ECx5148	Radar Engineering	L-T-P: 3-0-0; Cr: 03

Course Objectives:

1. Learn Radar fundamentals like principles of operation of Radar systems, Radar equation, operating frequencies & applications.
2. Understand the basic concepts of radar systems for military and civilian applications to the students.
3. Know the various types of tracking techniques involved.
4. Understand Radar Receivers, MTI filters, displays and antennas.

***Prerequisites*:** To study this course, knowledge of Communication, Electromagnetic Theory, and Antennas are required.

COURSE CONTENT:

Unit-I: Basics of Radar: Introduction, Maximum Unambiguous Range, Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Modified Radar Range Equation, Related Problems. **(4 L)**

Unit-II: Radar Equation: SNR, Envelope Detector-False Alarm Time and Probability, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Related Problems. **(6 L)**

Unit-III: 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, Related Problems. FM-CW Radar: FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets) **(6 L)**

Unit-IV: 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. MTI Radar Parameters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar. LPI Radar. **(7 L)**

Unit-V: Phased array and Imaging radar- Phase array working and feed systems; Introduction to Beamforming: conventional beamforming, adaptive beamforming; Synthetic aperture radars(SAR) and pulse compression techniques;

SAR - Fundamentals: cross range resolution in Radar, synthetic aperture viewpoint, Stripmap SAR Data Characteristics: Stripmap SAR Geometry, Stripmap SAR data set; Strippmap SAR Image formation Algorithm, Introduction of Plolarimetric and Interferometric SAR and its principle, Remote sensing applications of radars. **(9 L)**

Unit-VI: 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 **(8 L)**

Expected Outcomes:

Students will be able to

1. Compare the working of different types of radars.
2. Analyze the statistical parameters of the Noise and Radar cross-section of targets
3. Distinguish the fixed and moving targets using different types of radar systems
4. Explain various techniques employed in Phased array and Imaging radar for target detection.
5. Explain various techniques employed in radar receivers for the detection of signals in noise.

Text Books:

1. Merrill Skolnik:Introduction to Radar Systems; Tata McGraw-Hill, 2007, 2/e.
2. Mark A Richards: Fundamentals of Radar signal processing; M C Graw Hill 2014, 2/e.

Suggested Reading:

1. Ramon Nitzberg, "Radar Signal Processing and Adaptive Systems", Artech House, 1999.
2. Byron Edde "Radar: Principles, Technology, Applications". Pearson Education, 2004.
3. Radar Principles – Peebles. Jr., P.Z. Wiley. New York, 1998.
4. Principles of Modem Radar: Basic Principles – Mark A. Rkhards, James A. Scheer, William A. HoIm. Yesdee, 2013.
5. Harold Mott, "Remote Sensing with Polarimetric Radar" IEEE Press, 2007.
6. Nathanson, F E, " Radar Design Principles" Scitech Publishing, 2002.

ECx5149	Terahertz Engineering	L-T-P: 3-0-0; Cr: 03

Course Objectives: To demonstrate the concept of THz principles and its components and design applicability for different Industrial and communication applications.

COURSE CONTENT:

Unit-I: Terahertz Overview and Principles: Electromagnetic Radiation and Propagation Fundamentals, Terahertz Principles, Towards Terahertz Communication Systems, Key Technological Issues for Terahertz Technology, Fundamental Limits, Terahertz Technology Applications and Opportunities. **(8 L)**

Unit-II: THz Detectors: Single-Photon Detectors, Microbolometers, Golaycells, Pyroelectric Detectors, Diode Detectors, and Focal-Plane Arrays. **(6 L)**

Unit-III: THz Sources: Vacuum-Electronics-based, Semiconductor-based, Photoconduction-based and Nonlinearity-based. **(6 L)**

Unit-IV: THz Electronic Components: Waveguides, Metamaterials, Filters and Modulators. **(8 L)**