

(Following Paper ID and Roll No. to be filled in your Answer Books)

Paper ID : 2012381

Roll No.

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## B.TECH

Regular Theory Examination (Odd Sem - V), 2016 - 17

### FUNDAMENTALS OF E.M. THEORY

Time : 3 Hours

Max. Marks : 100

#### Section - A

Attempt all parts. All parts carry equal marks.

Write answer of each part in short. (10×2=20)

1. a) Given two vectors  $\vec{A} = 4f_x + 10f_z$  and  $\vec{B} = 2f_x + 3f_y$ . Find the projection of  $\vec{A}$  on  $\vec{B}$ .
- b) Given  $\vec{A} = 5f_x - 2f_y + f_z$ , find the expression of a unit vector  $f_B$  such that  $f_B$  is parallel to  $\vec{A}$ .
- c) Transform the vector  $4f_x - 2f_y - 4f_z$  into spherical coordinates at a point P(x = -2, y = -3, z = 4).
- d) A charge  $Q_2 = 121 \times 10^{-9}$  c is located in vacuum at  $P_2(-0.03, 0.01, -0.04)$ . Find force on  $Q_2$  due to  $Q_1 = 100 \mu\text{c}$  at  $P_1(0.03, 0.08, 0.02)$ . All distances in meters.
- e) Find the stored energy in a system of four identical charges  $Q = 2\text{nc}$ , at the corners 1m on a side.

- f) What happens when a solid conductor is placed in an electric field?
- g) Define - Polarization.
- h) Explain - electric susceptibility.
- i) Write and explain differential form of Faraday's law.
- j) Explain the significance of displacement current.

**Section - B**

**Attempt any five questions from this section**

**(5×10=50)**

- 2. Write and explain integral and differential form of Maxwell's equations.
- 3. A lossless dielectric medium has  $\sigma = 0$ ,  $\mu_r = 1$  and  $\epsilon_r = 4$ . An electromagnetic wave has magnetic field components expressed as

$$\vec{H} = -0.1 \cos(\omega t - z) f_x + 0.5 \sin(\omega t - z) f_y \frac{A}{m}$$

Find

- a) Phase constant  $\beta$ .
  - b) Angular velocity.
  - c) The wave impedance.
  - d) Electric field intensity.
4. What do you understand by skin effect? Define skin depth. Show that in case of a semi-infinite solid conductor, the

skin depth  $S$  is given by  $S = \sqrt{\frac{2}{\omega \mu \sigma}}$ .

- 5. Show that for uniform plane wave in a perfect medium,  $\vec{E}$  and  $\vec{H}$  are normal to each other and the ratio of their magnitude is constant of the medium.
- 6. State and explain Biot-Savart's law for static magnetic fields as applied to different types of current distributions.
- 7. State and explain Ampere's law both in integral and differential form as used in magnetic field.
- 8. State and explain Gauss's law of electromagnetics in integral form.
- 9. Derive Poisson's and Laplace's equations from fundamentals.

**Section - C**

**Attempt any two questions from this section**

**(2×15=30)**

- 10. A total charge of 40 nC is uniformly distributed over a circular disc lying in xy plane with its centre at the origin (0, 0, 0). Find the potential at point (0, 0, 5)m.
- 11. Magnetic field intensity in free space is given by  $\vec{H} = 20(xf_x + yf_y) / (x^2 + y^2) A/m$ 
  - a) Show that  $\vec{\nabla} \cdot \vec{B} = 0$
  - b) Find the current density  $\vec{J}$ .

c) Find the scalar vector potential  $V_m(x, y, z)$  if  $V_m = 0$  at  $P(1, 1, 1)$ .

12. Can a static magnetic field exist in the interior of a perfect conductor? Explain.

Can a time varying magnetic field exist in the interior of a perfect conductor? Explain.

