



**SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY  
PUTTUR (AUTONOMOUS)**

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**Subject with Code: Microwave Theory & Techniques  
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**Course & Branch: B.Tech – ECE**

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**UNIT –I  
INTRODUCTION OF MICROWAVE**

1	a	List out the applications of Microwaves.	[L1][CO1]	[2M]
	b	Categorize the Microwave frequency bands based on the IEEE standards.	[L4][CO1]	[2M]
	c	Distinguish between the waveguide and transmission lines.	[L4][CO1]	[2M]
	d	Define dominant mode with respect to a waveguide. Mention dominant mode for rectangular and circular waveguides	[L1][CO1]	[2M]
	e	Define Wave guide and guide wave length.	[L1][CO1]	[2M]
2	a)	Elaborate the history in evolution of Microwaves.	[L6][CO1]	[7M]
	b)	What is group Velocity. Express it in terms of cut-off frequency and guide wavelength.	[L1][CO1]	[3M]
3		Relate the Wavelengths and Impedance of the transverse electric (TE) field in terms of cutoff frequency.	[L2][CO1]	[10M]
4	a)	Calculate the characteristics impedance and propagation constant for a transmission line having the following parameters $R=2 \text{ Ohm/m}$ , $G=0.5 \text{ mmho/m}$ , $L= 8 \text{ nH/m}$ , $C=0.23 \text{ pF}$ , $f= 1 \text{ GHz}$ .	[L5][CO1]	[5M]
	b)	What is Phase Velocity. Express it in terms of cut-off frequency and guide wavelength.	[L1][CO1]	[5M]
5		Assume a lossless transmission line with its transmission parameters: $R=0$ and $G=0$ . Formulate the transmission line equation for this condition.	[L5][CO1]	[10M]
6	a)	Show that characteristics impedance of a transmission line $Z_0=\sqrt{L/C}$	[L2][CO1]	[4M]
	b)	Explain briefly on: (i) Guide wavelength (ii) dominant mode and (iii) over mode conditions in waveguide.	[L2][CO1]	[6M]
7	a)	Relate the phase velocity in transmission line with L and C. Also express the velocity factor with actual phase velocity.	[L2][CO1]	[5M]
	b)	A 600 Ohm transmission line is fed by a 50 Ohm generator. If the line is 200m long and terminated by load of 500 Ohm, Determine (i) reflection loss, (ii) transmission loss and (iii) return loss (in dB)	[L5][CO1]	[5M]
8	a)	A rectangular metal wave guide filled with a dielectric material of relative permittivity $\epsilon_r=4$ has the inside dimensions $3.0 \text{ cm} \times 1.2 \text{ cm}$ . Evaluate the cut off frequency for the dominant mode.	[L5][CO1]	[4M]
	b)	Outline the features of TEM, TE and TM Modes with neat sketch.	[L5][CO1]	[6M]
9		Relate the wavelength and impedance of the transverse magnetic(TM) field in terms of cutoff frequency.	[L5][CO1]	[10M]
10	a)	Classify the Power Losses in Rectangular Guide and explain how to estimate them.	[L2][CO1]	[6M]
	b)	Identify and elaborate the method to estimate the power transmission for $TE_{mn}$ and $TM_{mn}$ modes.	[L5][CO1]	[4M]
11		Explain the need for terminating the transmission line in its characteristics impedance.	[L5][CO1]	[10M]

