Code No: RR211002 **Set No.1**

II B.Tech. I Semester Supplementary Examinations, May -2005
ELECTROMAGNETIC THEORY
(Common to Electronics & Instrumentation Engineering and Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Distinguish between potential and potential gradient. Explain why in the analysis of electrostatic fields, it is simpler to use electric potential that electric field strength.
   (b) State and explain conservative property of electric field.
2. (a) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in the leads.
   (b) Investigate the vector magnetic potential for the infinite, straight, current element L in free space.
3. (a) Develop an expression for the magnetic field at any point on the axis at a distance 'h' from the center of a circular loop of radius 'a' and carrying current I
   (b) Define and distinguish between magnetic field intensing and fluxdensity
4. (a) In a nonmagnetic medium, E = 50cos(10^9t - 8x) a_y + 40sin (10^9t - 8x) a_z V/m, find the dielectric constant ε_r and the corresponding H.
   (b) A conducting bar can slide freely over two conducting parallel rails. While Sliding, the bar always makes 900 with the rails. The starting end of the first rail is at (0, 0, 0) and the rail aligns with y-axis. The starting end of the second rail is located at (0.06m, 0, 0). The starting ends of these to rails are connected by a straight conducting wire. The velocity of the sliding bar v = 20 a_y m/s.
   Rails, connecting wire, sliding bar make a rectangular loop in the xy-plane.Calculate the induce the e.m.f as a function a of time in the loop due to magnetic flux density B = 0.004 cos(10^6 t - y) a_z Tesla.
5. (a) Derive a general expression for the relation between Electric and Magnetic fields.
   (b) A wave propagating in a lossless dielectric has the components$\overline{E}$ = 500 cos(10^7t - βz)$\hat{a}_x$ V/m and $\overline{H} = 1.1$ cos($10^7 t - \beta z$) $\hat{a}_y$ A/m. if the wave is traveling at v = 0.5C, where C is the velocity of light, find $\mu_r, \varepsilon_r, \beta, \lambda$ and η.
6. (a) Prove that angle $\theta_\eta = \pi/4$, where θ_η is the phase angle of the intrinsic impedance of the perfect conducting medium.
   (b) A plane wave has wave length of 2 cm in free space and 1.6 cm in a perfect dielectric medium. Determine the relative permittivity of the medium.

(c) Most microwave ovens operate at 2.45 GHz . assume $\mu_r = 600$, $\sigma = 1.1$ x 10^6 mhos/m for the stainless steel interior. Find the depth of penetration.

7. (a) Explain the significance of Poynting vector .

   (b) An incident plane electromagnetic wave of 10 MHz and having E_x=3.0 V/m and traveling along positive Y-axis strikes an aluminium sheet at normal incidence. Calculate the average power densities of incident and reflected waves

8. (a) Discuss the significance and applications of Poynting Theorem.

   (b) Explain the utility of Poynting vector. If the peak poynting vector in free space is 10w/m^{2}find the amplitudes of electric and magnetic fields.

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Code No: RR211002 **Set No.2**

II B.Tech. I Semester Supplementary Examinations, May -2005
ELECTROMAGNETIC THEORY
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) State and explain Coulomb's law indicating clearly the units of quantities in the equation of force.
   (b) Calculate the force on a unit positive charge at P(x=2m, y=0) due to the charges Q_1 at origin and Q_2 at (x=1m, y=0)
   Q_1 = 1000 pico coulombs
   Q_2 = -2000 pico coulombs
2. (a) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in the leads.
   (b) Investigate the vector magnetic potential for the infinite, straight, current element L in free space.
3. (a) Define Energy density and derive an expression for the same in the magnetic field interms of field quantities
   (b) Define and distinguish between the terms: magnetic induction and magnetization.
4. (a) Why the Maxwell's equations are four only? Give the word statements of Maxwell's field equations.
   (b) Show that ∇. J = - $\partial\rho/\partial$t.
   (c) The conduction current density in a lossy dielectric is given by $J_c = 0.02 \sin(10^9 t)$ A/m^2. Find the displacement current density, if $\sigma = 10^3$ mho/m and $\varepsilon_r = 6.5$.
5. (a) Obtain the wave equation for a plane wave travelling in a conducting medium in terms of electric field.
   (b) A 10GHz uniform plane wave travelling in free space in z-direction has Ex =1V/m. Find the value of magnetic field and its direction and propagation constant. Write the complete expression for E_X assuming the singnal is simusoidal.
6. At 500 MHz a medium has constants $\mu_r = 5$, $\varepsilon_r = 7$, $\sigma = 1$ mhos/m. Find
   (a) The ratio of intrinsic impedance of the medium to that of free space,
   (b) The ratio of wavelength of the medium to that of free space,
   (c) The ratio of the wave velocity of the medium to that of free space,

