CBCS Scheme

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15EE45

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing one full question from each module.***

Module-1

1 a. Define field intensity at a point. Derive the expression for field intensity at a point due 'n' point charges kept in free space. **(05 Marks)**

b. Find the following :

i) Gradient of the scalar field $u = \rho^2 z \cos 2\phi$

ii) Divergence of the vector $\bar{A} = x^2 yz\, a\bar{x} + xz\, a\bar{z}$ **(06 Marks)**

c. If $\bar{D} = \rho\, z \cos^2 \phi\, a\bar{z}\ c/m^2$, determine the volume charge density and the flux crossing the surface bound by $0 \le \phi \le 2\pi$; $0 \le \rho \le 1$; $-2 \le z \le 2$. **(05 Marks)**

OR

2 a. State and prove Gauss's law. **(06 Marks)**

b. Three field quantities are given by

$P = 2a\bar{x} - a\bar{z}$; $Q = 2a\bar{x} - a\bar{y} + 2a\bar{z}$;

$R = 2a\bar{x} - 3a\bar{y} + a\bar{z}$

Determine :

i) $\bar{Q} \cdot \bar{R} \times \bar{P}$

ii) Angle between $\bar{Q}$ and $\bar{R}$

iii) Unit vector perpendicular to both $\bar{Q}$ and $\bar{R}$. **(06 Marks)**

c. An infinite line charge with charge density 20 n c/m is kept along x = 2m and y = –4m. Find the electric field intensity at a point P (-2, -1, 4). **(04 Marks)**

Module-2

3 a. With usual notations derive the expression for energy required to assemble 'n' point charges in space. **(05 Marks)**

b. Derive the boundary conditions the interface between a conductor and free space. **(05 Marks)**

c. For a potential field $V = 2x^2y - 5z$, determine the following at a point P(–4,3,6)

i) Electric field intensity, $\bar{E}$

ii) Flux density, $\bar{D}$

iii) Volume charge density, ρ_v **(06 Marks)**

OR

4 a. Prove that $\bar{E} = -\nabla V$ in an electric field. **(04 Marks)**

b. Derive the expression for capacitance of a parallel plate capacitor. **(06 Marks)**

c. Find the work done in moving a charge of 2C from (2, 0, 0) to (0, 2, 0)m along a straight line path joining the two points if $\bar{E} = 120x\, a\bar{x} + 4y\, a\bar{y}$. **(06 Marks)**

Module-3

5 a. State and prove uniqueness theorem. (05 Mark

b. State and explain Biot – Savart law. (05 Mark

c. A semi infinite conducting planes at $\phi = 0$ and $\phi = \pi/6$ are separated by an infinitesim insulating gap. If $V_{(\phi=0)} = 0$ and $V_{(\phi=\pi/6)} = 100V$. Calculate the V and $\bar{E}$ in the regi between the plate. (06 Mark

OR

6 a. Derive Poisson's and Laplace in Cartesian co-ordinates from Gauss's law in point form a write the expressions in cylindrical and spherical systems. (06 Mark

b. Define vector magnetic potential and derive the expression for it. (06 Mark

c. If $\bar{H} = 20\rho^2 \bar{a}\phi$ A/m, determine the current density $\bar{J}$ and the total current crossing a surfa $\rho = 1m$, $0 \le \phi \le 2\pi$ and $z = 0$ in cylindrical co-ordinate system. (04 Mark

Module-4

7 a. With usual notations, derive the equation for magnetic force between two differential curre elements. (06 Mark

b. Derive the boundary conditions at the interface between two magnetic materials of differe permeabilities. (06 Mark

c. Calculate the inductance of an air cored solenoid of 400 turns having 10cm diameter a 50cm length. (04 Mark

OR

8 a. Define inductance. Derive the expression for the inductance of a toroid with usual notatio (04 Mark

b. Derive the expression on for magnetic torque on a rectangular current loop. (06 Mark

c. A point change of Q = 18nc has a velocity of 5×10^6 m/sec in the directi $0.6a\bar{x} + \cdot 75a\bar{y} + \cdot 3a\bar{z}$. Find the magnitude of force exerted on the charge if

i) $\bar{E} = -3a\bar{x} + 4a\bar{y} + 6a\bar{z}$ kv/m

ii) $\bar{B} = -3a\bar{x} + 4a\bar{y} + 6a\bar{z}$ mWb/m^2 (06 Mark

Module-5

9 a. List the Maxwell's equations for time varying fields in integral form and point form. (04 Mark

b. Derive the wave equation from Maxwell's equation for free space. (06 Mark

c. Do the fields $\bar{E} = E_m \sin x \sin t a\bar{y}$ V/m and $\bar{H} = \frac{Em}{\mu o} \cos x \cos t a\bar{z}$ A/m satisfy Maxwel equation? (06 Mar

OR

10 a. State and explain Faraday's laws. (05 Mar

b. State Poynting theorem. Prove that $\bar{P} = \bar{E} \times \bar{H}$. (08 Mar

c. Find the frequency when the displacement current density and conduction current dens are equal in a medium with $\sigma = 2 \times 10^{-4}$ ℧/m and $\epsilon_r = 81$. (03 Mar

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