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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Electrical and Electronics Engineering

Semester End Examination; May/June - 2018

Electromagnetic Field Theory

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT – I

1 a. State and explain Coulomb's law in complete vector form. 6

b. Four point charges of 50 nc each are located at A(1, 0, 0), B(-1, 0, 0), C(0, 1, 0) and D (0, -1, 0) meters. Find the total force on charge at A. 6

c. Obtain the expression for electric field intensity at any point due to charge distribution (linear, point, surface and volume). 8

2 a. State and explain Gauss's law. Show that

$$Q = \oint \overline{D}.\overline{ds}$$ 6

For an arbitrary closed surface.

b. A Cylindrical volume $0 \le z \le 4$m and $0 \le \rho \le 2$m, enclose certain charge.If $\overline{E} = \frac{z\rho a_z}{\varepsilon_0}; V/m$, determine the total charge enclosed by the cylinder. 6

c. Given, $D = x^2 a_x + xy\, a_y + y\, a_z$; c/m^2. Verify divergence theorem over a cube of 1 unit for each side. The cube is situated in first octant of the Cartesian coordinate system with one corner at the origin. 8

UNIT - II

3 a. Show that energy expended in the moving a point charge in an uniform electric field is independent of path chosen and thus, Prove that electric field as a negative gradient of potential. 8

b. Determine the work done in carrying a charge of -2C from (2, 1,-1) to (8, 2,-1) in the electric field $E = ya_x + xa_y$;V/m. Considering the path along parabola $x = 2y^2$. 6

c. Potential is given by $V = 2(x+1)^2 \times (y+2)^2 \times (Z+3)^2$ volts in free space. At a point p (2,-1, 4). Calculate i) potential ii) Electric field intensity iii) Flux density. 6

4 a. Derive the expression for Laplace and Poisson's equations. 6

b. Determine whether or not the following potential fields satisfies Laplace equation : 6

i) $V = x^2 - y^2 + z^2$ i) $V = \rho \cos\varphi + z$

c. In a certain region, the volume charge density is constant and equal to 1 μC/m^3 in the x-direction. Given that the voltage is 100 v at x = 0.1 m and 0 V at x = 0 m . Solve for voltage using Poisson's equation. 8

Contd…2

UNIT - III

5 a. Discuss the properties of conductor, when subjected to electric field. 6

b. Derive the expression for continuity equation of current. 6

c. Find the total current crossing the surface z =3, ρ < 6 in the a_z direction , if the current density in that region is given as : 8

$$J = \frac{100}{\rho^2} a_\rho + \frac{10}{\rho^2 + 1} a_z ; A/m^2 . Also\ find\ \frac{\partial \rho v}{\partial t}.$$

6 a. Obtain the boundary conditions between dielectric to dielectric boundaries. 6

b. Derive the expression for the capacitance of coaxial cable with inner radius a and outer radius b. 6

c. Two extensive homogeneous isotropic dielectric meet on the Z = 0. For Z ≥ 0, E_{r1} = 5 and Z ≤ 0, E_{r2} = 3. An uniform electric field, 8

$\overline{E}_1 = 2a_x + 2a_y - 4a_z$; kV/m exists for z ≥ 0. Find;

i) E_2 for z ≤ 0 ii) The angles of $\overline{E}_1$ and $\overline{E}_2$ make the interface

UNIT - IV

7 a. Obtain the expression for H at a point due to a current in a straight conductor of finite length using Biot-Sovart's law. 6

b. Find the value of magnetic flux density at point 'p' for the current loop shown in Fig Q 7(b) 8

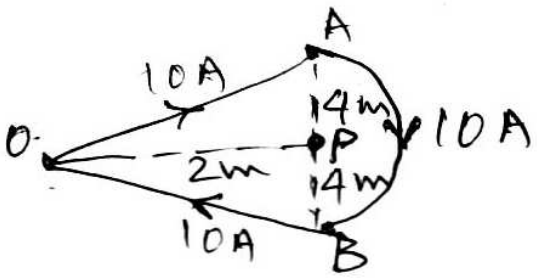

Fig. Q. 7(b)

c. State and prove ampere's circuital law. 6

8 a. Explain the concept of vector magnetic potential also, show that, $\oint A.dl = \phi$. 6

b. State and prove Strokes theorem. 6

c. A long straight tubular conductor circular cross section with the outside dia of 5 cm and wall thickness of 0.5 cm carries a direct current of 100 A. Find; H i) Just inside the wall of the tube ii) just outside the wall of the tube iii) at a point in the tube walls half way between the inner and outer surface. 8

UNIT - V

9.a Obtain the expression for force on a differential current element in a magnetic field. 6

b. A point charge of -1.2c has the velocity of ($5u_x$+$2u_y$-$3u_z$); m/sec. find the magnitude of force exerted in the field due to : 6

Contd…3

i) $\overline{E} = (-18u_x + 5u_y - 10u_z); v/m$

ii) $\overline{B} = (-4u_x + 4u_y + 3u_z); wb/m^2$

iii) *Both* $\overline{E}$ *and* $\overline{B}$

c. Obtain the expression for transformer emf and motional emf. 8

10 a. Obtain the expression for force between two differential current elements. 6

b. Fig. Q. 10(b) shows the identical circular loops each carrying a current of 100 A placed close to each other. Find approximate force of attraction or repulsion.

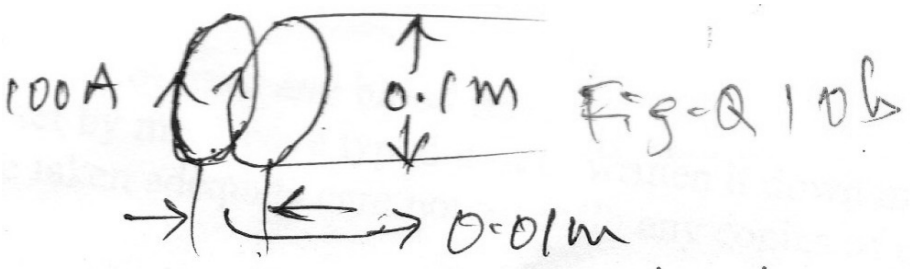

Fig-Q 10b

6

c. Obtain the expression for inductance of a solenoid. 8

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