

IV B.Tech I Semester

15AEC51 - MICROWAVE ENGINEERING

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Course Objectives:

1. To analyze micro-wave circuits incorporating hollow, dielectric and planar waveguides, transmission lines, filters and other passive components, active devices.
2. To Use S-parameter terminology to describe circuits.
3. To explain how microwave devices and circuits are characterized in terms of their "S" Parameters.
4. To give students an understanding of microwave transmission lines.
5. To Use microwave components such as isolators, Couplers, Circulators, Tees, Gyrotors etc..
6. To give students an understanding of basic microwave devices (both amplifiers and oscillators).
7. To expose the students to the basic methods of 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.

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, Both hole types, Ferrites-composition and characteristics, Faraday rotation, Ferrite components - Gyrotor, Isolator, Circulator, S Matrix calculations for 2-port junction, E plane and H plane Tees, Magic Tee, Directional coupler, circulator and Isolator, Illustrative Problems.

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.

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.

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.

Course Outcomes: At the end of the semester, students are provided learning experiences that enable them to:

- a. Analyze micro-wave circuits incorporating hollow, dielectric and planar waveguides, transmission lines, filters and other passive components, active devices.
- b. Understand the various principles involved in various Microwave oscillators and amplifiers such as Klystron tubes, TWTs, Magnetrons, Gunn diode etc.
- c. Use S-parameter terminology & to describe the characteristics of microwave circuits through scattering parameters.
- d. Ability to understanding of microwave transmission lines and how to use microwave components such as isolators, Couplers, Circulators, Tees, Gyrotors etc.
- e. Set up the microwave benches for measurement of various parameters such as microwave frequency, VSWR, Impedance of unknown load etc.
- f. Verify the characteristics of Microwave devices through measurements.

TEXT BOOKS:

1. Samuel Y. Liao, "Microwave devices and circuits," 3rd Edition, Pearson Publishing, 2003.
2. Herbert J. Reich, J. G. Skalnik, P. F. Ordnung and H. L. Krauss, "Microwave principles," CBS publishers and distributors, New Delhi, 2004.

REFERENCES:

1. R. E. Collin, "Foundations for microwave engineering," 2nd Edition, John Wiley, 2002.
2. Om. P. Gandhi, "Microwave Engineering and Applications," Pergamon, 1981.