Code No: RR220403 **Set No. 1**

II B.Tech II Semester Supplementary Examinations, November/December 2005

E M WAVES AND TRANSMISSION LINES

(Common to Electronics & Communication Engineering and Electronics & Telematics)

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

Answer any FIVE Questions

All Questions carry equal marks

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1. (a) Explain the following terms: [8]
   i. Homogeneous and isotropic medium and
   ii. Line, surface and volume charge distributions.

   (b) A circular ring of radius 'a' carries uniform charge ρ_L C/m and is in xy-plane. Find the Electric Field at Point (0, 0, 2) along its axis. [8]

2. Define Ampere's work law for magneto static fields. Hence derive the expressions for the magnetic fields in the different regions of a coaxial cable, having inner conductor radius of a , outer conductor of inner radius b and thickness t .Sketch the field variations with radial distance. [16]

3. (a) In a perfect dielectric medium, the EM wave has maximum value for E of 10 V/m with $\mu_r = 1$ and $\varepsilon_r = 4$. Find the velocity of the wave, peak poynting vector, average poynting vector, impedance of the medium and peak value of the magnetic field. [6]

   (b) What is the inconsistency in Ampere's Law? How it is rectified by Maxwell? [5]

   (c) Show that the total displacement current between the condenser plates connected to an alternating voltage sources is exactly the same as the value of charging current (conduction current). [5]

4. Write short notes on [16]
   (a) Surface impedance
   (b) Brewster angle
   (c) Uniform plane wave characteristics
   (d) Total internal reflection.

5. (a) Define plane of incidence and reflection coefficient? [6]

   (b) Derive an expression for reflection when a wave is incident on a dielectric obliquely with parallel polarization. [10]

6. (a) Explain the factors on which cut off frequency of a parallel plate wave guide depend. [8]

(b) Obtain the frequency in terms of cut off frequency f_c at which the attenuation constant due to conductor losses for the TM_n mode is minimum for a parallel plate wave-guide. [8]

7. (a) Derive a relation between reflection coefficient and characteristic impedance [8]

   (b) Determine the reflection coefficients when [8]

      i. $Z_L = Z_0$
      ii. $Z_L =$ short circuit
      iii. $Z_L =$ open circuit. Also find out the magnitude of reflection coefficient when Z_L is purely reactive.

8. (a) Explain clearly why the short circuited stubs are preferred over to a open circuited stubs? [8]

   (b) Derive the expression for the input impedance of a loss-less line Hence evaluate Z_{sc} and Z_{oc} and sketch their variation with line length [8]

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Code No: RR220403 **Set No. 2**

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E M WAVES AND TRANSMISSION LINES
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) A uniform line of length 2 m with total charge 3 nC is situated coincident to the z-axis with its center point 2 m from the origin. At a point on the x-axis, 2m from the origin, find V and $\overline{E}$ [8] .
   (b) A point charge of 3 nC is on the z-axis, 2 m away from the origin. Find the resultant V and $\overline{E}$? [8]
2. (a) Define and explain the Biot-Savart's Law. Hence obtain the field due to a straight current carrying filamentary conductor of finite length. [8]
   (b) In a medium of $\varepsilon= 5\varepsilon_o$,$\mu= 2.5\mu_o$,$\sigma= 0.2m\upsilon$/m., E = 20$\mu$V/m., find the conduction current density. If this current density exists in a cylindrical rod of 2 cm. diameter, evaluate the current that can flow through the rod. [8]
3. (a) Explain the terms "Conduction current" and "Displacement current'. Deduce the equation of continuity of current.
   $\nabla.\left(J + \partial D/\partial t\right) = 0$ [6]
   (b) Define and distinguish between the terms 'Perpendicular and Parallel Polarizations', for the case of reflection by a perfect conductor under oblique incidence. [10]
4. Write short notes on [16]
   (a) Surface impedance
   (b) Brewster angle
   (c) Uniform plane wave characteristics
   (d) Total internal reflection.
5. (a) Define reflection and transmission coefficients of a plane wave? [8]
   (b) Obtain an expression for reflection coefficient when a wave is incident on a dielectric with oblique incident parallel polarization. [8]
6. Starting from Maxwell's equations, derive the expressions for the E and H field components for TE waves in a parallel plane wave guide. [16]
7. (a) List out types of transmission lines and draw their schematic diagrams. [5]
   (b) Draw the directions of electric and magnetic fields in parallel plate and coaxial lines. [5]

(c) A transmission line in which no distortion is present has the following parameters $Z_0 = 50\Omega, \alpha = 20mNP/m, \upsilon = 0.6\upsilon 0$. Determine R, L, G, C and wavelength at 0.1 GHz. [6]

8. (a) Draw the equivalent circuits of a transmission lines when [8]
    i. length of the transmission line, $1 < \lambda/4$, with shorted load
    ii. when $1 < \lambda/4$, with open end
    iii. $1 = \lambda/4$.

