CBCS SCHEME

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15EC36

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Engineering Electromagnetics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. State and explain Coulomb's law. **(04 Marks)**

b. A charge $Q_A = -20\ \mu c$ is located $A(-6, 4, 7)_m$ and $Q_B = 50\ \mu c$ at $B(5, 8, -2)_m$ in free space. Find the force exerted on Q_A by Q_B? **(05 Marks)**

c. Define electric field intensity and electric flux density. **(03 Marks)**

d. Calculate the total charge within the volume
$0 \le \rho \le 0.1$, $0 \le \phi \le \pi$, $2 \le z \le 4$, $\rho_v = \rho^2 z^2 \sin 0.6\phi$ **(04 Marks)**

OR

2 a. Obtain an expression for electric field due to infinite line charge. **(06 Marks)**

b. A charge of $-0.3\mu c$ is located at A(– 25, 30, 15)cm and a second charge of 0.5 μc is at B(–10, 8, 12)cm. Find E at the origin. **(06 Marks)**

c. A uniform line charge of 2 $\mu c/m$ is located on the z-axis. Find E in rectangular coordinates at P(1, 2, 3) if the charge exists from $-\infty < z < \infty$. **(04 Marks)**

Module-2

3 a. State and prove Gauss law and derive first Maxwell's equations from it. **(05 Marks)**

b. Given a 60 μc point charge located at the origin. Find the total electric flux passing through the closed surface defined by $\rho = 26$ cm and $z = \pm 26$ cm. **(04 Marks)**

c. State and prove the Divergence theorem. **(05 Marks)**

d. Given the electric flux density $D = 0.3r^2\hat{a}_r$ nc/m^2 in free space. Find E at the point $P(r = 2, \theta = 25°, \phi = 90°)$. **(02 Marks)**

OR

4 a. Prove that the work done in moving a charge in the electric field is

$$W = -Q\int_{\text{initial}}^{\text{final}} E.dl$$ **(06 Marks)**

b. Calculate the work done in moving a 4C charge from B(1, 0, 0) to A(0, 2, 0) along the path $y = 2 - 2x$, $\tau = 0$ in the field $E = (5x\ a_x + 5y\ a_y)$ V/m. **(05 Marks)**

c. Show that $\nabla \cdot J = -\dfrac{\partial \rho_v}{\partial t}$ with usual notations. **(05 Marks)**

Module-3

5 a. Starting from Gauss law, derive Poisson's and Laplace's equations. **(04 Marks)**

b. Calculate ρ_v at point P in free space, if $V = 5\rho^2 \cos 2\phi$ at $P(3, \pi/3, 2)$ **(06 Marks)**

c. State uniqueness theorem. **(02 Marks)**

d. By using Laplace's equation, derive an expression for the capacitance of a parallel plate capacitor. **(04 Marks)**

OR

6 a. State and explain Biot-Savart's law. **(04 Marks)**

b. By using Ampere's law, derive an expression for $\overline{H}$, magnetic field intensity due to a coaxial cable. **(06 Marks)**

c. Evaluate both sides of Stokes theorem for the field, $H = \left(6ay\hat{a}_x - 3y^2 a_y\right)$ A/m and the rectangular path around the region $2 \le x \le 5$, $-1 \le y \le 1$, $z = 0$. Let the positive direction of ds be a_z. **(06 Marks)**

Module-4

7 a. The field $B = (-2a_x + 3a_y + 4\hat{a}_z)$mT is present in free space. Find the vector force exerted on a straight wire carrying a current of 12A in the a_{AB} direction. Given A(1, 1, 1,) and B(2, 1, 1). **(04 Marks)**

b. Two differential current elements, $I_1\Delta L_1 = 3\times10^{-6}$ A-m at $P_1(1, 0, 0)$ and $I_2\Delta L_2 = 3\times10^{-6}\left(-0.5\hat{a}_x + 0.4\hat{a}_y + 0.3\hat{a}_z\right)$A-m at $P_2(2, 2, 2)$ are located in free space. Find the vector force exerted on $I_2\Delta L_2$ by $I_1\Delta L_1$. **(06 Marks)**

c. Find the magnetization in a magnetic material where
(i) $\mu = 1.8\times10^{-5}$ H/m and H = 120 A/m
(ii) $\mu_r = 22$, there are 8.3×10^{22} atoms/m and each atom has a dipole moment of 4.5×10^{-27} A/m^2.
(iii) $B = 300\ \mu T \times \chi_m = 15$. **(06 Marks)**

OR

8 a. Derive the Magnetic Boundary Condition? **(06 Marks)**

b. Let the permittivity is 5 μH/m in the region 1 where x < 0 and 20 μH/m in the region 2 where x > 0, and if $H = \left(300a_x - 400a_y + 500\hat{a}_z\right)$ A/m and if there is a surface current density $K = \left(150\hat{a}_y - 200\hat{a}_z\right)$A/m at $x = 0$.
Find (i) $|H_{t_1}|$ (ii) $|H_{N_1}|$ (iii) $|H_{t_2}|$ (ii) $|H_{N_2}|$ **(06 Marks)**

c. Derive the expression for the energy density in a magnetic field? **(04 Marks)**

Module-5

9 a. State Faraday's laws of electromagnetic induction. Further derive Maxwell's equation from it. **(04 Marks)**

b. Find the amplitude of the displacement current density due to an automobile antenna where the magnetic field intensity of an FM signal is $H_x = 0.15\cos[3.12(3\times10^8 t - y)]$ A/m. **(06 Marks)**

c. State Maxwell's equation in both Point form and in Integral form. **(06 Marks)**

OR

10 a. Derive the wave equation in one dimension for an EM wave travelling in free space. **(06 Marks)**

b. The electric field amplitude of the uniform plane wave in the a_z direction is 250 V/m. If $E = E_x a_x$ and ω = 1.00 Mrad/s, find (i) the frequency (ii) the wavelength (iii) the period (iv) the amplitude of H. **(04 Marks)**

c. State and prove Poynting's theorem. **(06 Marks)**

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