Code No: R2031042 **R20** SET - 1

III B. Tech I Semester Regular Examinations, Dec/Jan – 2022-23
ELECTROMAGNETIC WAVES AND TRANSMISSION LINES
(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
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UNIT-I

1. a) Define a transmission Line? List out types of transmission lines? Draw an equivalent circuit of 2-wire transmission line? [7M]
   b) A lossy cable which has R = 25.2 Ω /m, L =2 μH/m, C = 2pF/m, and G = 0 operates at f = 5 MHz. Find the attenuation constant and phase constant of the line? [7M]

(OR)

2. a) Define Phase velocity and Group velocity? A lossless transmission line of length 100 m has an inductance of 28μH and a capacitance of 20nF. Estimate (i) propagation velocity (ii) propagation velocity in the medium of relative permittivity is 9. [7M]
   b) Derive an equation of 2-wire transmission line Input Impedance? [7M]

UNIT-II

3. a) Prove that the Z_{in} behavior of an Open End transmission line will change at every λ/4 length? [7M]
   b) Define a term reflection coefficient? Estimate the minimum and maximum values? [7M]

(OR)

4. a) Draw and explain the impedance behavior of a transmission line with respect to length when line is terminated with short end. [7M]
   b) Draw a diagram of Smith Chart and explain each part? List out the applications of Smith Chart? [7M]

UNIT-III

5. a) Two parallel line charges, ρL1 =5nC/m and ρL2 =4nC/m are located at (0, 0) and (3, 0) respectively. Find D at (3, 4). [7M]
   b) Define Gauss's Law? Derive an equation $\nabla.D= \rho_v$ [7M]

(OR)

6. a) Determine the charge enclosed in a cylinder shown in Fig.1 when the volume charge density is $\rho_v = 2e^{-z}(x^2 + y^2)^{-1/4}$ c/m^3. [7M]

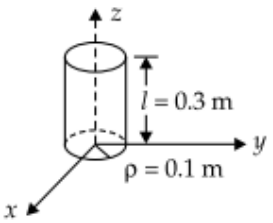

Fig.1 Charge in a Cylinder

   b) Find the capacitance of an isolated sphere of radius 1 cm. [7M]

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UNIT-IV

7. a) In a magnetic flux density of $B=2a_x +3 a_y$ wb/m^2, a current element, $10a_z$ mA-m is placed. Find the force on the current element. [7M]
   b) Derive H-field due to a finite current element placed along Z-axis. [7M]

(OR)

8. a) List out Maxwell's equations in Static and time varying form. Explain the differences between them? [7M]
   b) The tangential component of E in medium 1 is the same as that of E in medium 2 at any boundary? [7M]

UNIT-V

9. a) When the amplitude of the magnetic field in a plane wave is 2 A/m, (i) determine the magnitude of the electric field for the plane wave in free space (ii) determine the magnitude of the electric field when the wave propagates in a medium which is characterized by $0\ \sigma = ,0\ \mu = \mu_o$ and $\epsilon = 4\epsilon_0$. [7M]
   b) Discuss the techniques of wave incidences in the medium? [7M]

(OR)

10. a) The wavelength of an x-directed plane wave in a lossless medium is 1 m and the velocity of propagation is 1.5×10^{10} cm/s. The wave has z-directed electric field with an amplitude equal to 10 V/m. Find the frequency and permittivity of the medium. [7M]
    b) Explain the properties of Parallel Polarization in Oblique Wave Incidence? [7M]

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UNIT-I

1. a) Define Distortion Less Line? Estimate the propagation constant of a Distortion Less Line? [7M]
   b) A telephone line has R = 30 Ω/km, L = 100 mH/km, G = 0, and C = 20 μF/km. At f = 1 kHz, obtain: (a) The characteristic impedance of the line (b) The propagation constant. [7M]

(OR)

2. a) A transmission line is lossless and is 25 m long. The input Impedance of a line is Z_{in} = 37-j 23 Ω at a frequency of 10 MHz. The inductance and capacitance of the line are L = 300 nH/m, C = 40 pF/m. Find the Load impedance? [7M]
   b) Define and explain the properties of an infinite line? [7M]

UNIT-II

3. a) Define VSWR? Derive the relation between reflection coefficient and VSWR. [7M]
   b) How can be used UHF lines as circuit elements? Explain with suitable example. [7M]

