	Utech
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Invigilator's Signature :	

## CS/B.Tech (EE-New)/SEM-4/EE-402/2010 2010

#### **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) The vector identity of  $\square \infty (\square \infty \stackrel{\frown}{A})$  is
  - a)  $\Box$  (  $\Box$ .  $\overset{\circ}{A}$  )  $-\Box^2\overset{\circ}{A}$
  - b)  $\square$ .  $(\square \propto \stackrel{\frown}{A})$   $-\square^2 \stackrel{\frown}{A}$
  - c)  $\square \propto \stackrel{\bigcirc}{A} \square^2 \stackrel{\bigcirc}{A}$
  - d)  $\square \infty (\square \widetilde{A}) \square^2 \widetilde{A}$ .

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ii) The expression of  $\Box V$  ( r,  $\theta$  ) in  $r-\theta$  co-ordinate is

a) 
$$\partial \frac{\partial v}{\partial x} + \partial \frac{\partial v}{\partial y} + \partial \frac{\partial v}{\partial z}$$

b) 
$$\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z}$$

c) 
$$\frac{\partial v}{\partial r} \overset{\varnothing}{u}_r + \frac{\partial v}{r d\theta} + \overset{\varnothing}{u}_{\theta}$$

d) 
$$\frac{\partial v}{\partial r} \overset{\varnothing}{u}_r + \frac{\partial v}{\partial \theta} \overset{\varnothing}{u}_{\theta}$$

iii) In a perfect dielectric, the wavelength of E.M. wave is

a) 
$$\lambda = \frac{2\pi}{\sqrt{\mu \square}}$$

b) 
$$\lambda = \frac{1}{\sqrt{\mu \square}}$$

c) 
$$\lambda = \frac{\omega}{\sqrt{\mu \Box}}$$

d) 
$$\lambda = \frac{2\pi}{\omega\sqrt{\mu ||}}$$
.

where  $\mu$  = permeability of the medium

 $\square$  = permittivity of the medium

 $\omega$  = angular frequency.

iv) Relation among magnetic vectors  $\stackrel{\bigcirc}{B}$  ,  $\stackrel{\bigcirc}{M}$  &  $\stackrel{\bigcirc}{H}$  is

a) 
$$\stackrel{\bigcirc}{B} = \mu_o \stackrel{\bigcirc}{H} + \stackrel{\bigcirc}{M}$$

b) 
$$\overrightarrow{B} = \mu \overrightarrow{H} + \overrightarrow{M}$$

c) 
$$\stackrel{\bigcirc}{H} = \mu \stackrel{\bigcirc}{B} + \stackrel{\bigcirc}{M}$$

d) 
$$\stackrel{\bigcirc}{H} = \frac{\stackrel{\bigcirc}{B}}{\mu_0} - \stackrel{\bigcirc}{M}$$
.



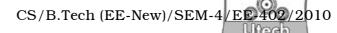
- v) The potential V due to an electric dipole located at a distance 'r' from the dipole
  - a) varies directly as r
  - b) varies inversely as r
  - c) varies inversely as  $r^2$
  - d) varies inversely as  $r^3$ .
- vi) The integral  $\oint \vec{E} \cdot d\vec{\rho} = 0$ , if the electric field  $\vec{E}$  is caused by
  - a) a static charge
  - b) a time varying magnetic field
  - c) moving charge
  - d) magnetic dipole.
- vii) One tesla is equal to
  - a) 10 <sup>6</sup> gauss
- b) 1 gauss
- c) 10<sup>-4</sup> gauss
- d)  $10^4$  gauss.
- viii) Electric potential & electric field intensity inside a spherical shell are
  - a) zero & constant respectively
  - b) both inversely proportional to radius
  - c) constant & zero respectively
  - d) zero & zero respectively.

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- ix) The direction of force on a conductor carrying current in the positive Y-axis & placed in magnetic field directed in positive X-axis, will be
  - a) positive *Z*-axis
- b) negative *Z*-axis
- c) negative X-axis
- d) negative Y-axis.
- x) A Gaussian surface is
  - a) an open surface
  - b) a closed surface
  - c) a semi-open surface
  - d) all of these.
- xi) Gradient of scalar function results in
  - a) vector function
- b) scalar function
- c) periodic function
- d) peak function.
- xii) Poynting vector has the unit
  - a) W m $^{-2}$
- b)  $J s^{-1}$

c) W

d)  $J m^{-2}$ .



#### **GROUP - B**

#### (Short Answer Type Questions)

Answer any three of the following.



- 2. Develop an expression of  $\stackrel{\bigcirc}{E}$  at (0, 0, 5) m due to  $Q_1 = 0.35 \,\mu\text{C}$  at (0, 4, 0)  $m \,\&\, Q_2 = -0.55 \,\mu\text{C}$  at (3, 0, 0) m.
- 3. Given an electric flux density  $D = 2x \frac{8}{a}x + 3 \frac{8}{a}y$  ( C / m<sup>2</sup> ), determine the net flux crossing the surface of a cube 2 m on an adge centered at origin. ( the edges of the cube are parallel to the co-ordinate axis ).
- 4. Find  $\overset{\varnothing}{H}$  on the axis of a circular loop of radius a.
- 5. Find the force per unit length on two long, straight, parallel, conductors, if each carries a current of 10 A in the same direction & the separation distance is 0.2 m.
- 6. Differentiate between magnetic scalar potential & magnetic vector potential.
- 7. State how transformer *emf* differs from motional *emf*. Derive the necessary expressions. 2 + 3



# ( Long Answer Type Questions ) Answer any *three* of the following.



8. Show that the electric field is conservative. Derive the relation  $\stackrel{\frown}{E} = -\stackrel{\frown}{\coprod} V$ . The symbols has usual meaning.

3 + 3

- b) State divergence theorem. Find the divergence of the electric flux density  $\stackrel{\textstyle olimits}{D}$  . Why is the divergence of the magnetic flux density B always zero? 2 + 5 + 2
- State & explain Ampere's law of magnetostatics. Explain 9. a) how this law is modified by introduction of displacement 3 + 5current.
  - Obtain an expression for the energy density in an b) electrostatic field. 7
- Obtain the Poynting theorem for conservation of energy 10. a) electromagnetic fields & discuss the physical meaning of each term in the resulting equation.
  - An EM wave travels in free space with electric field b) component

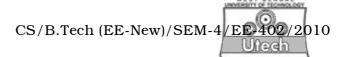
$$E = \left( 10 \stackrel{\text{\ensuremath}\ensuremath}\ensuremath}\ensuremath}}}$$

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Determine:

- (i) ω&λ
- the magnetic field component
- (iii) the time average power in the wave. 2 + 2 + 3

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- 11. a) Write & interpret two Maxwell's equations relating to  $\stackrel{\smile}{B}$  .
  - b) Explain the importance of propagation constant ( $\gamma$ ) & charactertic impedance ( $z_0$ ) of a transmission line. State the conditions for lossless & distortionless transmission line.
  - c) Why is it desirable to achieve an impedance match in a transmission line?
- 12. a) The parallel conducting disks shown in the figure are separated by 5 mm and contain a dielectric for which  $\Box_r = 2 \cdot 2$ . Determine the charge densities on the disk.

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- b) Explain the method of images for solving electrical problems.
- c) Write a note on continuity equation. 3

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