2002 SCHEME

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EC44

Fourth Semester B.E. Degree Examination, June 2012
Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

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.

1 a. Explain the terms electric potential and electric field intensity. Obtain a relation between them in rectangular coordinates. **(06 Marks)**

b. Derive an expression for the electric field intensity at a point on the axis of a charged circular ring. Hence show that the electric field at the center of the ring is zero. **(08 Marks)**

c. A line charge density $\rho_L = 50$ nC/m is located along the line x = 0, y = 5 in free space. Find the magnitude and direction of the electric field intensity at a point P(1, 3, –4). **(06 Marks)**

2 a. Using the Gauss law obtain an expression for the electric field at some distance from an uniformly charged infinite plane sheet. **(06 Marks)**

b. State and prove Gauss divergence theorem, hence arrive at Poisson's equation. **(08 Marks)**

c. Find the total charge in a volume defined by six planes for which $1 \le x \le 2$, $2 \le y \le 3$, $3 \le z \le 4$, if $\vec{D} = \left(4x\hat{a}_x + 3y^2\hat{a}_y + 2z^2\hat{a}_z\right)$ Coulomb/m^2. **(06 Marks)**

3 a. Applying Laplace equation show that the potential in the space between the two conductors of a co-axial cable of infinite length is $V = V_0 \dfrac{\ln(R_2/n)}{\ln(R_2/R_1)}$, where $R_1 < r < R_2$

$V_0 \rightarrow$ Potential on the inner conductor
$R_1 \rightarrow$ Radius of the inner conductor
$R_2 \rightarrow$ Radius of the outer conductor **(07 Marks)**

b. Prove that the energy density in an electrostatic field is $\frac{1}{2}\vec{D}\cdot\vec{E}$ where D and E are the electric flux density and the electric field intensity respectively. **(08 Marks)**

c. Calculate the potential at the center of a square of side 2m, while charges 2μc, – 4μc and 2μc are located at its four corners. **(05 Marks)**

4 a. Derive the boundary conditions at the interface of two different dielectric media in an electric field. **(06 Marks)**

b. On the basis of Biot-Savart law, obtain an expression for the magnetic field intensity at some distance due to a current carrying straight conductor of infinite length. **(08 Marks)**

c. A circuit carrying direct current of 5 A forms a hexagon inscribed in a circle of radius 1 m. Calculate the magnetic flux density at the center of the current hexagon. Assume the medium is free space. **(06 Marks)**

5 a. Distinguish between scalar and vector magnetic potential. Derive an expression for the vector magnetic potential. **(08 Marks)**

b. Obtain Faraday's law of electromagnetic induction in integral form and hence arrive at the differential form of Faraday's law. **(08 Marks)**

c. A solenoid with air core has 2000 turns and length 50 cm, core radius 4 cm. Find its inductance. Find the total flux if 1 ampere of current flows trough the solenoid. **(04 Marks)**

6 a. Using Ampere's circuital law, derive Maxwell's curl equation

$$\nabla \times \vec{B} = \mu_o \cdot \vec{J}$$ **(06 Marks)**

b. Derive expressions for i) Motional e.m.f. and ii) Energy stored in a magnetic field in a magnetic field. **(08 Marks)**

c. In a lossy dielectric medium, the conduction current density is given by $J = 0.02 \sin 10^9 t$ ampere/m^2. Find the displacement current density, if $\sigma = 10^3$ s/m and $\in_r = 6.5$. **(06 Marks)**

7 a. Prove and explain the Poynting theorem using Maxwell's equations. **(08 Marks)**

b. Prove that traveling electromagnetic waves are transverse in nature. **(06 Marks)**

c. Using Maxwell's equations, show that the free space wave equation in E may be written as

$$\nabla^2 \vec{E} - \mu \in \frac{\partial \vec{E}}{\partial t^2} = 0$$ **(06 Marks)**

8 Write explanatory notes on the following :

a. Equation of continuity

b. Skin effect

c. Uniqueness theorem

d. Ampere's circuital law. **(20 Marks)**

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