



Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech(EIE-NEW)/SEM-4/EE-402(EI)/2013

2013

FIELD THEORY

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

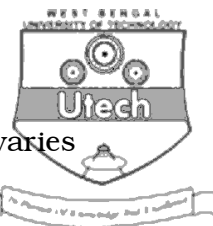
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following questions : 10 × 1 = 10

- i) Where surface $r = 2$ and $z = 2$ intersect in cyl. coordinates
 - a) an infinite plane
 - b) a suminfinite plane
 - c) a cylinder
 - d) a circle.
- ii) Gradient of a scalar field is expressed as
 - a) Outward flux of a vector field per unit volume as the volume about the point tends to zero
 - b) Circulation of a vector field per unit area tends to zero
 - c) Maximum rate of increase of scalar function at a point
 - d) Gradient of divergence of vector field minus the curl of the vector field.



- iii) For a good plane conductor, skin depth varies
- a) directly as square root of frequency
 - b) inversely as square root of frequency
 - c) directly as a function of frequency
 - d) inversely with frequency.
- iv) Energy density in an electrostatic field is
- a) $\frac{1}{2} (\epsilon E^2)$
 - b) (ϵE^2)
 - c) $2 (\epsilon E^2)$
 - d) $\frac{1}{2} (\epsilon E)$.
- v) The value of intrinsic impedance of free space is
- a) 50 ohm
 - b) 72 ohm
 - c) 120 ohm
 - d) 377 ohm.
- vi) Electric field inside a uniformly charged sphere
- a) varies linearly with the distance from the centre
 - b) remains constant
 - c) varies inversely with the distance from the centre
 - d) is zero.
- vii) Two thin parallel wires carry currents along the same direction. The force experienced by one due to the other is
- a) Parallel to the lines
 - b) Perpendicular to the lines and attractive
 - c) Perpendicular to the lines and repulsive
 - d) Zero.



viii) Impedance inversion may be obtained with a

- a) half wave line b) quarter wave line
- c) short circuited stub d) open circuited stub.

ix) Curl of a gradient of a scalar function results in

- a) nonzero scalar b) nonzero vector
- c) zero vector d) periodic function.

x) The direction of propagation of an electromagnetic wave is

- a) independent of the direction of the associated electric field
- b) only perpendicular to the direction of associated electric field
- c) only perpendicular to the direction of associated magnetic field
- d) perpendicular to both the electric and magnetic field.

xi) A transmission line is said to be distortion-less if

- a) $\frac{R}{G} = \frac{C}{L}$ b) $\frac{R}{G} = \frac{L}{C}$
- c) $RG = LC$ d) $R = 0$.



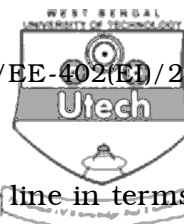
- xii) At the boundary of two media of permeability μ_1 and μ_2 the boundary conditions is satisfied by
- a) the normal component of the magnetic field strength H which is continuous
 - b) the normal component of the flux density B which is continuous
 - c) the tangential component of the flux density B which is continuous
 - d) the tangential component of the field strength H which is continuous.

GROUP – B

(Short Answer Type Questions)

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

2. Write the mathematical expression for the Law of conservation of charge. Hence obtain the equation of continuity. 1 + 4
3. What do you mean by 'skin effect' ?
- Calculate the skin depth in Cu at 100 MHz. Given $\sigma = 5.8 \times 10^{-7} \text{ S/m}$. Compare the magnitude of the field intensity at this depth with its initial value. Determine also the surface resistance at this frequency. 1 + 4
4. Explain what is meant by a uniform plane wave. A uniform plane wave has a wavelength of 2 cm in free space and 1 cm in a perfect dielectric ($\sigma = 0$, and $\mu_r = 1$). Determine the relative permittivity of the medium. 2 + 3



5. Draw the equivalent circuit of a transmission line in terms of the line parameters. Give the adequate reasoning for adopting such an equivalent circuit. 2 + 3
6. Explain the physical significances of the following : $2\frac{1}{2} + 2\frac{1}{2}$
- Gradient of a field.
 - Curl of a vector field.

GROUP – C

(Long Answer Type Questions)

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

- Obtain an expression for the energy density in an electrostatic field. 6
 - Find the expression of total force on the charge Q in the presence of both electric and magnetic field. 5
 - It is found that $\vec{E} = 60 \vec{a}_x + 20 \vec{a}_y + 30 \vec{a}_z$ mV/m at a particular point on the interface between air and a conducting surface. Find \vec{D} and ρ at that point. 4
- Write down the Maxwell's equation of electromagnetic field. 4
 - Obtain the Poynting's theorem for the conservation of energy in an electromagnetic field and discuss the physical meaning of each term in resulting equation. 6
 - In free space the electric field vector is given by $E = 100 \cos (\omega t + 4\pi/3x) \vec{a}_z$ V/m, where $\omega = 2\pi f$ and $f = 200$ MHz. Determine the direction of power flow and the time average power crossing the surface area bounded by $y = 2\text{m}$, $y = 0$, $z = 2\text{m}$ and $z = 0$. 5



9. a) State and explain Biot-Savart Law. Derive an expression for the force between two parallel wires carrying currents in the same direction. 5

- b) What do you mean by polarization of a uniform plane wave ?

Determine the polarization of the following uniform plane wave :

$$E = 1 \cos (\omega t + \beta z) a_x - 2 \sin(\omega t + \beta z - 45^\circ) a_y \quad 1 + 4$$

- c) In a material for which $\sigma = 5.0 \text{ S/m}$, and $\epsilon_r = 1$, the electric field intensity is $250 \sin (10^{10} t) \text{ V/m}$. Find the conduction and displacement current densities. Determine the frequency when these two currents will be equal in magnitude. 5
10. a) Define characteristic impedance of a transmission line. Explain the formation of standing wave pattern on transmission line. 2 + 3
- b) Deduce the relation between the reflection coefficient and VSWR. 5



- c) A transmission line of characteristic impedance 50 ohm is terminated by resistor of 100 ohm. What will be the VSWR in the line ? Calculate the impedances at the voltage minimum and maximum position. 5

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

- a) Uniqueness Theorem
- b) Boundary conditions for electrostatic fields
- c) Propagation constant
- d) Quarter Wave Transmission Line
- e) Vector Magnetic Potential.

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