Ref. No. : Ex/ET/PC/B/T/224/2025

B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING
SECOND YEAR SECOND SEMESTER – 2025

TRANSMISSION LINES AND WAVEGUIDES

Time (Full Paper): Three hours | Full Marks : 100

Use separate answer scripts for each half.

PART I

(50 Marks)

Answer **Q.1** and ***any three*** questions from the rest.

1. Consider the transmission line shown in Fig. 1. At t = 0 a 10 V battery with zero source resistance is attached to the line, which has a total length of L = 400 m, a velocity of propagation of v = 200 m/μs, and a characteristic impedance of Z_C = 50 Ω. Sketch the voltage on a line as a function of position for t = 2.5 μs, t = 4.5 μs and t = 6.5 μs. Plot voltage across R_L for 0 to 20 μs. [6+14]

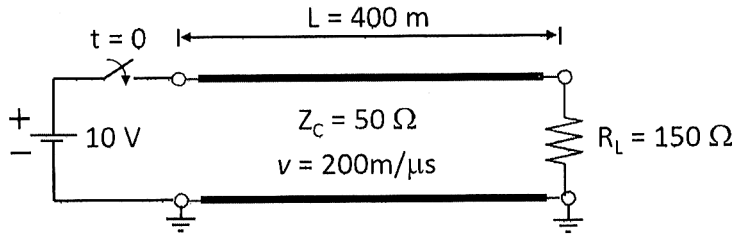

Fig. 1

2. Write differences between lumped parameters and distributed parameters in circuits. Draw typical equivalent circuit and plot frequency response for a practical resistor. When does a cable behave like transmission line? Give an example of balanced transmission line and draw its equivalent circuit. Draw the E and H field lines for a balanced transmission line section. [2+1+1+1+1+2+2]

3. Draw the equivalent circuit of transmission line. Explain the derivation of the Telegrapher's equations. Derive the expressions for voltage and current at any point on a transmission line in terms of the incident and reflected waves. [2+4+4]

4. For a transmission line, calculate input impedance Z_{in} for load impedance Z_L and line length l. How will you realize inductors and capacitors using transmission line sections? [5+5]

5. a) Explain the significance of the propagation constant (γ) in transmission lines. Derive its expression in terms of the primary constants (R, L, G, C). [1+3]
   b) Derive expression for characteristic impedance for a transmission line in terms of the primary constants (R, L, G, C). A lossless transmission line has an inductance of 0.3 μH/m and a capacitance of 50 pF/m. Calculate its characteristic impedance and phase velocity. [4+1+1]

6. Write short notes on: [2x5]
   a) Microstrip Lines
   b) Smith Chart

[Turn over

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B. ETCE 2ND YEAR 2ND SEMESTER EXAMINATION, 2025
TRANSMISSION LINES AND WAVEGUIDES

Time: 3 Hours **Full Marks: 100**

Use separate Answer - Script for each Part
50 marks for each part

PART - II

Answer Question NO. 1 and any two (2) from the rest.

1. Answer any five questions: 5×2=10

(a) Why Planner transmission line is preferred for transmission of signal compared to the other transmission line?

(b) Why suspended substrate microstrip line increases the frequency range of operation?

(c) Write down the special features of Co-planner waveguide.

(d) Draw the field pattern of TM_{21} mode in a rectangular waveguide with a/b =2.

(e) Draw the field pattern of TE_{31} mode in a circular waveguide.

(f) Give the special properties of Fin-Lines.

(g) Sketch the coaxial probe excitation scheme for a rectangular waveguide.

(h) Why TE_{01} mode attenuation in a cylindrical wave guide is low?

2. A microstrip transmission line consists of the following parameters: W = 30 mm, h = 1.59 mm, ε_r = 2.32 and $tan\delta$ = 0.0012. Determine (i) $\varepsilon_{r,eff}(0)$, (ii) Filling fraction (q), (iii) maximum frequency (f_{max}), (iv) Z_0, (v) $\varepsilon_{r,eff}(f)$, (vi) λ_g (f), (vii) R_r, (viii) Q_r, (ix) Q_c and (x) Q_d. (Symbols have their usual meanings)

(20)

3. (a) The inner dimension of an X-band WR-90 waveguide are a = 22.86 mm and b = 10.16 mm. Assume free space within the guide and determine the cut-off frequencies, in ascending order, of first 10 TE^Z modes. Derive the necessary relation you use.

(b) The inside dimension of an X-band WR-90 waveguide are a = 22.86 mm and b = 10.16 mm. Assume that the waveguide is air-filled and operates in the dominant TE_{01} mode and that the air will break down when the maximum electric field intensity 3×10^6 V/m. Find the maximum power that can be transmitted at f = 9.0 GHz in the waveguide before air breakdown occurs. Derive the necessary relation you use.

(5+15)

4. (a) A lossless, air-dielectric cylindrical waveguide, of inside diameter 30 mm, operated at 14 GHz. For the TM_{11} mode propagating in the + Z direction. Find the cut-off frequency, guide wavelength and wave impedance.

(b) An air-dielectric cylindrical waveguide (r =5 mm) operates in the TM_{01} mode at frequency f =1.3fcTM_{01}. Find the dB/m of attenuation due to wall loss in a short section of copper (σ_w = 58 MS/m). Derive the necessary relation you use.

(5+15)