

## GUJARAT TECHNOLOGICAL UNIVERSITY

**BRANCH NAME: Electronics Engineering / Electronics & Communication  
Engineering / Electronics & Telecommunication Engineering  
SUBJECT NAME: Microwave Engineering  
SUBJECT CODE: 2171001  
B.E. 7<sup>th</sup> SEMESTER**

**Type of course:** Core Course.

**Prerequisite:** Electromagnetic theory, Wave propagation, Antennas and Semiconductor physics

**Rationale:** This course provides basic knowledge of designing of transmission lines and wave guides. The various modes of propagations through transmission line and wave guides are included. Students will become familiar with the usage of active and passive components of microwave systems. Measurements of various parameters of microwave systems are also part of the subject.

### 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		
04	00	02	06	70	20	10	20	10	20	150

### Content:

Sr. No.	Content	Total Hrs	% Weightage
1	<b>Introduction to Microwaves.</b> History of Microwaves, Microwave Frequency bands, General Applications of Microwaves, Advantages of Microwaves	2	5
2	<b>Mathematical model of Microwave Transmission</b> Concept of Mode, Characteristics of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission	4	5
3	<b>Analysis of Microwave Transmission Lines and Waveguides</b> Transmission line equations & solutions, reflection and transmission coefficient, standing wave and standing wave ratio, line impedance and admittance, impedance matching, using stub line, application of smith chart in solving transmission line problems Introduction to strip lines, Micro strip lines, parallel strip lines, coplanar strip lines, shielded strip lines , Rectangular and circular waveguides-theory and analysis.	13	20
4	<b>Microwave Network Analysis</b> Equivalent Voltages and currents for non-TEM lines, Network	5	10

	parameters for microwave Circuits, Scattering Parameters.		
<b>5</b>	<b>Passive and Active microwave Devices</b> Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, Wave-guide Corners, Bends, Twists, Attenuator, Circulator, Isolator and Resonator. Microwave Active components: Tunnel diode, Varactor diodes, Step recovery diodes, Schottky Barrier diodes, PIN diodes, Gunn Diodes, IMPATT and TRAPATT diodes, Parametric Amplifiers, Microwave Transistors, Microwave oscillators and Mixers. Microwave tubes: Klystron, TWT, Magnetron.	<b>12</b>	20
<b>6</b>	<b>Microwave Measurements</b> 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.	<b>6</b>	15
<b>7</b>	<b>Modern Trends in Microwaves Engineering</b> Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference / Electromagnetic Compatibility (EMI / EMC), Monolithic Microwave IC fabrication , RF MEMS for microwave components, Microwave Imaging	<b>5</b>	15
<b>8</b>	<b>Microwave Systems</b> Wireless Communications system, Radar Systems, Radiometer Systems, Satellite Communication, Remote sensing, Microwave Propagation, Microwave Antennas.	<b>5</b>	10
<b>Total</b>		<b>52</b>	

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>05</b>	<b>20</b>	<b>10</b>	<b>20</b>	<b>10</b>	<b>05</b>

**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. Samuel Liao - Microwave devices and circuits, PHI
2. Dennis Roddy - Microwave Technology, PHI
3. G. Kennedy - Electronic Communication systems, McGraw-Hill Book Company
4. Annapurna Das, Sisir K.Das- Microwave engineering, (TMG)

5. Siteshkumar Roy & Manojit Mitra - Microwave semiconductor devices, PHI
6. A. K. Gautam - Microwave engineering, (S. K. Kataria pub)
7. Sanjeev Gupta, Microwave Engineering, Khanna Pub.

### **Course Outcome:**

After learning the course the students should be able to:

- 1 Understand basic concepts and applications of microwave systems.
- 2 Design, analyze and solve problems related to microwave transmission lines.
- 3 Design, analyze and solve problems related to microwave waveguide.
- 4 Analyze, test and use various passive microwave components for different applications.
- 5 Design and implement the microwave layouts.
- 6 Design and implement the microwave amplifier, oscillator, and mixer circuits

### **Suggested List of Experiments:**

- 1 Introduction and identification of microwave component.
- 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 TE<sub>10</sub> 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 perform PC to PC Communication using Microwave test bench
- 9 To study and perform the voice communication by using Microwave Test Bench
- 10 To study the Fixed and variable attenuator.
- 11 To measure an unknown impedance with smith chart.
- 12 To measure SWR of ports, isolation and coupling coefficients of Magic Tee.
- 13 To measure Input VSWR, Insertion loss and isolation of isolator/ circulator
- 14 To measure resonant frequency of Cavity resonator.
- 15 To study and perform the square law behavior of a microwave crystal detector.
- 16 Introduction to spectrum analyzer and measurement of spectrum of microwave signal using the same.

### **Design based Problems (DP)/Open Ended Problem:**

Designing and simulation of various waveguides, micro-strip line, coupler in HFSS.

### **Major Equipment:**

Microwave test bench, klystron and gunn power supply, SWR meter, Frequency meter, Microwave spectrum analyzer

### **List of Open Source Software/learning website:**

HFSS, NPTEL video

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.