Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (ECE-NEW)/SEM-4/EC-401/2012

2012

ELECTROMAGNETIC THEORY & TRANSMISSION LINES

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 divergence of $G = xa_x + ya_y + za_z$ at point P (2, 2, 2) is

a) 1

b) 2

c) 3

d) 4.

ii) The Stokes' theorem is

a) $\int_1 H.dL = \oint_S (\nabla \times H).\, dS$

b) $\int_1 H.dL = \oint_S (\nabla \,.\, H).\, dS$

c) $\int_1 H.dL = \int_S (\nabla \times H).\, dS$

d) $\oint H.dL = \int_S (\nabla \,.\, H).\, dS$

iii) Energy density in an electrostatic field E is

a) $\frac{1}{2}\left(\varepsilon E^2\right)$ b) $\left(\varepsilon E^2\right)$

c) $2\left(\varepsilon E^2\right)$ d) $\frac{1}{2}(\varepsilon E)$.

iv) The electric field intensity due to sheet charge density is

a) $E = \frac{\rho_s}{2\varepsilon_0} a_p$ b) $E = \frac{\rho_s}{2\varepsilon_0} a_n$

c) $E = \frac{\rho_s}{2\varepsilon_0} a_z$ d) $E = \frac{\rho_s}{2\varepsilon_0} a_\theta$.

v) Yag-Uda antenna is one kind of

a) array b) reflector

c) dipole d) none of these.

vi) Intrinsic impedance in free space is

a) 0 ohm b) 370 ohm

c) 377 ohm d) none of these.

vii) The condition for distoritionless transmission line is

a) $RL = GC$ b) $RG = LC$

c) $RC = LG$ d) none of these.

viii) The rate of energy flow is given by

a) Maxwell equation

b) Poynting vector

c) Poisson equation

d) Equation of continuity.

ix) Effective length of a half wave dipole is

a) $> \frac{\lambda}{2}$ b) $< \frac{\lambda}{2}$

c) $0{\cdot}55\ \lambda$ d) $0{\cdot}6\ \lambda$.

x) Polarization refers to the orientation of the

a) E-H fields b) H-field

c) Transverse E-field d) E-field.

xi) A transmission line is said to be distoritionless if

a) $R/G = C/L$ b) $R/G = L/C$

c) $RG = LC$ d) $R/Y = L/Z$.

xii) Which one of the following is not a source of magnetostatic fields ?

a) A d.c. current in a wire

b) A permanent magnet

c) An accelerated charge

d) An electric field linearly changing with time.

GROUP – B

(Short Answer Type Questions)

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

2. State and prove Uniqueness theorem.

3. Starting from Ampere's circuit law establish the relation, $\nabla \times H = J + \frac{\delta D}{\delta t}$, where symbols have their usual meanings.

4. Establish the relation between reflection coefficient and VSWR.

5. Explain what 'quarter-wave' transformer means. Write applications of such a transformer. 3 + 2

6. a) What are the characteristics of Smith chart ? 2

   b) Define Reflection Coefficient and VSWR. What is their range of values ? 3

GROUP – C

(Long Answer Type Questions)

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

7. a) What do you mean by Electric Potential ? Derive the relation $E = -\vec{\nabla} V$. 4

   b) Given the spherically symmetric potential field in free space, $V = V_0 e^{-r/a}$, find ρ_v at $r = a$. 3

   c) Write and explain the point forms and integral forms of Maxwell's equation in time-varying EM field. 8

8. a) Write Maxwell's equations in differential vector form for time varying fields. 4

   b) Define the following terms in relation to uniform plane wave propagation in a dielectric medium : 4 × 1

      i) Propagation constant

      ii) Phase velocity

      iii) Wavelength

      iv) Phase constant.

   c) Prove that the electromagnetic power (P) passing through free space is given by the expression $P = E \times H$ W/m ^{2}. 7

9. a) Derive an expression for the input impedance Z_m of a lossless transmission line, in erms of relevant parameters, when the line is terminated into impedance Z_L. 5

b) Show that for a lossless transmission line the input impedance of a line repeats over every $\lambda/2$ distance. 5

c) At a frequency of 80 MHz, a lossless transmission line has a characteristic impedance of 300 Ω and a wavelength of 2·5 m. Find the value of L and C. 5

10. a) Establish the boundary conditions for electric and magnetic field intensities and the interference between two dielectric media. 6

b) Explain how these conditions will be modified, if one of the media is a perfect conductor. 5

c) If $x < 0$ defines region 1 and $x > 0$ defines region 2, then find the electric field intensity in region 2 $\left(\varepsilon_{r_2} = 5 \right)$, if electric field intensity in region 1 $\left(\varepsilon_{r_1} = 1 \right)$ is $\vec{E}_1 = \left(4\hat{u}_x + 1{\cdot}5\hat{u}_y - 2\hat{u}_z \right)$ V/m. 4

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

a) Skin effect

b) Smith chart

c) Half-wave dipole antennas

d) Yagi-Uda antenna.