**UNIT-II**  
**MICROWAVE PARAMETERS**

1	a	Classify the various microwave transmission line.	[L2][CO3]	[2M]
	b	List the applications of Rectangular Waveguide.	[L1][CO3]	[2M]
	c	What do you mean by Faraday rotation.	[L1][CO3]	[2M]
	d	Define ferrites.	[L1][CO3]	[2M]
	e	Why TEM mode cannot propagate in rectangular waveguides?	[L1][CO3]	[2M]
2	a)	Explain the mechanism of electromagnetic wave propagation in Rectangular Waveguide.	[L2][CO3]	[6M]
	b)	Explain the working of coaxial transmission line with the help of a cross-section sketch.	[L2][CO3]	[4M]
3		Deduce expression for $E_x$ , $E_y$ , $E_z$ , $H_x$ , $H_y$ and $H_z$ for TE mode propagation in Rectangular Waveguide.	[L5][CO3]	[10M]
4	a)	Explain the mechanism of electromagnetic wave propagation in circular Waveguide.	[L2][CO3]	[5M]
	b)	A waveguide component that uses a ferrite section to give zero phase shift for one direction of propagation and $180^\circ$ phase shift for the other direction- Identify this microwave device, explain its working mechanism and obtain its S-matrix.	[L3][CO3]	[5M]
5		Identify an explain the working of a multiport junction microwave device in which the wave can travel from one port to the next immediate port in one direction only; Obtain its S-matrix also.	[L3][CO3]	[10M]
6	a)	An air filled rectangular waveguide of inside dimension 7cm x 3.5cm operates in the $TE_{10}$ dominant mode. Determine (i) the cutoff frequency, (ii) the phase velocity of the wave in the guide at 3.5GHz.	[L5][CO3]	[4M]
	b)	Deduce the field expression for TE mode propagation in Circular Waveguide.	[L5][CO3]	[6M]
7	a)	Discuss about the excitation modes in circular waveguides.	[L1][CO3]	[4M]
	b)	Explain the working of strip line transmission line with the help of a neat sketch of its field distribution. Obtain the expression for characteristic impedance.	[L2][CO3]	[6M]
8	a)	Deduce expression for $E_x$ , $E_y$ , $E_z$ , $H_x$ , $H_y$ and $H_z$ for TM mode propagation in Rectangular Waveguide.	[L6][CO3]	[6M]
	b)	Discuss about the excitation modes in rectangular waveguides	[L1][CO3]	[4M]
9		Deduce the field expression for TE mode propagation in Circular Waveguide.	[L5][CO3]	[10M]
10	a)	$TE_{11}$ mode is propagating through a circular waveguide. The radius of the guide is 5cm and the guide contains an air dielectric. Determine (i) guide wavelength at 3GHz and (ii) the wave impedance in the guide.	[L5][CO3]	[4M]
	b)	Explain the working of Microstrip line transmission line with the help of a neat sketch of its field distribution.	[L2][CO3]	[6M]
11		A 2 port non-reciprocal ferrite device produces a minimum attenuation to wave propagation in one direction and maximum attenuation in the opposite direction-identify this device, explain its working and derive its Scattering matrix.	[L3][CO3]	[10M]

