B.Tech III Year II Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AEC63- MICROWAVE ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to make the students learn about

- To analyze different modes in rectangular and circular waveguides and resonators
- To study and analyze various microwave components.
- To understand the principles of different microwave sources
- To gain knowledge on microwave semiconductor devices.
- To learn how to do different microwave measurements.

UNIT – I:

Waveguides & Resonators: Introduction, Microwave spectrum and bands, applications of Microwaves, Rectangular Waveguides-Solution of Wave Equation in Rectangular Coordinates, TE/TM mode analysis, Expressions for fields, Cutoff frequencies, filter characteristics, dominant and degenerate modes, sketches of TE and TM mode fields in the cross-section, Mode characteristics - Phase and Group velocities, wavelengths and impedance relations, Circular Waveguides - Dominant mode (qualitative treatment only), Rectangular Waveguides – Power Transmission and Power Losses, Impossibility of TEM Modes, losses, Q-factor, Cavity resonators-introduction, Rectangular and cylindrical cavities, dominant modes and resonant frequencies, Q-factor and coupling coefficients, Illustrative Problems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about Rectangular Wave guide sand resonators. **L1**
- Analyze different modes in rectangular and circular waveguides and resonators. **L4**

UNIT – II:

Waveguide Components: Scattering Matrix - Significance, Formulation and properties, Coupling mechanisms - Probe, Loop, Aperture types, Wave guide discontinuities - waveguide Windows, tuning screws and posts, matched loads, Waveguide attenuators - Resistive card, rotary vane Attenuators, waveguide phase shifters-dielectric, rotary vane phase shifters, Wave guide multiport junctions - E plane and H plane Tees, Magic Tee, Directional couplers-2 hole, Bothe hole types, Ferrites-composition and characteristics, Faraday rotation, Ferrite components - Gyrator, Isolator, Circulator, S Matrix calculations for 2-port junction, E plane and H plane Tees, Magic Tee, Directional coupler, circulator and Isolator, Illustrative Problems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand Scattering matrix formulation and properties. **L2**
- Learn the working and applications of different microwave components. **L1**

UNIT – III:

Linear beam Tubes: Limitations and losses of conventional tubes at microwave frequencies, Classification of Microwave tubes, O type tubes - 2 cavity klystrons-structure, Reentrant cavities, velocity modulation process and Applegate diagram, bunching process and small signal theory-Expressions for o/p power and efficiency, Reflex Klystrons-structure, Velocity Modulation, Applegate diagram, mathematical theory of bunching, power output, efficiency, oscillating modes and o/p characteristics, Effect of Repeller Voltage on Power o/p, Significance, types and characteristics of slow wave structures, structure of TWT and amplification process (qualitative treatment), Suppression of oscillations, Gain considerations.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand different 'O' type microwave tube structures. **L2**
- Learn the principles and working of different microwave sources. **L1**

UNIT – IV:

Cross-field Tubes & Microwave Semiconductor Devices: Introduction, Cross field effects, Magnetrons-different types, cylindrical travelling wave magnetron-Hull cutoff and Hartree conditions, modes of resonance and PI-mode operation, separation of PI-mode, O/P characteristics, Introduction to Microwave semiconductor devices, classification, applications, Transfer Electronic Devices, Gunn diode - principles, RWH theory, Characteristics, Basic modes of operation - Gunn oscillation modes, LSA Mode, Varactor diode, Parametric amplifier, Introduction to Avalanche Transit time devices (brief treatment only), Illustrative Problems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand cross field effects and working of cross field microwave tubes. **L2**
- Analyze the characteristics of microwave semiconductor devices. **L4**

UNIT – V:

Microwave Measurements: Description of Microwave bench-different blocks and their features, errors and precautions, Microwave power measurements, Measurement of attenuation, frequency, VSWR (low, medium, high), Measurement of 'Q' of a cavity, Impedance measurements.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand microwave bench setup and precautions to be taken while doing microwave measurements.(L2) **L1**
- Explain different microwave measurements.(L1) **L2**

Text Books:

1. Samuel Y. Liao, "Microwave devices and circuits",3rd Edition, Pearson Publishing, 2003.
2. R. E. Collin, "Foundations for microwave engineering", 2nd Edition, John Wiley, 2002.

Reference Books:

1. G.S.N Raju, "Microwave Engineering", 2nd Edition, IK International Publications 2008.
2. M. Kulkarni, "Microwave and Radar Engineering", Umesh Publications, 4th edition 2009.

Course Outcomes:

At the end of this Course the student will be able to

- Analyze different modes in rectangular and circular waveguides and resonators **L4**
- Explain the working of various microwave components. **L1**
- Understand the principles of microwave sources **L2**
- Compare the performance of various microwave semiconductor devices. **L2**
- Explain how to do different microwave measurements. **L1**