Code No: 07A4EC10 **R07** **Set No. 2**

II B.Tech II Semester Examinations,December 2010
ELECTRO MAGNETIC WAVES AND TRANSMISSION LINES
Common to Electronics And Telematics, Electronics And Communication Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Prove that TEM wave does not exist in hollow waveguides?
   (b) Find the broad wall dimension of a rectangular waveguide when the cut-off frequency for TE_{10} mode is 3GHz. [8+8]
2. (a) Define line charge distribution and prove that $E = \frac{\rho_L}{2\pi\epsilon\rho} a_\rho$ due to uniform infinite line charge.
   (b) Find out E at (2, 0, 2) if a line charge of 10 PC/m lies along the y-axis. [8+8]
3. (a) Write a note on power loss in a plane conductor?
   (b) A Uniform plane wave with 10MHz frequency has average Poynting vector 1 W/m^2. If the medium is perfect dielectric with $\mu_r = 2$, $\varepsilon_{r1} = 3$, find:
      i. velocity
      ii. wavelength,
      iii. intrinsic impedance
      iv. RMS value of electric field. [6+10]
4. (a) Derive the currents and voltages along an infinite line?
   (b) A telephone line has R = 30 Ω/km, L = 100mH/km, G=0, C=20μF/km. At f=1KHz, obtain:
      i. The characteristics impedance of the line
      ii. The propagation constant
      iii. The phase velocity. [7+9]
5. (a) What is the inductance of parallel conductors.
   (b) What is the inductance of a pair of transmission lines separated by 1.868 m, if the diameter of the each wire is 0.01m and the medium between the lines has $\mu = 2\ \mu_0$. The length of line is 10 m. [8+8]
6. (a) Define surface impedance and derive its expression.
   (b) A perpendicularly polarized wave is incident at angle of $\theta_i = 15^0$. It is propagating from medium 1 to medium 2. The medium 1 is defined by $\in_{r_1} = 8.5$, $\mu_{r_1} = 1$, $\sigma_1 = 0$ and medium 2 is free space. If $\mathbf{E}_i = 1.0$ mV/m, determine $\mathbf{E}_r$, $\mathbf{H}_i$, $\mathbf{H}_r$. [8+8]
7. (a) State Stoke's and divergence theorems.

(b) Convert differential form of Maxwell's equations into integral form applying the above theorems. [8+8]

8. Antenna with impedance 40+j30Ω is to be matched to a 100Ω losses line with a shorted stub. Determine:

(a) the required stub admittance

(b) the distance between the stub and the antenna

(c) the stub length

(d) the standing wave ratio on each ratio of the system. [16]

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1. (a) Explain Snell's law of reflection and snell's law of refraction?
   (b) Show that the vertical polarization of Brewester angle is $\theta = \tan^{-1}\sqrt{\frac{\varepsilon_2}{\varepsilon_1}}$.[8+8]
2. (a) When a wave of 6GHz propagates in parallel conducting plates separated by 3cm, find the phase velocity, group velocity of the wave for the dominant wave.
   (b) Write the characteristics of TEM waves. [12+4]
3. (a) List out at least 10 applications of magnetostatic fields.
   (b) Explain Faradays law of induction. [8+8]
4. A 100 MHz uniform plane wave propagates in a lossless medium for which $\varepsilon_r = 4$, $\mu_r = 2$, find:
   (a) v_P
   (b) β
   (c) λ. [16]
5. (a) Explain briefly properties of smith chart?
   (b) A lossless transmission line of length 100m has an inductance of 28μH and a capacitance of 20nF. Find propagation velocity, phase constant at an operating frequency of 100kHz and characteristic impedance of the line. [8+8]
6. A loop of one turn is in air and the uniform magnetic field is normal to its plane. The area of the loop is 10m^2. Find the emf at the terminals of the loop if the rate of change of flux density is 2 $wb/m^2/$ sec. [16]
7. (a) Prove $J = \rho_v V$ from fundamentals.
   (b) Find out electric flux density in free space if the electric field, $\mathbf{E} = 6\mathbf{a}_x$ - $2\mathbf{a}_y$ + $3\mathbf{a}_z$, V/m also find ρ_v . [8+8]
8. For a loss less two wire transmission line, show that:
   (a) The phase velocity is $\frac{1}{\sqrt{LC}}$
   (b) The characteristic impedance $Z_0 = \frac{120}{\sqrt{\varepsilon_r}} \cosh^{-1}\left(\frac{d}{2a}\right)$, where 'd' is the separation between the lines & 'a' is the radius of conducting line. [8+8]

