Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(EE)(N)/EEE(N)/ICE(N)/SEM-3/EE-302/2012-13

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) Divergence theorem relates between

      a) line integral over closed line and surface integral over open surface

      b) line integral over closed line and volume integral over open volume

      c) surface integral over closed surface and volume integral over open volume

      d) none of these.

ii) The Gauss's law of electrostatics is expressed as

a) $\overline{E} = -\nabla\phi$ b) $\nabla \cdot \overline{D} = \rho_v$

c) $\nabla \times \overline{D} = \rho_v$ d) $\nabla \times \overline{E} = \rho_v$.

iii) Electrostatic field is

a) solenoidal

b) conservative

c) both solenoidal and conservative

d) sometimes solenoidal, sometimes conservatives.

iv) Electric field of a region containing space charges can be found using

a) Laplace's equation b) Poisson's equation

c) Coulomb's law d) Helmholtz equation.

v) The magnetic field strength $\overline{H}$ produced by a conductor carrying current I at a distance r is given by

a) $\overline{H} = 2\pi rl$ b) $\overline{H} = 2\pi rl$

c) $\overline{H} = I / 4\pi r$ d) $\overline{H} = 4\pi r / I$.

vi) At the boundary of two media of permeability μ_1 and μ_2 the boundary conditions satisfied is

a) the normal component of the magnetic field strength H is continuous

b) the normal component of the flux density B is continuous

c) the tangential component of the flux density B is continuous

d) the tangential component of the field strength H is continuous.

vii) The magnetic flux density and the magnetic vector potential are related by

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

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

viii) If the number of turns in a solenoid is doubled and its radius is halved its self inductance

a) is doubled b) becomes four times

c) remains same d) becomes half.

ix) Which of the following is not Maxwell's equation ?

a) $\overline{\nabla} \cdot \overline{D} = \rho$ b) $\overline{\nabla} \times \overline{E} = -\frac{\partial \overline{B}}{\partial t}$

c) $\overline{\nabla} \times \overline{H} = \overline{J} + \frac{\partial \overline{D}}{\partial t}$ d) $\overline{\nabla} \cdot \overline{J} = -\frac{\partial \rho}{dt}$.

x) Displacement current can flow through

a) capacitor b) inductor

c) resistor d) none of these.

xi) The direction of propagation of electromagnetic wave is obtained from

a) $\vec{E} \times \vec{H}$ b) $\overline{E}$

c) $\vec{H}$ d) none of these.

xii) A transmission line of length $\frac{\lambda}{4}$ shorted at far end behaves like

a) series resonant circuit

b) parallel resonant circuit

c) pure inductor

d) pure capacitor.

GROUP – B

(Short Answer Type Questions)

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

2. Explain the physical significance of the terms :

i) divergence of a vector field

ii) curl of a vector field.

3. Derive an expression of electric field due to uniform charge distribution over an infinite plane with surface charge density σ.

4. What is the inconsistency of Ampere's law ? How is this inconsistency be rectified by Maxwell ? 1 + 4

5. State how transformer *emf* differs from motional *emf*. Derive the necessary expressions.

6. Write down the primary and secondary parameters of a transmission line. Express the secondary parameters in terms of primary parameters and primary parameters in terms of secondary parameters. 3 + 2

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) What do you understand by uniform plane wave ?

   b) Show that the components of electric field and magnetic field are orthogonal to the direction of propagation and they are also orthogonal to each other.

   c) When the amplitude of the magnetic field in a plane wave is 1 A/m,

      i) determine the magnitude of the electric field for the plane wave in free space

      ii) determine the magnitude of the electric field when the wave propagates in a medium characterized by $\sigma = 0$, $\mu = \mu_0$ and $\varepsilon_r 4\varepsilon_0$. (The parameters have their usual significance).

   d) Discuss the importance of the Loss Tangent term $(= \sigma / \omega \in)$ in classification of materials as conductors or dielectrics. 2 + 6 + (1 + 3) + 3

8. a) Obtain an expression for the energy density in an electrostatic field.

   b) If is found that $E = 60u_x + 20u_y - 30u_z$ mv/m at a particular point on the interface between air and a conducting surface. Find D and ρ_s at the point.

   c) Two dipole with dipole moments $-5a_z\ nC-m$ and $9a_z\ nC-m$ are located at the points (0, 0, – 2) and (0, 0, 3) respectively. Find the potential at the origin.

6 + 4 + 5

9. a) State Biot-Savart law for the magnetic field due to a current element. Use it to obtain the magnetic field due to an infinite, thin straight wire carrying current *I*.

   b) What is Poynting vector ? Prove that the Poynting vector gives the power flow per unit area of cross-section, at a point in the medium. 2 + 5 + 2 + 6

10. a) Find the amplitudes of the reflected and refracted waves in terms of the incident wave amplitude in the case of parallel polarization assuming plane monochromatic waves incident normally on the boundary surface between two dielectrics.

b) Derive the expression of input impedance, Z_{in} of a transmission line in terms of relevant parameters, when the line is terminated in a load impedance, Z_L. Hence or otherwise show that,

$$Z_0 = \sqrt{Z_{sc} \times Z_{oc}}$$

Where, Z_0 is the characteristic impedance, Z_{sc} and Z_{oc} are the input impedance of the transmission line respectively when they are terminated by short circuit and open circuit. 7 + (6 + 2)

11. Write short notes on any *three* of the following : 3 × 5

a) Coulomb's law in vectorial form

b) Polarisation

c) Helmholtz's theorem

d) Faraday's law of electromagnetic induction

e) Distortion less transmission line.

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