Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (EEE)/SEM-5/EEE-502/2010-11

2010-11
ELECTROMAGNETIC 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) Curl of a vector is always a

a) vector

b) scalar

c) both vector and scalar

d) none of these.

ii) Stokes' Theorem transforms the

a) line integral to volume integral

b) volume integral to surface integral

c) surface integral to volume integral

d) surface integral to line integral.

iii) Poisson's equation is

a) $\nabla^2 V = \frac{\rho}{\in_0}$ b) $\nabla^2 V = -\frac{\rho}{\in_0}$

c) $\nabla^2 V = 0$ d) $\nabla^2 V = \rho$.

iv) The condition for an equipotential surface is given by

a) $\nabla \times \overline{E} = 0$ b) $\nabla \overline{E} = 0$

c) $\nabla V = 0$ d) None of these.

v) Divergence of a vector is always a

a) vector b) scalar

c) can be both d) none of these.

vi) Which is the correct statement ?

a) $\nabla \overline{D} = \frac{\rho}{\in_0}$ b) $\nabla.\overline{D} = q$

c) $\nabla \cdot \overline{E} = \frac{\rho}{\in_0}$ d) None of these.

vii) Condition for a transmission line to be distortionless is

a) $LG = RC$ b) $RG = LC$

c) $\frac{L}{R} = \frac{G}{C}$ d) $\frac{C}{G} = \frac{R}{L}$.

viii) Equation of continuity for time varying fields is

a) $\nabla \cdot \bar{J} = \frac{\partial \rho}{\partial t}$ b) $\nabla \times \bar{J} = \frac{\partial \rho}{\partial t}$

c) $\nabla \cdot \bar{E} = -\frac{\partial \rho}{\partial t}$ d) none of these.

ix) Gauss' law in magnetism is given by

a) $\nabla \cdot \bar{B} = 0$ b) $\nabla \bar{B} = 0$

c) $\nabla \times \bar{B} = 0$ d) $\nabla \times \bar{H} = 0$.

x) Which of the following layers persists at night ?

a) *D* layer b) *E* layer

c) F_1 layer d) F_2 layer.

xi) The magnetic flux density *B* and magnetic vector potential *A* are related as

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

c) $\bar{A} = \nabla \cdot \bar{B}$ d) $\bar{B} = \nabla \cdot \bar{A}$

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Derive the relation between $\bar{J}$ and $\bar{H}$.

3. a) Write down Gauss's law in differential form explaining cache term.

   b) Using Gauss's law, derive Poisson's equation in electrostatics. 2 + 3

4. a) Define equipotential line and equipotential surface.

   b) Prove $\bar{E}$ = – grad V where $\bar{E}$ = Electric field intensity and V = electric potential. 3 + 2

5. Obtain the expression for the surface charge density at the interface between two conducting media with different conductivities.

6. Derive an expression for the magnetic flux of passing through the region bounded by two very long identical parallel conductors.

GROUP – C

(Long Answer Type Questions)

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

7. a) Derive Poynting's Theorem for the conservation of energy in an electromagnetic field and discuss the physical meaning of each term in the resulting equation. 10

   b) Define skin depth. Find the skin depth at a frequency of 1·6 MHz in aluminum, where $\sigma = 38 \cdot 2 \times 10^{-6}$ s/m and $\mu_r = 1$. 2 + 3

8. a) Explain the inconsistency present in the Ampere's law. How is the law modified by Maxwell ? 4 + 5

   b) The electric field intensity is E = 250 sin 10^{10}t V/m for a field propagating in the medium whose conductivity σ = 5·0 s/m and $\in_r = 1 \cdot 0$. Calculate the

      i) conduction current density

      ii) frequency at which conduction current density equals displacement current density. 3 + 3

9. a) State and explain Biot-Savart law for static magnetic field. 5

b) Derive general expression for the boundary relations for magnetic field for

i) tangential component

ii) normal component.

Assume the common boundary has been separated by two different media having constant $\mu_1 \cdot \in_1$ and $\mu_2 \cdot \in_2$. The common boundary has a surface current density of $K_s \text{A/m}^2$. 6

c) Explain the significance of the polarization victor. 4

10. a) What do you understand by uniform plane wave ? 2

b) Derive the wave equation in terms of electric field. 6

c) Prove that electric field and magnetic field constituting an electromagnetic wave are perpendicular to each other. 5

d) A lossless dielectric medium has $\sigma = 0$, $\mu_r = 1$ and $\in_r = 4$. Find the wave impedance. 2

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

a) Duct propagation

b) Boundary conditions for electrostatic fields

c) Tropospheric scatter

d) Propagation constant

e) Equation of continuity

f) Retarded Vector Potential

g) MUF.