

MICROWAVE ENGINEERING

VII Semester: ECE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AEC015	Core	L	T	P	C	CIA	SEE	Total
		3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil			Total Classes: 60			
I. COURSE OVERVIEW:								
This course allows students to study and analyze microwave systems at high frequencies, typically in the MHz and GHz range where lumped elements (e.g., resistors, capacitors, inductors) are no longer appropriate. It introduces passive and active microwave devices, filters, amplifiers, mixers, couplers and power dividers that constitute wireless communication systems between the antenna and the signal processor. The applications include cellular communications, high-speed digital and analog circuits, wireless networks and radar.								
II. OBJECTIVES:								
The course should enable the students to:								
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.								
III. COURSE OUTCOMES:								
After successful completion of the course, students should be able to:								
CO 1	Recall the concepts of transmission lines and waveguides to derive the field components of wave equations in Rectangular modes.						Remember	
CO 2	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						Understand	
CO 3	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						Apply	
CO 4	Demonstrate the operation of microwave tubes, solid state devices for the generation and transmission of the microwave frequencies						Understand	
CO 5	Describe avalanche transit time devices of different modes for determining the noise figure, operating frequency range and output power .						Understand	
CO 6	Analyze microwave test bench setup to measure microwave parameters at microwave frequency						Analyze	
IV. SYLLABUS:								
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: 09
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: 10
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.faadoengineers.com/threads/11621-Microwave-engineering-ebook-pdf-Free-Download 3. http://www2.electron.frba.utn.edu.ar/~jcecon/Bibliografia/Ocultos/Libros/Microwave_Engineering_David_M_Pozar_4ed_Wiley_2012.pdf		
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