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10ES36

Third Semester B.E. Degree Examination, June/July 2018
Field Theory

Time: 3 hrs. Max. Marks:100

Note: *Answer FIVE full questions, selecting at least TWO questions from each part.*

PART – A

1 a. State and explain Coulomb's law in vector form. **(06 Marks)**

b. State and prove Gauss's law for point charge. **(06 Marks)**

c. If a point charge $Q_1 = 25nC$ be located at A(4,–2,7) and a charge $Q_2 = 60nC$ be at B(–3,4,2) in air. Find $\overline{D}$ at C(1, 2, 3). **(08 Marks)**

2 a. Define potential and potential difference and establish the relation $\overline{E} = -\nabla V$. **(06 Marks)**

b. Deduce the relations for boundary conditions between two dielectrics. **(06 Marks)**

c. Let $V = \frac{\cos 2\phi}{r}$ in the free space. Find

(i) $\overline{E}$ at $P(2,30^\circ,1)$

(ii) ρ_V at $Q\left(\frac{1}{2},60^\circ,1\right)$ **(08 Marks)**

3 a. Derive an expression for Poisson's and Laplace's equation in an electrostatic field. **(04 Marks)**

b. Derive the following for a concentric spheres filled with dielectric using Laplace's equation,

(i) Potential (V) (ii) Electric field intensity ($\overline{E}$) (iii) Charge density (ρ_s)

(iv) Capacitance (C). **(08 Marks)**

c. Determine whether or not the potential equations, satisfies Laplace equation,

(i) $V = 2x^2 - 4y^2 + z^2$ (ii) $V = r\cos\phi + z$ (iii) $V = r^2\cos\phi + \theta$ **(08 Marks)**

4 a. Explain Biot Savart law for a magnetic field. **(04 Marks)**

b. State and prove Ampere's circuital law. By using it derive an expression for $\overline{H}$ due to infinite long straight conductor. **(08 Marks)**

c. Find the magnetic field intensity at point 'P' for the circuit shown in Fig. Q4 (c). **(08 Marks)**

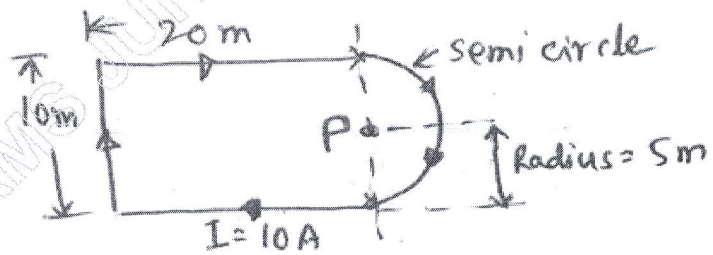

Fig. Q4 (c)

PART – B

5 a. Derive an expression for magnetic force on:
(i) Moving point charge and
(ii) Differential current element. **(10 Marks)**

b. A single turn circular coil 5 cm diameter carries a current of 2.8A . Determine the magnetic flux density $\overline{B}$ at a point on the axis 10 cm from the center. Derive the formula used. **(10 Marks)**

6 a. Write the Maxwell's equations in point form. **(04 Marks)**

b. For a closed stationary path in space linked with a changing magnetic field prove that, $\nabla \overline{E} = -\frac{\partial \overline{B}}{\partial t}$. **(08 Marks)**

c. Determine the value of 'K' such that following pairs of fields satisfies Maxwell's equation in the region where $\sigma = 0$ and $\rho_V = 0$,
$\overline{E} = (Kx - 100t)\overline{a_y}$ V/m and $\overline{H} = (x + 20t)\overline{a_z}$ A/m if $\mu = 0.25$ H/m, $\varepsilon = 0.01$ F/m. **(08 Marks)**

7 a. Derive general wave equations interms of $\overline{E}$ and $\overline{H}$ in uniform medium using Maxwell's equations. **(08 Marks)**

b. A 300 MHz uniform plane wave propogates through (lossless medium) fresh water for which $\sigma = 0$, $\mu_r = 1$ and $\varepsilon_r = 78$. Calculate (i) α (ii) β (iii) λ (iv) η **(08 Marks)**

c. Define (i) Poynting's theorem and (ii) Skin effect. **(04 Marks)**

8 a. Define and explain voltage standing wave ratio (VSWR). **(04 Marks)**

b. Derive an expression for transmission co-efficient and reflection co-efficient at normal incidence of waves at plane dielectric boundary. **(08 Marks)**

c. Find ratio $\left(\frac{E_r}{E_i}\right)$ and $\left(\frac{E_t}{E_i}\right)$ at the boundary for the normal incidence if for the region-1;
$\varepsilon_{r_1} = 8.5$, $\mu_{r_1} = 1$ and $\sigma_1 = 0$ and if region-2 is free space. **(08 Marks)**

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