B.Tech/ECE/4thSem/ECEN-2201/2016

2016

EM THEORY & TRANSMISSION LINE

(ECEN 2201)

Time Alloted : 3 Hours *Full Marks : 70*

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : **[10×1=10]**

i) Ampere's law with Maxwell's corection is

(a) $\nabla \times H = J_c$ (b) $\nabla \times H = J_c + \frac{\partial D}{\partial t}$

(c) $\nabla \times H = J_c - \frac{\partial D}{\partial t}$ (d) $\nabla \times E = \sigma J_c$

ii) Any vector can be defined uniquely, within a region using its

(a) curl only

(b) devergence only

(c) both curl and divergence

(d) can't be defined uniquely

iii) By saying that the electrostatic field is conservative, we do not mean that

(a) it is the gradient of a scalar potential.

(b) its circulation is identically zero.

(c) its curl is identically zero.

(d) the potential difference between any two points is zero.

iv) Which of these statements is not characteristic of a static magnetic field?

(a) It is solenoidal

(b) It has no sink or source

(c) It is conservative

(d) Magnetic flux lines are always closed.

v) The voltage reflection coeffecient Γ_L and standing wave ratio s, for an open circuited transmission line are

(a) 1, 1 (b) 1, ∞

(c) ∞, ∞ (d) none of them

vi) What is the major factor for determining whether a medium is free space, a lossless dielectric, a lossy dielectric or a good conductor?

(a) Attenuation constant

(b) Loss tangent

(c) Constitutive parameters (σ, ε, μ)

(d) Reflection coefficient

vii) In an air line, adjacent maxima are found at 12.5 cm and 37.5 cm. The operating frequency is

(a) 1.5 GHz (b) 300 MHz

(c) 600 MHz (d) 1.2 GHz

viii) The condition of distortion less transmission line is

(a) R/C = G/L (b) RG = LC

(c) RC = LG (d) C/R = G/L

ix) If E_t, E_n, H_t, H_n represent the tangential and normal components of electric and magnetic fields, the corresponding boundary conditions, at the interface of two dielectric medium, are to be written as

(a) $E_{t1}=E_{t2}$, $H_{n1}=H_{n2}$ (b) $E_{n1}=E_{n2}$, $H_{n1}=H_{n2}$

(c) $E_{t1}=E_{t2}$, $H_{t1}=H_{t2}$ (d) $E_{t1}=E_{t2}$, $H_{n1}=H_{n2}$

x) Antenna is a

(a) filter (b) transmission line

(c) transducer (d) none of these

GROUP - B

2. (a) Show that the vector field A is conservative if A possesses one of the following properties :

(i) The line integral of the tangential component of A along a path extending from a point P to a point Q is independent of the path.

(ii) The line integral of the tangential component of A around any closed path is zero.

(b) Mathematically explain the following :

(i) Absolute potential

(ii) Relative Potential

Further establish the relation between potential and electrostatic field.

6+6 = 12

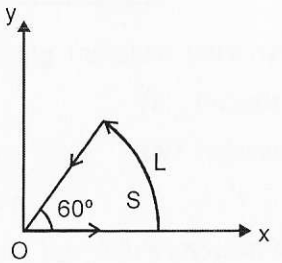
3. (a) Explain the physical significances of Curl and Divergence. State Stoke's and drivergence theorem.

(b) Determine the divergence of the following vector fields and evaluate them at the specified points.

(a) $A = yz\hat{a}_x + 4xy\hat{a}_y + y\hat{a}_z$ at (1, -2, 3)

(b) $B = \rho z\sin(\phi)\hat{a}_\rho + \rho z^2\hat{a}_\phi$ at$(5, \pi/2, 1)$

(c) For a vectot $A = \rho\cos(\varphi)\hat{a}_\rho + z\sin(\varphi)\hat{a}_z$, show that $\oint A.dl = \int(\nabla \times A).dS$ where L is a line, defined by $0 \le \rho \le 2$, $0 \le \varphi \le 60$, z = 0, enclosing the surface S, shown in the figure bellow



4+2+6 = 12

GROUP - C

4. (a) State Gauss' law and Ampere's circuit law. What are the limitations of these laws?

   (b) Using Gauss' law, find the electric flux density everywhere around an uniformly charged sphere of radius a and volume charge density ρ_v.

   (c) Using Ampere's law, find the magnetic field imensity around an infinitely long current carrying conductor.

4+4+4 = 12

5. (a) What do you mean by skin depth?

   (b) Derive the general expression of power associated with electromagnetic waves.

   (c) In a lossless dielectric for which $\eta = 60\pi$, $\mu_r = 1$ and $H = -0.1 \cos(\omega t - z)\, a_x + 0.5 \sin(\omega t - z)\, a_y$ A/m, calculate ε_r, ω and E.

2+(2+2+1)+5 = 12

Group - D

6. (a) A certain transmission line 2m long operating at $\omega = 10^6$ rad/s has $\alpha = 8$ dB/m, $\beta = 1$ rad/m and $Z_0 = 60 + j40\Omega$. If the line is connected to a source of 10 V, $Z_g = 40\Omega$ and terminated by a load of $20 + j50\ \Omega$, determine

   (i) the input impedance

   (ii) the sending end current

   (iii) the current at the middle of the line

   (b) Why it is desirable to achieve an impedance match in a transmission line? Explain the different methods of impedance matching?

5+7 = 12

7. (a) The spatial voltage and current, at any position z, of a transmission line placed along z direction are related with each other as $\frac{-dV_s(z)}{dz} = (R + j\omega L)I_s(z)$ and $\frac{-dI_s(z)}{dz} = (G + j\omega C)V_s(z)$ where R, L, G and C are the distributed resistance (Ω/m), inductance (H/m), admittance ($\mho$/m) and capacitance (F/m). Derive and expression for the characteristics impedence Z_0, for this transmission line.

   (b) Find the conditions for lossless and distortionless transmission line.

   (c) An air line has characteristic impedance of 70Ω and β=3 (rad/m) at 100 Mhz. Calculate the inductance per meter and the capacitance per meter of the line.

6+3+3 = 12

GROUP - E

8. (a) Explain the following radiation parameters :

   (i) HPBW (ii) Impedance bandwidth

   (iii) Polarization (iv) Antenna Field regions

   (v) Absolute Gain.

   (b) A lossless antenna has input impedance of 73 ohms. It is fed by a 50 ohm transmission line. If the radiation power pattern of the antenna is given by $U = 4 \sin^3\theta$, find the maximum absolute gain of the antenna and its overall efficiency.

5+7 = 12

9. (a) Find the expressions of E and H for field components for a Hertzian dipole antenna placed along z direction.

(b) Prove that, for a Hertzian dipole antenna, the time-averaged radiated power $P_{rad} = 40\pi^2\left[\frac{dl}{\lambda}\right]^2 I_0^2$ where, λ is the wavelength associated with the retarded current I with peak amplitude I_0. Assume the free space intrinsic impedence $\eta = 120\pi$.

6+6 = 12