USN

10ES36

Third 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 Coulomb's law. Four concentrated charges are located at the vertices of a plane rectangle as shown in Fig.Q1(a). Find the magnitude and direction of resultant force on Q1. **(10 Marks)**

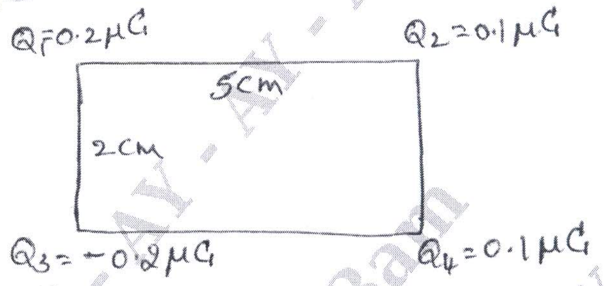

Fig.Q1(a)

b. State and explain Gauss law. Derive an equation to covert the surface integral of the normal component over a closed surface into its volume integral of any other differential form [Divergence form]. **(10 Marks)**

2 a. Derive an equation for potential at any point along the axis of uniformly charged line. **(08 Marks)**

b. Derive an equation for the capacitance of an co-axial cable. **(04 Marks)**

c. Find the work done in moving a 5μC charge from the origin to P(2, −1, 4) through the field $\vec{E} = 2xyz\,\vec{a}_x + x^2z\,\vec{a}_y + x^2y\,\vec{a}_z$ V/m via the path.

i) straight line segments (0, 0, 0) to (2, 0, 0) to (2, −1, 0) to (2, −1, 4)

ii) straight line $x = -2y$; $z = 2x$

iii) curve $x = -2y^3$, $z = 4y^2$. **(08 Marks)**

3 a. State prove the uniqueness theorem. **(10 Marks)**

b. Prove that, at the boundary of two perfect dielectric materials $\in_1$ and $\in_2$ D_1 is incident at an angle θ_1 with respect to normal to the boundary surface as :

$$D_2 = D_1\sqrt{\cos^2\theta_1 + (\in_2/\in_1)^2\sin^2\theta_1}\ .$$ **(05 Marks)**

c. Derive the junction potential of a P-N junction from the Poisson's equation. **(05 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

4 a. Derive an expression for $\vec{H}$ at any point in cylindrical system due to filamentary conductor carrying a current I on the z – axis from $-\infty < z < \infty$. **(04 Marks)**

b. Find the incremental field $\vec{\Delta} H_2$ at P_2 caused by a source at P_1 at $I_1 \, \vec{\Delta L_1} =$

i) $2\pi \vec{a}_2$ μAm, given $P_1(4,0,0)$ and $P_2(0,3,0)$

ii) $2\pi \vec{a}_2$ μAm, given $P_1(4,-2,3)$ and $P_2(0,3,0)$

iii) $2\pi(0.6\vec{a}_x - 0.8\vec{a}_y)$ μAm, given $P_1(4,-2,3)$ and $P_2(1,3,2)$. **(06 Marks)**

c. Given $\vec{H} = y^2 z \vec{a}_x + 2(x+1)yz\vec{a}_y - (x+1)z^2 \vec{a}_z$

i) Find $\oint \vec{H} \, d\vec{L}$ around the square path going from P(0, 2, 0) to A(0, 2 + b_1 0) to B(0, 2 + b, b) to C(0, 2, b) to P

ii) Evaluate $\oint \vec{H} \, d\vec{L}$ for b = 0.1

iii) Find $\vec{\nabla} \times \vec{H}$

iv) Evaluate $\left(\vec{\nabla} \times \vec{H}\right)_x$ at P

v) Show that $\left(\vec{\nabla} \times \vec{H}\right)_x = \dfrac{\oint \vec{H} \, d\vec{L}}{\Delta S}$. **(10 Marks)**

PART – B

5 a. Derive the boundary conditions for normal and tangential components of 2 isotropic homogeneous linear materials with permeability μ_1 and μ_2 in a magnetic field. **(10 Marks)**

b. If $\vec{B} = 0.05x \, \vec{a}_y$ T in a material for which $\chi_m = 2.5$, find : i) μ_R ii) μ iii) $\vec{H}$ iv) $\vec{M}$ v) $\vec{J}$. **(10 Marks)**

6 a. From Ampere's circuit law, derive an expression for Maxwell's second equation in integral form. **(08 Marks)**

b. List all the Maxwell's relations for time varying and static conditions both in point and integral form. **(04 Marks)**

c. Derive the relation for ratio of magnitude of conduction current density to the displacement current density. **(04 Marks)**

d. A perfectly conducting filament containing a small 500Ω resistor is formed into a square, find I(t) if $\vec{B} = 0.2\cos 120\pi t \, \vec{a}_2$ T. **(04 Marks)**

7 a. State and prove Poynting theorem. **(10 Marks)**

b. Discuss briefly skin depth and skin effect. **(04 Marks)**

c. A wave propagating in a lossless dielectric has the components :

$$\vec{E} = 500\cos[10^7 t - \beta z]\vec{a}_x \text{ V/m}$$

$$\vec{H} = 1.1\cos[10^7 t - \beta z]\vec{a}_y \text{ A/m}$$

If the wave is travelling at v = 0.5c, find :

i) μ_r ii) $\in_r$ iii) β iv) λ v) z. **(06 Marks)**

8 a. Show that $\frac{P_{t\,avg}}{P_{i\,avg}} = \frac{4\eta_2\eta_1}{[\eta_1 + \eta_2]^2}$ and

$$P_{r\,avg} + P_{t\,abg} = P_{i\,avg}.$$

Where,

$P_{r\,avg}$ is average reflected power

$P_{t\,avg}$ is, A power of transmitted wave in average

$P_{i\,avg}$ is power of incident wave in average

η_1 is intrinsic impedance of medium 1

η_2 is intrinsic impedance of medium 2. **(12 Marks)**

b. A radio station transmits power radially around the spherical region. The desired electrical field intensity at a distance of 10 km from the station is 1mV/m. Calculate the corresponding H, P and station power. **(08 Marks)**

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