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 : $10 \times 1 = 10$

   i) Stokes Theorem state that

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

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

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

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

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

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

   c) $\overline{H} = \frac{I}{2\pi\rho} \overline{a}_\phi$ d) $\overline{H} = \frac{I}{4\pi\rho} \overline{a}_\phi$.

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

a) $\overline{B} = \overline{\nabla} \cdot \overline{A}$ b) $\overline{B} = -\nabla\ \overline{A}$

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

iv) Divergence theorem for electrostatic field states that

a) $\oiint \overline{D} \cdot d\overline{S} = \iiint (\overline{\nabla} \cdot \overline{D})\, d\overline{V}$

b) $\oiint \overline{D} \cdot d\overline{S} = \iiint (\overline{\nabla} \times \overline{D})\, d\overline{V}$

c) $\oiint \overline{D} \cdot d\overline{S} = \iiint (\overline{\nabla} \cdot \overline{E})\, d\overline{V}$

d) $\oiint \overline{E} \cdot d\overline{S} = \iiint (\overline{\nabla} \cdot \overline{D})\, d\overline{V}$.

v) The Kirchhoff's current law equation is

a) $\overline{\nabla} \cdot \overline{B} = 0$ b) $\overline{\nabla} \times \overline{J} = 0$

c) $\overline{\nabla} \times \overline{H} = \overline{J}$ d) $\overline{\nabla} \cdot \overline{J} = 0$.

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) $\mu_o\varepsilon_o$ b) $\sqrt{\frac{\mu_o}{\varepsilon_o}}$

c) $\frac{1}{\sqrt{\mu_o\varepsilon_o}}$ d) $\frac{1}{\mu_o\varepsilon_o}$.

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) $\frac{j\sigma}{\omega\varepsilon}$ b) $\frac{\sigma}{j\omega\varepsilon}$

c) $\frac{\sigma\omega}{j\varepsilon}$ d) $\frac{\varepsilon\sigma}{j\omega}$

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 $\overline{E}$ and $\overline{H}$ is

a) 180° b) 0°

c) 45° d) 90°.

xii) Poynting vector has the unit of

a) Watt b) Watt/metre^3

c) watt/meter d) Watt/metre^2.

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 $(\overline{A})$, $\overline{\nabla} \times \overline{A}$ in Cartesian co-ordinate system using fundamental definition of curl.

3. Using vector Magnetic potential establish Biot-Savart law.

4. Establish that $\nabla \times \overline{H} = \overline{J}$. What is the physical significance of $\nabla \times \overline{H}$?

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 $\in$.

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 $2 \cdot 5 \times 10^8 \text{m/s}$. 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 × 15 = 45

8. a) Sate Gauss Law. Explain the 'Gaussian surface' 2 + 2

   b) Find the divergence of Electric flux density $\overline{D}$. 3

   c) Show that for electrostatic field $\nabla \times \overline{E} = 0$ 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 i xy plane and centred at the origin. 5

9. a) Establish the relation $\nabla \times \overline{E} = \frac{\partial \overline{B}}{\partial t}$ 5

   b) Explain the relation $\nabla \times \overline{H} = \overline{J} + \frac{\partial \overline{D}}{\partial t}$. 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 Maxwellt'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 is 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 $\nabla \cdot \bar{B} = 0$.

d) Boundary relations when magnetic field travels through different medium having permeabilitics μ_1 and μ_2.