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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree (S, FE) Examination January 2023 (2015 Scheme)

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 capacitance for coaxial cable. (7)

b) In a certain material $\sigma = 0, \mu = \mu_0$ and $\epsilon = 81\epsilon_0$. The magnetic field intensity in this material is $\boldsymbol{H} = 10\cos(2\pi \times 10^9 t + \beta x)\,\boldsymbol{a_z}$ A/m. Determine $\boldsymbol{E}$ and β. (8)

2 a) What is the inadequacy of Amphere's circuital law and how is it solved? (6)

b) In a certain medium with $\epsilon = 4\epsilon_0, \mu = \mu_0$. (9)

$$\boldsymbol{H} = 12e^{-0.1y}\sin(\pi \times 10^8 t - \beta y)\,\boldsymbol{a_x}\ \text{A/m}$$

Find (a) the wave period T, (b) the wavelength λ, (c) the electric field $\boldsymbol{E}$, (d) the phase difference between $\boldsymbol{E}$ and $\boldsymbol{H}$

3 a) State Maxwell's equations in differential form, integral form and point form. Also mention the laws from which each of the equation is derived. (8)

b) Current sheets of $20\,\boldsymbol{a_x}$ A/m and $-20\,\boldsymbol{a_x}$ A/m are located at $y = 1$ and $y = -1$ respectively. Find $\boldsymbol{H}$ in the region $-1 < y < 1$. (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive the expression of reflection and transmission coefficients when a plane wave propagating in +x direction is incident normally on the boundary x=0 between medium 1 (x<0) characterized by $\mu_1, \epsilon_1, \sigma_1$ and medium 2 (x>0) characterized by $\mu_2, \epsilon_2, \sigma_2$. (8)

b) A lossless 50 Ω transmission line of length 3.2 m is terminated with an impedance of 30-j50 Ω. If the line operates at a frequency of 400MHz, determine the input impedance. (7)

5 a) Derive the expression for characteristic impedance in a transmission line. (7)

b) The plane wave $\vec{E} = 30\cos(\omega t - \beta z)\,\hat{a}_x$ V/m in air ($\mu = \mu_0, \epsilon = \epsilon_0$) hits normally on a lossless medium ($\mu = \mu_0, \epsilon = 4\epsilon_0$) at z = 0. Calculate (i) reflection (8)

coefficient, (ii) transmission coefficient, (iii) standing wave ratio (iv) the reflected electric field.

6 a) State Poynting Theorem. Derive the expression for total power flowing out of a volume when a plane wave with electric field **E** and magnetic field **H** passes through it. (9)

b) The propagation constant of a lossy transmission line is $(2 + j5)m^{-1}$ and its characteristic impedance is 50Ω at $\omega = 10^6 rad/s$ .What are the values of L, C, R and G? (6)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive the expression for the radius and the center of resistance circles in a Smith Chart. (10)

b) Write short notes on single stub matching. What are the steps to find the stub admittance, stub length and stub position using Smith chart? (10)

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

b) A 100+j150Ω load is connected to 75Ω lossless line. Using smith chart find (i) Reflection coefficient (ii) Standing Wave Ratio (iii) The load admittance Y_L (iv) Z_{in} at 0.4λ from the load (v) The locations of voltage maximum and voltage minimum with respect to the load if the line is 0.6λ long. (10)

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

b) Consider a TM_{13} propagating inside a rectangular waveguide having a=3cm, b=1.6cm, $\sigma = 0$, $\mu = \mu_0$, $\epsilon = 4\epsilon_0$ and $H_x = 2sin(\pi x/a)\cos(3\pi y/b)\sin(\pi \times 10^{11}t - \beta z)$ 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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