Code No: R05220404 **Set No. 1**

II B.Tech II Semester Regular Examinations, Apr/May 2008
ELECTROMAGNETIC 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) State and Prove Gauss's law. List the limitations of Gauss's law.
   (b) Derive an expression for the electric field strength due to a circular ring of radius 'a' and uniform charge density, ρ_L C/m, using Gauss's law. Obtain the value of height 'h' along z-axis at which the net electric field becomes zero. Assume the ring to be placed in x-y plane.
   (c) Define Electric potential. [6+8+2]

2. (a) State Maxwell's equations for magneto static fields.
   (b) Show that the magnetic field due to a finite current element along Z axis at a point P, 'r' distance away along y- axis is given by $H = (I/4\pi r)(\sin\alpha_1 - \sin\alpha_2).\widehat{a}_\phi$ where I is the current through the conductor , α_1 and α_2 are the angles made by the tips of the conductor element at ?P?. [6+10]

3. The electric field intensity in the region $0 < x < 5, 0 < y < \pi/12, 0 < z < 0.06m$ in free space is given by E=c sin12y sin az $cos2 \times 10$ t ax v/m. Beginning with the ∇xE relationship, use Maxwell's equations to find a numerical value for a , if it is known that a is greater than'0'. [16]

4. (a) For good dielectrics derive the expressions for $\alpha, \beta, \nu \, and \, \eta$.
   (b) Find $\alpha, \beta, \nu \, and \, \eta$. for Ferrite at 10GHz $\in r = 9, \mu r = 4, \sigma = 10ms/m$. [8+8]

5. (a) Define surface impedance and explain how it exists.
   (b) Derive expression for Reflection and Transmission coefficients of an EM wave when it is incident normally on a dielectric. [8+8]

6. (a) Explain about attenuation in parallel-plate wave guides. Also draw attenuation versus frequency characteristics of waves guided between parallel conducting plates.
   (b) A parallel plate wave guide made of two perfectly conducting infinite planes spaced 3 cm apart in air operates at a frequency of 10 GHz. Find the maximum time average power that can be propagated per unit width of the guide for $TE_1 and TM_1$ modes. [8+8]

7. (a) Explain the different types of transmission lines. What are limitations to the maximum power that they can handle.

(b) A coaxial limes with an outer diameter of 8 mm has 50 ohm characteristic impedance. If the dielectric constant of the insulation is 1.60, calculate the inner diameter.

(c) Describe the losses in transmission lines [8+4+4]

8. (a) Define the reflection coefficient and derive the expression for i/p impedance in terms of reflection coefficient.

(b) Explain how the i/p impedance varies with the frequency with sketches. [8+8]

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

Answer any FIVE Questions
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1. (a) State and prove Gauss's law. Express Gauss's law in both integral and differential forms.
   (b) Discuss the salient features and limitations of Gauss's law .
   (c) Derive Poisson's and Laplace's equations starting from Gauss's law. [6+4+6]

2. (a) State Maxwell's equations for magneto static fields.
   (b) Show that the magnetic field due to a finite current element along Z axis at a point P, 'r' distance away along y- axis is given by $H = (I/4\pi r)(\sin\alpha_1 - \sin\alpha_2).\widehat{a}_\phi$ where I is the current through the conductor , α_1 and α_2 are the angles made by the tips of the conductor element at ?P?. [6+10]

3. (a) Write down the Maxwell's equations for Harmonically varying fields.
   (b) A certain material has $\sigma = 0 and \in_R = 1 if H = 4sin(10^6 t - 0.01z)\overline{a}_y$ A/m. make use of Maxwell's equations to find μ_r [8+8]

4. (a) For a conducting medium derive expressions for $\alpha and \beta$.
   (b) Determine the phase velouty of propagation, attenuation constant, phase constant and intrinsic impedance for a forward travelling wave in a large block of copper at 1 MHz ($\sigma = 5.8 \times 10^7, \in r = \mu r = 1$) determine the distance that the wave must travel to be attenuated by a factor of 100 (40 dB) [8+8]

5. For an incident wave under oblique incident from medium of ε_1 to medium of ε_2 with parallel polarization
   (a) Define and establish the relations for the critical angle θ_C and Brewster angle θ_{Br} for non-magnetic media with neat sketches.
   (b) Plot θ_C and θ_{Br} versus the ratio of $\varepsilon_1/\varepsilon_2$ [8+8]

6. For a parallel plane wave guide of 3 cm separation, determine all the propagation characteristics, for a signal at 10 GHz, for
   (a) TE_{10} waves
   (b) TEM waves [16]

   Explain the terms used.

7. (a) Definite following terms and explain their physical significance.

i. Attenuation function
ii. Characteristic impedance
iii. Phase function, and
iv. Phase velocity as applied to a transmission line.

(b) At 8 MHz the characteristic impedance of transmission line is (40-j2) Ω and the propagation constant is (0.01+j0.18) per meter. Find the primary constants. [8+8]

8. (a) Explain the significance and Utility of $\lambda/8$, $\lambda/4$, and $\lambda/2$ Line.

