CBCS Scheme

USN | | | | | | | | | | |

15EE45

Fourth Semester B.E. Degree Examination, June/July 2017
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define scalar and vector. For a given vectors $\bar{A} = 6\bar{a}_x + 2\bar{a}_y + 6\bar{a}_z$ and $\bar{B} = -2\bar{a}_x + 9\bar{a}_y - \bar{a}_z$.
i) Show that vectors $\bar{A}$ and $\bar{B}$ are perpendicular to each other.
ii) Find $\bar{A} \times \bar{B}$ and show $\bar{A} \times \bar{B} = -\bar{B} \times \bar{A}$. **(06 Marks)**

b. Derive the relationship between rectangular and cylindrical coordinates. **(05 Marks)**

c. Using surface integral obtain an expression for surface area of a sphere of radius 'r_1' meter. **(05 Marks)**

OR

2 a. State and prove Gauss law. **(05 Marks)**

b. Two identical uniform line charges of line charge density 5 nc/mt are parallel to x-axis are kept at z = 0, y = –2 m and z = 0, y = +4 mt. Find the electric field at P(4, 1, 3) mt. Assume free space conditions and infinite line charge. **(06 Marks)**

c. If $\bar{D} = 2xy\bar{a}_x + 3yz\bar{a}_y + 4zx\bar{a}_z$ c/m^2, how much electric flux passes through that portion of the plane at x = 3 mt for which $-1 \le y \le 2$ mt and $0 \le z \le 4$ mt. **(05 Marks)**

Module-2

3 a. Show that the electric field intensity (E) can be expressed as negative gradient of scalar potential (V). **(06 Marks)**

b. Find the work done in moving a point charge of Q = -20 μC from origin to P(4, 2, 0) along the path $x^2 = 8y$. Given $\bar{E} = 2(x+4y)\bar{a}_x + 8x\bar{a}_y$ V/m and $\epsilon = t_0$. **(06 Marks)**

c. A point charge of 1 μC is at y = -3mt and another point charge of 2 μC is at y = +3mt. Find the electric potential at a point P(4, 0, 0)mt. **(04 Marks)**

OR

4 a. With usual notations prove that $\nabla . \bar{J} = -\frac{\partial \rho_v}{\partial t}$. **(06 Marks)**

b. Derive an expression for capacitance of a parallel plate capacitor with a dielectric interface (εr_1 and εr_2) parallel to the conducting plates. **(06 Marks)**

c. A parallel plate capacitor of 8.0 nF has an area of 1.51 m^2 and separation of 10 mm. What separation would be required to obtain the 10 nF capacitance between the plates? **(04 Marks)**

Module-3

5 a. Starting from Gauss's law in integral form, derive Poisson's and Laplace equation. Write Laplace equation in all the coordinate systems. **(08 Marks)**

b. Obtain electric potential at a point between two parallel plates at z = 10 mt and z = 5 mt kept at potential of 60 Volts and 10 Volts respectively. Also find the electric field intensity at point. **(08 Marks)**

OR

6 a. Derive an expression for magnetic field intensity at a point due to an infinite long straight conductor carrying a current of I Amps along z-axis. **(06 Marks)**

b. Evaluate both sides of stokes theorem for the field $\bar{H} = 10\sin\theta\,\bar{a}_\phi$ Ampers/meter and the surface r = 3m, $0 \le \theta \le 90°$, $0 \le \phi \le 90°$. Let the surface has the $\bar{a}_r$ direction. What each side of stokes theorem represents? **(10 Marks)**

Module-4

7 a. Derive an expression for the force between differential current elements. **(08 Marks)**

b. A point charge of Q = –40μC is moving with a velocity of $\bar{v} = (-3\bar{a}_x - 4\bar{a}_y + 4.5\bar{a}_z) \times 10^6$ m/sec. find the magnitude of the vector force exerted on the moving particle by the field:

i) $\bar{B} = 2\bar{a}_x - 3\bar{a}_y + 5\bar{a}_z$ mT,

ii) $\bar{E} = 2\bar{a}_x + 3\bar{a}_y - 4\bar{a}_z$ KV/m,

iii) Both B and E acting together. **(08 Marks)**

OR

8 a. The z = 0 plane marks the boundary between two magnetic medium. Medium-1 is the region z > 0 and the medium-2 is the region z < 0. The magnetic flux density in the medium-1 is, $\bar{B}_1 = 1.5\bar{a}_x + 0.8\bar{a}_y + 0.6\bar{a}_z$ mT. Find:

i) The magnetic flux density in medium-2;

ii) Angle between the magnetic flux density and the boundary between two magnetic medium. Assume $\mu_{r_1} = 3$ and $\mu_{r_2} = 4$. **(07 Marks)**

b. Derive an expression for inductance of a solenoid. **(04 Marks)**

c. A solenoid with air core has 2000 turns and a length of 500 mm. Core radius is 40 mm. Find its self inductance. **(05 Marks)**

Module-5

9 a. Write Maxwell's equations in point form and in integral form for time varying fields. **(06 Marks)**

b. The circular loop conductor at z = 0 plane has a radius of 0.1 mt and resistance of 5Ω. Given $\bar{B} = 0.2\sin 10^3 t\,\bar{a}_z$ Telsa. Find the current in the coil. **(06 Marks)**

c. Derive continuity equation from Maxwell equation. **(04 Marks)**

OR

10 a. Starting from Maxwell's equations obtain the general wave equations in electric and magnetic fields. **(08 Marks)**

b. A 50 GHz plane wave is travelling in a perfect dielectric medium has E_0 = 20 V/m. Find:

i) Intrinsic impedance

ii) Propogation constant

iii) Velocity of wave

iv) Magnetic field intensity.

Given $\epsilon_r = 2$ and $\mu_r = 5$. **(08 Marks)**

* * * * *