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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

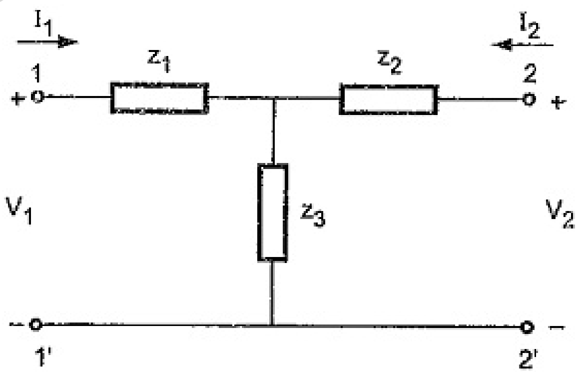
June 2025 Semester End Main Examinations

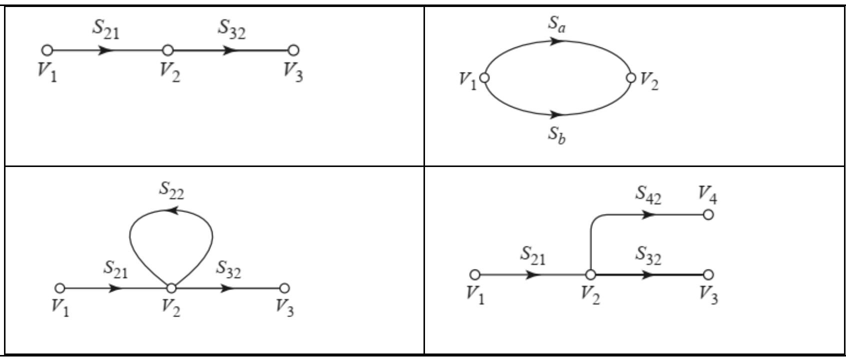
Programme: B.E. **Semester: VI**
Branch: Electronics and Telecommunication Engineering **Duration: 3 hrs.**
Course Code: 23ET6PCMWA **Max Marks: 100**
Course: Microwaves and Antenna

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	***CO***	***PO***	**Marks**
1	a)	Derive the general solution of a transmission line using Telegrapher's equations. State assumptions for lossless and distortion less lines.	*CO2*	*PO1*	**07**
	b)	A 50 Ω line is terminated with a load Z_L = 25 + j50Ω. Find: i) Reflection coefficient ii) SWR iii) Return Loss	*CO2*	*PO1*	**07**
	c)	A short-circuited 75 Ω lossless coaxial line is 0.1λ long. Compute the input impedance and comment on its nature (capacitive/inductive).	*CO3*	*PO2*	**06**
		OR			
2	a)	Derive the input impedance expression of a transmission line and explain conditions for resonance for short and open circuit terminations.	*CO2*	*PO1*	**07**
	b)	A transmission line exhibits the equation $i(z,t) = 1.5\cos(2\pi(2.4\times10^9 t) - \beta z)$ Determine: i) Frequency ii) Phase velocity (assume β = 50 rad/m) iii) Relative permittivity of the medium	*CO2*	*PO1*	**07**
	c)	A lossless open-wire transmission line at 3 GHz has length 3 cm and characteristic impedance of 60 Ω. The load impedance is 30 + j20 Ω. Compute: i) Reflection coefficient, ii) Input impedance, iii) VSWR	*CO3*	*PO2*	**06**

