Code No: R22042 **R10** SET - 1

II B. Tech II Semester Supplementary Examinations January – 2014
ELECTRO MAGNETIC WAVES AND TRANSMISSION LINES
(Com. to ECE, EIE)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) What is a point charge? Derive the expression for electric field intensity using coulombs law from fundamentals.
   b) Two point charges 5nC and -2nC are located at (2,0,4) and (-3,0,5) respectively.
      i) Determine the force on a point charge located at (1,-3,7)
      ii) Find the electric field E at (1,-3,7).

2. a) State Biot-Savart's law and find field at arbitrary point "p" due to a straight filamentary conductor.
   b) A circular loop located on $x^2+y^2 = 9$, z=0 carries a direct current of 10 A along a_ϕ. Determine **H** at (0,0,4) and (0,0,-4).

3. a) Differentiate conduction and displacement current densities.
   b) In a medium, conduction current density given by $\mathbf{J} = 10\ z \sin^2\phi\ a_\rho$ A/m^2, find the current through the cylindrical surface $\rho = 2$, $1 \le z \le 5$ m.

4. a) Derive the wave equation for conducting medium.
   b) A plane wave is propagating in a medium having the properties $\mu_r = 4$, $\varepsilon_r = 36$, $\sigma = 1$ S/m and the $\mathbf{E} = 100e^{-az}\cos(10^9 t-\beta z)a_x$ V/m, determine the associated magnetic field.

5. a) Explain the factors on which cut off frequency of a parallel plane wave guide depend.
   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 plane wave-guide.

6. a) Explain the principal of impedance matching with quarter-wave transformer.
   b) A 50Ω loss less line connects a signal of 50 kHz to a load of 140Ω. The load power is 75mW. Calculate
      i) Voltage Reflection coefficient ii) VSWR, iii) Position of V_{Max} , I_{max} ,V_{min} and I_{min}

7. a) A transmission line of length 70 meters is terminated in an impedance of $Z_R = 125 + j48$. If the frequency is 3 MHz and the characteristic impedance is 230 Ω, find the sending end impedance using Smith chart, explaining the procedure.
   b) What is meant by inductive loading? With the help of suitable expressions explain the advantages of loading and also discuss the disadvantages.

8. a) Define the Brewster angle and derive an expression for Brewster angle when a wave is parallely polarized.
   b) A plane wave traveling in a medium of $\varepsilon_r = 1$; $\mu_r = 1$ has an electric field intensity of 200 x $\sqrt{\pi}$ V/m. Determine the energy density in the magnetic field and also the total energy density.
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Code No: R22042 **R10** SET - 2

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1. a) Derive the expression for electric field intensity **E** considering the surface charge distribution.
   b) The finite sheet $0 \leq x \leq 1$, $0 \leq y \leq 1$ on the z = 0 plane has a charge density $\rho_s = xy(x^2+y^2+25)^{3/2}$ nC/m^2. Find: i) Total charge on sheet ii) The electric field at (0,0,5) iii) The force experienced by a -1mC charge located at (0,0,5)

2. a) Prove that the energy stored in an inductor is given by $W_L = 1/2\ L\ I^2$.
   b) If the magnetic field is $H = (0.01/\mu_o)\ a_x$ A/m, what is the force on a charge of 1.0 pC moving with a velocity of $10^6\ a_x$ m/s.

3. a) Derive the equation of continuity for time varying fields.
   b) A Parallel plate capacitor with a plate area of 5cm^2 and plate separation of 3mm has a voltage 50 sin 10^3t V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\ \varepsilon_o$.

4. a) Derive the Helmholtz wave equation from the fundamentals and determine the *Loss tangent*. What is the significance of the *loss tangent*?
   b) A lossy dielectric has an intrinsic impedance of $200\angle 30^0\ \Omega$ at a particular radian frequency ω. If, at that frequency, the plane wave propagating through the dielectric has the magnitude field component $\mathbf{H} = 10\ e^{-\alpha x} \cos(\omega t - 0.5x)a_y$ A/m Find **E** and α. Determine the skin depth.

5. a) Discuss the nature of variation of wave impedances for TE, TM and TEM waves with frequency in a parallel plane wave guide.
   b) Define and derive the equations for phase and group velocities in a parallel plane guide. Explain on which factors these will depend.

6. a) Explain the significance of pointing vector and the pointing theorem.
   b) A plane wave traveling in a medium of $\varepsilon_r = 1$; $\mu_r = 1$ has an electric field intensity of $100 \times \sqrt{\pi}$ V/m. Determine the energy density in the magnetic field and also the total energy density.