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1. (a) Derive the expressions for attennation constant, phase shift constant and phase velocity of wave propagating in a distortion less transmission line.
   (b) A loss less line has characteristics impedance of 70Ω & phase constantof 3rad/m at 100MHz. Calculate the inductance & capacitance per meter of the line. [8+8]

2. (a) Explain the following:
      i. Total internal reflection
      ii. Surface impedance
      iii. Poynting Vector.
   (b) Find the depth of penetration, δ of an EM wave in copper at f = 60Hz. For copper, $\sigma = 5.8 \times 10^7$ mho/m, $\mu_r = 1$, $\varepsilon_r = 1$. [12+4]

3. (a) State and explain the meaning of Maxwell's equations.
   (b) In a medium in which $\rho_v = 0$ and the permittivity is a function of position. Find the conditions on the permittivity variation such that $\nabla \cdot E = 0$. [8+8].

4. (a) List the characteristics of ferromagnetic materials.
   (b) A magnetic material has $\mu_r = 10/\pi$, is in a magnetic field of strength, $\mathbf{H} = 5\rho^3\ \mathbf{a}_\phi$ A/m. Find magnetization. [8+8]

5. (a) Define complex Poynting vector and explain.
   (b) A plane wave of frequency = 2 MHz is incident upon a copper conductor normally. The wave has an electric field amplitude of $\mathbf{E}$ = 2 mV/m. The copper has $\mu_r = 1$, $\in_r = 1$ and $\sigma = 5.8 \times 10^7$ mho/m. Find average power density absorbed by copper. [8+8]

6. What is a rectangular wave guide? Derive the field expressions for TEm,n mode subject to the boundary conditions imposed by geometry of the wave guide. [16]

7. (a) Differentiate polar and non-polar dielectrics in detail.
   (b) A dielectric slab ($\in_r = 2$) is placed under the influence of electric flux density = $10a_x$ C/m^2. The slab has a volume of 0.1 cm^3. Determine polarization in the slab and total dipole moment. [8+8]

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8. (a) A 100 Km telephone line has R = 4Ω/km, L = 3mH/km, G = 1.0 μ mho/m and C = 15n F/m. It operates at f = 796Hz. Find the attenuation and phase constant.

   (b) Compare propagation parameters of general T.L., loss less line and Distortion less line. [8+8]

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1. (a) Derive the expression for γ interms of primary constants of a line?
   (b) A copper wire transmission line operates at 1MHz. For copper μ=μ_0, ε=ε_0, σ=5.8×10^7 mho/m. The radius of the wire a = 2.0mm. Find dc and ac resistances of the line. [8+8]
2. (a) Describe the characteristics of scalar magnetic potential.
   (b) In cylindrical coordinates $J = 10^5 (\cos^2 2r)\, a_z$ in a Cartesian region. Find H for this current density. [8+8]
3. (a) Write Maxwell's equation in free space.
   (b) Given **E** = 10 sin(ωt - βz)$\mathbf{a}_y$ V/m in free space, determine **D, B, H**. [8+8]
4. (a) If the electric field in free space is **E** = 2.0 cos (ωt - βz) a_x V/m, find out average power flowing across a square whose each side is 2m. The square is in z = a constant plane.
   (b) Derive the condition under which the electric field **E** = k cos(3 × 10^8t - z)$\mathbf{a}_y$ exists in a source free dielectric medium. Here k is a constant, β is a constant. [8+8]
5. What are the field components for TM waves? Derive them draw sketches for TM_{10} mode. [16]
6. (a) Differentiate different capacitors.
   (b) Prove $C = \frac{2\pi\in\ell}{\ell_n\left(\frac{\rho_2}{\rho_1}\right)}$ Farads for a coaxial cable of length ℓ. [8+8]
7. Derive the equation for input impedance of the Eighth-Wave (λ/8) line? Explain its significance? [16]
8. (a) Obtain the solution for a uniform plane wave in an isotropic homogeneous dielectric medium.
   (b) Find the skin depth δ at a frequency of 1.6 MHz in aluminium, where σ = 38.2 MS/m and μ_r =1 also find the propogation constant, and the wave velocity. [12+4]

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