USN | | | | | | | | | | **10EE44**

Fourth Semester B.E. Degree Examination, Dec.2018/Jan. 2019
Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. State and explain Gauss's law. **(06 Marks)**

b. A line charge densities of 24 nc/m is located in free space on the line y = 1, z = 2.
   i) Find E at p(6, –1, 3)
   ii) What point charge Q_A should be located at Q(–3, 4, 1) to cause E_y to be equal to zero at point P. **(08 Marks)**

c. A vector field $\bar{D} = \left(\frac{5r^2}{4}\right)\bar{a}_r$ given in spherical coordinates. Evaluate both sides of divergence theorem for the volume enclosed between $\theta = 0°$ to $\theta = \frac{\pi}{4}$ and r = 4m. **(06 Marks)**

2 a. Show that the vector electric field intensity E is the negative gradient of scalar electric potential V. **(06 Marks)**

b. Obtain the boundary conditions between the two dielectric materials of permittivities ε_1 and ε_2. **(08 Marks)**

c. Give $V = 2x^2y - 5z$ at point p(–4, 3, 6). Find the potential, electric field intensity and volume charge density. **(06 Marks)**

3 a. State and prove uniqueness theorem. **(08 Marks)**

b. Two concentric conducting spheres have radius of 3cm and 5cm. The region between them is filled with a homogeneous dielectric for which $\varepsilon_r = 5$. If the potential of the inner sphere is 100 volts while that of the outer sphere is –100 volts, find :
   i) V
   ii) $\bar{E}$
   iii) $\bar{D}$
   iv) the value of r at which V = 0. **(08 Marks)**

c. If a potential $V = x^2yz + Ay^3z$, find :
   i) The value of 'A', so that V satisfies the Laplace's equation
   ii) With the value of 'A' determine electric field at (2, 1, –1). **(04 Marks)**

4 a. Using Biot-Savart law, obtain the magnetic field intensity expression due to an infinite length conductor carrying current I amps along Z – direction. **(06 Marks)**

b. Discuss the concept of scalar and vector magnetic potential. **(08 Marks)**

c. In cylindrical coordinates a magnetic field is given as $H = [2\rho - \rho^2]\ \bar{a}_\phi$ A/m.
   i) Determine the current density
   ii) What total current passes through the surface $z = 0, 0 \le \rho \le = 1$ in the $\bar{a}_z$ direction. **(06 Marks)**

PART – B

5 a. Derive an expression for the force on a differential current carrying element. **(06 Marks)**

b. A current filament carrying 8 A in the $\bar{a}_z$ direction lies along the entire z – axis n free space. A rectangular loop connecting A(0, 0.2, 0) to B(0, 0.2, 0.3) to C(0, 0.7, 0.3) to D(0, 0.7, 0.2) to A lies in the x = 0 plane. The loop current is 3mA and it flows in the $\bar{a}_z$ direction in the AB segment.

i) Find F on the AB segment
ii) Find F on the side DA
iii) Find F_{total} on the loop. **(08 Marks)**

c. Define mutual inductance. Calculate the inductance of 400 turns wound on a solenoid with 10cm diameter and 50cm length. Assume that solenoid is in air. **(06 Marks)**

6 a. What is inconsistency of Ampere's law with the equation of continuity? Derive the modified form of Ampere's law of Maxwell. **(08 Marks)**

b. Starting from Faraday's law of electromagnetic induction derive $\nabla \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$. **(06 Marks)**

c. For the losses dielectric $\sigma = 5$ s/m and $\varepsilon_r = 1$. The electric field intensity is $E = 100 \sin 10^{10}t$. Find J_C, J_D and frequency at which both have equal magnitude. **(06 Marks)**

7 a. Determine the relation between E and H of an EM wave travelling in z – direction. **(10 Marks)**

b. Obtain the solution of wave equation for uniform plane wave propagating in free space. **(10 Marks)**

8 a. With necessary equations, explain standing wave ration. **(10 Marks)**

b. A 100 V/m, 3 GHz wave is propagating in material having $\varepsilon_{R1} = 4$, $\mu_{R1} = 1$ and $\sigma = 0$. It is normal to another perfect dielectric in region 2, z > 0, where $\varepsilon_{R2} = 9$, $\mu_{R2} = 1$. Calculate, phase constants, coefficient of reflection, transmission and standing wave ratio. **(10 Marks)**

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