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

II B.Tech I Semester Regular Examinations, November 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

⋆ ⋆ ⋆ ⋆ ⋆

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) Derive the capacitance per km length of two identical parallel wires. [8M]
   (b) Determine the capacitance per km length of two identical parallel wires of diameter 1.5cm spaced 0.75m apart. Also find the potential difference between them which will make the maximum electric field intensity at the conductor surface just 3×10^6 Volts per meter. [8M]

3. Two narrow circular coils A and B have a common axis and are placed 15cm apart. Coil A has 10 turns of radius 5cm with a current of 2A passing through it, and Coil B has a single turn of radius of 8cm. If the magnetic field at the center of coil A is to be zero, what current must be passed through coil B. Explain the relations used. [16M]

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) Starting from the Maxwell's curl equations, derive the wave equation in magnetic field for free space. [6M]
   (b) Consider a material for which $\mu_r = 1$, $\varepsilon_r = 4$, and loss tangent is 0.1 at frequency 50 MHz. Calculate conductivity, wavelength, phase velocity and intrinsic impedance. [10M]

6. (a) Define the term intrinsic impedance of the medium, hence derive an expression for the same for a conducting medium, in terms of medium constants. [8M]
   (b) Determine the loss per kilometer for a plane wave propagating in certain medium at a frequency 2.5 MHz , if $\mu_r = 1$, $\varepsilon_r = 12$, $\sigma = 4.5 \times10^{-5}$ mhos/m for the medium. [8M]

7. (a) An electro magnetic wave is normally incident on a conductive medium. Derive the expressions reflection coefficient and transmission coefficients, under horizontal polarization. [10M]

(b) A 1 GHz plane wave traveling in air with peak electric field intensity of 1 V/m is incident normally on a large copper sheet. Find the average power absorbed by the sheet per square meter of area. [6M]

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 $10 w/m^2$find the amplitudes of electric and magnetic fields. [8M]

⋆ ⋆ ⋆ ⋆ ⋆

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

II B.Tech I Semester Regular Examinations, November 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

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Determine and sketch the variation of field and potential from point to point due to two concentric spherical shells of charges Q_1 and Q_2 at radii R_1 and R_2 respectively. The charges are uniformly distributed. [10M]
   (b) Define potential at a point in an electric field and state the relationship between potential and field intensity. [6M]

2. (a) What are the important properties of the potential in a charge free region that can be obtained from the Laplace's equation. [8M]
   (b) The region between two concentric right circular cylinders contains a uniform charge density ρ use Poisson's equations to find V. [8M]

3. Define the vector magnetic potential A and find A due to a straight long current conductor of length 2L meters , located on Z-axis. Hence find H at any point in yz plane. [16M]

4. (a) Given $E = E_m \sin(\omega t - \beta z) a_y$ 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 $\mu_{r1} = 3$, from region 2, x > 0 and $\mu_{r2} = 1$. Given $H_1 = (10/\mu_0)\ (a_y + a_z)$ A/m find H_2. [8M]

5. (a) Starting from the Maxwell's curl equations, derive the wave equation in Electric field for free space. [6M]
   (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. [10M]

6. (a) If loss tangent $\tan\varphi = (\sigma\ /\omega\varepsilon)$,Show that
   $|\eta| = (\mu\ /\ \varepsilon)^{0.5}\ (1 + \tan^2\varphi)^{-0.25}$ and
   $\theta_\eta = \tan^{-}\{\tan\varphi\ /\ (1 + (1 + \tan^2\varphi)^{0.5})$ [8M]
   (b) Sea water at a frequency of 5 x 10^8 Hz has $\mu_r = 1$, $\varepsilon_r = 81$, $\sigma = 4.5$ mhos/m. Find the attenuation constant α for a plane wave propagating in sea water. [8M]

7. (a) Explain Non uniform plane wave and skin depth. [4M]

(b) Derive the relation ship between the surface resistance and skin depth of good conductors. [6M]

