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

II B.Tech I Semester Supplementary Examinations, November 2006
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) State and explain Coulomb's law of electrostatic field in vector form. [8M]
   (b) It is required to hold four equal point charges to each in equilibrium at the corners of a square. Find the point charge, which will do this if placed at the center of the square. [8M]

2. Obtain an expression for the energy stored in a capacitor.
   An air field capacitor consists of two parallel square plates of 50cm side is charged to potential difference of 250V when the plates are 1mm apart. Find the work done in separating the plates from 1 to 3mm. Assume perfect insulation. [16M]

3. (a) Define and explain the significance of vector magnetic potential. [4M]
   (b) If the vector potential $\overline{A} = 5(x^2+y^2+z^2)^{-1}$ i Wb/m ,fnd flux density $\overline{B}$ and current density $\overline{J}$ [12M]

4. (a) Why the Maxwell's equations are four only? Give the word statements of Maxwell's field equations. [6M]
   (b) Show that $\nabla .\ J = -\ \partial\rho/\partial t$. [4M]
   (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 $\varepsilon_r = 6.5$. [6M]

5. (a) Prove that the velocity of an electromagnetic wave decreases as the conductivity of a medium increases? [10M]
   (b) Using Maxwell's equations show that$\overline{\nabla}.\overline{D} = 0$ in a conducting medium assuming sinusoidal time variations. [6M]

6. (a) What is wave polarization? Explain the different types of polarization with analytical treatment. [6M]
   (b) A 100 V/m plane wave of frequency 300 MHz travels in an infinite, loss less medium having $\mu_r = 1$, $\varepsilon_r = 9$, $\sigma = 0$ mhos/m.. write the complete time domain expressions for the E and H field vectors. [10M]

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

8. (a) Discuss the significance and applications of Poynting Theorem. [8M]
   (b) Explain the utility of Poynting vector. If the peak poynting vector in free space is 10w/m^2find the amplitudes of electric and magnetic fields. [8M]

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

II B.Tech I Semester Supplementary Examinations, November 2006
ELECTROMAGNETIC THEORY
(Common to Electronics & Instrumentation Engineering and Electronics & Control Engineering)

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

Answer any FIVE Questions
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1. (a) Derive an expression for the field intensity due to uniform line charge ρ_L.[8M]
   (b) A line charge ρ_L=$10\pi\varepsilon_0$ (C/m) lies along the x-axis in free space while a point charge Q=$40\pi\varepsilon_0$ C is located at (2,4,1). Three points are identified as A(1,-1,2), B(4,0,5),C(-2,-5,3) [8M]
      i. find V_{AB}.
      ii. Find V_C if V_B =0
      iii. Find V_C if V_A =20 V.

2. (a) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in the leads. [8M]
   (b) Investigate the vector magnetic potential for the infinite, straight, current element L in free space. [8M]

3. (a) Define magnetic moment. [3M]
   (b) Determine force per meter length between two parallel wires A& B separated by 4cm in air and carrying currents of 30 amps [6M]
      i. in the same direction
      ii. in the opposite direction
   (c) Determine the vector magnetic potential near a long conductor carrying steady current of I. [7M]

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. [8M]
   (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. [8M]

5. (a) Starting from the Maxwell's curl equations, derive the wave equation in Electric field for free space. [6M]

(b) Given a non-magnetic material having $\varepsilon_r = 2.35$, $\sigma = 10_4$ mhos/m., find the loss tangent, attenuation, phase factor and intrinsic impedance at 2.5 MHz. [10M]

6. (a) Explain EM wave propagation in a lossless medium. [6M]

   (b) In a sinusoidal travelling wave define the terms [10M]

   i. phase velocity
   ii. Phase-shift constant
   iii. Wave length

7. (a) A uniform plane wave is normally incident from air in to a medium of ε_r=4, μ_r=1.21.Determine the reflection and transmission coefficients for E and H fields. [8M]

   (b) A Plane wave of 10 MHz in space impinges normally on an aluminum sheet of 0.05 cm thickness. Find the electric field strength on reaching the other side of the sheet if for the sheet σ=3.82x10^7mhos/m, and the incident field strength is 10 mV/m [8M]

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

   (b) Explain the utility of Poynting vector. If the peak poynting vector in free space is 10w/m^2find the amplitudes of electric and magnetic fields. [8M]

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Code No: RR211002 **Set No. 3**

