GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3171001
Microwave Theory and Techniques
SEMESTER-VII

Type of course: Professional Elective Course

Prerequisite: Knowledge of Basic Electronics, Electromagnetics and Antennas &Wave propagation

Rationale: This course introduces the principles of microwave engineering and the devices, circuits and systems used at microwave frequencies. The course also introduces the design principles and measurement techniques for microwave circuits.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
L	T	P	C	Theory Marks			Practical Marks		
				ESE (E)	PA (M)		ESE (V)	PA (I)	
					PA	ALA	ESE	OEP	
3	0	2	4	70	30		30	20	150

Contents:

Sr. No.	Content	Total Hrs
1	**Introduction to Microwaves**-History of Microwaves, Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC.	3
2	**Mathematical Model of Microwave Transmission**-Concept of Mode, Features of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission.	3
3	**Analysis of RF and Microwave Transmission Lines**- Coaxial line, Rectangular waveguide, Circular waveguide, Strip line, Micro strip line.	5
4	**Microwave Network Analysis**- Equivalent voltages and currents for non-TEM lines, Network parameters for microwave circuits, Scattering Parameters.	3
5	**Passive and Active Microwave Devices**- Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers. Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes: Klystron, TWT, Magnetron.	15
6	**Microwave Design Principles**-Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design. Microwave Antennas- Antenna parameters, Antennas for ground based	7

	systems, Antennas for airborne and satellite borne systems, Planar Antennas.	
7	**Microwave Measurements**- Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure. Measurement of Microwave antenna parameters.	**3**
8	**Microwave Systems**- Radar, Terrestrial and Satellite Communication, Radio Aids to Navigation, RFID, GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging.	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
5	15	25	10	10	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. R.E. Collins, Microwave Circuits, McGraw Hill

2. K.C. Gupta and I.J. Bahl, Microwave Circuits, Artech house

3. Samuel Liao - Microwave devices and circuits, PHI

4. Dennis Roddy - Microwave Technology, PHI

5. G. Kennedy - Electronic Communication Systems, McGraw-Hill Book Company

6. Annapurna Das, Sisir K.Das- Microwave Engineering, (TMG)

Course Outcome:

After learning the course, the students should be able to:

1. Understand various microwave system components and their properties.

2. Appreciate that during analysis/ synthesis of microwave systems, the different mathematical treatment is required compared to general circuit analysis.

3. Design microwave systems for different practical applications.

List of Experiments: (General guidelines.. Institute may change list of experiments based on laboratory set up available)

1 Introduction and identification of microwave components and connectors.

2 Study of the characteristics of Klystron tube and to determine its electronic tuning range.

3 Study of following characteristics of Gunn Diode :

3.1 Output power and frequency as a function of voltage.

3.2 Square wave modulation through PIN diode.

4 To measure the polar pattern and the gain of a waveguide horn antenna.

5 To determine the frequency & wavelength in a rectangular waveguide working in TE10 mode.

6 Study of function of multi hole directional coupler by measuring the following parameters:

6.1 Main line and auxiliary line SWR

6.2 Coupling factor and directivity.

7 To determine the standing wave ratio and reflection coefficient.

8 To measure attenuation of the Fixed and variable attenuator.

9 To measure an unknown impedance with smith chart.

10 To measure SWR of ports, isolation and coupling coefficients of Magic Tee.

11 To measure Input VSWR, Insertion loss and isolation of isolator/ circulator

12 To measure resonant frequency of Cavity resonator.

13 To study and measure the square law behavior of a microwave crystal detector.

14 Introduction to spectrum analyzer and measurement of spectrum of microwave signal using the same.

Major Equipment: Microwave test bench, klystron and gunn power supply, SWR meter, Frequency meter, Microwave spectrum analyzer**, network analyzer**