(d) 1/e depth of penetration

(e) wave attenuation in dB for a 5mm thickness.

7. (a) Explain the phenomenon of Total Internal Reflection and the conditions for its existence.

(b) Determine the reflection coefficient when a wave is incident normally from air on an iron sheet at a frequency of 1MHz σ=1x10^4 mho/m and, μ_r=1000.

8. (a) A uniform plane wave with wave length 3cm in free space is normally incident on fiber glass ($\sigma = o$, $\varepsilon_r = 4.9$).

i. What thickness of glass will produce no reflections

ii. What percentage of the incident power will be transmitted through the fiber glass if the frequency is reduced by 10%.

(b) The poynting vector is given by 300cos(3×10^8t-z) $\mathbf{a_z}$ (w/m^2). Find the average power crossing

i. 1m^2 of the z = 0 plane

ii. 1m^2 of the plane defined by points (0,0,0),(0,4,0)and(3,0,2).

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Answer any FIVE Questions
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1. (a) Show that in an electrostatic field, electric field intensity E and electrostatic potential V are related as E=$-\nabla$V.
   (b) Three equal positive charges are placed at the corners of an equilateral triangle with a side of 'd' meters. Determine the magnitude and direction of the electric field at the point bisecting each side of the equilateral triangle.
2. (a) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in the leads.
   (b) Investigate the vector magnetic potential for the infinite, straight, current element L in free space.
3. (a) State Faraday's law of electro magnetic induction.
   (b) Define Motional EMF.
   (c) A straight conductor of length 40cm moves perpendicularly to its axis at a velocity of 50 m/sec in a uniform magnetic field of flux density 1.2 Tesla . Evaluate the EMF induced in the conductor if the direction of motion
      i. Normal to the magnetic field
      ii. Parallel to the field .
      iii. At an angle 60 degree to the orientation of field.
4. (a) Given E = E_m sin(ωt -βz)a_y in free space, find D, B and H.
   (b) A current sheet K= $(8/\mu_0)$ a_y (A/m), at x = 0 separates region 1, x < 0 and $\mu_{r1} = 3$, from region 2, x > 0 and $\mu_{r2} = 1$. Given $H_1 = (10/\mu_0)$ (a_y + a_z) A/m find H_2.
5. (a) Show that the intrinsic impedance for a lossy dielectric is approximately given by
   $(\mu/\varepsilon)^{0.5}$ (1 + j($\sigma/(2\omega\varepsilon)$)).
   (b) A 30 GHz radar signal may be represented as a uniform plane wave in a sufficiently small region. Calculate λ and α in dB/m if the wave is propagating in a non-magnetic material for which $\varepsilon_r = 2.1$, $\sigma = 5$ mhos/m
6. (a) What is a right circularly polarized wave?
   (b) Why elliptical polarization is the most general form of polarization? Explain.

7. (a) In free space $\mathbf{E(z,\ t\ )}= 50\cos(\omega t\ -\ \beta z)\mathbf{a}_x$ v/m. find the total power passing through a rectangular area, of sides 90mm and 45mm, in the z=0 plane.

