CBCS SCHEME

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15EE45

Fourth Semester B.E. Degree Examination, Aug./Sept. 2020
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. State and explain Coulomb's law in vector form. **(05 Marks)**

b. Find the divergence and curl of the following vector fields.

i) $\overline{A} = 30\bar{a}_x + 2xy\,\bar{a}_y + 5xz^2\,\bar{a}_z$

ii) $\overline{A} = \left(\frac{150}{r^2}\right)\bar{a}_r + 10\bar{a}_\phi$ (Cylindrical coordinates). **(06 Marks)**

c. A line charge density 24 nc/m is located in free space on the line y = 1, z = 2.

i) Find $\overline{E}$ at P(6, −1, 3)

ii) What point charge Q_A should be located at A(−3, 4, 1) to cause E_y to be equal to zero at P. **(05 Marks)**

OR

2 a. Derive an expression for electric filed due to an infinite line charge with density of ρ_L c/m placed along z − axis, using Gauss's law. **(06 Marks)**

b. Find electric flux density at point P(1, 2, 4) due to a point charge of 6 μC is located at origin, a uniform line charge density of 180 nc/m lies along the x − axis and a uniform sheet of charge equal to 25 nc/m^2 lies in the z = 0 plane. **(06 Marks)**

c. A vector filed $D = \left(\frac{5r^2}{4}\right)\bar{a}_r$ is given in spherical coordinates. Evaluate both sides of Divergence theorem for the volume enclosed between $Q = \frac{\pi}{4}$ and r = 4. **(04 Marks)**

Module-2

3 a. Derive an expression for energy expanded in moving a point charge in an electric fields. **(06 Marks)**

b. Electric field intensity in a perfect dielectric medium is given by $\overline{E} = 4y\,\bar{a}_x + 4x\,\bar{a}_y$ V/m. Find the potential difference between the points A(−1, 4, 0)m and B(1, 2, 0)m along the freight line path. **(04 Marks)**

c. An electric potential is given by $V = x^3y - xy^2 + 3z$ volts. Find :

i) V ii) $\overline{E}$ iii) $\overline{D}$ and iv) ρ_V at point P(1, 1, 1). **(06 Marks)**

OR

4 a. Starting from principle of charge conservation obtain the point form of continuity equation. **(06 Marks)**

b. Determine an equation for the capacitance of coaxial cable of length 'L', radius of inner conductor is 'a' and outer conductor is 'b'. **(06 Marks)**

c. The region $y < 0$ contains a dielectric material for which $\in_{r_1} = 2$ and the region $y > 0$ contains a dielectric material for which $\in_{r_2} = 4$. If $\overline{E}_1 = -3\overline{a}_x + 5\overline{a}_y + 7\overline{a}_z$ V/m, find the $\overline{E}_2$ and $\overline{D}_2$ in medium 2. **(04 Marks)**

Module-3

5 a. Starting from the point form of Gauss's law, derive the Poisson's and Laplace's equation. **(06 Marks)**

b. Find the potential and electric filed intensity for the region between two concentric right circular cylinders, where V = 0 at r = 1mm and V = 100 volts at r = 20mm. **(06 Marks)**

c. A current element of 0.05 $\overline{a}_x$ A-m is located P(0, 0,1)m in rectangular coordinates. Find the magnetic field intensity of A(2, 3, −1.2). **(04 Marks)**

OR

6 a. State and explain Ampere's circuital law. **(06 Marks)**

b. Explain vector magnetic potential. **(04 Marks)**

c. The magnetic field intensity in the region of the rectangle as shown in Fig Q6(c), is given by $H = y^2 \overline{a}_x + 3x\ \overline{a}_y$ A/m. verify Stoke's theorem.

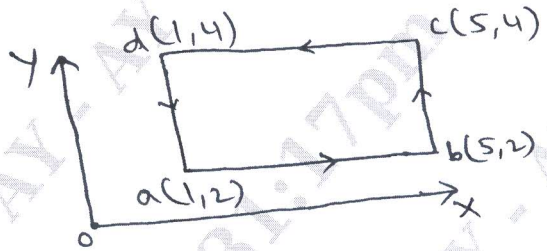

Fig Q6(c) **(06 Marks)**

Module-4

7 a. Derive an expression for the force on a differential current element placed in a magnetic field. **(06 Marks)**

b. In a certain region of space, B is given by $0.1x\ \overline{a}_x + 0.2y\ \overline{a}_y - 0.3z\ \overline{a}_z$ T. Find the total force on the rectangular loop shown in Fig Q7(b), if it lies in the z = 0 plane and is bounded by x = 1, x = 3, y = 2 and y = 5m.

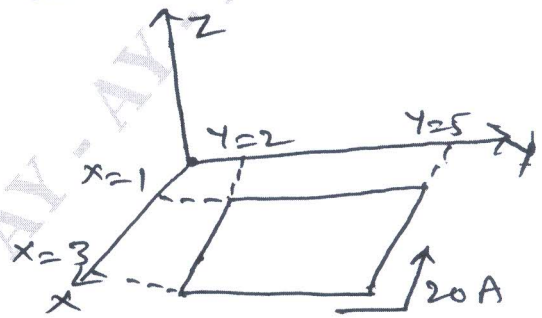

Fig Q7(b) **(10 Marks)**

OR

8 a. Derive the magnetic boundary conditions at the interface between the two different magnetic materials. **(08 Marks)**

b. Calculate the inductance of a solenoid of 400 turns wound on a cylindrical tube of 10cm diameter and 50cm length. Assume that solenoid is in air. **(06 Marks)**

c. Define self inductance. **(02 Marks)**

Module-5

9 a. List the Maxwell's equations in integral and point form for time varying fields. **(08 Marks)**

b. What is the drawback of Ampere's circuital law? Derive the modified form of Ampere's circulator law to suit the time varying fields. **(08 Marks)**

OR

10 a. Obtain the solution of wave equation for uniform plane wave propagating in free space. **(10 Marks)**

b. A 10GHz plane wave travelling in free space has an amplitude of $\overline{E}$ as $E_x = 10V/m$. Find β, η, v, λ and amplitude, direction of $\overline{H}$. **(06 Marks)**

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