

## 4/4 B.Tech - SEVENTH SEMESTER

EC7T5C

Radar Systems

Credits: 3

Lecture: 3 periods/week

Internal assessment: 30 marks

Tutorial: 1 period /week

Semester end examination: 70 marks

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**Prerequisites:** Analog Communications (EC 4T5), Antennas & Wave Propagation (EC5T4), Microwave Engineering (EC6T3).

### Course Objectives:

- To study the principles of operation of various blocks of Radar systems and Radar Range equation in detail.
- To study the functions of various blocks of CW Radar, FM-CW Radar, MTI and Pulse Doppler Radars, Tracking radar and their limitations and applications.
- To study the functions of various blocks of Radar receivers and detection of Radar signals in noise in detail.
- To study the principles and working of phased array antennas and their application to radar systems

### Learning Outcomes:

Student will be able to

- Compare working of different types of radars.
- Analyze the statistical parameters of Noise and Radar cross section of targets
- Distinguish the fixed and moving targets using different types of radar systems
- Explain various techniques employed in radar receivers for detection of signals in noise.
- Observe the variation in parameters of radar system by the estimation of noise figure & noise temperature
- Identify the different types of display devices & duplexers

## UNIT I

**Nature of Radar:** Maximum Unambiguous Range, Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Minimum Detectable Signal, Receiver Noise and SNR, Integration of Radar Pulses, Radar Cross Section of Targets, Transmitter Power, PRF and Range Ambiguities, System Losses.

## UNIT II

**CW and Frequency Modulated Radar :** Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Multiple Frequency CW Radar.

## UNIT III

**MTI and Pulse Doppler Radar:** Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters, Non-coherent MTI, MTI versus Pulse Doppler Radar.

## UNIT IV

**Tracking Radar:** Tracking with Radar, Sequential Lobing, Conical Scan, Monopulse Tracking Radar – Amplitude Comparison Monopulse (one and two coordinates), Phase Comparison Monopulse.

## UNIT V

**Detection of Radar Signals in Noise :** Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation Function and Cross-correlation Receiver, Efficiency of Non-matched Filters Matched Filter with Non-white Noise. Radar Receivers – Noise Figure and Noise Temperature. Displays – types. Duplexers – Branch type and Balanced type.

### Learning Resources

#### Text Books:

1. Introduction to Radar Systems – Merrill I. Skolnik, 2<sup>nd</sup> Edition, McGraw-Hill, .

#### References:

1. Introduction to Radar Systems – Merrill I. Skolnik, 3<sup>rd</sup> Edition, Tata McGraw- Hill,
2. Understanding Radar Systems – Simon kingsley, McGraw-Hill, 1st edition., 1992
3. Radar Principles- Peyton Z. Peebles, Jr., Wiley India Pvt. Ltd., 2009

#### Web Resources:

1. <http://nptel.iitm.ac.in/courses.php?branch=Ece>
2. <http://www.radartutorial.eu/07.waves/wa04.en.html>