

### 3/4 B.Tech - SIXTH SEMESTER

**EC6T3**

**Microwave Engineering**

**Credits: 3**

**Lecture: 3 periods/week**

**Internal assessment: 30 marks**

**Tutorial: 1 period /week**

**Semester end examination: 70 marks**

---

**Prerequisites:** Antennas and Wave Propagation (EC5T4)

#### **Course Objectives:**

- To identify various microwave bands in frequency spectrum and to know their applications in different fields
- To understand the limitations of conventional tubes to operate in microwave region and to learn constructional details of various microwave tubes and solid state devices.
- To analyze single port and multiport passive waveguide components using their scattering parameters
- To learn the procedures to measure various important parameters in microwave engineering

#### **Learning Outcomes:**

Student will be able to

- Know various frequency bands of microwave range and their designations in electromagnetic spectrum and applications of microwaves.
- Design the microwave bench setup with different wave guide components.
- Use various microwave tubes and microwave solid state devices for high frequency applications to overcome the disadvantages of conventional tubes
- Measure the characteristic values of microwave components by conducting several tests on microwave bench setup

#### **UNIT – I**

Microwave Spectrum, Bands and applications, Limitations of conventional tubes at microwave frequencies

**Microwave Tubes:** Linear Beam Tubes (O-type): Two Cavity Klystron: Velocity modulation, Bunching process, Output power and Beam loading, Multicavity Klystron Amplifier: Beam current density, Output current, Reflex Klystron: Velocity modulation, Power output and Efficiency.

**Microwave Crossed Field Tubes (M Type):** Cylindrical Magnetron (Qualitative analysis only), Forward Wave Cross Field Amplifier, Backward Wave Oscillator and Backward Wave Amplifiers.

Helix Traveling Wave Tube Amplifiers, Amplification process, Wave modes and Gain considerations.

#### **UNIT – II**

**Microwave Passive Components – I:** Waveguide Sections: Matched terminations, Short circuit plungers, Waveguide bends, Corners and Twists, Probe and Loops, Attenuators and Phase Shifters of different types, Waveguide multiport junctions – E plane and H plane Tees, Magic Tee and its applications, Hybrid Ring.

S – Matrix calculation for Attenuator, Phase shifter, Multiport junctions

## **UNIT – III**

**Microwave Passive Components – II:** Ferrite Devices: Faraday rotation, Gyrator, Isolator, Circulator, Directional couplers, Coupler parameters, Applications of directional couplers.

S – Matrix calculation for Gyrator, Isolator, circulator, Directional coupler.

**Microwave Resonators:** Waveguide cavity resonators, Cavity excitation and Tuning, Q-Factor calculation.

## **UNIT – IV**

**Solid State Devices:** Microwave Tunnel Diode: Principle of operation and characteristics

Transferred Electron Devices: Gunn diodes, RWH Theory, Modes of operation, LSA diodes, InP diodes Avalanche Transit Time Devices: Read diode, IMPATT diode, TRAPATT diode, BARITT diode. Parametric Amplifier: Non-linear reactance and Manley-Rowe power relations.

## **UNIT – V**

**Microwave Measurements:** Description of microwave bench – Different blocks and their features, Precautions. Power measurement, Attenuation measurement, Impedance measurement, VSWR measurement, Frequency measurement, Measurements of cavity Q factor.

### **Learning Resources**

#### **Text books:**

1. Foundations for Microwave Engineering – R.E. Collin, John Wiley, 2nd Edition, 2005
2. Samuel Y Liao, “Microwave Devices and Circuits”, 3rd edition, 2003, Pearson Education.

#### **References:**

1. Annapurna Das, Sisir K Das, “Microwave Engineering”, 2nd edition, 2006, Tata McGraw Hill.
2. Microwave Engineering- David M.Pozar, John Wiley & Sons, Inc., 2nd Edition, 2004
3. Microwave Circuits and Passive Devices – M.L. Sisodia and G.S.Raghuvanshi, Wiley Eastern Ltd., New Age International Publishers Ltd., 1995.
4. Microwave Engineering Passive Circuits – Peter A. Rizzi, PHI, 1999

#### **Web Resources:**

1. <http://technology.niagarac.on.ca/courses/elnc1730/microsolid.ppt>
2. [http://www.intechopen.com/---/passive\\_microwave\\_components\\_ana\\_antenna](http://www.intechopen.com/---/passive_microwave_components_ana_antenna)
3. <http://home.sandiego.edu/~ekim/e194rfs01/>
4. <http://www.slideshare.net/sarahkrystelle/lecture-notes-microwaves>