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## Fifth Semester B.E. Degree Examination, December 2010 Transmission Lines and Waveguides

Time: 3 hrs.

Max. Marks:100

**Note: 1. Answer any FIVE full questions.**

**2. Use of Smith chart is permitted, wherever pertinent.**

- 1 a. Distinguish between characteristic impedance and input impedance of a transmission line. Under what conditions both will be the same? (10 Marks)
- b. Show that, for a transmission line of length L, the attenuation constant  $\alpha$  is :

$$\alpha = \text{Re} \left[ \frac{1}{2L} \left\{ \ln \left( \frac{\sqrt{Z_{oc}} + \sqrt{Z_{sc}}}{\sqrt{Z_{oc}} - \sqrt{Z_{sc}}} \right) \right\} \right] \quad (06 \text{ Marks})$$

- c. A lossless transmission line with air dielectric is 12 m long. What is the normalized line length and phase constant when operating at a frequency of 15 MHz? (04 Marks)
- 2 a. With the help of neat sketches, explain the variation of attenuation constant ( $\alpha$ ), phase constant ( $\beta$ ) and characteristic impedance ( $Z_0$ ), with frequency in case of a constant K LPF and HPF. (06 Marks)
- b. Derive the expression for quality factor and bandwidth in terms of  $\alpha$  and  $\beta$  of a line. (09 Marks)
- c. A 750 Hm low loss transmission line has a loss of 1.5 dB/m. The velocity of the voltage wave on a line is used to make a series resonant circuit at 1 GHz. Find the input impedance of the line, quality factor and the bandwidth of a circuit? (05 Marks)
- 3 a. What is stub matching? Explain the various steps involved in single stub matching, using Smith chart. (08 Marks)
- b. Deduce an equation for open and short circuit impedance of the line with small dissipation. (08 Marks)
- c. A  $(200 + j75)$  ohm load is to be matched to a  $300 \Omega$  line to give  $\text{SWR} = 1$ . Find the reactance of the stub and the characteristic impedance of the quarter wave transformer, both connected directly to the load. (04 Marks)
- 4 a. A 50 ohm line feeds an inductive load  $z = 35 + j35\Omega$ . Using Smith chart, design a double stub tuner to match this load to a line if the distance of separation is  $\lambda/4$ . (12 Marks)
- b. In a 1 meter long transmission line, a voltage minimum occurs at a distance of 20 cm from the load end and adjacent voltage minima occurs at a distance of 25 cm. If  $S = 3$  and  $Z_0 = 200$  ohm, find the load impedance and input impedance. (08 Marks)
- 5 a. Define incident wave, reflected wave and reflected coefficient. Derive an expression for the reflection coefficient, in terms of characteristic impedance and load impedance. Comment on the equation obtained. (09 Marks)
- b. Explain briefly different types of propagation. (05 Marks)
- c. Define and explain the meaning of the term SWR. Sketch the standing wave pattern for a lossless transmission line under:
- i) Open circuit condition                      ii) Short circuit condition (06 Marks)

**Important Note :** 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

- 6 a. Derive the expression for quality factor of a cavity resonator. (08 Marks)
- b. A parallel plate wave guiding system transmits TEM mode, at an average power of 500 watts/meter of its width. If the plane of separation between the plates is 5 cm, obtain the values of the electric and magnetic fields existing, between the plates. (06 Marks)
- c. Find cutoff frequency, cutoff wavelength, guide wavelength, phase constant, phase velocity and group velocity when a  $TE_{11}$  mode is propagated through a rectangular waveguide of 4 cm  $\times$  2 cm, operated at a frequency of 10 GHz. (06 Marks)
- 7 a. Derive the expression for the field components for transmission of TM wave between parallel plates. (08 Marks)
- b. Derive the equation for the attenuation constant for the coaxial line, filled with air as the dielectric. (08 Marks)
- c. A waveguide has an internal breadth  $a = 3$  cm and carries the dominant mode of a signal of unknown frequency. If the characteristic wave impedance is 500 ohm, what is the frequency? (04 Marks)
- 8 Write short notes on the following: (20 Marks)
- Loading of telephone cables
  - Exponential lines
  - Excitation of waveguides
  - Transmission lines as a resonant circuit.

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