

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 :

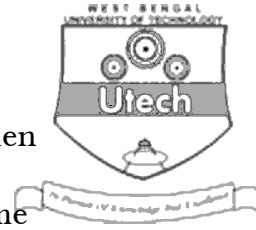
10 × 1 = 10

i) A region of field for which $\nabla \times \mathbf{A} \neq 0$ 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

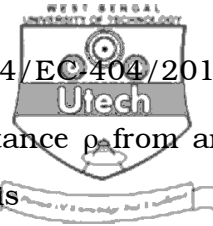
- a) $\lambda/8$
- b) $\lambda/4$
- c) $\lambda/2$
- d) λ .

v) Tropospheric scatter is used with frequencies in the range

- a) HF
- b) VHF
- c) UHF
- d) VLF.

vi) The Stokes' theorem is

- a) $\int_L H \cdot dL = \oint_s (\nabla \times H) \cdot dS$
- b) $\int_L H \cdot dL = \oint_s (\nabla \cdot H) \cdot dS$
- c) $\oint H \cdot dL = \int_s (\nabla \times H) \cdot dS$
- d) $\oint H \cdot dL = \int_s (\nabla \cdot H) \cdot dS$.



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

- a) $H = (I/2\pi\rho)a_\phi$ b) $H = (I^2/2\pi\rho)a_\phi$
 c) $H = (I/\pi\rho)a_\phi$ d) $H = (I/\rho)a_\phi$.

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 $\rho_v = 40xyz \text{ C/m}^3$. The total charge within the region defined by $0 \leq x, y, z \leq 1$, is

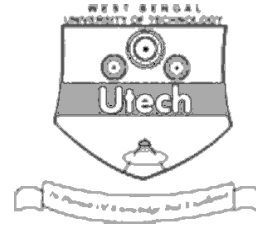
- a) 10 C b) 20 C
 c) 30 C d) 40 C.

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

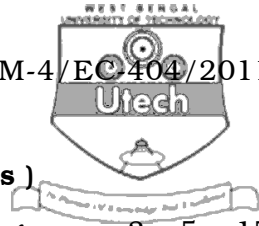
- a) $E = \frac{\rho_s}{2\epsilon_0}a_\rho$ b) $E = \frac{\rho_s}{2\epsilon_0}a_N$
 c) $E = \frac{\rho_s}{2\epsilon_0}a_z$ d) $E = \frac{\rho_s}{2\epsilon_0}a_\theta$.

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 :

$$\vec{A} = \frac{1}{2} \alpha t (\vec{a}_y x - \vec{a}_x y)$$

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

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

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

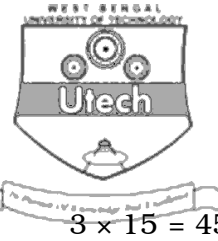
b) If the skin depth is $80 \mu m$ at 4 MHz in a certain conducting medium, calculate the skin depth if the frequency is changed to 16 MHz. 3

4. A transmission line has characteristic impedance of 70Ω 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 radio 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)



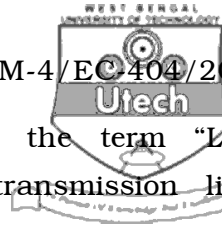
GROUP – C

(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 \vec{a}_r , \vec{a}_θ , \vec{a}_φ are related to the unit vectors \vec{a}_x , \vec{a}_y and \vec{a}_z as follows
- $$\begin{pmatrix} \vec{a}_r \\ \vec{a}_\theta \\ \vec{a}_\varphi \end{pmatrix} = \begin{pmatrix} \sin \theta \cos \varphi & \sin \theta \sin \varphi & \cos \theta \\ \cos \theta \cos \varphi & \cos \theta \sin \varphi & -\sin \theta \\ -\sin \varphi & \cos \varphi & 0 \end{pmatrix} \begin{pmatrix} \vec{a}_x \\ \vec{a}_y \\ \vec{a}_z \end{pmatrix} \quad 10$$
- 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
- Input impedance
 - Reflection coefficient
 - 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
- Horn antenna
 - MUF
 - Propagation constant
 - Sky wave propagation
 - Boundary conditions for electric field.