MICROWAVE ENGINEERING

III Semester: ECE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEC015	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

OBJECTIVES:

The Students Will Try To Learn:

I The fundamental concepts of wave guide components and electromagnetic wave propagation for microwave communication using Maxwell's equations

II The generation of microwave signals to measure different parameters using microwave test bench.

III The real time applications of microwave engineering in radars, defense, navigation, remote sensing, satellite communications etc.

COURSE OUTCOMES:

After successful completion of the course, Students will be able to:

CO 1 **Recall** the concepts of transmission lines and waveguides to derive the field components of wave equations in TE, TM and TEM and understand their field patterns.

CO 2 **Explain** the concepts of dominant mode and degenerate modes in a rectangular waveguide using cutoff frequency/cutoff wavelength.

CO 3 **Illustrate** the principle of waveguide components which are used to couple microwave power from the waveguide system to make the relation between input and output power

CO 4 **Apply** the concept of S-Matrix to measure output power in microwave components such as E-plane Tee, H-plane Tee, Magic –Tee and directional couplers

CO 5 **Analyze** the Performance of passive microwave components such as isolator, circulator and gyrator using Faraday rotation principle.

CO 6 **Determine** the performance characteristics of reflex klystron and two-cavity klystron for obtaining the mathematical expressions related to power gain and efficiency.

CO 7 **Explain** the concept of microwave tubes for analyzing the microwave solid state devices.

CO 8 **Describe** avalanche transit time devices of different modes for determining the noise figure, operating frequency range, output power and efficiency.

CO 9 **Apply** the principle of M-Type tube to design magnetron for working of a pulsed radar

CO10 **Explain** the operating principle of GUNN diode using Ridley-Watkins- Hilsum theory for obtaining the differential negative resistance.

CO11 **Analyze** and measure various microwave parameters using microwave test bench setup

UNIT - I	WAVEGUIDES	Classes: 08

Introduction, microwave spectrum and bands, applications of microwaves, types of waveguides, rectangular waveguides, field equations in rectangular waveguide, field components of TM and TE waves for rectangular waveguide, modes of TM and TE waves in rectangular waveguide, impossibility of TEM waves, cut off frequency of rectangular waveguide; Wave impedance in rectangular waveguide: Wave impedance for a TM and TE wave in rectangular waveguide, Dominant mode and degenerate modes, mode characteristics of phase velocity, group velocity, wavelength and impedance relations; Illustrative problems; Cavity resonators: Types of cavity resonators; Rectangular cavity resonator: Dominant modes and resonant frequencies, illustrative problems.

UNIT - II	WAVEGUIDECOMPONENTS AND APPLICATIONS	Classes: 10

Coupling mechanisms: Probe, loop, coupling to a cavity resonator, waveguide discontinuities, waveguide irises, tuning screws and posts, matched loads; Waveguide attenuators; Waveguide phase shifters; waveguide multiport junctions: E plane Tee, H plane Tee, Magic Tee, applications of Magic Tee, hybrid ring; Ferrites: Faraday rotation principle, gyrator, isolator, circulator

UNIT - III	MICROWAVE LINEAR BEAM AND CROSS FIELD TUBES (OTYPE AND MTYPE)	Classes: 10

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, conventional current; Microwave cross field tubes (M type): Introduction, cross-field effects; Magnetrons: Different types, 8- cavity cylindrical travelling wave Magnetron, Hull cut-off and Hartree conditions, modes of resonance and PI-mode operation.

UNIT - IV	MICROWAVE SOLID-STATE DEVICES	Classes: 08

Microwave solid-state devices: Microwave tunnel diode; Transferred electron devices: Gunn-effect diodes, RWH theory, modes of operations; Avalanche transit time devices: IMPATT diode, TRAPATT diode, BARITT diode, Pin diodes, varactor diodes, crystal detectors.

UNIT - V	MICROWAVE MEASUREMENTS	Classes: 09

Description of microwave bench: Different blocks and their features, precautions; Microwave power measurement: Bolometer; Measurement of attenuation; Frequency standing wave measurements: measurement of low and high VSWR; Cavity Q; Impedance measurements.

Text Books:

1 K.B. Madhu Sahu, " Eelectromagnetic Fields", Scitech Ltd., 2nd Edition.
2 David J Griffiths, "Introduction to Electrodynamics" Pearson Education Ltd., 4th Edition, 2014.
3 Sunil Bhooshan, "Fundamentals of Engineering Electromagnetics", Oxford University Press,1st Edition, 2012.
4 E Kuffel, W S Zaengl, J Kuffel, "High Voltage Engineering Fundamentals", Newnes, 2nd Edition, 2000.

Reference Books:

1 Samuel Y. Liao, —Microwave Devices and Circuits‖, Pearson, 3rd Edition, 2003.
2 Herbert J. Reich, J.G. Skolnik, P.F. Ordung and H.L. Krauss, -Microwave Principles‖, CBS Publishers and Distributors, New Delhi, 1st Edition, 2004.
3 F.E. Terman, —Electronic and Radio Engineering‖, Tata McGraw-Hill Publications, 4th Edition,1955.

Web References:

1. https://www. montana.edu/aolson/ee433/EE43308_L1-3.pdf
2. https:// www.microwaves101.com/uploads/MESA-front.pdf
3. https:// www.onlinecourses.nptel.ac.in/noc20_ee63/preview
4. https://www.iare.ac.in

E-Text Books:

1. https:// www.technicalsymposium.com/allenggebooks.html
2. https:// www.gradeup.co/best-books-for-microwave-engineering
3. https://www.aliexpress.com/item/EBOOK..Microwave Engineering