**UNIT-III**  
**WAVEGUIDE COMPONENTS AND APPLICATIONS**

1	a	Define directivity and coupling factor of a directional coupler.	[L1][CO5]	[2M]
	b	What is scattering matrix?	[L1][CO5]	[2M]
	c	What is magic tee? And write applications of magic tee.	[L1][CO5]	[2M]
	d	Sketch a 4 port Hybrid junction. Justify that it is basically a 3 dB directional coupler.	[L5][CO5]	[2M]
	e	What is an attenuator and mention different attenuator?	[L1][CO5]	[2M]
2	a)	Interpret the coupling mechanism of waveguide.	[L2][CO5]	[5M]
	b)	Explain the following (i) Waveguide irises (ii) Tuning Screws	[L2][CO5]	[5M]
3		Explain the following (a) precision variable attenuator (b) rotary vane attenuator.	[L2][CO5]	[10M]
4		Explain the working mechanism of following: (a) E-plane Tee (b) H-plane Tee	[L2][CO5]	[10M]
5	a)	Sketch a typical directional coupler and explain its working in detail.	[L2][CO5]	[6M]
	b)	The coupling factor and isolation of a lossless, symmetric directional coupler are 8dB and 20dB respectively. Determine the scattering matrix of the directional coupler. Also determine the directivity of the device?	[L5][CO5]	[4M]
6	a)	What is the principle of phase shifter? Sketch the diagram of phase shifter and discuss the working mechanism.	[L2][CO5]	[5M]
	b)	Explain the significance and formulation of S-matrix in detail.	[L2][CO6]	[5M]
7		Identify the microwave tee, where the H-plane and E-plane tee are combined for wave propagation. Explain its working mechanism. And derive its S-matrix,	[L3][CO6]	[10M]
8	a)	Explain the various performance parameters of a directional coupler with relevant expressions.	[L2][CO5]	[4M]
	b)	State and prove the Symmetry property of [s] for a reciprocal network	[L5][CO5]	[6M]
9	a)	Deduce the S-matrix for E-plane junction.	[L5][CO5]	[6M]
	b)	Explain the principle of Ferrite phase shifter.	[L2][CO5]	[4M]
10	a)	Deduce the S-matrix for H-plane junction.	[L5][CO5]	[5M]
	b)	Discuss on the various losses associated with the S-parameters.	[L6][CO6]	[5M]
11	a)	Deduce the S-matrix for directional coupler.	[L5][CO6]	[5M]
	b)	State and prove the following properties of S-parameters: (i) Zero diagonal property (ii) Unitary property, and (iii) Phase shift property	[L5][CO6]	[5M]

**UNIT-IV**  
**MICROWAVE TUBES**

1	A	Justify the reason for impossibility of conventional tubes usage at Microwave frequencies?	[L5][CO2]	[2 M]
	B	What do you mean by bunching?	[L1][CO2]	[2 M]
	c	What is transit time?	[L1][CO2]	[2 M]
	d	List the different microwave signal sources.	[L1][CO2]	[2 M]
	e	Compare O-type and M-type Microwave tubes.	[L2][CO2]	[2 M]
2	a)	Explain the constructional details and principle of operation of two cavity Klystron with the neat sketch.	[L1][CO2]	[7 M]
	b)	Illustrate the phenomenon of bunching with the help of Applegate diagram of two cavity Klystron tube.	[L2][CO2]	[3 M]
3		Explain the velocity modulation process in two cavity Klystron tube and derive the equation for velocity modulation.	[L2][CO2]	[10 M]
4	a)	Explain the operation of 8-cavity cylindrical travelling wave.	[L2][CO2]	[6 M]
	b)	A normal circular magnetron has the following parameters Inner radius $R_a=0.15m$ Outer radius $R_b=0.45m$ Magnetic flux density $\beta_0=1.2mWb/m^2$	[L5][CO2]	[4 M]
	i)	Determine the Hull cut-off voltage		
	ii)	Determine the cyclotron frequency in GHz.		
5		Discuss in detail about the working of Reflex Klystron with mechanism and modes of oscillation.	[L6][CO2]	[10 M]
6	a)	Explain the process of velocity modulation of a Reflex Klystron.	[L1][CO2]	[5 M]
	b)	A reflex Klystron operates at the peak of $n= 1$ or $3/4$ mode. The dc power input is 40mw and ratio of $V_1$ over $V_0$ is 0.278	[L2][CO2]	[5 M]
	i)	Determine the efficiency of the reflex Klystron.		
	ii)	Find the total power output in mW.		
7	a)	Discuss about the power output, condition for maximum efficiency of a reflex Klystron.	[L6][CO6]	[5 M]
	b)	Write short notes on bunching process in a two-cavity klystron amplifier.	[L1][CO6]	[5 M]
8	a)	Write short notes on the characteristics and application of the reflex klystron.	[L1][CO6]	[4 M]
	b)	Discuss about the power output, condition for maximum efficiency of two cavity Klystron.	[L6][CO6]	[6 M]
9		Determine the Hull cutoff magnetic and voltage expression for cylindrical magnetron for field condition $B_0 < B_{0c}$	[L5][CO6]	[10 M]
10	a)	Write short notes on the characteristics and application of the two-cavity klystron.	[L1][CO6]	[4 M]
	b)	Discuss about the pi-mode of operation in cylindrical magnetron, and derive the expression for its circuit and electronic efficiency.	[L6][CO6]	[6 M]
11		A pulsed cylindrical magnetron is operated with the following parameters: Anode voltage=25KV, beam current=25A, Magnetic density = $0.34Wb/m^2$ Radius of cathode cylinder=5cm, Radius of anode cylinder=10cm. Determine: (i) The cyclotron angular frequency, (ii) The cut-off voltage, and the cutoff magnetic field density.	[L5][CO6]	[10 M]