7. a) Draw the equivalent circuits of the transmission lines when
      i) length of the transmission line, $L < \lambda/4$, with shorted load
      ii) when $L < \lambda/4$, with open end
      iii) $L = \lambda/4$
   b) Find out VSWR if i) $Z_0 = 200\Omega$; $R_L = 80\Omega$ ii) when $Z_0 = 80\Omega$; $R_L = 200\Omega$

8. a) What is single stub matching? How is it used in impedance matching? Find the location of the stub with respect to the load under matched conditions.
   b) A certain low loss line has a characteristic impedance of 400Ω. Determine the standing wave ratio with the following receiving end impedance.
      i) $Z_R = 70 + j0.0\Omega$ ii) $Z_R = 800 + j0.0\Omega$ iii) $Z_R = 650 - j475\Omega$
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Code No: R22042 **R10** SET - 3

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1. a) Prove $J = \rho_v V$ from fundamentals.
   b) Find out electric flux density in free space if the electric field, $E = 6a_x - 2a_y + 3a_z$, V/m also find ρ_v.

2. a) Mention some applications of magneto static fields.
   b) A toroid of circular cross section whose center is at origin and the axis the same as the z-axis has 1000 turns with ρ_o(mean radius) = 10 cm, a(radius of the cross circular section) = 1cm. If the toroid carries a 100mA current, find |**H**| at
   i) (3 cm, -4 cm, 0) ii) (6cm, 9cm, 0)

3. a) Derive and explain the Maxwell's equations in point form and integral form.
   b) Given the conduction current density in a lossy dielectric as $Jc = 0.02\sin 10^9 t$ (A/m^2). Find the displacement current density if $\sigma = 10^3$ S/m and $\varepsilon_r = 6.5$?

4. a) State and prove the Poynting theorem from the fundamentals.
   b) A uniform plane wave propagating in a medium has $E = 2e^{-\alpha z}\sin(10^8 t - \beta z)a_y$ V/m
   If the medium is characterized by $\varepsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3$ S/m, find α, β and **H**.

5. a) Explain the significance of TEM wave in a parallel plane guide and derive the expression for the attenuation factor for TEM waves.
   b) Explain and sketch the nature of variations of attenuation with frequency in a parallel plane wave guide for TE, TM and TEM waves.

6. a) Define the following:
   i) loss tangent ii) Distinguish between conductors and Dielectrics
   b) A good conductor is planar in form and it carries a uniform plane wave that has a wave length of 0.3 mm and a velocity of 3×10^5 m/s assuming the conductor is non-magnetic determine the frequency and the conductivity.

7. a) What is distortion less line? Determine the condition for distortionlessness and minimum attenuation.
   b) A certain transmission line 2 m long operating at $\omega = 10^6$ rad/s has α = 8 dB/m. β = 1 rad/m and $Z_0 = 60 + j40\Omega$. If the line is connected to a source of $10\angle 0^0$ V, $Z_g = 40\Omega$ (Z_g source impedance) and terminated by a load of $20 + j50\Omega$, determine
   i) The input impedance ii) The sending-end current

8. a) Explain the working principle of quarter-wave transformer.
   b) A loss less transmission line with $Z_0 = 50\Omega$ is 30 m long and operates at 2MHz. The line is terminated with a load $Z_L = 60 + j40\Omega$. If velocity $u = 0.6c$ (where "c" is the free space velocity) on the line, find the following using smith chart
   i) The reflection coefficient ii) The standing wave ratio iii) input impedance

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Code No: R22042 **R10** SET - 4

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ELECTRO MAGNETIC WAVES AND TRANSMISSION LINES
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Time: 3 hours Max. Marks: 75

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1. a) State Guass law. Explain any two applications of Guass law in detail.
   b) The point charges -1nC,4nC, and 3nC are located at (0,0,0), (0,0,1) and (1,0,0) respectively. Find the energy in the system.

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 $H = (I/4\pi r)(\sin\alpha_1 - \sin\alpha_2).a_\phi$, 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?

3. a) Explain Faraday's laws for time-varying fields.
   b) Verify the displacement current in the parallel plate capacitor is the same as the conduction current in the connecting wires.

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 incidence, with neat sketches.

5. a) Derive the relation $\lambda = (\lambda_c\ \lambda_g)/\sqrt{(\lambda_c^2 + \lambda_g^2)}$ where λ is the free space wavelength, λ_g is the wave length measured in guide and λ_c is the cut-off wave length.
   b) Explain the impossibility of TEM mode propagation in the wave guides.

6. a) Explain the principal of impedance matching with quarter-wave transformer.
   b) A 50Ω loss less line connects a signal of 50 kHz to a load of 140Ω. The load power is 75mW. Calculate
      i) Voltage Reflection coefficient ii) VSWR, iii) Position of V_{Max} , I_{max} ,V_{min} and I_{min}

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      i) The input impedance ii) The sending-end current

8. a) What is single stub matching? How is it used in impedance matching? Find the location of the stub with respect to the load under matched conditions.
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      i) Z_R = 70 + j0.0Ω ii) Z_R = 800 + j0.0Ω iii) Z_R = 650 – j475Ω
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