(c) Calculate the power loss of a plane conductor in terms of surface resistance and liner current density per unit width. [6M]

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 $10 w/m^2$find the amplitudes of electric and magnetic fields. [8M]

⋆ ⋆ ⋆ ⋆ ⋆

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

II B.Tech I Semester Regular Examinations, November 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

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) A hemispherical surface is uniformly charged with a surface charge density of ρ_s using Coulomb's law, calculate electric field intensity at the center of hemisphere. [8M]
   (b) Transform E field given in cylindrical coordinates: E= 2 cos θ a_r + sin θ a_θ into Cartesian coordinates. [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) An infinite conductor carries a current of 2A in the Z direction . Find the magnitude of the force on 1m length of the conductor , if the field in which the conductor is placed is given as $\overline{B}$ = (0.1 $\hat{u}_x$ - 0.2 $\hat{u}_y$) Tesla. [12M]
   (b) Explain why ∇. B = 0 ? [4M]

4. (a) Why the Maxwell's equations are four only? Give the word statements of Maxwell's field equations. [6M]
   (b) Show that ∇. 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) Show that the intrinsic impedance of the free space is 120 π Ohms. [6M]
   (b) A lossy dielectric is characterized by $\mu_r = 4$, $\varepsilon_r = 2.5$, $\sigma = 10^{-3}$ mhos/m. at 10 MHz. Let $\overline{E} = 20e^{-\gamma z}\ \hat{a}_X$ V/m. find $\alpha, \beta, \nu, \lambda, \eta$ and $\overline{H}$. [10M]

6. (a) Derive an expression for intrinsic impedance of perfect conducting medium in terms of skin depth δ. [7M]
   (b) Determine the polarization of the following plane waves. [9M]
      i. $\mathbf{E} = \cos(\omega t + \beta z)\ \mathbf{a}_x + \sin(\omega t + \beta z)\ \mathbf{a}_y$
      ii. $\mathbf{E} = \cos(\omega t + \beta z)\ \mathbf{a}_x - \sin(\omega t + \beta z)\ \mathbf{a}_y$
      iii. $\mathbf{E} = \cos(\omega t + \beta z)\ \mathbf{a}_x - 2\sin(\omega t + \beta z - 45^o)\ \mathbf{a}_y$

7. (a) Explain the terms reflection and refraction of uniform plane waves. [4M]

(b) Explain the mechanism of reflection of plane waves by a perfect conductor for normal incidence, and sketch the resulting standing waves. [12M]

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

   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 [8M]

   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).

⋆ ⋆ ⋆ ⋆ ⋆

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

II B.Tech I Semester Regular Examinations, November 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

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) A charge of 0.2 micro coulombs is acted upon by a force of 0.1Nw.in the presence of another charge of 0.45μc. Determine the distance between the two charges. Take the medium as air. [8M]
   (b) What is the electric field intensity at a distance of 20cm from a charge of 0.2 micro coulombs in a vaccum. [8M]

2. (a) Derive the expression for capacitance for concentric cylinders. [8M]
   (b) Establish Gauss Law in point form and integral form.Hence deduce the Laplace's and Poissions's equations. [8M]

3. A single phase circuit comprises of two parallel conductors A and B, 1cm radius and 1m apart. The conductors carry +10A and -10A respectively .Determine the magnetic field intensity at the surface of each conductor and also in the space exactly mid way between A and B. Establish the relations used. [16M]

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) Prove that in a uniform plane wave propagating in x-direction has no longitudinal components of electric and magnetic fields. [6M]
   (b) Derive wave equation for electric field in free space starting from Maxwell's equations. [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) Explain the terms [4M]
   i. Plane of incidence
   ii. Horizontal polarization
   iii. Vertical Polarization
   (b) Find E_r/E_i for horizontal polarized wave incidence obliquely on a perfect dielectric surface. Is it possible NOT to have reflected wave justify. [12M]
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 $10 w/m^2$find the amplitudes of electric and magnetic fields. [8M]

⋆ ⋆ ⋆ ⋆ ⋆