Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (ECE)/SEM-4/EC-404/2011

2011

ELECTROMAGNETIC WAVES AND RADIATING SYSTEMS

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) A region of field for which $\nabla \times A \neq 0$ is called

a) solenoidal field

b) vortex field

c) irrotational field

d) conservative field.

ii) The unit of magnetic vector potential is

a) volt/m b) weber/m

c) coulomb/m d) newton/m.

iii) A circularly polarised wave results when

a) magnitudes of two waves are same

b) phase of the two waves are same

c) magnitudes of two waves are same but phase difference is 90

d) magnitudes of two waves are same and phase difference is 0.

iv) In a transmission line, the distance between adjacent maxima and minima of a standing wave is

a) $\lambda/8$ b) $\lambda/4$

c) $\lambda/2$ d) λ.

v) Tropospheric scatter is used with frequencies in the range

a) HF b) VHF

c) UHF d) VLF.

vi) The Stokes' theorem is

a) $\int_L H.dL = \oint_s (\nabla \times H).dS$

b) $\int_L H.dL = \oint_s (\nabla.H).dS$

c) $\oint H.dL = \int_s (\nabla \times H).dS$

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

vii) The magnetic field intensity at any distance ρ from an infinity long current carrying conductor is

a) $H = (I/2\pi\rho)a_\varphi$ b) $H = (I^2/2\pi\rho)a_\varphi$

c) $H = (I/\pi\rho)a_\varphi$ d) $H = (I/\rho)a_\varphi$.

viii) 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.

ix) If the volume charge density is $\rho_v = 40xyz\ C/m^3$. The total charge within the region defined by $0 \le x, y, z \le 1$, is

a) 10 C b) 20 C

c) 30 C d) 40 C.

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

a) $E = \frac{\rho_s}{2\varepsilon_0} a_\rho$ b) $E = \frac{\rho_s}{2\varepsilon_0} a_N$

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

xi) Reflector in Yagi-Uda antenna is

a) active element b) driven element

c) identical to dipole d) parasitic element.

xii) Duct propagation is similar to

a) free space propagation

b) propagation in waveguides

c) propagation in water

d) uniform plane wave.

xiii) Fresnel region is

a) Far field region

b) Near field region

c) The region of constant field

d) The region of no field.

xiv) Gradient of a scalar function results in

a) Vector function

b) Scalar function

c) Peak function.

xv) If the frequency of the incident wave increase by a factor of 4, the depth to which a wave penetrates a conducting material

a) increases by a factor of 2

b) increases by a factor of 4

c) decreases by a factor of 2

d) decreases by a factor 4.

GROUP – B
(Short Answer Type Questions)

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

2. The vector potential $\vec{A}$ and the scalar potential ϕ in a certain region of space are given by :

$$\vec{A} = \frac{1}{2} \propto t \left(\overrightarrow{a_y}\, x - \overrightarrow{a_x}\, y \right)$$

$$\phi = \frac{1}{4} \alpha \left(x^2 + y^2 \right)$$

where α is a constant. Calculate the electric and magnetic fields. 5

3. a) What do you mean by skin effect ? 2

   b) If the skin depth is 80 μ *M* at 4 MHz in a certain conducting medium, calculate the skin depth if the frequency is changed to 16 MHz. 3

4. A transmission line has characteristic impedance of 70 Ω and a phase constant of 3 rad/m at 100 MHz. Calculate the inductance per metre and capacitance per metre of the line. 5

5. Why is ionosphere important for raido wave propagation ? Describe the different layers of ionosphere. 5

6. a) What is radiation resistance of an antenna ?

   b) Define directivity of an antenna. What is the minimum value of directivity ? 2 + (2 + 1)

GROUP – C

(Long Answer Type Questions)

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

7. a) What is a Lorentz gauge ? 2

   b) Use this gauge to obtain the inhomogeneous wave equations for the scalar and vector potentials. 10

   c) Indicate how solutions of the above wave equations lead to retarded scalar and vector potentials. 3

8. a) For spherical polar coordinates $x = r \sin\theta \cos\varphi$, $y = r \sin\theta \sin\varphi$ and $z = r \cos\theta$, show that the unit vectors $\overrightarrow{a_r}$, $\overrightarrow{a_\theta}$, $\overrightarrow{a_\varphi}$ are related to the unit vectors $\overrightarrow{a_x}$, $\overrightarrow{a_y}$ and $\overrightarrow{a_z}$ as follows

$$\begin{pmatrix} \overrightarrow{a_r} \\ \overrightarrow{a_\theta} \\ \overrightarrow{a_\varphi} \end{pmatrix} = \begin{pmatrix} \sin\theta\cos\varphi & \sin\theta\sin\varphi & \cos\theta \\ \cos\theta\cos\varphi & \cos\theta\sin\varphi & -\sin\theta \\ -\sin\varphi & \cos\varphi & 0 \end{pmatrix} \begin{pmatrix} \overrightarrow{a_x} \\ \overrightarrow{a_y} \\ \overrightarrow{a_z} \end{pmatrix}$$ 10

   b) Hence find the spherical components of a vector $\vec{A}$ in terms of the rectangular components. 5

9. a) What is critical frequency ? Derive secant law. 4 + 7

   b) A signal is propagated at an angle of 22° with the surface of the earth, after reflection from the ionosphere, it is received at a station 1800 km away. Assuming flat earth, find out the virtual height. 4

10. a) Explain what you understand by the term "Line parameter" in the context of a transmission line. Mention the units of the line parameters. 4

b) Draw the equivalent circuit of a transmission line and hence write the transmission line equations for an elemental section of a transmission line. 3

c) A lossless line has a characteristic impedance of 50 ohm and is terminated in a load impedance of 75 ohm. If the length of line is $\lambda/2$, determine

i) Input impedance

ii) Reflection coefficient

iii) VSWR.

What will be the value of reflection coefficient, if the load impedance is 50 ohm ? 3

d) Show that for a lossless transmission line the impedance of a line repeats over every distance. 5

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

a) Horn antenna

b) MUF

c) Propagation constant

d) Sky wave propagation

e) Boundary conditions for electric field.