**UNIT-V**  
**MICROWAVE MEASUREMENTS**

1	a	What do you mean by Slotted line?	[L1][CO4]	[2 M]
	b	Distinguish between low frequency measurements and microwave measurements.	[L4][CO4]	[2 M]
	c	Distinguish between thermistor and baretter?	[L1][CO4]	[2 M]
	d	Define Reflection coefficient.	[L1][CO4]	[2 M]
	e	List the possible errors in VSWR measurement.	[L1][CO4]	[2 M]
2	a)	Discuss in detail about the microwave power measurement using Bolometric technique.	[L6][CO4]	[5 M]
	b)	Using calorimeter technique, explain in detail about the microwave power measurement.	[L2][CO4]	[5 M]
3	a)	With the help of a neat sketch, briefly explain the functions of different blocks of a microwave bench.	[L2][CO4]	[5 M]
	b)	Two identical directional couplers are used in a waveguide to sample the incident and reflected powers. The output of the two couplers is found to be 2.5mw and 0.15mW. Determine the value of VSWR in the waveguide.	[L5][CO4]	[5 M]
4	a)	Explain about measurement of attenuation using a microwave bench setup.	[L2][CO4]	[6 M]
	b)	Using the Wave meter method explain the microwave frequency measurement.	[L2][CO4]	[4 M]
5		Explain briefly on the following microwave frequency measurement methods: (i) Slotted line method. (ii) Down conversion method.	[L2][CO4]	[10 M]
6	a)	What is VSWR? Explain how Low values of VSWR( $S < 20$ ) can be measured directly from the VSWR meter using the experimental set-up.	[L1][CO4]	[5 M]
	b)	Explain how high values of VSWR( $S > 20$ ) can be measured directly from the VSWR meter using the experimental set-up.	[L2][CO4]	[5 M]
7	a)	Explain the Power ratio method in microwave attenuation measurement with help of block diagram.	[L2][CO4]	[5 M]
	b)	Explain briefly how does the RF substitution method works for microwave attenuation measurement.	[L2][CO4]	[5 M]
8	a)	Discuss why it is difficult measure Q at microwave frequencies of a high Q cavity. Give the expressions for loaded, unloaded and external Q.	[L6][CO4]	[5 M]
	b)	Assume you have two directional couplers (20 dB) in a guide to sample the incident and reflected powers. The outputs of the two couplers are 3mw and 0.1mw respectively. What is the value of VSWR in the main waveguide? What is the value of reflected power.	[L4][CO4]	[5 M]
9	a)	Show the experimental setup necessary for the measurement of impedance using slotted line. Explain it in detail.	[L2][CO4]	[5 M]
	b)	Using the reflectometer method, explain how to measure the impedance with the help a block diagram.	[L2][CO4]	[5 M]
10	a)	Explain the measurement of Quality factor (Q) using Reflectometer method.	[L2][CO4]	[5 M]
	b)	Estimate the SWR of a transmission system operating at 10GHz. Assume $TE_{10}$ wave transmission inside a waveguide of dimensions $a=4\text{cm}$ , $b=2.5\text{cm}$ . The distance measured between twice minimum power points = 1 mm on a slotted line.	[L6][CO4]	[5 M]
11	a)	Explain in detail about Swept Frequency method of Q Measurement.	[L2][CO4]	[5 M]
	b)	Explain the measurement of Quality factor (Q) using slotted line method	[L2][CO1]	[5 M]

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