(b) A low transmission line of 100 Ω characteristic impedance is connected to a load of 400 Ω. Calculate the reflection coefficient and standing wave ratio. Derive the Relationships used. [8+8]

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Set No. 3

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

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1. (a) Define conductivity of a material.
   (b) Apply Gauss's law to derive the boundary conditions at a conductor-dielectric interface.
   (c) In a cylindrical conductor of radius 2mm, the current density varies with distance from the axis according to $J = 10^3 e^{-400r} A/m^2$. Find the total current I. [4+6+6]

2. (a) State Ampere's circuital law. Specify the conditions to be met for determining magnetic field strength, H, based on Ampere's circuital law
   (b) A long straight conductor with radius 'a' has a magnetic field strength $H = (Ir/2\pi a^2)\,\hat{a}_\phi$ within the conductor $(r < a)$ and $H = (I/2\pi r)\,\hat{a}_\phi$ outside the conductor $(r > a)$ Find the current density J in both the regions $(r < a \ and \ r > a)$
   (c) Define Magnetic flux density and vector magnetic potential. [4+8+4]

3. In figure 3 let B=0-2cos 120π t T, and assume that the conductor joining the two ends of the resistor is perfect. It may be assumed that the magnetic field produced by I(t) is negligible find
   (a) V_{ab} (t)
   (b) I(t) [8+8]

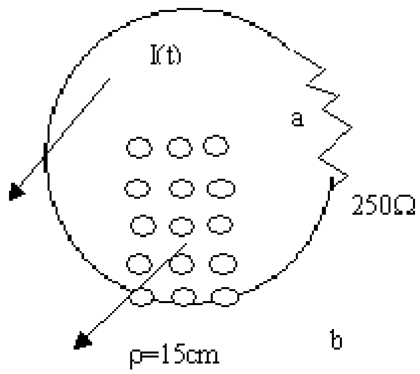

Figure 3

4. (a) A plane sinusoidal electromagnetic wave travelling in space has $E_{max} = 1500\mu v/m$
      i. Find the accompanying H_{max}

ii. The average power transmitted

(b) The electric field intersity associated with a plane wave travelling in a perfect dielectric medium is given by $E_x(z, t) = 10 \cos (2\pi \times 10^7 t - 0.1 \pi z)$v/m [4+4+8]

i. What is the velocity of propagation

ii. Write down an expression for the magnetic field intesity associated with the wave if $\mu = \mu_0$

5. Write short notes on the following

(a) Surface Impedance

(b) Brewster angle

(c) Total Internal Reflection [5+5+6]

6. (a) Account for the presence of TE, TM and TEM waves in parallel plane wave guides and explain their significance.

(b) Assuming z-direction of propagation in a parallel plane wave guide, determine the expressions for the transverse field components in terms of partial derivatives of $E_z \; and \; H_z$. [8+8]

7. (a) Define the following

i. Infinite line

ii. Insertion loss

iii. Lossy and loss less lines

iv. Phase and group velocities

(b) Derive the characteristic impedance of a transmission line in terms of its line constants [8+8]

8. (a) Explain the significance of $V_{max} and V_{min}$ positions along the transmission line, for a complex load Z_R Hence calculate the impedances at these positions.

(b) An aerial of (200-j300) Ω is to be matched with 500 Ω lines. The matching is to be done by means of low loss 600Ω stub line. Find the position and length of the stub line used if the operating wave length is 20 meters. [8+8]

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

Answer any FIVE Questions
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1. (a) Using Gauss's law derive expressions for electric field intensity and electric flux density due to an infinite sheet of conductor of charge density ρ C/cm

   (b) A parallel plate capacitance has 500mm side plates of square shape separated by 10mm distance. A sulphur slab of 6mm thickness with $\in_r = 4$ is kept on the lower plate find the capacitance of the set-up. If a voltage of 100 volts is applied across the capacitor, calculate the voltages at both the regions of the capacitor between the plates. [8+8]

2. (a) Derive equation of continuity for static magnetic fields.

   (b) Derive an expression for magnetic field strength, H, due to a current carrying conductor of finite length placed along the y- axis, at a point P in x-z plane and 'r' distant from the origin. Hence deduce expressions for H due to semi-infinite length of the conductor. [6+10]

3. (a) What is the inconsistency of Amperes law?

   (b) A circular loop conductor of radius 0.1m lies in the z=0plane and has a resistance of 5Ω given B=0.20 sin 10^3 t az T. Determine the current [8+8]

4. (a) Explain wave propagation in a conducting medium.

   (b) A large copper conductor ($\sigma = 5.8 \times 10^7 s/m, \varepsilon r = \mu r = 1$)support a unifom plane wave at 60 Hz. Determine the ratio of conduction current to displacement current compute the attenuation constant. Propagation constant, intrinsic impedance, wave length and phase velocity of propagation. [8+8]

5. (a) Explain the difference between the Intrinsic Impedance and the Surface Impedance of a conductor. Show that for a good conductor , the surface impedance is equal to the intrinsic impedance.

   (b) Define and distinguish between the terms perpendicular polarization, parallel polarization, for the case of reflection by a perfect conductor under oblique incidence. [8+8]

6. (a) Derive the relation $\lambda = \frac{\lambda_c \quad \lambda_g}{\sqrt{\lambda_g^2 \ + \lambda_c^2}}$ where λ is free space wave length, λ_g is the wave length measured in the guide, and λ_c is the cut off wave length.

   (b) Explain the impossibility of TEM wave propagation in wave guides. [10+6]

7. (a) Explain the meaning of the terms characteristic impedance and propagation constant of a uniform transmission line and obtain the expressions for them in terms of Parameters of line?

   (b) A telephone wire 20 km long has the following constants per loop km resistance 90 Ω, capacitance 0.062 μF, inductance 0.001H and leakage = 1.5 x 10^{-6} mhos. The line is terminated in its characteristic impedance and a potential difference of 2.1 V having a frequency of 1000 Hz is applied at the sending end. Calculate :

      i. The characteristic impedance
      ii. Wavelength.
      iii. The velocity of propagation [8+8]

8. (a) Describe all the characteristics of UHF Lines?

   (b) Explain the significance and design of single stub impedance Matching .Discuss the factors on which stub length depends. [6+10]

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