MICROWAVE ENGINEERING

VII 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 course should enable the students to:

I. Perceive the concepts of waveguides and analyze the field components in different types of Waveguides.
II. Categorize different types of microwave components based on their applications.
III. Imbibe knowledge to use microwave oscillators & amplifiers in microwave communication and Compare their characteristics.
IV. Demonstrate the ability to measure different microwave parameters using microwave bench setup.

COURSE OUTCOMES:

I. Describe the types of waveguides, rectangular waveguides and field equations
II. Understand the coupling mechanisms in waveguides and analyze the waveguide multiport junctions
III. Explore the microwave linear tubes and analyze with microwave cross field tubes
IV. Understand the microwave solid state devices and avalanche transit time devices
V. Demonstrate the microwave bench set up and conducting measurements of different parameters

COURSE LEARNING OUTCOMES (CLOs):

1. Understand the microwave spectrum and applications of microwaves
2. Analyze the types of waveguides, rectangular waveguides and field equations in rectangular Waveguide.
3. Determine the wave impedance for a TM and TE wave in rectangular waveguide
4. Understand the types of cavity resonators and determine the dominant mode.
5. Explore the coupling mechanisms for a cavity resonator.
6. Apply Understand the waveguide discontinuities: waveguide irises, tuning screws, posts and matched loads
7. Understand the operation of multiport junctions and its applications
8. Understand the Faraday rotation principle and analyze the different ferrite devices.
9. Understand the limitations of conventional vacuum tubes at microwave frequencies and Understand the velocity modulation process and bunching process in microwave linear beam tubes
10. Determine the beam current density in Multi cavity Klystron amplifiers
11. Understand the velocity modulation process and power output in Reflex Klystron
12. Determine the amplification process in helix Traveling wave tube (TWT)
13. Describe the 8-cavity cylindrical travelling wave Magnetron
14. Analyze the Hull cut-off and Hartree conditions in Magnetron.
15. Illustrate the microwave solid-state devices: microwave tunnel diode and transferred electron devices
16. Determine the RWH theory and modes of operations in Gunn diodes
17. Understand the Avalanche transit time devices: IMPATT diode, TRAPATT diode and BARITT diode

18. Describe the microwave bench set-up with different blocks and their features
19. Determine the measurements of microwave power, attenuation, frequency, VSWR and impedance

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	WAVEGUIDE COMPONENTS AND APPLICATIONS	Classes: 09

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 (O TYPE AND M TYPE):	Classes: 09

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: 10

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: Bolometers; Measurement of attenuation; Frequency standing wave measurements: measurement of low and high VSWR; Cavity Q; Impedance measurements.

Text Books:

1. Samuel Y. Liao, ―Microwave Devices and Circuits‖, Pearson, 3rd Edition, 2003.
2. Herbert J. Reich, J.G. Skalnik, 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.

Reference Books:

1. R.E. Collin, ―Foundations for Microwave Engineering‖ IEEE Press, John Wiley, 2nd Edition, 2002.
2. Peter A. Rizzi, ―Microwave Engineering Passive Circuits‖ PHI, 3rd Edition, 1999.
3. M.L. Sisodia, G.S.Raghuvanshi, ―Microwave Circuits and Passive Devices‖ Wiley Eastern Ltd., New Age International Publishers Ltd, 1st Edition, 1995.

Web References:

1. http://nptel.ac.in/courses/117101119/1
2. http://www-group.slac.stanford.edu/kly/Lecture_Series/slac_klystron_lecture_series.htm
3. https://books.google.co.in/books?id=ZU19Uemy83YC&printsec=frontcover&dq=microwave+ engineering & hl=en & redir_esc=y#v=onepage & q&f = false

E-Text Books:

1. https://ecedmans.files.wordpress.com/2014/10/microwave-devices-and-circuits-samuel-liao.pdf
2. http://www.faadooengineers.com/threads/11621-Microwave-engineering-ebook-pdf-Free-Download
3.http://www2.electron.frba.utn.edu.ar/~jcecconi/Bibliografia/Ocultos/Libros/Microwave_Engineering_David_M_Pozar_4ed_Wiley_2012.pdf.