MTE 7203 Radar System Engineering & Design

Course Description:

This course discusses the fundamental principles behing the design and operation of Radar systems for different applications. It is intended to make the student understand the principles of Radar and its use in military and civilian environment and give them them familiarity with navigational aids available for navigation of aircrafts and ships.

AIMS:

1. To derive and discuss the Range equation and the nature of detection.
2. To apply doppler principle to radars and hence detect moving targets, cluster, also to understand tracking radars
3. To refresh principles of antennas and propagation as related to radars, also study of transmitters and receivers.

Detailed Course Content:

1. THE NATURE OF RADAR: Introduction ; The Radar Equation; Radar Block Diagram and Operation; Radar Frequencies; History of Radar Development; Applications of Radar
2. THE RADAR EQUATION: Prediction of Range Performance; Minimum Detectable Signal; Receiver Noise; Probability-density Functions; Signal-to-noise Ratio; Integration of Radar Pulses; Radar Cross Section of Targets; Cross-section Fluctuations; Transmitter Power; Pulse Repetition Frequency and Range Ambiguities; Antenna Parameters; System Losses; Propagation Effects
3. CW AND FREQUENCY-MODULATED RADAR: The Doppler Effect; CW Radar; Frequency-modulated CW Radar; Airborne Doppler Navigation; Multiple-frequency CW Radar
4. MTI AND PULSE-DOPPLER RADAR: Moving-target-indication (MTI) Radar; Delay Lines and Cancelers; Subclutter Visibility; MTI Using Range Gates and Filters; Pulse-doppler Radar; Noncoherent MTI; MTI from a Moving Platform—AMTI; Fluctuations Caused by Platform Motion; Effect of Sidelobes on Pulse-doppler AMTI Radar
5. TRACKING RADAR: Tracking with Radar; Sequential Lobing; Conical Scan; Simultaneous Lobing or Monopulse; Target-reflection Characteristics and Angular Accuracy; Tracking in Range; Tracking in Doppler; Acquisition; Examples of Tracking Radars; Comparison of Trackers
6. RADAR TRANSMITTERS : Magnetron Oscillator ; Klystron Amplifier ; Traveling-wave-tube Amplifier ; Amplitron and Stabilitron ; Grid-controlled Tubes ; Comparison of Tubes ; Modulators
7. ANTENNAS : Antenna Parameters ; Antenna Radiation Pattern and Aperture Distribution ; Parabolic-reflector Antennas ; Scanning-feed Reflector Antennas ; Cassegrain Antenna ; Lens Antennas ; Array Antennas ; Pattern Synthesis ; Cosecant-squared Antenna Pattern ; Effect of Broadband Signals on Antenna Patterns ; Effect of Errors on Radiation Patterns ; Radomes ; Focused Antennas

8. RECEIVERS: The Radar Receiver ; Superheterodyne Receiver ; Receiver Noise ; Noise Figure ; Effective Noise Temperature ; Environmental Noise ; RF Amplifiers ; Crystal Mixers ; IF Amplifiers ; Displays ; Duplexers
9. PROPAGATION OF RADAR WAVES : Propagation over a Plane Earth ; The Round Earth ; Refraction ; Anomalous Propagation ; Low-altitude Coverage ; Radar Diffraction Screen ; Attenuation by Atmospheric Gases ; Microwave-radiation Hazards
10. SYSTEMS ENGINEERING AND DESIGN : Systems Engineering ; Radar Parameter Selection ; Example—Aircraft-surveillance Radar ASDE ; Airborne Weather-avoidance Radar ; Bistatic Radar ; Radar Beacons

Teaching and Learning Pattern

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

References:

[1] David K. Barton, "Modern Radar System Analysis", Artech House, Inc., Norwood, MA, 1988

[2] G.W. Stimson, "Introduction to Airborne Radar" 2nd edition, SciTech, 1998

[3] Merrill I.Skolnik, Introduction to Radar Systems, 3rd edition

[4] Peyton Z. Peebles:, "Radar Principles", Johnwiley, 2004

[5] J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004