II B.Tech I Semester Supplementary Examinations, November 2006
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) By applying Gauss's law to an isolated point charge q, show that Coulomb's law can be deduced from Guass' law. [8M]
   (b) Charge is uniformly distributed in the region $-2 <$y< 2. Use Gauss law suitably and find E at all points for which y< -2, $-2 <$y< 2, y> 2. [8M]

2. (a) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in the leads. [8M]
   (b) Investigate the vector magnetic potential for the infinite, straight, current element L in free space. [8M]

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. [12M]
   (b) Define and distinguish between magnetic field intensing and fluxdensity. [4M]

4. (a) What are the transformer and motional electromotive forces (emfs) in the context of Faraday's law ? [8M]
   (b) In a medium characterized by $\sigma = 0$, $\mu = \mu_0$, $\varepsilon = \varepsilon_0$ and E = 20 sin (10^8 t - βz) a_y V/m calculate β and H using Maxwell's equations. [8M]

5. (a) Show that the intrinsic impedance for a lossy dielectric is approximately given by
   $(\mu/\varepsilon)^{0.5}$ (1 + j($\sigma/(2\omega\varepsilon)$)). [6M]
   (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. [10M]

6. (a) Describe linear polarization of EM wave with neat diagrams. [6M]
   (b) A wave travelling in z-direction is the resultant of two linearly polarized waves E_x=3cosωt, E_y=2cosωt.Find the axial ratio and the angle between the major axis of the polarization ellipse and positive axis. [10M]

7. (a) A right circularly polarized wave is incident at an angle 45 degrees from air onto [8M]
      i. a perfect conductor and

ii. polystyrene (ε_r= 2.7).
What is the polarization state of the reflected wave for these two cases.

(b) A plane wave is normally incident on a conduction medium in a free space find the expressions for resultant of field strengths of E&H. [8M]

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

(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. [8M]

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

II B.Tech I Semester Supplementary Examinations, November 2006
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. [10M]
   (b) State and explain conservative property of electric field. [6M]
2. (a) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in the leads. [8M]
   (b) Investigate the vector magnetic potential for the infinite, straight, current element L in free space. [8M]
3. Find the magnetic field intensity due to the presence of a finite straight filament conductor carrying current I using Ampere's Law for current element: Hence establish the relations for semi-infinite and infinite wires. [16M]
4. (a) Given E = E_m sin(ωt -βz)a_y in free space, find D, B and H. [8M]
   (b) A current sheet K= $(8/\mu_0)$ a_y (A/m), at x = 0 separates region 1, x < 0 and μ_{r1} = 3, from region 2, x > 0 and μ_{r2} = 1. Given H_1 = $(10/\mu_0)$ (a_y + a_z) A/m find H_2. [8M]
5. (a) Show that the ratio of total electricfield E to the total magnetic field H is equal to the intrinsic impedance of the medium. [10M]
   (b) A copper wire carries a conduction current of 1 amp. Determine the displacement current in the wire at 100MHz. Assume copper has the same permittivity as free space and $\sigma = 5.8 \times 10^7$mhos/m. [6M]
6. (a) If loss tangent tanφ = (σ /$\omega\varepsilon$) , show that
   $\alpha = 0.5\omega(\mu\varepsilon)^{0.5}$ tanφ [{1 + (1 + $\tan^2\varphi$)$^{0.5}$}/ 2]$^{-0.5}$and
   $\beta = \omega(\mu\varepsilon)^{0.5}$ [{1 + (1 + $\tan^2\varphi$)$^{0.5}$}/ 2]$^{-0.5}$ [8M]
   (b) A plane wave propagates in a certain medium with $\mathbf{E}$ = 5 cos(10^9t - 30z) $\mathbf{a}_x$ V/m Find α, β, η, λ and phase velocity of propagation. [8M]
7. (a) Give and explain a proper interpretation of the poynting vector. [4M]
   (b) In free space (z<=0), a plane wave with $\mathbf{H}_i$ = 10 cos (10^8t -βz) $\mathbf{a}_x$ mA/m is incident normally on a lossless medium (ε= 2 ε_o ,μ = 8μ_o) in region z>=0. Determine the expression for reflected and transmitted electric and magnetic fields. [12M]

8. (a) Derive the pointing theorem from Maxwell's equations and explain its physical significance. [10M]

   (b) A plane wave is traveling in a medium for which σ=0, εr=3,μr=1 if E_{peak}=5v/m find [6M]

      i. Peak poynting vector
      ii. Average poynting vector
      iii. Peak value of H
      iv. Impedance of medium

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