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Total Number of Pages: 03

B.TECH
PEL31001

3rd Semester Regular Examination 2016-17
ELECTROMAGNETIC THEORY

BRANCH: EEE

Time: 3 Hours

Max Marks: 100

Q.CODE: Y692

Answer Part-A which is compulsory and any four from Part-B.
The figures in the right hand margin indicate marks.

Part – A (Answer all the questions)

Q1 Answer the following questions: *multiple type or dash fill up type* **(2 x 10)**

- a) The curl of gradient of any scalar field is identically _____.
(i) 0 (ii) 1 (iii) -1 (iv) None of these.
- b) In spherical co-ordinate system, the value of differential volume _____.
(i) $r \sin\theta \, dr \, d\theta \, d\phi$ (ii) $r^2 \sin\theta \, dr \, d\theta \, d\phi$ (iii) $r^3 \sin\theta \, dr \, d\theta \, d\phi$ (iv) None of these.
- c) The potential difference V_{AB} is independent of _____.
(i) Line (ii) Path (iii) surface (iv) None of these.
- d) In electrostatic screening or shielding electric field intensity E is _____,
(i) 0 (ii) 1 (iii) -1 (iv) None of these.
- e) In magneto static fields if no sources or sinks are present, then $\nabla \cdot B =$ _____.
(i) 1 (ii) 0 (iii) J (iv) None of these.
- f) $\nabla \times H =$ _____ will represent Ampere's circuital law in differential form.
(i) J (ii) $-J$ (iii) B (iv) None of these.
- g) One of the following is not a source of magneto static fields.
(i) A dc current in a wire (ii) A permanent magnet (iii) An accelerated charge
(iv) An electric field linearly changing with time.
- h) The concept of displacement current was a major contribution attributed to _____.
(i) Faraday (ii) Lenz (iii) Maxwell (iv) Lorentz.
- i) Which of the following statements is not true of a phasor ?
(i) It may be a scalar or a vector
(ii) It is a time-dependent quantity
(iii) A phasor V_s may be represented as $V_0 \angle \theta$ or $V_0 e^{j\theta}$ where $V_0 = |V_s|$
(iv) It is a complex quantity.
- j) In a certain medium, $E = 10 \cos(10^8 t - 3y) \, a_x$ V/m.
What type of medium is it ?
(i) Free space
(ii) Lossy dielectric
(iii) Lossless dielectric
(iv) Perfect conductor.

Q2 Answer the following questions: Short answer type (2 x 10)

- Define curl of a vector field A.
- Define Laplacian operator. For which condition a scalar function is said to be a harmonic function?
- Find the unit vector normal to the surface $xy^3z^2=4$ at a point $(-1,-1,2)$.
- Write down the Maxwell's second equation in integral and differential form within a static electric field.
- For a line charge $\rho_l = \frac{10^{-9}}{2}$ C/m on the z-axis, find V_{AB} where A is $(2, \frac{\pi}{2}, 0)$ and B is $(4, \pi, 5)$.
- Ampere's law is a special case of which law & defines the state when magnetostatic field is not conservative.
- What is displacement current? Is it exist in time-varying electric field?
- Write the plane wave equation for dielectric medium.
- Define lossy dielectric medium.
- Define Lenz's law. What is curl of the induced electric field?

Part – B (Answer any four questions)

Q3 a) Evaluate ∇V , $\nabla \cdot \nabla V$ and $\nabla \times \nabla V$ if: (10)

- $V = 3x^2y + xz^{10}$
- $V = \rho z \cos \phi$
- $V = 4r^2 \cos \theta \sin \phi$

- b) What is Laplacian of a scalar? Express Laplacian operator in Cartesian, cylindrical & spherical co ordinate system. (5)**

Q4 a) Show that vector transformation between cylindrical and spherical co ordinate system & express the vector field $H = xy^2z a_x + x^2y z a_y + x y z^2 a_z$ in cylindrical and spherical coordinates. (10)

- b) Verify the divergence theorem of a vector field $\vec{D} = 3x^2\vec{a}_x + (3y + z)\vec{a}_y + (3z - x)\vec{a}_z$ in the region bounded by the cylinder $x^2 + y^2 = 9$ and the planes $x=0, y=0, z=0$ and $z=2$. (5)**

Q5 a) State Gauss's law and using Gauss's law find out electric flux density for (i) Infinite line charge (ii) uniformly charged sphere. (10)

- b) A charge distribution with spherical symmetry has volume charge density (5)**

$$\rho_V = \begin{cases} \rho_V & 0 \leq r \leq a \\ 0 & r > a \end{cases}$$

- Calculate : (i) The electric field intensity at all the points
(ii) Potential at all points.

Q6 a) What is boundary condition? Derive the law of refraction of the electric field at a dielectric-dielectric boundary free of charge conditions. (10)

- b) Verify that the following potential satisfy Laplace's equation: (5)**

(i) $V = 15x^2yz - 5y^3z$

(ii) $V = \frac{\cos \phi}{r}$

(iii) $V = \frac{\rho \sin \theta \sin \phi}{r^2}$

Q7 a) State Ampere's circuit law. A hollow conducting cylinder has inner radius 'a' and outer radius 'b' and carries current I along the positive z-direction. Find H everywhere. **(10)**

b) The magnetic field intensity in a certain conducting medium is $H = xy^2 a_x + x^2 z a_y - y^2 z a_z$ A/m **(5)**

(i) calculate the current density at point P(2,-1,3).

(ii) what is $\frac{\partial \rho_v}{\partial t}$ at P ?

Q8 a) Derive poynting theorem & poynting vector using Maxwell's equation in electromagnetic wave propagation. **(10)**

b) In a nonmagnetic medium, $H = 0.2e^{-y} \cos(2\pi x 10^8 t - 5y) a_z$ A/m **(5)**

(i) Find ϵ_r and σ

(ii) Obtain E.

Q9 a) Derive time-varying electric scalar potential $V(x,y,z,t)$ and magnetic vector potential $A(x,y,z,t)$ to satisfy wave equation. **(10)**

b) A medium is characterized by $\sigma = 0$, $\mu = 2\mu_0$ and $\epsilon = 5\epsilon_0$.
If $H = 2\cos(\omega t - 3y) a_z$ A/m, Calculate ω and E. **(5)**