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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 - 2019**

**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. Explain Coulomb's law in electrostatics. 6

b. Derive the expression for field intensity due to an infinite sheet of charge. 8

c. Infinite uniform the charges of 5 nC/m tie along the (positive and negative) *x* and *y* axes in free space. Find E at; 6

i) $P_A(0, 0, 4)$ ii) $P_B(0, 3, 4)$

2 a. Starting from fundamental's, obtain Maxwell's first equation in electrostatics. 6

b. Discuss the Gauss's law application to determine field due to a spherical shell of charge. 8

c. Given $D = [10\, r^2 + 5\, e^{-r}]\, a_r$ (C/m$^2$). Find the following : 6

i) $\rho_v$ as a function of $r$

ii) The total charge enclosed by a sphere of radius '*a*' centered at the origin

## UNIT - II

3 a. What is electric potential? Also derive the expression for potential due to a point charge. 6

b. Obtain the expression for energy density in an electrostatic field. 8

c. The electric potential at an arbitrary point in force space is given as, 6

$V = (x + 1)^2 + (y + 2)^2 + (z + 3)^2$ At P(1, 1, 1), find;

i) $V$ ii) $E$ iii) $|E|$ iv) $D$ v) $|D|$ vi) $\rho_v$

4 a. Discuss in brief about the Poisson's and Laplace's equations. 6

b. State and prove Uniqueness theorem. 8

c. *If* $D = 0.1r\ a_r\ (C/m^2)$, *and* $\frac{0.0064}{r^2}\ (C/m^2)$ *for* $r \geq 0.4(m)$: 6

i) Find $\rho_v$ at $r$ = 0.2 and 0.5 (m)

ii) What point charge could be placed at the origin to cause $D$ to be zero for $r \geq 0.4$?

## UNIT - III

5 a. Derive the equation for continuity of current. 6

b. Discuss the boundary conditions between conductor and free space. 8

c. Find the total current in outward direction from a cube of 1 m, with one corner at the origin and edges parallel to the coordinate axes if , 6

$\bar{J} = 2x^2\bar{a}_x + 2xy^3\bar{a}_y + 2xy\,\bar{a}_z\ A/m^2$

Contd…2

6 a. Derive the expression for the capacitance of a parallel plate capacitor. 6

b. Discuss the boundary conditions between two perfect dielectrics. 8

c. A spherical condenser has a capacity of 54 pF. It consists of two concentric spheres differing in radii by 4 cm and having air as dielectric. Find their radii. 6

## UNIT - IV

7 a. State and explain Biot-Savart's law. 6

b. Using Biot-Savart's law, find the magnetic flux density at a point due to current in a straight conductor of infinite length. 8

c. Find the magnetic field intensity at a point *P* for the circuit shown in Fig. 7(C). 6

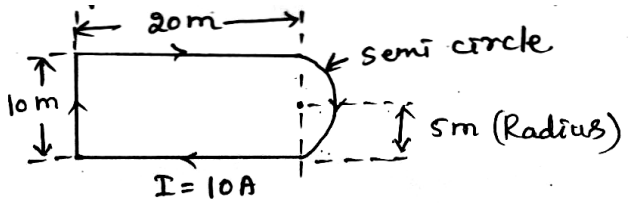


Fig. 7(C).

8 a. State and prove Stoke's theorem. 6

b. With the help of Ampere's circuital law, find the magnetic field intensity due to a straight solid cylindrical conductor. 8

c. A radial magnetic field, $\overline{H} = \frac{(2.239)\times 10^6}{r}\cos\phi\,\bar{a}_r\ A/m$ exists in free space. 6

Find the magnetic flux $\phi$ crossing the surface defined by, $-\frac{\pi}{4} \le \phi \le \frac{\pi}{4}, 0 \le z \le 1\,m.$

## UNIT - V

9 a. For a stationary closed path in time varying magnetic field B, 6

show that $\nabla \times \overline{E} = \frac{-\partial \overline{B}}{\partial t}$.

b. Derive the equation for the *emf* induced, when a conductor is moved in a uniform constant magnetic field. 7

c. An area of 0.65 $m^2$ in the plane $z = 0$ enclosed a filamentary conductor. Find the induced voltage if 7

$$\overline{B} = 0.005\cos 10^3 t\left[\frac{\bar{a}_y + \bar{a}_z}{\sqrt{2}}\right] tesla$$

10 a. Derive the expression for force on a moving point charge. 6

b. Derive the expression for force between differential current elements. 8

c. Find the force per *m* length between two long parallel wires separated by 10 cm in air and carrying current of 100 A in opposite directions. State the nature of force between wires. 6

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