

**EC-401****MICROWAVE ENGINEERING****L T P C****4 1 - 3****COURSE OBJECTIVES:**

1. To analyze and study rectangular and circular wave guides using field theory.
2. To understand the theoretical principles underlying microwave devices and networks.
3. To design microwave components such as power dividers, hybrid junctions, Directional Couplers, microwave filters, Microwave Wave-guides and Components, Ferrite Devices.
4. To study about Microwave Solid-State Microwave Devices and Microwave Tubes.
5. To Study about Microwave Measurement Techniques.

**COURSE OUTCOMES:****After successful completion of the course, the students are able to**

1. analyze and design rectangular wave guides and understand the propagation of electromagnetic waves.
2. describe the components using the basics of S parameters.
3. demonstrate various perceive operating principles of basic passive and active microwave devices.
4. formulate the limitations of existing vacuum tubes and solid state devices at microwave frequencies.
5. Measure microwave components.

**UNIT I***Text Book - 1 (18)*

**RECTANGULAR WAVE GUIDES** : Wave equations in Rectangular Coordinates, TE modes in Rectangular Waveguides, TM modes in rectangular Waveguides, Power Transmission in Rectangular Wave guides, and Power Losses in Rectangular Wave guides.

**CIRCULAR WAVE GUIDES** : Wave equations in Cylindrical Coordinates, TE modes in Circular Waveguides, TM modes in Circular Waveguides, TEM modes in Circular Waveguides, Power Transmission in Circular Wave guides or Coaxial Lines, Power Losses in Circular Wave guides (Qualitative treatment only), Coaxial Lines.

**UNIT II***Text Book - 2 (14)*

**INTRODUCTION** : Microwave Spectrum and Bands, Applications of microwaves. **MICROWAVE COMPONENTS** : Microwave Cavities - Rectangular and Circular cavity Resonators, Microwave Hybrid Circuits - Waveguide Tees E-plane or Series tee, H-plane or shunt Tee, Magic Tees(Hybrid Tees), Applications of magic Tee, Hybrid Rings (Rat-Race Circuits) Hybrid Rings, Waveguide Corners, Bends and Twists, Directional Couplers, Two-Hole Directional Couplers, S Matrix of a Directional Coupler, Circulators and Isolators.

**UNIT III***Text Book - 2 (8)*

**MICROWAVE SOLID-STATE DEVICES - Transferred Electron Devices** : GUNN-EFFECT Diodes, RWH Theory, Two-Valley Modes of operations, Avalanche Transit Time Devices: Read diode, IMPATT diode, TRAPATT diode, BARITT diodes, Pin diodes, Varactor diode.

**UNIT IV***Text Book - 2 (15)*

**MICROWAVE LINEAR BEAM TUBES (O TYPE)** : Limitations of Conventional tubes at Microwave frequencies, Klystron: Velocity modulation process, bunching process, output power and beam loading, **Multicavity Klystron amplifiers** : Beam current density, output current and output power of two cavity Klystron, Reflex Klystron: Velocity modulation, Power output and efficiency. Helix Traveling Wave tube: Slow Wave structures, Amplification process, and Conventional current.

**UNIT V**

*Text Book - 2 (10)*

**MICROWAVE CROSS FIELD TUBES (M TYPE) :** Magnetron Oscillators : Cylindrical Magnetron, CFA and BWO.

**MICROWAVE MEASUREMENTS :** Components of Microwave Bench, Detection of Microwaves, Microwave power measurement, Impedance measurements, VSWR measurement, Frequency measurement.

**LEARNING RESOURCES:**

**TEXT BOOK(s):**

1. E C Jordan and K G Balmain - Electromagnetic Waves and Radiating Systems, 2nd Edition, PHI, 2003.
2. ML Sisodia and V.L.Gupta - Microwave Engineering, 1st Edition, New Age International, 2005.

**REFERENCE BOOK(s):**

1. Samuel Y Liao - Microwave Devices and Circuits, 3rd Edition, Pearson Education, 2003.
2. M.L.Sisodia and GS Raghuvamshi - Microwave Circuits and Passive Devices, Wiley Eastern, 1987.

**WEB RESOURCES:**

<http://nptel.iitm.ac.in/courses/>