2011

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 intrinsic impedance of free space is given by

a) 333 Ω b) 377 Ω

c) $4\pi\ \Omega$ d) $2\pi\ \Omega$.

ii) Minimum value of VSWR is

a) $-\infty$ b) – 2

c) 0 d) 1.

iii) ϵ_0 for vacuum is given by

a) $10^{-9}/(36\pi)$ b) $10^{-19}/(36\pi)$

c) 0 d) 1.

iv) Which one is true for charge free region ?

a) $\nabla^2 \phi = 1$ b) $\nabla^2 \phi = 0$

c) $\nabla^2 \phi = -\frac{\epsilon}{\rho}$ d) none of these.

v) Which one is conservation of charge equation for the steady currents ?

a) $\nabla \cdot J = 1$ b) $\nabla \cdot J = 0$

c) $\nabla \cdot J = 4\pi$ d) $\nabla \cdot J = \rho$

vi) Lorentz force for a point charge in motion in external electric and magnetic field is given by

a) $F = Q (E + u \times B)$

b) $F = Q (B + u \times H)$

c) $F = Q (H + uB)$

d) $F = Q (E + uB)$.

vii) Which of the following can be the unit of *emf* ?

a) Wb/s b) Wb/v

c) v/s d) s/v.

viii) In a co-axial cable the mode of wave propagation is

a) TEM b) quasi TEM

c) TE d) TM.

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

a) $\sqrt{\frac{C}{L}}$ b) $\sqrt{\frac{L}{C}}$

c) $2\pi\sqrt{\frac{C}{L}}$ d) $2\pi\sqrt{\frac{L}{C}}$.

x) For a lossless transmission line terminated with a short circuit, the i/p impedance is given by (for line characteristic impedance z_0)

a) $jz_0 \tan \beta l$ b) $-jz_0 \tan \beta l$

c) $jz_0 \cot \beta l$ d) $-jz_0 \cot \beta l$.

xi) Wave number is given by

a) $k = \omega\sqrt{\mu\epsilon}$ b) $k = 2\pi\sqrt{\mu\epsilon}$

c) $k = \sqrt{\mu\epsilon}$ d) $k = \omega^2 \mu\epsilon$.

xii) Skin depth is given by

a) $\delta = \sqrt{2/(\omega\mu\sigma)}$

b) $\delta = \sqrt{\pi/(\omega\mu\sigma)}$

c) $\delta = 2/\sqrt{(\omega\mu\sigma)}$

d) $\delta = \pi/\sqrt{(\omega\mu\sigma)}$.

GROUP – B

(Short Answer Type Questions)

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

2. State and explain the following :

a) Stoke's theorem

b) Helmholtz theorem.

3. Using Cartesian coordinates show that

$\nabla \cdot (\nabla \times A) \equiv 0$ and $\nabla \times (\nabla\phi) \equiv 0$.

4. Show that a lossless $x/8$ length line terminated as open circuit, behaves like a capacitor.

5. a) Derive an expression for the wave equation in terms of electric field intensity in a perfect dielectric of permittivity ϵ, permeability μ for the medium with no absorption.

b) For a lossy dielectric $\mu_r = 1$, $\epsilon_r = 48$, $\sigma = 20$ S/m, calculate the attenuation constant and phase constant at frequency of 16 GHz.

6. Deduce boundary conditions on electric vector $\vec{E}$ and $\vec{D}$ for Dielectric-Dielectric interface.

GROUP – C
(Long Answer Type Questions)

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

7. a) What is polarization ? How will you generate right handed circular polarize waves using linearly polarized wave sources ? Define axial ratio. 2 + 2 + 2

b) State and prove Poynting Theorem. 9

8. a) Draw the equivalent circuit of a transmission line. What is distortionless line ? How to achieve distortionless condition on the line ? Derive necessary conditions. 2 + 2 + 5

b) Find the characteristic impedence, propagation constant and velocity of propagation for a transmition line having the following parameters :

R = 84 ohm/km, $G = 10^{-6}$ mho/m, L = 0·01H/km, C = 0·061 μF/km, frequency = 1000 Hz. 6

9. a) State and explain Gauss's law in differential form and explain what do you mean by div. D. 7

b) A circular disc of radius 'a' is situated in the xy plane at $Z = 0$, with its centre at the origin charge density on disc is ρ_s = constant c/m^2 . Calculate the field at any point (0, 0, h) in cylindrical co-ordinate system. 8

10. Fine the Gradient of a function G at the point (4, 5, 6) and Divergence of F at (3, 2, 1), given that

$$G = x^2 + y^2 + z^2 \text{ and } \bar{F} = 2xya_x + za_y + yz^2 a_z .$$

Given point P (1, 2, 3). Express P in cylindrical and spherical co-ordinates. 9 + 6

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

a) Magnetic material

b) Poisson's and Laplace's equation

c) Maxwell's equations

d) Propagation constants

e) Biot-Savart law.