(OR)

4. a) Prove that at every half wave length the Input Impedance of a transmission line will be repeated? [7M]
   b) A 50-m-long lossless transmission line with Zo =75Ω operating at 1 MHz is terminated with a load Z_L = 60 + j50Ω. If velocity of the wave is 0.6times of free space velocity on the line, find (i) The reflection coefficient and (ii) The standing wave ratio [7M]

UNIT-III

5. a) Find the capacitance for a 10 km long coaxial cable shown in Fig.2 [7M]

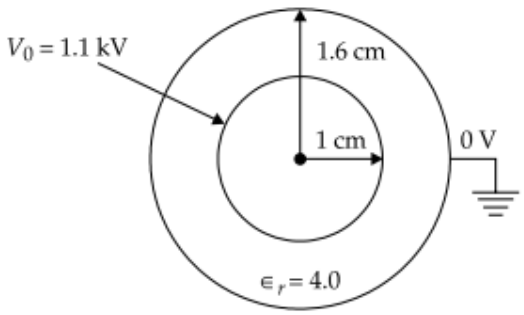

Fig.2 Coaxial cable

   b) A charge, Q1 = −10 nC is at the origin in free space. If the x-component of E is to be zero at the point (3, 1, 1), what charge, Qt should be kept at the point (2, 0, 0)? [7M]

(OR)

|'''|'|'|''|''||'|||

6. a) Two parallel line charges ρ_{L1} = 10 nC/m and ρ_{L2} = 5nC/m are located at (3, 0) and (0, 4) m respectively. Find D and E at (0, 0). [7M]
   b) Define electric potential? Derive the potential equation due to charge Q. [7M]

UNIT-IV

7. a) What is the current density which produces a magnetic field of H= 28 sin x a_y ? [7M]
   b) The normal component of D is continuous across any boundary except at the surface of the conductor. Prove this statement? [7M]

(OR)

8. a) If a magnetic field, H = $3a_x + 2a_y$ A/m exists at a point in free space, what is the magnetic flux density at the point? [7M]
   b) List out the Maxwell's Magneto static fields and derive any one of the equation? [7M]

UNIT-V

9. a) Explain the Propagation Characteristics of EM Waves in a Conducting Medium with suitable equations? [7M]
   b) If H field is given by H(z,t)=10 Cos (10^8 t+40z) a_y A/m, identify the amplitude, frequency and phase constant. Find the wavelength. [7M]

(OR)

10. A medium like copper conductor which is characterized by the parameters $\sigma = 5.8X10^7$ mho/m, $\epsilon_r = 1$, $\mu_r = 1$ supports a uniform plane wave of frequency 1KHz. Find the attenuation constant, propagation constant, intrinsic impedance, wavelength and phase velocity of the wave [14M]

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UNIT-I

1. a) Classify the transmission lines based on frequency and draw the T & Π equivalent circuit? Define each part? [7M]
   b) A certain transmission line operating at $\omega = 10^6$ rad/s has $\alpha = 10$ dB/m, $\beta = 2$ rad/m, and $Zo = 50 + j50\ \Omega$, and is 10 m long. If the line is connected to a source of 10 V, $Zs = 40\Omega$ and terminated by a load of $20 + j50\ \Omega$, determine input impedance? [7M]

(OR)

2. a) A telephone line has $R = 50\ \Omega/km$, $L = 50$ mH/km, $G = 2X10^{-6}$ mhos/km, and $C = 20\ \mu F/km$. At $f = 5$ kHz, obtain: (a) The propagation constant (b) The phase velocity [7M]
   b) Derive an equation of Characteristic Impedance? Estimate the Characteristic Impedance offered by a Lossless line? [7M]

UNIT-II

3. Prove that the Z_{in} of a Short End transmission line of length $l < \lambda/4$ is an Inductor? [14M]

(OR)

4. a) Explain the construction of a Smith chart and explain how it is different from general charts? [7M]
   b) Find the input impedance of a 75Ω lossless transmission line of length λ, if it is terminated in open circuit. [7M]

UNIT-III

5. a) In a spherical region, the electric displacement is given by $D=10\ r^2\ a_r$ mC/m. Find the total charge enclosed by the volume specified by $r = 40$cm, $\theta = \pi/4$ and $\varphi = 2\pi$. [7M]
   b) Define Gauss's Law? Derive one of the Maxwell's equation with help of Gauss' law? [7M]

