DEFENCE INSTITUTE OF ADVANCED TECHNOLOGY

(Deemed to be University)
Girinagar, Pune – 411025 (Maharashtra)

www.diat.ac.in

INFORMATION BULLETIN

Admission to
M. Tech. in Industrial Systems Engineering
(Specialization: Radar Systems and Technologies)
For Working Professionals
2026-2027

CONTENTS

1. About DIAT

Amidst the lush, green Sahyadri Hills and overlooking the picturesque Khadakwasla Lake lies the Defence Institute of Advanced Technology (DIAT). Established on 1st May 1952 as the Institute of Armament Studies, it was originally located on the sprawling campus of the College of Military Engineering, Dapodi, Pune. In 1967, the institute was renamed the Institute of Armament Technology and relocated to its present location at Girinagar, Pune. Since then, the institute, under the aegis of the Department of Defence Research and Development, Ministry of Defence, Government of India, has grown in strength and stature. It was recognized as a Deemed-to-be University on 1st April 2006. The institute has also acquired ISO 9001:2000 certification from DNV, Norway. Having been conferred the status of a Category "A" Deemed-to-be University by the Ministry of Human Resource Development, Government of India, the institute is now on its path to achieving NBA and NAAC 'A' Grade accreditations.

The Institute, a premier autonomous educational entity equipped with modern laboratories and well-qualified faculty members, is engaged in postgraduate education and research leading to M.Tech. and Ph.D. degrees.

Continuous efforts are made to maintain high standards of quality training in the critical area of modern Defence Technologies, thereby enhancing the technical capabilities of DRDO scientists, service officers, officers from defence industries, and fresh engineering graduates. The Institute also contributes to preparing skilled manpower for industries involved in the Government of India's "Make in India" campaign.

At DIAT, to meet the needs of the Armed Forces, DRDO, Defence Quality Assurance, Defence Ordnance Factories, Directorate of Aeronautical Quality Assurance, and other public sector undertakings, many specialized and customized postgraduate courses are conducted. In addition to the Ph.D. and M.Tech. programmes, the Institute also offers specific, limited-duration courses of 1 to 1.5 years, along with a variety of specialized short-term courses.

DIAT opened its doors to the general public in 2006 and has since been admitting students under the open category with scholarships for its Ph.D. and M.Tech. programmes. To strengthen ongoing research initiatives and enhance the quality of teaching and training, the Institute has introduced a scheme for appointing "Visiting Professors/Scientists."

The Institute is steadily progressing toward a quantum leap in the field of technical education and research, with a focus on the specific needs of the defence sector.

2. Location

Location of DIAT by Lat, Long is (18.424463, 73.758395) and GPS coordinates are 18° 25' 28.0668'' N and 73° 45' 30.222'' E.

Traveling from Mumbai to Pune takes about three hours by road or train. Private cabs such as Ola, Uber, and other services are frequently available from the airport and railway station.

Trains such as the Duronto, Intercity, and Deccan Queen run frequently from Mumbai Railway Station to Pune Railway Station.

Several trains, including the Duronto, Nizamuddin Express, Goa Express, and Mysore Express, run frequently from New Delhi Railway Station to Pune Railway Station. The journey takes approximately one day.

Many direct flights, such as those operated by SpiceJet, Air India, and IndiGo, are available frequently from New Delhi Airport to Pune Airport. The flight duration is about two hours.

3. Information Center and Library

Information Centre and Library (IC&L) is the knowledge hub of the Defence Institute of Advanced Technology (DU), Pune. It reflects the institute's commitment to providing the best possible library and information services to its academic community, including faculty members, scientists, students, and staff. The IC&L is a significant resource for information related to defence, science and technology, and allied subjects in this region of the world.
The library houses a vast collection of both printed and digital resources. It offers a wide range of services, including reference and consultation, membership, circulation, document delivery, resource sharing, information alerts, bibliographic services, and digital library services. The IC&L continues its mission of facilitating new knowledge through the procurement, retrieval, preservation, organization, and dissemination of diverse resources. The library's collection—comprising books, journals, e-journals, databases, theses, reports, standards, and other reading materials—is its greatest asset. The library subscribes to 350

print and online journals and databases such as ScienceDirect, IEL, ASME, ACM, ProQuest (TRC, ABI/Inform), Scopus, SpringerLink, J-Gate, and e-books. The total collection includes 57,242 books, 4,772 e-books, 21,875 back volumes, 2,000 reports, and 1,762 dissertations and theses.

A compact storage system has been installed in the new library building to preserve older materials, including back volumes dating before the 1960s. To provide integrated access to its resources, the library uses LibSys-10, a web-centric library management software. IC&L has implemented RFID technology through LibSys-10 for managing its collections and services. RFID significantly reduces the time needed for circulation operations, as it allows information to be read from tags much faster than from barcodes. It also enables automated data collection without requiring line-of-sight or item-by-item scanning, reducing human effort and error.

The library has also developed the DIAT (DU) Digital Repository, an information system designed to ingest, store, manage, preserve, and provide access to digital content. The institutional digital repository supports scholarly communication and provides open access to articles, dissertations, research data, and more. It consists of formally organized digital content generated by faculty, staff, and students of the institute.

This repository plays a crucial role in capturing and managing the university's intellectual assets as part of its broader information strategy. The library uses DS pace, an open-source repository software package, to build and maintain this repository. DS pace meets DIAT's specific needs as a digital archive system, focused on long-term storage, access, and preservation of digital content.

