

**IV B.Tech – I Semester**  
**(20EC7323) Microwave Engineering**  
**(Program Elective-IV)**

<b>Int. Marks</b>	<b>Ext. Marks</b>	<b>Total Marks</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>30</b>	<b>70</b>	<b>100</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Pre-Requisites:** Electromagnetic Waves and Transmission Lines

**Course Objectives:**

- Carryout a study on transmission lines, different wave guides and their mode of operations
- Study of coupling mechanisms, waveguide attenuators, phase shifters and S-Matrix calculations
- Learn the fundamental concepts, limitations and losses of conventional tubes, Reflex klystrons applications, oscillating modes
- Study and understand solid state amplifiers and oscillators
- Measure various microwave parameters using a microwave test bench

**UNIT I**

Microwave Transmission Lines: Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Rectangular wave guide: Field Components, TE, TM Modes, Dominant TE<sub>10</sub> mode, Field Distribution, Power, Attenuation. Circular waveguides: TE, TM modes. Wave velocities, Micro strip transmission line (TL), Coupled TL, Strip TL, Coupled strip line, Coplanar TL, Microwave cavities.

**UNIT II**

Waveguide Components and Applications: Coupling Mechanisms – Probe, Loop, Aperture types. Waveguide Discontinuities – Waveguide irises, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Resistive Card, Rotary Vane types; Waveguide Phase Shifters – Dielectric, Rotary Vane types, Scattering Matrix– Significance, Formulation and Properties, S-Matrix Calculations for – 2 port Junction, E-plane and H-plane Tees, Magic Tee, Hybrid Ring; Directional Couplers – 2Hole, Bethe Hole types, Ferrite Components– Faraday Rotation, S-Matrix Calculations for Gyrator, Isolator, Circulator, Related Problems.

**UNIT - III**

Microwave Tubes: Limitations and Losses of conventional tubes at microwave frequencies, Re-entrant Cavities, Microwave tubes – O type and M type classifications, O type tubes: 2 Cavity Klystrons – Structure, Velocity Modulation Process and Applegate Diagram,

Bunching Process and Small Signal Theory, Applications, Reflex Klystrons – Structure, Applegate Diagram and Principle of working, Electronic Admittance; Oscillating Modes and output Characteristics, Electronic and Mechanical Tuning, Application. Helix Traveling - Wave Tubes (TWTs): Slow Wave Structures, Amplification Process (qualitative treatment), M-Type Tubes - Introduction, Cross-field Effects, Cylindrical Traveling Wave Magnetron.

#### UNIT IV

Solid state amplifiers and oscillators: Transferred electron devices: Gunn-effect diodes & modes of operation. Avalanche transit-time devices: IMPATT diode, TRAPPAT diode, BARITT diode.

#### UNIT V

Microwave Measurements: VSWR meter, Frequency meter, Spectrum analyzer, Network analyzer, Tunable detector, Slotted line carriage, Power meter, Microwave power measurement, Insertion loss and attenuation measurement, VSWR measurement, Return loss measurement by a reflectometer, Frequency measurement, measurement of cavity Q, Dielectric constant measurement of a solid, EM radiation & measurement.

#### Course Outcomes:

After successful completion of the course, the students can be able to

S. No	Course Outcome	BTL
1	Apply electromagnetic wave equations for the analysis of rectangular and circular waveguides.	L3
2	Understand the structure and applications of waveguide components.	L2
3	Identify the limitations and losses of conventional vacuum tubes and study the performance of O type and M type microwave tubes.	L3
4	Appraise the principle of operation of Transferred Electron Devices and Avalanche Transit-Time devices and summarize their features.	L4
5	Analyze and measure various microwave parameters using a Microwave test bench.	L4

#### Correlation of COs with POs & PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	-	-	-	-	1	-
CO2	3	1	1	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	2	2	-	-	-	-	-	-	-	-	1	-
CO4	3	2	2	1	-	-	-	-	-	-	-	-	1	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	1	-

#### Text Books:

1. Foundations for Microwave Engineering – R.E. Collin, IEEE Press, John Wiley, 2nd Edition, 2002.
2. Microwave Engineering- Annapurna Das and Sisir K.Das, Mc Graw Hill Education, 3rd Edition.

**Reference Books:**

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition,1994.
2. Microwave Engineering – G S N Raju , I K International
3. Microwave and Radar Engineering- M.Kulkarni, Umesh Publications, 3rd Edition