Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Regular and Supplementary Examination December 2020

Course Code: EC303

Course Name: APPLIED ELECTROMAGNETIC THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Derive the expression of energy stored in electric field. (7)

b) Four 10-nC point charges are located in the z=0 plane at the corners of a square 8cm on a side. A fifth 10-nC positive charge is located at a point 8cm distant from each of the other charges. Calculate the magnitude of the total force on the fifth charge for $\epsilon = \epsilon_0$. (8)

2 a) Derive the boundary conditions of electric field and magnetic field from Maxwell's equations at the interface of dielectric-dielectric medium. (6)

b) A lossy dielectric has an intrinsic impedance of $50\angle 10°\ \Omega$ at a particular frequency. If at that frequency, the plane wave propagating through the dielectric has the magnetic field component $\boldsymbol{H} = 10e^{-\alpha y}\cos(\omega t - 5y)\,\boldsymbol{a}_x$ A/m find (i) $\boldsymbol{E}$ (ii) α (iii) Skin depth (9)

3 a) State Maxwell's equations in differential form, integral form and mention the laws from which each of the equation is derived. (7)

b) Derive Continuity equation. (8)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive the expression for reflection and transmission coefficients field when a plane wave having parallel polarization is incident obliquely at an angle θ_i on the boundary (z plane) at x=0 between medium 1 (z<0) characterized by $\mu_1, \epsilon_1, \sigma_1$ and medium 2 (z>0) characterized by $\mu_2, \epsilon_2, \sigma_2$. (7)

b) A 100Ω lossless line is terminated by unknown load impedance Z_L. If at a distance 0.2λ from the load the voltage is $V_S = 1 + 2j\ V$ while the current is 5mA. Find the load impedance and VSWR. (8)

5 a) Derive the expression for volatege , current and input impedance of a transmission line at a distance l from load impedance Z_L (7)

b) An electromagnetic wave travelling in free space has $\boldsymbol{E} = (5a_y + 2\boldsymbol{a}_z)\cos(\omega t + 2y - 4z)\, V/m$. Determine (i) ω (ii) λ (iii) The magnetic field component (iv) The time average power. (8)

6 a) State Poynting Theorem. Derive the expression for complex Poynting vector. (9)

b) The propagation constant of a lossy transmission line is $(1 + 2\text{j})\text{m}^{-1}$ and its characteristic impedance is 100Ω at $\omega = 10^6 \text{rad/s}$ .What are the values of L, C, R and G? (6)

PART C

Answer any two full questions, each carries 20 marks.

7 a) If we want to calculate an impedance at 0.4λ from the load using smith chart, how much degree should we move from the load in the smith chart? (8)

b) Consider a 50Ω, quarter-wave long transmission line at 2GHz. It is connected to a 5V, 10Ω source at one end and is left open circuited at the other end. Calculate the magnitude of voltage at the open circuit end. (12)

8 a) Derive expression for TM mode in rectangular wave guide. (10)

b) A 50+j75Ω load is connected to 100Ω lossless line. Using smith chart find (10)
(i) Reflection coefficient (ii) Standing Wave Ratio (iii) The load admittance Y_L (iv) Z_{in} at 0.5λ from the load.

9 a) Derive expression for TE mode in rectangular wave guide. (10)

b) Consider a TM_{13} propagating inside a rectangular waveguide having a=5cm, b=6cm, $\sigma = 0$, $\mu = \mu_0$, $\epsilon = 9\epsilon_0$ and $H_x = 9sin(\pi x/a)\cos(3\pi y/b)\sin(2\pi \times 10^{11}t - \beta z)$ A/m. Determine (i)The cut-off frequency (ii) The phase constant (iii) The propagation constant (iv) The intrinsic impedance (10)

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