   (b) In a non magnetic material, $\mathbf{H} = 30$ Cos $(2\ \pi\ 10^8\ t\ -\ 6\ x\ )\ \mathbf{a}_y$ m A/m. find the pointing vector and the time average power crossing the surface x=1, $0 < y < z$, $0<z < 3$ m.

8. (a) Define and explain the significance of the terms: Polyting vector. Instantomeors, Average and complex pointing vectors.

   (b) Obtain an expression for the power loss in a plane conductor.

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Code No: RR211002 **Set No.4**

II B.Tech. I Semester Supplementary Examinations, May -2005
ELECTROMAGNETIC THEORY
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Show that $\nabla.\mathbf{E} = 0$ for the field of an uniform sheet charge in all the three coordinate systems.
   (b) Define divergence theorem and verify both sides of this theorem for the volume enclosed by r = 2, z = 0, and z = 10. if $\mathbf{D} = (10\ r^3\ /\ 4)\ \mathbf{a_r}$.
2. (a) Differentiate and explain conductors and dielectrics
   (b) The electric field E in air above a block of paraffin with relative dielectric constant=2.1 is at an angle of 45^0 with respect to the plane surface of the block. Find the angle between E and the surface in the paraffin
3. A single turn circular coil of 50m diameter carries a current of $28{\times}10^{-4}$ A. Determine the magnetic field intensity H at a point on the axis of the coil and 100m away from the coil. The relative permeability of free space surrounding the coil is unity and also derive the formula employed.
4. (a) Given $E = E_m \sin(\omega t - \beta z) a_y$ in free space, find D, B and H.
   (b) A current sheet $K = (8/\mu_0)\ a_y$ (A/m), at x = 0 separates region 1, x < 0 and $\mu_{r1} = 3$, from region 2, x > 0 and $\mu_{r2} = 1$. Given $H_1 = (10/\mu_0)\ (a_y + a_z)$ A/m find H_2.
5. (a) Starting from the Maxwell's curl equations, derive the wave equation in Electric field for free space.
   (b) A 9 GHz plane wave is propagating in a medium with $\varepsilon_r = 2.5$. If E = 20 V/m and the material is assumed to be loss less, find the phase constant, wave length, phase velocity, propagation constant, intrinsic impedance and the magnitude of the H field.
6. At 500 MHz a medium has constants $\mu_r = 5$, $\varepsilon_r = 7$, $\sigma = 1$ mhos/m. Find
   (a) The ratio of intrinsic impedance of the medium to that of free space,
   (b) The ratio of wavelength of the medium to that of free space,
   (c) The ratio of the wave velocity of the medium to that of free space,
   (d) 1/e depth of penetration
   (e) wave attenuation in dB for a 5mm thickness.
7. (a) Explain Surface impedance in detail. Hence state the significance of surface resistance relate in to skin depth of the conductor.

(b) Given a uniform plane wave in air as
$\mathbf{E_i} = 40\ \cos(\omega t\text{-}\ \beta z)\ \mathbf{a_x} + 30\ \sin(\omega t\ \beta z)\ \mathbf{a_y}$ V/m.
Find $\mathbf{H_i}$.

8. (a) Define perfect dielectric, imperfect dielectric, good conductors and perfect conductors. Give one example for each.

   (b) The magnetic field associated with a uniform plane wave propagating in the +z-direction in a nonmagnetic (μ=μ_o) material medium is given by
   $\mathbf{H} = \mathbf{H_o}\ e^{-z} \cos\ (6\pi \times 10^7 t\ \text{-}\ \sqrt{3}\ z)\ a_y$ A/m.
   Find the following :

      i. the instantaneous power flow across a surface of area 1 m^2 in the z = 0 plane at t = 0.
      ii. the time-average power flow across a surface of area 1 m^2 in the z = 0 plane; and
      iii. the time-average power flow across a surface of area 1 m^2 in the z = 1m plane

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