(OR)

6. a) A charge of 50 PC is at rest in free space. Find the potential at a point, A 1m away from the charge. [7M]
   b) An infinite sheet in x-y plane extending from $-\infty$ to ∞ in both directions has a uniform charge density of 50 nC/m^2 . Find the electric field at z = 5cm. [7M]

UNIT-IV

7. a) Determine J at $(2,\pi,0)$ in cylindrical coordinates if the magnetic field, $H = 5\rho \sin\phi\ a_z\ mA/m^2$. [7M]
   b) Explain about Magnetic Scalar and Vector potentials? [7M]

(OR)

8. a) If a magnetic field, $H = 2a_x + 5a_y + 1a_z$ A/m exists at a point medium $\mu_r = 4$, what is the magnetic flux density at the point? [7M]
   b) Define and explain Ampere's circuit law and Ampere's force law? [7M]

UNIT-V

9. a) Explain the property of "Depth of penetration"? [7M]
   b) Define the terms Good conductor and Dielectrics? Discuss about Wave Propagation Characteristics in Good Dielectrics? [7M]

(OR)

10. a) Earth has a conductivity of 10^{-2} mho /m, $\mu_r = 4$, $\epsilon_r = 10$. What are the conducting characteristics of the earth at (a) f = 50 Hz (b) f = 10MHz [7M]
    b) Explain about Circular and Elliptical polarization? [7M]

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UNIT-I

1. a) Define Primary and Secondary constants? Derive the relation between them? [7M]
   b) A distortionless line has Zo = 50 Ω, α = 15 mNp/m, V = 0.6C, where C is the speed of light in a vacuum. Find R, L, G, C, and λ at 100 MHz. [7M]

(OR)

2. a) A transmission line operating at 500 MHz has Zo = 80 Ω, α = 0.04 Np/m, β=2 rad/m. Find the line parameters? [7M]
   b) Discuss the differences between Distortion Less Line, Lossless Line and Infinite line interms of line parameters? [7M]

UNIT-II

3. a) Define Quarter Wave transformer? Explain the impedance behavior of the line? [7M]
   b) For a transmission line which is terminated in a normalized impedance, Z_n, VSWR = 100. Find the normalized impedance magnitude. [7M]

(OR)

4. a) Prove that the Z_{in} of a Open End transmission line of length l= λ/4 is a resonant circuit? Draw the circuit diagram? [7M]
   b) Define stub matching? Explain the designing procedure of a single stub matching. [7M]

UNIT-III

5. a) An electric field is given by E= 10y a_x +20 a_y V/m. Find the potential function, V. Assume V = 0 at the origin. [7M]
   b) Solve some of applications (any two) using Gauss's Law? [7M]

(OR)

6. a) Given that D = Zp $\cos^2 \phi$ az C/m2 , calculate the charge density at (1, 𝜋/4, 3) and the total charge enclosed by the cylinder of radius 1 m with -2≤ Z ≤2m. [7M]
   b) Classify the capacitors and estimate capacitance of any of the capacitor? [7M]

UNIT-IV

7. a) How to convert Maxwell's Static EM fields into Time varying fields? Explain? [7M]
   b) Determine the magnetic flux between the conductors of a coaxial cable of length 5m. The radius of the inner conductor is a = 2 cm and that of the outer conductor is 3 cm. The current enclosed is 5A. [7M]

(OR)

8. a) What is the magnetic field, H in Cartesian coordinates due to z-directed current element? Find J if I =5A. [7M]
   b) The region y < 0 contains a dielectric material for which ϵ_{r1}= 2 and the region y > 0 contains a dielectric material for which ϵ_{r2} = 4. If $E_1 = -3a_x + 5a_y + 7\ a_z$ V/m, find the electric field, E2 and D2 in medium 2. [7M]

UNIT-V

9. a) Based on Maxwell's equations, Derive wave equations in free space. [7M]
   b) Explain the properties of a EM wave incident in normal on perfect conductor in Uniform plane wave? [7M]

(OR)

10. a) Prove that the ratio of E to H is 377Ω in UP Wave? [7M]
    b) Define polarization, write and explain different types of polarization. [7M]