			UNIT - II			
	3	a)	Derive the expression for the input impedance of a lossless transmission line terminated with any load. Discuss special cases of open- and short-circuited terminations.	*CO2*	*PO1*	**07**
		b)	A 75 Ω coaxial line of length 2.5 cm is terminated with a load of Z_L=25−j30Ω. The line operates at 2.4 GHz with relative permittivity ε_r=2.25. Determine: i) The guide wavelength ii) The input impedance iii) The reflection coefficient at the input	*CO2*	*PO1*	**07**
		c)	Explain the Quarter-wave transformer. Derive the condition for perfect matching using it.	*CO3*	*PO2*	**06**
			OR			
	4	a)	A rectangular waveguide with a = 5cm, b = 2.5cm operates in fundamental mode with an operating frequency of f = 9GHz. Calculate the cut-off frequency and group velocity of the wave inside the waveguide.	*CO2*	*PO1*	**05**
		b)	Use a Smith chart to determine the stub position and length for matching a Z_L=100−j50 Ω load to a 50 Ω line using a single-stub.	*CO2*	*PO1*	**08**
		c)	Consider a Teflon filled copper K band rectangular waveguide having dimensions a = 1.07cm and b = 0.43cm. Find the cut-off frequencies of the first five propagating modes. The operating frequency is 15GHz	*CO3*	*PO2*	**07**
			UNIT - III			
	5	a)	Define S-matrix and derive its properties for a 3-port lossless reciprocal network.	*CO2*	*PO1*	**07**
		b)	Consider the network shown, find the Z-matrix. Z_1 = 10Ω, Z_2 = 20Ω, Z_3 = 15Ω. 	*CO2*	*PO1*	**07**
		c)	For the signal flow graph edges, apply the relevant decomposition rule to reduce them to a single branch in each case, except for the last case, which will have two surviving branches.	*CO3*	*PO2*	**06**

						
			OR			
	6	a)	A T-junction divider has Z_0=50 Ω and delivers 10 W to each load Z_L=60 Ω. Calculate reflection coefficients and reflected power.	*CO2*	*PO1*	**07**
		b)	Design a 3rd-order Butterworth low-pass filter with cutoff at 3 GHz. Show normalized element values and scaled implementation.	*CO2*	*PO1*	**07**
		c)	Consider the ABCD parameters of a 2-port network. Convert the parameters to Z –matrix $\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 2 & 50 \\ 0.01 & 1 \end{bmatrix}$	*CO3*	*PO2*	**06**
			UNIT - IV			
	7	a)	Define and derive expressions for the following antenna parameters: i) Beam area ii) Directivity iii) Aperture efficiency	*CO4*	*PO3,5,12*	**07**
		b)	An antenna has a beamwidth of 25° in both principal planes. Calculate: i) Beam solid angle ii) Directivity (in linear scale and dBi) Assume isotropic radiator as reference.	*CO4*	*PO3,5,12*	**07**
		c)	Explain the field zones of an antenna. Derive expressions for electric field components in the far-field region for a λ/2 dipole.	*CO4*	*PO3,5,12*	**06**
			OR			
	8	a)	Derive the expressions for electric and magnetic fields of a small loop (magnetic dipole) antenna. State assumptions and draw field pattern.	*CO4*	*PO3,5,12*	**07**
		b)	A parabolic dish antenna of diameter 2.4 m operates at 12 GHz. Calculate: i) Gain in dBi ii) Effective aperture Assume efficiency = 65%.	*CO4*	*PO3,5,12*	**07**

		c)	Define and derive the expression for effective height of a receiving antenna. How is it related to gain and effective aperture?	*CO4*	*PO3,5,12*	**06**
			UNIT - V			
	9	a)	Derive the array factor for a broadside linear array of ‘n’ isotropic elements with λ/2 spacing and equal amplitude. Sketch for 4 elements.	*CO4*	*PO3,5,12*	**07**
		b)	Two isotropic sources spaced λ apart are fed with equal magnitude and a phase difference of 120°. Derive the resultant field expression and plot.	*CO4*	*PO3,5,12*	**07**
		c)	Define pattern multiplication. Using an example of a 3-element linear array, explain its effect on main lobe and side lobes.	*CO4*	*PO3,5,12*	**06**
			OR			
	10	a)	Derive expressions for radiation intensity and beamwidth for an end-fire array of two λ/2 spaced isotropic elements fed with 180° phase shift.	*CO4*	*PO3,5,12*	**07**
		b)	Differentiate isotropic and non-isotropic antennas. Explain how non-isotropic sources affect array performance and beam shaping.	*CO4*	*PO3,5,12*	**07**
		c)	Prove the power theorem for antenna arrays. Show how total radiated power is conserved using superposition principle.	*CO4*	*PO3,5,12*	**06**

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