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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: VII**

Branch: Electronics & Telecommunication Engineering **Duration: 3 hrs.**

Course Code: 22ET7PCMWR **Max Marks: 100**

Course: MICROWAVES AND RADAR

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)	Explain the concept of generator and load mismatch in a transmission line. Discuss the effects of mismatch on the system performance and the techniques used to minimize these effects.	*CO1*		**07**
	b)	A 50-ohm coaxial line is terminated with a load impedance of 75+j25 ohms. Design a quarter-wave transformer to match the load to the line. Calculate the characteristic impedance of the transformer and its physical length at a frequency of 1 GHz.	*CO2*	*PO1*	**07**
	c)	Compare and contrast the characteristics of coaxial lines, waveguides, and microstrip transmission lines in terms of their frequency range, attenuation, power handling capacity, and applications.	*CO2*	*PO1*	**06**
		OR			
2	a)	Describe the concept of Voltage Standing Wave Ratio (VSWR) on a transmission line. How is it related to the reflection coefficient? Explain how VSWR is measured and what its significance is in practical applications.	*CO1*		**07**
	b)	Explain the concept of modes in a waveguide. Describe the characteristics of the dominant mode in a rectangular waveguide. How does the cutoff frequency of a waveguide affect its operating range?	*CO1*		**07**
	c)	Compare and contrast the advantages and disadvantages of microstrip lines and stripline transmission lines. Discuss their typical applications.	*CO1*		**06**
		UNIT - II			
3	a)	Define the scattering parameters (S-parameters) of a two-port network. How are they related to incident and reflected waves?	*CO2*	*PO1*	**07**

		b)	A two-port network has the following S-parameters: • $S_{11} = 0.2 \angle 30°$ • $S_{12} = 0.8 \angle -45°$ • $S_{21} = 0.8 \angle -45°$ • $S_{22} = 0.1 \angle 90°$ If a wave of 1 V amplitude is incident on Port 1, calculate the amplitude and phase of the reflected wave at Port 1 and the transmitted wave at Port 2.	*CO2*	*PO1*	**06**
		c)	Explain how to find the overall transmission matrix for a cascaded system of two-port networks.	*CO1*		**07**
			OR			
	4	a)	Derive and discuss the properties of S matrix.	*CO2*	*PO1*	**07**
		b)	A 50 Ω transmission line is terminated with a load impedance $Z_L = (75 + j25)$ Ω. i) Calculate the reflection coefficient (Γ_L) at the load. ii) Determine the VSWR on the transmission line.	*CO2*	*PO1*	**06**
		c)	Analyze the purpose of impedance matching in microwave circuits? Describe the concept of binomial multi-section matching transformers.	*CO2*	*PO1*	**07**
			UNIT - III			
	5	a)	Describe the operation of a Wilkinson power divider. Explain the purpose of the resistor and how it contributes to the isolation between the output ports.	*CO2*	*PO1*	**07**
		b)	What are the key differences between a T-junction power divider and a Wilkinson power divider? Discuss their advantages and disadvantages in terms of power handling, isolation, and impedance matching.	*CO2*	*PO1*	**06**
		c)	A microwave amplifier has the following characteristics: • Input power: -10 dBm • Output power: 15 dBm • Noise figure: 3 dB i) Calculate the power gain of the amplifier in decibels (dB). ii) Calculate the noise power at the output of the amplifier in dBm.	*CO2*	*PO1*	**07**
			OR			
	6	a)	Design a 4th-order low-pass Butterworth microwave filter with a cutoff frequency ωc=2 GHz. The filter should have a maximum passband ripple of 0.1 dB. Compute the element values for the physical implementation and explain the significance of impedance scaling in microwave filters.	*CO3*	*PO2*	**07**

		b)	Discuss and analyze the steps involved in designing a microwave filter using the insertion loss method. What are the key considerations in choosing the appropriate filter topology and component values?	*CO2*	*PO1*	**06**
		c)	An amplifier has the following S-parameters: $S_{11} = 0.1\angle -30°$, $S_{12} = 0.05\angle 60°$, $S_{21} = 5\angle 45°$, $S_{22} = 0.2\angle -15°$. Calculate the following: • The transducer power gain (Gt) • The available power gain (Ga) • The operating power gain (Go) • The unilateral power gain (Gu)	*CO2*	*PO1*	**07**
			UNIT - IV			
	7	a)	What is the radar equation, and what are its key parameters?	*CO2*	*PO1*	**07**
		b)	How does CW radar work, and what are its limitations?	*CO2*	*PO1*	**07**
		c)	A radar system has the following parameters: • Transmitted power (Pt) = 1 MW • Antenna gain (G) = 30 dB • Wavelength (λ) = 3 cm • System losses (L) = 6 dB Calculate the maximum range of the radar to detect a target with a radar cross-section (σ) of 1 m², assuming a minimum detectable signal-to-noise ratio (SNR) of 10 dB.	*CO3*	*PO2*	**06**
			OR			
	8	a)	Analyze how the shape, size, and material composition of a target affect its Radar Cross Section (RCS).	*CO2*	*PO1*	**07**
		b)	How does a Pulsed Doppler Radar distinguish between moving targets and stationary clutter?	*CO2*	*PO1*	**07**
		c)	A Radar system has the following parameters: - Transmitted power (Pt) = 100 kW - Antenna gain (G) = 25 dB - Wavelength (λ) = 5 cm - System losses (L) = 4 dB - Radar cross-section (σ) = 0.1 m² - Minimum detectable signal-to-noise ratio (SNR) = 15 dB Calculate the maximum range of the Radar system to detect a target with the given parameters. Assume a bandwidth (B) of 1 MHz and a system temperature (T) of 290 K.	*CO2*	*PO2*	**06**

			UNIT - V			
	9	a)	Explain the significance of the Radar Ambiguity Function in radar system design. How does it help in understanding the performance limitations of a radar system?	*CO1*		**07**
		b)	How are the probabilities of false alarm and detection related in radar systems? Explain the concept of receiver operating characteristic (ROC) curves in this context.	*CO2*	*PO1*	**07**
		c)	Analyze the potential health effects associated with prolonged exposure to high-frequency electromagnetic fields.	*CO2*	*PO1*	**06**
			OR			
	10	a)	Describe and analyze the concept of Pulse Compression and how it improves radar performance.	*CO2*	*PO1*	**07**
		b)	What are Swerling target models and how do they influence the radar equation?	*CO1*		**07**
		c)	What are the potential hazards of Electromagnetic (EM) waves, and explain the effects of exposure to different frequency ranges of EM waves on human health and the environment?	*CO1*		**06**

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