



Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (EE-OLD)/SEM-4/EE-402/2013

2013

ELECTROMAGNETIC FIELD THEORY

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) Unit of Dipole moment

- | | |
|---------------------------|--------------|
| a) Coulomb/m ² | b) Newton-m |
| c) Coulomb-m | d) Newton/m. |

ii) Given $A = 2i + \alpha j + 2k$ and $B = \alpha i + j + k$. If A and B are normal to each other, α is

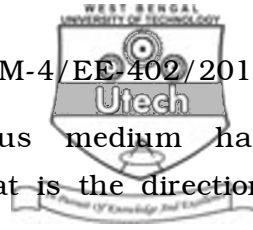
- | | |
|---------|-----------|
| a) 1 | b) $-2/3$ |
| c) -1 | d) 0. |

iii) Which statement is correct ?

- | | |
|----------------------------------|--|
| a) $A \times B + B \times A = 1$ | b) $i \times j = k$ |
| c) $i \cdot j = k$ | d) $A \cdot B \cdot C = B \cdot C \cdot A$. |



- iv) If a vector field P is solenoidal, which of this is true ?
- $\oint_L P \cdot dI = 0$
 - $\oint_L P \cdot dS = 0$
 - $\nabla \cdot P = 0$
 - $\nabla \times P \neq 0$.
- v) If a point is denoted by (3, 4, - 2) in Cartesian Coordinate system, then which one of these is incorrect in spherical coordinate system ?
- $r = \sqrt{29}$
 - $\theta = \tan^{-1} (\sqrt{5}/2)$
 - $\Phi = \tan^{-1} (4/3)$
 - $z = -2$.
- vi) Which one of the following is zero ?
- grad div A
 - div gradient ∇
 - div curl A
 - curl curl A .
- vii) The magnetic field at any point on the axis of a current carrying circular coil will be
- perpendicular to the axis
 - parallel to the axis
 - at an angle 45° to the axis
 - zero.



viii) A plane wave in a homogeneous medium has $E = 50 \sin (10^8 t + 2z) j$ V/m. What is the direction of wave propagation ?

- a) y direction
 - b) z direction
 - c) $-z$ direction
 - d) $-y$ direction.
- ix) Skin depth is proportional to
- a) frequency
 - b) permeability
 - c) $1 / \sqrt{\sigma}$
 - d) $\sqrt{\sigma}$.
- x) Which statement does not say that electrostatic field is conservative ?
- a) if the curl of E is identically zero
 - b) the potential difference between two points is zero
 - c) it is gradient of a scalar potential
 - d) the work done in a closed path inside the field is zero.



xi) Which of the following is incorrect ?

- a) Continuity equation : $\nabla \cdot J = - \partial \rho / \partial t$
- b) Faraday's Law : $\nabla \times E = \partial B / \partial t$
- c) Ampere's circuital law : $\nabla \times H = J + \partial D / \partial t$
- d) Poisson's equation : $\nabla^2 \nabla = 0$.

xii) The characteristic impedance of a transmission line is

- a) directly proportional to its length
- b) inversely proportional to its length
- c) independent of its length
- d) directly proportional to square root of its length.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

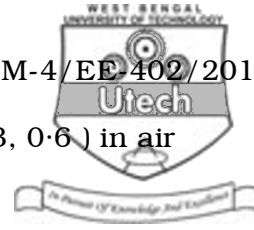
2. Given points $A (x = 2, y = 3, z = 1)$ & $B (\rho = 4, \phi = -50^\circ, z = 2)$. Find

the distance from

- a) A to origin
- b) B to origin and

c) A to B .

$$1\frac{1}{2} + 1\frac{1}{2} + 2$$



3. A charge $Q = 7\text{nC}$ is located at $(-0.2, -0.3, 0.6)$ in air

a) Find the magnitude of the electrical field intensity at a point 1 mtr from the charge,

b) Find \vec{E} at $(0.4, 0.6, -1.2)$. 2 + 3

4. Define vector & scalar field with proper examples. Show a point P in 3 different co-ordinate systems with standard notations. What is equipotential surface ? 2 + 2 + 1

5. Find the nature of the Field by determining its Divergence & Curl. $B = \left(150/r^2\right) \hat{a}_r + 10 \hat{a}_\phi$ (cylindrical co-ordinate system). $2\frac{1}{2} + 2\frac{1}{2}$

6. Using Gauss's theorem find the charge density (D) outside a uniformly charged sphere (where $r > a$).



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

3 × 15 = 45

7. The electric field associated with a EM wave propagating through a lossless medium of relative permittivity (ϵ_r) 78

and $\mu_r = 1$ at a frequency of 300 MHz is represented as

$$E_y = 10 \cos \left(6\pi \times 10^8 t - \beta x \right) \hat{j}. \text{ Determine}$$

i) The phase constant

ii) Wave velocity

iii) Intrinsic impedance

iv) Wavelength and

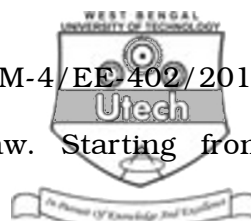
v) Corresponding magnetic field H .

5 × 3

8. State and define Biot-Savart Law. An infinitely long conductor is bent into an L shape. If 15 Amp current flows

find H at $(0, 0, 2)$ and $(0, -2, 0)$.

5 + 10



9. State and define Ampere's Circuital law. Starting from

Maxwell's equation $\text{Curl } E = - \partial B / \partial t$ and $\text{Curl } H = J + \partial D / \partial t$

respectively, show that $\text{Div } B = 0$ and $\text{Div } D = \rho$. 5 + 10

10. State Gauss's law. What is Gaussian surface ? Derive an

expression for electric field (E) due to sheet of charge.

5 + 2 + 8

11. Write short notes on any *three* of the following :

3 × 5

- a) Waves in transmission lines
- b) Polarisation in dielectrics
- c) Helmholtz's theorem
- d) Law of conservations of charges.

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