CBCS SCHEME

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15EE45

Fourth Semester B.E. Degree Examination, June/July 2019
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 operator Del, ∇. Explain its operation with solar and vector fields. Define divergence, gradient and curl and expression the same in rectangular coordinate system. **(06 Marks)**

b. Evaluate both sides of the Divergence theorem for the field $\bar{D} = 2xy\,\bar{a}_x + x^2\bar{a}_y\ c/m^2$, the surface is a rectangular parallelepiped formed by planes x = 0 and x = 1, y = 0 and y = 2 and z = 0 and z = 3. **(10 Marks)**

OR

2 a. With empherical formula to support, state the following:
i) Gauss law ii) Gauss Divergence theorem iii) Coulomb's law. **(06 Marks)**

b. Determine electric flux density D in Cartesian coordinates caused by P(6, 8, -10) by
i) A point charge of 30 MC at origin.
ii) An infinite line charge with $\rho_L = 40\ \mu c/m$ on x = 0 ; y = 0
iii) A surface charge with $\rho_S = 57.2\ \mu c/m^2$ on this plane z = 9m. **(10 Marks)**

Module-2

3 a. Derive the boundary conditions on E and D at the interface of perfect dielectrics. **(05 Marks)**

b. Determine work done in carrying a charge of -2C from (2, 1, -1) to (8, 2, -1) in an electric field $\bar{E} = y\bar{a}_x + x\bar{a}_y$ v/m along this path $x = 2y^2$. **(07 Marks)**

c. Explain the following terms with empherical formula to support:
i) Current density ii) Potential difference iii) The dipole. **(04 Marks)**

OR

4 a. Derive an expression for the equation of continuity. **(06 Marks)**

b. Obtain an expression for this capacitance per unit length of a co-axial cable with inner conductor radius 'a' meters and outer conductor radius 'b' meters. **(06 Marks)**

c. Determine the capacitance consisting of two parallel metal plates 30cm × 30cm, surface area, separated by 5mm in air. What is the total energy stored by this capacitor of the capacitor is charged to a potential difference of 500V? **(04 Marks)**

Module-3

5 a. State the following terms with empherical formula/expressions to support
i) Biot-Savart's law
ii) Ampere's circuital law and
iii) Stokes theorem. **(05 Marks)**

b. Clearly distinguish between scalar magnetic potential and vector magnetic potential. **(04 Marks)**

c. Given $V = [Ar^4 + Br^{-4}] \sin 4\phi$. Show that $\nabla^2 V = 0$. Select A and B so that V = 100V and (E) = 500 v/m at p(r = 1, ϕ = 22.5 and z = 2). **(07 Marks)**

OR

6 a. Derive Poisson's and Laplace's equation. (04 Marks)

b. State and prove uniqueness theorem. (06 Marks)

c. Given the field $\bar{H} = 20r^2\bar{a}_\phi$ A/m. Determine: i) the current density, $\bar{J}$ and ii) Also the total current that crosses the surface r = 1m, $0 < \phi < 2\pi$ and z = 0 (in cylindrical coordinates) (06 Marks)

Module-4

7 a. A point charge Q = 18nc moves with a velocity of $5 * 10^6$ m/sec in the direction of $0.06\bar{a}_x + 0.75\bar{a}_y + 0.3\bar{a}_z$ $(\bar{a}_v)$. Calculate the magnitude of the force exerted on the charge by the field

i) $\bar{E} = -3\bar{a}_x + 4\bar{a}_y + 6\bar{a}_z$ kv/m

ii) $\bar{B} = -3\bar{a}_x + 4\bar{a}_y + 6\bar{a}_z$ MT

iii) $\bar{B}$ and $\bar{E}$ acting together. (08 Marks)

b. Discuss the magnetic boundary condition to be applied to B, H and M at the interface between two different magnetic materials. (05 Marks)

c. Define the terms with empherical formula to support
i) Magnetization and ii) Permeability. (03 Marks)

OR

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

b. A toroid 0.2m in diameter and 10sqcm sectional area of the core is uniformly wound with 250 truss of wire. If the flux density in the core is to be 1wb/m^2 and relative permeability of iron is $\mu_r = 500$, what is the exciting current required to be passed in the winding? Determine also the value of self inductance and the stored energy. (06 Marks)

c. Find the force /mtr length between two long parallel wires separated by 10cm in air and carrying a current of 100A is opposite direction. State the nature of force between the wires. (04 Marks)

Module-5

9 a. Explain Faraday's laws applied to
i) Stationary path, changing field and
ii) Steady field moving circuit
Derive necessary relationship. (08 Marks)

b. State and derive an expression for Poynting's theorem. (08 Marks)

OR

10 a. List Maxwell's equations for both:
i) Steady and
ii) Time varying fields in integral and differential form, also mention the relevant laws they demonstrate. (08 Marks)

b. Discuss the physical significance of displacement current and justify that for the case of a parallel plate capacitor the displacement current is equivalent to conduction current. Comment on the ratio of magnitudes of conduction current density to displacement current density. (08 Marks)

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