   (b) Find out VSWR if [8]
    i. $Z_0 = 100\ \Omega$, $R_L = 80\ \Omega$
    ii. when $Z_0 = 80\ \Omega$, $R_L = 100\Omega$

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1. (a) What are equipotential surfaces? Give two examples of these. [8]
   (b) A line charge $\rho_L = 400$pC/m lies along the x-axis. The surface of zero potential passes through the point (0,5,12)m. Find the potential at point (2,3,-4)m. [8]
2. (a) A square conducting loop of side a carries a current I in clockwise direction, and is in z = 0 plane. Find the field and flux density at the centre of the loop. [8]
   (b) Compare and explain the field expressions for the cases of [8]
      i. a long solenoid and
      ii. a toroid, considering the inside and outside regions.
3. (a) Derive Maxwell's equations in integral form and differential form for time varying fields. [8]
   (b) Explain how the concept of Displacement current was introduced by Maxwell to account for the production of Magnetic fields in the empty space. [8]
4. Prove that under the condition of no reflection at an interface, the sum of the Brewster angle and the angle of refraction is $\pi/2$ for parallel polarization for the case of reflection by a perfect conductor under oblique incident, with neat sketches. [16]
5. (a) Define reflection and transmission coefficients of a plane wave? [8]
   (b) Obtain an expression for reflection coefficient when a wave is incident on a dielectric with oblique incident parallel polarization. [8]
6. (a) Explain the causes for attenuation in Parallel plane wave guides. [4]
   (b) Define and explain the significance of the following terms as applicable to parallel plane guides: [12]
      i. Wave impedance.
      ii. Phase and group velocities
      iii. Principal wave and its characteristics
7. (a) List out the applications of transmission lines. [5]
   (b) Draw an equivalent circuit of a two wire transmission line. [5]

(c) A lossy cable which has R = 2.25 Ω /m, L = 1.0 μ H/m, C = 1 pF/m and G = 0 operates at f = 0.5 GHz. Find out the attenuation constant of the line. [6]

8. (a) An open-wire transmission line having Z_0= 650 $\underline{\lfloor -12}\ ^0$ Ω is terminated in Z_0 at the receiving end. If this line is supplied from a source of internal resistance 300Ω , calculate the reflection factor and reflection loss at the sending end terminals. [8]

   (b) A two wire line has a characteristic impedance of 300 Ω and is to feed a 90 Ω resistor at 100 MHz. A Quarter wave line is to be used as a tube, 0.25 inch in diameter. Find centre-to-centre spacing in air? [8]

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Code No: RR220403 **Set No. 4**

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

Answer any FIVE Questions
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1. (a) A charge Q_1 is at point (0,-1,0)m. Another charge Q_2 is at the point (0,2,0)m. Find the ratio Q_2 / Q_1 resulting in zero force on a test charge at the origin. Q_1, Q_2 and the test charge are all of the same sign. [8]
   (b) A circular disk of radius 'a' is uniformly charged with ρ_s C/m^2 and is in z=0 plane. Find the Electric Field at the point (0, 0, h) along its axis. [8]

2. (a) A square conducting loop of side a carries a current I in clockwise direction, and is in z = 0 plane. Find the field and flux density at the centre of the loop. [8]
   (b) Compare and explain the field expressions for the cases of [8]
      i. a long solenoid and
      ii. a toroid, considering the inside and outside regions.

3. (a) Explain the terms "Conduction current" and "Displacement current'. Deduce the equation of continuity of current.
   $\nabla.\,(J + \partial D/\partial t) = 0$ [6]
   (b) Define and distinguish between the terms 'Perpendicular and Parallel Polarizations', for the case of reflection by a perfect conductor under oblique incidence. [10]

4. A y-polarized uniform plane wave with fields (E_i , H_i) and a frequency of 100 MHz propogates in air in the + x direction and impinges normally on a perfectly conducting plane at x = 0, assuming the amplitude of E_i to be 6 mV/m, write the phasor and instantaneous expressions for. [4x4=16]
   (a) E_i and H_i of the incident wave
   (b) E_r and H_r of the reflected wave
   (c) E_T and H_T of the total wave in air
   (d) Determine the location nearest to the conducting plane where E_T and H_T are zero.

5. (a) Explain the significances of Poynting theorem and Poynting Vector. By integrating the Poynting Vector over the cross-section of co-axial cable, show that the total power carried by the cable is VI, where V is the voltage and I is the current. [8]

(b) Obtain an expression for the Power loss in a plane conductor in terms of the surface resistances R_s. [8]

6. (a) Explain the factors on which cut off frequency of a parallel plate wave guide depend. [8]

   (b) Obtain the frequency in terms of cut off frequency f_c at which the attenuation constant due to conductor losses for the TM_n mode is minimum for a parallel plate wave-guide. [8]

7. (a) Derive a relation between reflection coefficient and characteristic impedance [8]

   (b) Determine the reflection coefficients when [8]

      i. $Z_L = Z_0$
      ii. $Z_L =$ short circuit
      iii. $Z_L =$ open circuit. Also find out the magnitude of reflection coefficient when Z_L is purely reactive.

8. (a) In a uniform line there exists, in general two traveling waves. Explain how the superposition of the two waves produces standing waves of voltage and current in a short circuited transmission line. [8]

   (b) An open wire unloaded line, 50 km long is operated at a frequency of 800 Hz. The open circuit impedance if found to be 330 $\underline{|-30^0}$ Ω and short circuit impedance is S40 $\underline{|7}^{\,0}$ Ω . Calculate the parameters of line. [8]

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