COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC403	MICROWAVE & RADAR ENGINEERING	3-0-0-3	2016

Prerequisite: EC303 Applied Electromagnetic Theory, EC306 Antenna & Wave Propagation

Course objectives:

- To introduce the various microwave sources, their principle of operation and measurement of various parameters
- To study the various microwave hybrid circuits and formulate their S matrices.
- To understand the basic concepts, types, working of radar and introduce to radar transmitters and receivers.

Syllabus:

Microwaves: introduction, advantages, Cavity Resonators, Microwave vacuum type amplifiers and sources, Klystron Amplifiers, Reflex Klystron Oscillators, Magnetron oscillators, Travelling Wave Tube, Microwave measurements, Microwave hybrid circuits, Directional couplers, Solid state microwave devices, Gunn diodes, Radar, MTI Radar, Radar Transmitters, Radar receivers.

Expected outcome:

The students will be able to understand the basics of microwave engineering and radar systems.

Text Books:

1. Merrill I. Skolnik, Introduction to Radar Systems, 3/e, Tata McGraw Hill, 2008.
2. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.

References:

1. Das, Microwave Engineering, 3/e, McGraw Hill Education India Education , 2014
2. David M. Pozar, Microwave Engineering,4/e, Wiley India, 2012.
3. Kulkarni M, Microwave and Radar Engineering, 4/e, Umesh Publications, 2012.
4. Rao, Microwave Engineering, 2/e, PHI, 2012.
5. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.

Course Plan

Module	Course contents	Hours	End Sem. Exam Marks
I	**Microwaves:** introduction, advantages, Cavity Resonators - Rectangular and Circular wave guide resonators- Derivation of resonance frequency of Rectangular cavity.	4	15%
	Microwave vacuum type amplifiers and sources: Klystron Amplifiers - Re-entrant cavities, Velocity modulation, Bunching (including analysis), Output power and beam	4	
II	**Reflex Klystron Oscillators**: Derivation of Power output, efficiency and admittance	2	15%
	Magnetron oscillators: Cylindrical magnetron, Cyclotron angular frequency, Power output and efficiency.	3	
FIRST INTERNAL EXAM			
III	**Travelling Wave Tube**: Slow wave structures, Helix TWT, Amplification process, Derivation of convection current, axial electric field, wave modes and gain.	4	15%
	Microwave measurements: Measurement of impedance, frequency and power	2	

IV	**Microwave hybrid circuits**: Scattering parameters, Waveguide tees- Magic tees, Hybrid rings, Corners, Bends, and Twists. Formulation of S-matrix.	5	**15%**
	Directional couplers: Two hole directional couplers, S-matrix of a directional coupler. Circulators and isolators.	4	
SECOND INTERNAL EXAM			
V	**Solid state microwave devices**: Microwave bipolar transistors, Physical structures, Power frequency limitations equivalent circuit. Principle of **Tunnel diodes** and tunnel	4	**20%**
	Gunn diodes: Different modes, Principle of operation Gunn Diode Oscillators.	2	
VI	**Radar**: The simple Radar equation. Pulse Radar, CW Radar, CW Radar with non zero IF, Equation for doppler frequency FM-CW Radar using sideband super heterodyne receiver. **MTI Radar**-Delay line canceller, MTI Radar with power amplifier & power oscillator, Non coherent MTI Radar, Pulse	5	**20%**
	Radar Transmitters: Radar Modulator-Block diagram, **Radar receivers**- noise figure, low noise front ends, Mixers, Radar Displays	3	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 60% for theory and 40% for logical/numerical problems, derivation and proof.