

Ans

Indian Institute of Technology, Kharagpur

Date FN/AN, Time 2 Hrs, Full marks 27, Deptt E&ECE, No of Students 116, Mid Autumn Semester Examination, Sub. No. EC31005, Sub. Name RF & Microwave Engg. 3rd Yr. B.Tech, Instruction Answer All questions, Figures on the margin indicate marks.

Q1. Use the method of conformal transformation to find the capacitance per unit length of a coaxial cable. Show that the l and c parameters of a transmission line satisfy the relation $lc = \mu\epsilon$ where μ and ϵ are the permeability and permittivity of the surrounding medium respectively and hence find the expression for the characteristic impedance of the coaxial line. The inner and outer radii of the cable are respectively a and b . (7)

Q2. Show that the group velocity for a narrow band signal can be defined as $\frac{d\omega}{d\beta}$ where

$j\beta$ is the imaginary part of the propagation constant and find an expression for this velocity in a rectangular wave guide. Assume all structures and media to be lossless. (4)

Q3. The magic-T hybrid has the following $[S]$ matrix

$$[S] = (1/\sqrt{2}) \begin{bmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & -1 \\ 1 & 0 & 0 & 1 \\ 0 & -1 & 1 & 0 \end{bmatrix}$$

Do you agree? Give Reasons. If you do not write it correctly giving reasons. (4)

Q4. Determine the resonant frequencies of a rectangular cavity by carrying out a full separation of variables solution to the wave equation for E_z (for TM modes) and H_z (for TE modes), subject to the boundary conditions of the cavity. (Assume a solution of the form $X(x)Y(y)Z(z)$). (5)

Q5. Show that the fundamental component of the beam current at the catcher cavity of the two cavity klystron has a magnitude $I_f = 2I_0J_1(X)$ where I_0 is the dc beam current and X is the bunching parameter. $J_1(X)$ is the usual notation for a Bessel function and has a maximum magnitude at $X = 1.841$. Show that the optimum distance between the buncher and catcher is

$$\frac{3.682v_0V_0}{\omega\beta_1V_1}$$

where β_1 is the beam coupling coefficient of the buncher cavity, V_0 is the dc accelerating voltage of the klystron and the gap voltage between the buncher grids is $V_1 \sin \omega t$.

(7)