MICROWAVE ENGINEERING

Course Code:13EC1121

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Pre requisites: Electromagnetic Field Waves and Transmission lines.

Course Educational Objectives:

To familiarize concepts Microwave components, terminology, tubes &Solid state Microwave Devices

Course Outcomes:

At the end of the course the student will be able to

CO 1 Apply electromagnetic field theory to Rectangular and Circular waveguides.

CO 2 Design different waveguide components, Couplers and phase shifters.

CO 3 Comprehend the design aspects of O-type tubes and M-type tubes and its characteristics.

CO 4 Analyze basic principles and operation of Microwave solid state devices.

CO 5 Infer various microwave parameter measurement.

UNIT-I **(12 Lectures)**

WAVEGUIDES:

Introduction, Microwave Spectrum and Bands, Applications of Microwaves, Guided waves-parallel plane, TE, TM, TEM modes, Rectangular Waveguides, Circular Waveguides, Cavity resonators.

UNIT-II **(12 Lectures)**

MICROWAVE COMPONENTS:

Coupling Mechanisms – Probe, Loop, Aperture types, joints, bends, corners, transitions, twists, irises, Tuning Screws and Posts, Matched Loads, Attenuators and phase shifters.

MICROWAVE JUNCTIONS:

Multiport Junctions – E plane and H plane Tees, Magic Tee, Hybrid Ring; Directional Couplers, Faraday Rotation, Ferrite Devices – Gyrator, Isolator, Circulator, Scattering Matrix, S Matrix Calculations for Multi-port Junctions.

UNIT-III (15 Lectures)

MICROWAVE TUBES:

High frequency limitations of conventional tubes, Reentrant cavities, Klystrons, velocity modulation process, bunching process, output power and beam loading. Multicavity Klystron amplifiers. Applications. Reflex Klystron: Velocity modulation, power output and efficiency, electronic admittance, mode patterns. Slow wave structures, Traveling wave tube, amplification process, wave modes, gain considerations. Principle of operation, Magnetron - types, principle of operation of cylindrical magnetron, cavity magnetron, theory of oscillations, Hartee resonance condition: Pi-mode separation, Backward wave crossed field amplifier.

UNIT-IV (10 Lectures)

MICROWAVE SOLID STATE DEVICES:

Introduction, Classification, Applications, Varactor Diodes, Parametric Amplifiers, PIN Diode, Tunnel Diode –Principle, Characteristics, Applications. TEDs – Introduction, Gunn Diode – Principle, Characteristics, Basic Modes of Operation, Oscillation Modes. Avalanche Transit Time Devices – Introduction, IMPATT and TRAPATT Diodes – Principle of Operation and Characteristics.

UNIT-V (12 Lectures)

MICROWAVE MEASUREMENTS:

Description of Microwave Bench – Different Blocks and their Features, Precautions; Microwave Power Measurement – Bolometer Method, Measurement of Attenuation, Frequency, VSWR, Impedance Measurements.

TEXT BOOKS:

1. Samuel Y. Liao, *"Microwave Devices and Circuits"*, PHI, 3rd Edition, 1996.
2. Peter A. Rizzi, *"Microwave Engineering Passive Circuits"*, PHI, 1999.

REFERENCES:

1. R.E. Collin, *"Foundations for Microwave Engineering"*, IEEE Press, John Wiley, 2nd Edition, 2002.
2. M.Kulkarni, *"Micro Wave and Radar Engineering"*, Umesh Publications, 3rdEdn.,2003
3. Annapurna Das and Sisir K Das, *"Microwave Engineering"*, TMH, 2nd ed., 2008.
4. M.L. Sisodia and G.S.Raghuvanshi, *"Microwave Circuits and Passive Devices"*, Wiley Eastern Ltd., New Age International Publishers Ltd., 1995.