

8 a. With necessary equations, explain standing wave ratio. **(10 Marks)**

b. Find weather the wet, marshy soil characterized by $\sigma = 10^{-2}$ s/m, $\epsilon_r = 15$ and $\mu_r = 1$ may be considered as a conductor, a dielectric or neither for the frequencies: i) 60 Hz ii) 1 MHz iii) 100 MHz iv) 10 GHz. **(10 Marks)**

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