Subject Name: Electromagnetic Field Theory **Branch: EC** **Subject Code: TEC-244**

Time: 3 Hours **M. M: 120**

Q1. Answer the following questions (very short answers): **(5x2=10 Marks)**

(a) Transform the vector $B = ya_x - xa_y + za_z$ into cylindrical coordinates.

(b) Define the Amperes circuital Law and find the H field due to infinitely long straight filament.

(c) A lossless transmission line 80 cm long and operates at a frequency of 600 MHz. The line parameters are $L = 0.25\mu H/m$ and $C = 100pF/m$. Find the characteristic impedance, the phase constant, and the phase velocity.

(d) Write Maxwell equation's equations for free space.

(e) Light is incident from air to glass at Brewster's angle. Determine the incident and transmitted angles.

Q2. Answer the following questions (short answers): **(5x4=20 Marks)**

(a) Let $V = (cos\ 2\varphi)/\rho$ in free space. Find the volume charge density at point $A(0.5, 60^o, 1)$. (b) Find the surface charge density on the conductor surface passing through the point $B(2, 30^o, 1)$.

(a) Define and derive the equation for displacement current.

(b) A 50 W lossless line has a length of 0.4λ. The operating frequency is 3000MHz. A load $Z_L = 40 + j30\ \Omega$ is connected at $z = 0$, and the Thevenin-equivalent source at $z = -l$ is $12\angle 0^o$ V in series with $Z_{Th} = 50 + j0\ \Omega$. Find (a) refection coefficient (b) VSWR; (c) Z_{in}.

(c) Explain the wave polarization and its types.

(d) We wish to coat a glass surface with an appropriate dielectric layer to provide total transmission from air to the glass at a free-space wavelength of 570nm. The glass has refractive $n_3 = 1.45$. Determine the required index for the coating and its minimum thickness.

Q3. All questions from UNIT-I. Part (a) is compulsory and attempt any one of part (b) or part (c).

(a) Find the equation for energy density in the electrostatic field. **(6 Marks)**

(b) Derive the expression for potential gradient in rectangular coordinates. **(12 Marks)**

(c) Evaluate both sides of the divergence theorem for the field $D = 2xya_x + x^2a_y\ C/m^2$ and the rectangular parallelepiped formed by the planes $x = 0$ and 1, $y = 0$ and 2, and $z = 0$ and 3. **(12 Marks)**

Q4. All questions from UNIT-II. Part (a) is compulsory and attempt any one of part (b) or part (c).

(a) Explain the scaler and vector magnetic potentials and also explain how they are different from electric potential. **(6 Marks)**

(b) Derive the expression for curl in rectangular coordinates. **(12 Marks)**

(c) Evaluate both sides of the stokes theorem for the field $H = 6xya_x - y^2a_y\ A/m$ and the rectangular path around the region, $2 \leq x \leq 5,\ -1 \leq y \leq 1, z = 0$. Let the positive direction of dS be a_z. **(12 Marks)**

Q5. All questions from UNIT-III. Part (a) is compulsory and attempt any one of part (b) or part (c).

(a) Derives the equations for waveform distortions (i.e., α & β) and explain its effect on the wave transmission. **(6 Marks)**

(b) Derive the expressions for general solution of transmission line of distributive elements. **(12 Marks)**

(c) At an operating radiation frequency of 500 Mrad/s, typical circuit values for certain transmission line are: $R - 0.2\Omega/m$, $L = 0.25\mu H/m$, $G = 10\mu S/m$ and $C = 100pF/m$. Find: (a) $\propto$; (b) β; (c) λ; (d) v_p; (e) Z_0. **(12 Marks)**

Q6. All questions from UNIT-IV. Part (a) is compulsory and attempt any one of part (b) or part (c).

(a) Derive the Poynting's theorem and wave power for uniform plane wave. **(6 Marks)**

(b) Derive the field equations and parameters of the wave propagation in free space **(12 Marks)**

(c) A 1 MHz plane wave propagating in fresh water. At this frequency, losses in water are negligible, which means that we can assume that $\epsilon'' = 0$. In water, $\mu_r = 1$ and at 1 MHz, $\epsilon' = 31$. Find (a) E; (b) H (c) β; (d) λ; (e) v_p. **(12 Marks)**

Q7. All questions from UNIT-V. Part (a) is compulsory and attempt any one of part (b) or part (c).

(a) Drive the conditions for total reflection and total transmission of obliquely incident wave. **(6 Marks)**

(b) Explain the wave reflection from multiple interfaces. **(12 Marks)**

(c) Write down and explain physical significance of Maxwell's equations for static and time varying fields. **(12 Marks)**

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