CBCS SCHEME

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15EE45

Fourth Semester B.E. Degree Examination, June/July 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. Two points A and B have the following orientations.
A(2.614, 7.369, –3.079) and B (3.162, 7.023, –2.318)
Check whether $\overline{AB}$ is a unit vector. **(05 Marks)**

b. Given two points, C(–3, 2, 1) and D(r = 5, θ = 20°, ϕ = –70°)
Find (i) The spherical coordinates of C
(ii) The rectangular coordinates of D
(iii) The distance from C to D. **(06 Marks)**

c. Two point charges Q_1 = 100 μC and Q_2 = 100 μC are located at points $(-1, 1, -3)_m$ and $(3, 1, 0)_m$ respectively. Find the X, Y & Z components of the forces on Q_1. **(05 Marks)**

OR

2 a. Determine the electric field intensity at a point 'A' located at distance 0.3m and 0.4m respectively from charges Q_1 and Q_2 spaced 0.5m apart. Given $Q_1 = 1\times10^{-9}$ C and $Q_2 = 8\times10^{-10}$ C. **(06 Marks)**

b. State and prove Gauss Divergence theorem. **(06 Marks)**

c. If $\overline{D} = 9x^3\hat{a}_x + 5y^2\hat{a}_y + 2z\hat{a}_z$ c/m^2, find the charge density at the point (1, 5, 9)m. **(04 Marks)**

Module-2

3 a. Prove that electric field intensity is expressed as negative gradient of scalar potential. **(05 Marks)**

b. Prove that the potential at a point P due to a charge disc at distance 'r' is $\frac{Q}{4\pi \in_0 r}$ V. **(06 Marks)**

c. A parallel plate capacitor consists of 3 dielectric layers if
$\in_1 = 1$, $d_1 = 0.4$ mm
$\in_2 = 2$, $d_2 = 0.6$ mm
$\in_3 = 1$, $d_3 = 0.8$ mm
and the area of cross section is 20 cm^2, find its capacitance C. **(05 Marks)**

OR

4 a. Find the electric field strength at the point (1, 2, –1) given the potential $V = 3x^2y + 2yz^2 + 3xyz$. **(05 Marks)**

b. An electric field of strength 3 V/m in air enters a dielectric medium. The orientation of electric fields with respect to boundary in air and dielectric are 30 and 60 respectively. Find the relative permeability of the dielectric. Also find the electric field strength in the dielectric. **(06 Marks)**

c. Determine the capacitance of a capacitor consisting of two parallel plates 30cm × 30cm surface area separated by 5 mm in air. What is the total energy stored by the capacitor is capacitor is charged to a potential difference of 500 V? What is the energy density? **(05 Marks)**

Module-3

5 a. Derive Poisson's and Laplace's equations. Write Laplace's equations in cylindrical and spherical coordinate system. **(06 Marks)**

b. State and explain uniqueness theorem. **(05 Marks)**

c. Given vector field $\overline{E} = (12yx^2 - 6z^2x)\hat{a}_x + (4x^3 + 18zy^2)\hat{a}_y + (6y^3 - 6zx^2)\hat{a}_z$. Check for Laplace or Poisson's field. **(05 Marks)**

OR

6 a. State Biot-Savart's law, Ampere's circuital law and Stoke's theorem. **(06 Marks)**

b. A single turn circular coil of 50 meter in diameter carries a current of 28×10^4 Amps. Determine the magnetic field intensity $\overline{H}$ at a point on the axis of coil and 100 m from the coil. The μ_r of the free space is unity. **(05 Marks)**

c. Verify whether the vector field $\overline{F} = y^2z\hat{a}_x + z^2x\hat{a}_y + x^2y\hat{a}_z$ is irrotational or solenoidal. **(05 Marks)**

Module-4

7 a. Obtain the expression of Energy stored in a magnetic field. **(05 Marks)**

b. Derive Lorentz force equation and mention the applications of its solution. **(06 Marks)**

c. Derive the boundary conditions at the boundary between two magnetic media of different permeabilities. **(05 Marks)**

OR

8 a. Derive the expression for the inductance of a solenoid. **(05 Marks)**

b. Calculate the inductance of a 10 m long co-axial cable filled with a material for which $\epsilon_r = 18$, $\sigma = 0$, $\mu_r = 80$. The external and internal diameters of the cable are 1 mm and 4 mm respectively. **(06 Marks)**

c. Find the maximum torque on an 85 turn rectangular coil 0.2m by 0.3m carrying a current 2A in a field B = 6.5 J. **(05 Marks)**

Module-5

9 a. State and explain Poynting theorem with derivation. **(08 Marks)**

b. Determine the propagation constant at 500 kHz for a medium in which $\mu_r = 1$, $\epsilon_r = 15$, $\sigma = 0$. At what velocity will an electromagnetic wave travel in this medium? **(08 Marks)**

OR

10 a. A uniform plane wave $E_y = 10\sin(2\pi10^8t - \beta x)$ is travelling in x-direction in free space. Find the phase constant, phase velocity and the expression for H_z. Assume $E_z = 0 = H_y$. **(08 Marks)**

b. Explain skin depth and skin effect. Derive an expression for skin depth. **(08 Marks)**

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