EC44

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NEW SCHEME

Fourth Semester B.E. Degree Examination, Dec. 06 / Jan. 07
EC/EE/BM/TE/ML/IT
Field Theory

Time: 3 hrs.] [Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Assume the missing data, if any.

1 a. Charge is uniformly distributed on a circular ring of radius a. Find the vector E at a height h (h < a), along the axis normal to the plane of the ring charge. **(05 Marks)**

b. Charges of 20 nC and -20 nC are located at (3,0,0) and (-3,0,0) respectively. Let $\varepsilon = \varepsilon_0$. Determine |E| at P(0,y,0). **(05 Marks)**

c. Find the electric field E at origin, if the following charge distributions are present in free space:
- Point charge 12 nC at P(2,0,6)
- Uniform line charge of linear charge density 3 nC/m at x = 2, y = 3
- Uniform surface charge of density 0.2 nC/m^2 at x = 2. **(10 Marks)**

2 a. Derive an expression for field due to a uniformly charged infinite plane sheet, using Gauss's law. **(05 Marks)**

b. A charge Q is uniformly distributed in a square ring of side '*l*'. Find E and V at the centre of the ring. **(05 Marks)**

c. There exists a potential of V = -2.5 volts on a conductor at 0.02 m and V = 15 volts at r = 0.35 m. Determine E and D by solving the Laplace's equation in spherical coordinates representing the potential system. **(10 Marks)**

3 a. Let $\overline{D} = (2y^2z - 8xy)\overline{a}_x + (4xyz - 4x^2)\overline{a}_y + (2xy^2 - 4z)\overline{a}_z$. Determine the total charge within a volume of 10^{-14} m^3 located at P(1,-2,3). **(05 Marks)**

b. Derive the boundary conditions on E and D at the interface of perfect dielectrics. **(05 Marks)**

c. State and prove Maxwell's Divergence theorem applied to electrostatic fields. **(10 Marks)**

4 a. State and prove Uniqueness theorem. **(05 Marks)**

b. Given vector $E = (12yx^2 - 6z^2x)a_x + (4x^3 + 18zy^2)a_y + (6y^3 - 6zx^2)a_z$, check whether it represents a possible electric field. **(05 Marks)**

c. Conducting spherical shells with radii a = 10 cm and b = 30 cm are maintained at a potential difference of 100 V such that V(r = b) = 0 and V(r = a) = 100 V. Determine V and E in the region between the shells. If $\varepsilon_r = 2.5$ in the region, determine the total charge induced on the shells and the capacitance there on. **(10 Marks)**

5 a. The conducting triangular loop in fig.5(a) carries a current of 10 A. Find vector H at (0,0,5) due to side 1 of the loop. **(05 Marks)**

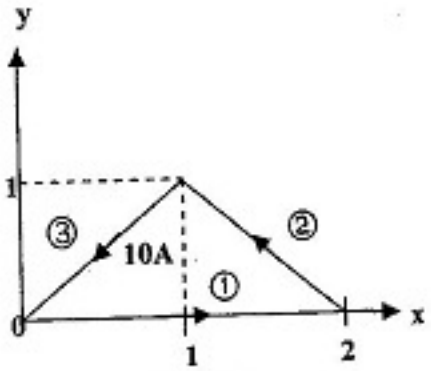

Fig.5(a)

b. A current element 4 cm long is along y-axis with a current of 10 mA flowing in y-direction. Determine the force on the current element due to the magnetic field, if the magnetic field $H = [5\ a_x / \mu]$ A/m. **(05 Marks)**

c. State Biot-Savart's law. Determine the flux density at a given point due to a current carrying element of finite length and extend it for the case of infinitely long straight conductor. **(10 Marks)**

6 a. Derive the boundary conditions on H and B. **(05 Marks)**

b. Explain the concept of scalar and vector magnetic potentials. **(05 Marks)**

c. A parallel plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage of $50\sin 10^3 t$ Volts applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$. **(10 Marks)**

7 a. With suitable assumptions, workout the solution of wave equation for uniform plane wave propagating in free space. **(10 Marks)**

b. Derive the wave equation for vector E and H fields in a conducting medium. **(10 Marks)**

8 Write explanatory notes on:

a. Energy density in electric field.

b. Force between two current elements.

c. Maxwell's equations in point and integral forms for time varying fields.

d. Wave propagation in lossy dielectric. **(20 Marks)**