INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

MICROWAVE AND RADAR ENGINEERING								
VII Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AECD46	**Core**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Electromagnetic Waves and Transmission Lines								

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 also deals with the concepts of radar systems. The main applications such as electronic warfare, navigation system, missile terminal guidance and landing systems of air and space vehicles.

II. COURSES OBJECTIVES:
The students will try to learn

I. The 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 principle and operation of radar systems and radar range equation for communication.

III. COURSE OUTCOMES:
At the end of the course students should be able to:

CO 1 Illustrate the principle of waveguide components to couple microwave power and make the relation between input and output power.
CO 2 Demonstrate the operation of microwave linear and cross field tubes for the generation and transmission of the microwave frequencies.
CO 3 Make use of microwave bench set-up for measuring the parameters of microwave signal.
CO 4 Outline the working principle and operation of radar using radar range equation to calculate transmitted power in CW radar.
CO 5 Identify the importance of avoiding blind speed phenomenon, staggered PRF MTI systems are used in modern radar for detection of high-speed moving targets.
CO 6 Choose the appropriate microwave sources, amplifiers and mixers for employing the transmitters and receivers in radar.

IV. COURSE CONTENT:

MODULE - I: WAVE-GUIDES AND COMPONENTS (10)

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; waveguide multiport junctions: E plane Tee, H plane Tee, Magic Tee, applications of Magic Tee, hybrid ring; Ferrites: Faraday rotation principle, gyrator, isolator, circulator illustrative problems.

MODULE –II: MICROWAVE LINEAR BEAM AND CROSS FIELD TUBES (O-TYPE AND M-TYPE) (08)

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.

MODULE –III: MICROWAVE MEASUREMENTS, CW AND PULSE RADAR (10)

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. Radar Range equation; Pulse Radar: Block diagram and Operation; Maximum unambiguous range; Radar wave forms; Prediction of Target range.

Integration of echo pulses, PRF and Range ambiguities; system losses. CW Radar: Introduction, Block Diagram, Isolation between transmitter and receiver, Non-zero IF receiver, Receiver bandwidth requirements, Applications; Frequency Modulated CW radar: Range and Doppler measurement, Mathematical Analysis, Block Diagram and characteristics, FM-CW altimeter, multiple frequency CW radar, Ambiguity Diagram & its application.

MODULE –IV: : RADAR DETECTION IN NOISE (10)

Moving target indication (MTI) on A scope, butterfly effect, MTI using delay line canceller (DLC), Doppler measurement using Pulse radar, MTI radar (with power amplifier transmitter), MTI radar (with power oscillator transmitter), filter characteristics of DLC, blind speeds, double DLCs, Blind speeds, Staggered PRFs. Matched Filter (MF) receiver, MF response characteristics; Correlation Receiver, Efficiency of non-matched filters, Matched filter with non-white noise, Automatic Detection of radar signals: Tapped Delay Line (TDL) detection, CFAR receiver, Radar Clutter: Land and Sea clutter (without mathematical treatment).

MODULE –V: RADAR TRANSMITTERS & RECEIVERS (10)

Hybrid Linear-Beam Amplifier and Crossed-Field Amplifiers, Solid State Sources & Amplifiers, Methods for employing solid-state transmitters. Receiver Noise Figure (NF) - Noise Temperature; Measurement of NF, NF of Mixers, Basics of Radar Displays and Duplexers.

V. TEXT BOOKS:

1. M. Kulkarni, “Microwave and radar engineering “, Umesh Publications,5th Edition, 2016.
2. Samuel Y. Liao, “Microwave Devices and Circuits”, Pearson, 3rd Edition, 2003.

VI. REFERENCE BOOKS:

1. Herbert J. Reich, J.G. Skolnik, P.F. Ordung and H.L. Krauss, “Microwave Principles, CBS Publishers and Distributors, New Delhi, 1st Edition, 2004.
2. F.E. Terman, “Electronic and Radio Engineering”, Tata McGraw-Hill Publications, 4th Edition, 1955.

3. Warren L. Stutzman, Gary A. Thiele, “Antenna Theory and Design”, 3rd Edition, 2012.

VII. ELECTRONICS RESOURCES:

1. NPTEL :: Electrical Engineering: Microwave Engineering
2. NPTEL::Electromagnetic waves and transmit lines
3. https://khub.nthu.edu.tw/

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech-talk topics
5. Assignments
6. Model question paper - I
7. Model question paper - II
8. Lecture notes
9. Early learning readiness videos (ELRV)
10. Power point presentations