

Name :

Roll No. :

Invigilator's Signature :

CS/B.TECH(EIE-NEW)/SEM-4/EE-402(EI)/2012

2012

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 × 1 = 10

i) Stokes Theorem state that

a) $\oint \bar{A} \cdot d\bar{L} = \iint (\bar{\nabla} \times \bar{A}) \cdot d\bar{S}$

b) $\oint \bar{A} \cdot d\bar{L} = \iint (\bar{\nabla} \cdot \bar{A}) \cdot d\bar{S}$

c) $\oint \bar{A} \cdot d\bar{S} = \iint (\bar{\nabla} \cdot \bar{A}) \cdot d\bar{L}$

d) $\oint \bar{A} \cdot d\bar{S} = \iint (\bar{\nabla} \times \bar{A}) \cdot d\bar{L}$

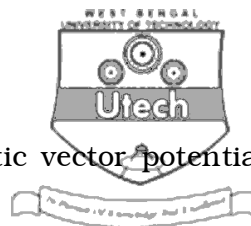
ii) The magnetic field intensity \bar{H} for an infinite straight current at a distance ρ in cylindrical co-ordinate is

a) $\bar{H} = \frac{I}{\rho} \bar{a}_\phi$

b) $\bar{H} = \frac{I}{2\pi\rho} \bar{a}_\rho$

c) $\bar{H} = \frac{I}{2\pi\rho} \bar{a}_\phi$

d) $\bar{H} = \frac{I}{4\pi\rho} \bar{a}_\phi$



iii) Magnetic flux density \vec{B} and magnetic vector potential \vec{A} are related as

a) $\vec{B} = \nabla \cdot \vec{A}$

b) $\vec{B} = -\nabla \vec{A}$

c) $\nabla \times \vec{B} = \vec{A}$

d) $\vec{B} = \nabla \times \vec{A}$.

iv) Divergence theorem for electrostatic field states that

a) $\oint \vec{D} \cdot d\vec{S} = \iiint (\nabla \cdot \vec{D}) dV$

b) $\oint \vec{D} \cdot d\vec{S} = \iiint (\nabla \times \vec{D}) dV$

c) $\oint \vec{D} \cdot d\vec{S} = \iiint (\nabla \cdot \vec{E}) dV$

d) $\oint \vec{E} \cdot d\vec{S} = \iiint (\nabla \cdot \vec{D}) dV$.

v) The Kirchhoff's current law equation is

a) $\nabla \cdot \vec{B} = 0$

b) $\nabla \times \vec{J} = 0$

c) $\nabla \times \vec{H} = \vec{J}$

d) $\nabla \cdot \vec{J} = 0$.

vi) For a lossless transmission line the characteristic impedance is given by

a) $\sqrt{\frac{c}{L}}$

b) $2\pi\sqrt{\frac{c}{L}}$

c) $2\pi\sqrt{\frac{L}{c}}$

d) $\sqrt{\frac{L}{c}}$.



vii) The velocity of Electromagnetic wave propagating in free space is

- | | |
|--|--------------------------------------|
| a) $\mu_o \epsilon_o$ | b) $\sqrt{\frac{\mu_o}{\epsilon_o}}$ |
| c) $\frac{1}{\sqrt{\mu_o \epsilon_o}}$ | d) $\frac{1}{\mu_o \epsilon_o}$ |

viii) Displacement current can flow through

- | | |
|--------------|-------------------|
| a) Inductor | b) Resistor |
| c) Capacitor | d) none of these. |

ix) The ratio of conduction current density to the displacement current when electromagnetic wave travels through a partially conducting medium, is

- | | |
|-------------------------------------|-------------------------------------|
| a) $\frac{j\sigma}{\omega\epsilon}$ | b) $\frac{\sigma}{j\omega\epsilon}$ |
| c) $\frac{\sigma\omega}{j\epsilon}$ | d) $\frac{\epsilon\sigma}{j\omega}$ |

x) In a transmission line, electrical energy is transported by

- | |
|--|
| a) the flowing electrons |
| b) the flowing electrons and holes |
| c) the associated electric and magnetic fields |
| d) none of these. |



xi) In transverse electromagnetic wave propagation the space difference between \vec{E} and \vec{H} is

- a) 180° b) 0°
- c) 45° d) 90° .

xii) Poynting vector has the unit of

- a) Watt b) Watt/metre³
- c) watt/meter d) Watt/metre².

GROUP – B

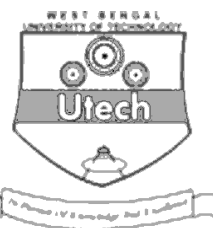
(Short Answer Type Questions)

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

2. Derive an expression for curl of a vector field \vec{A} , $\nabla \times \vec{A}$ in Cartesian co-ordinate system using fundamental definition of curl.
3. Using vector Magnetic potential establish Biot-Savart law.
4. Establish that $\nabla \times \vec{H} = \vec{J}$. What is the physical significance of $\nabla \times \vec{H}$?



5. Derive the expression for capacitance of a co-axial cable having inner and outer conductor's radii a and b respectively filled by dielectric in the space between the conductors. The length of the cable is L and permittivity is ϵ .
6. Prove that the displacement current through the capacitor is equal to conduction current when a capacitor is supplied from a voltage source $v = V_m \sin \omega t$, having a capacitance C . Assume other parameters related to the system.
7. In a lossless transmission line, the velocity of propagation is $2 \cdot 5 \times 10^8$ m/s. Capacitance of the line is 30 pF/m. Find,
- (i) inductance of the line
 - (ii) phase constant at 100 MHz
 - (iii) characteristics of the line.



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) State Gauss Law. Explain the 'Gaussian surface' 2 + 2
- b) Find the divergence of Electric flux density \vec{D} . 3
- c) Show that for electrostatic field $\nabla \times \vec{E} = 0$ 3
- d) Find the potential at a point $P (0,0,4)$ m produced by a total charge of 10 nC distributed uniformly along a ring of radius 4m lying in xy plane and centred at the origin. 5
9. a) Establish the relation $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ 5
- b) Explain the relation $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$. 5
- c) Explain the concept of skin depth developing the equation of current density for an electromagnetic wave travelling through good conductor. 5
10. a) Using Maxwell's equations derive the wave equations in free space involving Electric and Magnetic fields. 5
- b) Find an analytical solution for the electric field wave travelling in free space. What is the velocity of the wave in free space ? 5
- c) Establish Poynting theorem. 5



11. a) Explain the importance of propagation constant (γ) and characteristic impedance (z_o) of a Transmission line. 4
- b) State the conditions for lossless and distortionless transmission line and also derive the relations for those conditions. 4
- c) What do you mean by linearly polarised plane E.M. wave ? 4
- d) Sketch the T.E.M. wave propagation in lossy medium. 3
12. Write short notes on any *three* of the following : 3 × 5
- a) Poisson's and Laplace's Equations for Electro-static field.
- b) Various kinds of electromagnetic waves in real world.
- c) Physical significance of Divergence and $\nabla \cdot \vec{B} = 0$.
- d) Boundary relations when magnetic field travels through different medium having permeabilities μ_1 and μ_2 .
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