4. Eligibility

1. **Degree:** B.E. / B. Tech. in Engineering with specialization in Electronics (E) / Electronics & Electrical (EEE) / Electronics & Communication (ECE) / Electrical Engineering (EE) / Computer Science / Computer Engineering /Mechatronics / Instrumentation or M.Sc. in Physical Sciences / Applied Physics / Applied Electronics / Electronics / Instrumentation / Computer Science of a recognized Institute/University.
2. **Experience:** Two years professional experience in Radar Systems Development and/or relevant field. The candidate shall be currently employed. Candidate has to provide certificate from the employer to confirm the employability and candidate has to provide NOC from their respective employer

5. Admission

Working professionals who fulfils the eligibility criteria will undergo Written Test & Interview or only Interview based on the number of applications received.

Minimum students' enrolment required to run this program will be 15.

6. Selection Process

Admission to M. Tech. in Industrial Systems Engineering (Specialization: Radar Systems and Technologies) will be based on the performance in the written test and interview or only interview depending upon the number of applications received. Interview will be conducted by a panel of experts through online/offline mode. The merit list will be valid only for the academic year 2026-2027.

7. Fee Structure

One Time Fee		**Total**
Admission Fee (Non-Refundable	Rs. 6000/-	Rs. 26,000/-
Caution Deposit (Refundable)	Rs. 20,000/-	
Per Semester Fee		Total
Tuition Fee	Rs. 1,06,000/-	Rs. 1,25,000/- per semester per student
Library Fee	Rs. 2,000/-	
Miscellaneous	Rs. 17,000/-	

8. Schedule of Admissions 2026-27

- Last date to receive applications: 23/08/2026
- Announcement of candidates called for Interview (www.diat.ac.in): 27/08/2026
- Interview (online): 30/08/2026
- Announcement of selected candidates (www.diat.ac.in): 02/09/2026
- Admission: 03/09/2026 – 18/09/2026
- Commencement of Classes: 21/09/2026

9. Instructions to Apply

The application fee for GEN, EWS, and OBC categories is INR 1000/-, and for SC, ST, and PWD categories, it is INR 500/-. The application fee must be paid online through State Bank Collect. To make the payment, click on the **Online Payment Gateway** link available on the institute's homepage: www.diat.ac.in. **Do not use mobile applications** to make the payment.

The scan copy of application form with necessary documents in 1 single pdf format to be uploaded in Google Form (https://forms.gle/kWMwf8wikVeYufse6) and also to be sent through email at mtech_admissions@diat.ac.in.

10. List of documents to be uploaded with application

- Copy of SSC/Class X marks card/certificate in support of Date of Birth.
- Copy of Intermediate/ (10+2) / Class XII marks card/certificate
- Copies of Provisional Certificate / Degree Certificates and Marks Cards of the qualifying examinations
- Copy of the valid caste certificate (in case of SC/ST/OBC/EWS candidates)
- Photograph on application form
- Fee payment receipt with transaction number
- NOC from the respective employer
- Certificate from the employer to confirm his nature of work experience.

11. Department Specific Qualifications, Specializations and other details

Sr. No.	Offering Department	Program (M.Tech.)	Specialization	Years	Minimum Qualification and Work Experience Required
1	Department of Electronics Engineering	Industrial Systems Engineering	Radar Systems and Technologies	2.5 Years (5 Semesters)	As in Sr. No: 4 above with 55% of marks or 6.0 CGPA (on a 10- point scale).

About the Program:

M.Tech in Industrial Systems Engineering (Specialization in Radar Systems and Technologies) focuses on Radar Technologies as an applied Technology course. The course is designed for imparting practical Radar Systems Knowledge from professional experts having several years of hands-on experience in making actual systems with wide exposure to field deployment operations and user needs. The program is aimed at introducing the mathematical background required for understanding a Radar System, Radar Systems Engineering Concepts, Various Radar Subsystems, System and Sub-System functionalities starting from a generic Radar system architecture. A sample Radar shall be considered right from requirements, design, subsystem specifications and integration including calibration, testing and performance evaluation for instruction. Critical software and firmware components of a typical Radar System are also being covered, so as to give a complete knowledge of a Radar System and its technologies with hands-on from a practical engineering perspective, rather than mere theoretical view.

M. Tech. in Industrial Systems Engineering (Specialization in Radar Systems and Technologies) focuses radar system modeling, radar system designs, signal processing for targets detection, beamforming techniques, tracking/surveillance radars, advanced radar technology (SAR/ISAR), futuristic radar system design such 9 as cognitive radar, photonic radar, quantum radar, passive radar etc. This program also puts emphasis on radar design, RSP and modeling aspects with the recent tools/modules such as MATLAB, ADS, System Vue, EMPro, Vivado, CST/HFSS, RF components to build the short-range/low- power radars etc.,

Early career professionals who want to become Radar Systems specialist. Any professional working in areas such as RF / Microwave / Antenna / Signal & Data Processing / Software & firmware development / Power Systems / Integration & testing / any other specific areas associated with Radar who desires to become a Radar Systems Engineer. Any other professional interested in upgrading their knowledge in Radar Systems & Technologies.

Mode of Conduct: Hybrid/ blended Mode

Faculties Involved: Professionals from Industries, Research Laboratories and Academia

Classes:

- Classes and tutorials will be conducted through hybrid mode.
- Classes will be conducted on Friday Evening & Saturdays.
- All students have to be present at DIAT for one week at the beginning and two weeks at the end of 1st and 2nd semesters for lab classes / hands on training / tutorials / end semester exams. Students have to present at DIAT for two weeks at the end of 3rd to 5th semester to complete their thesis work report / thesis followed by presentation / end semester exams.

Examination/Evaluation:

Theory Courses:

- Two formative assessments during the semester with 20 marks each. (Online or Offline Mode)
- Assignments/Quizzes shall carry 10 marks.

- End Semester Examination shall carry 50 marks. Students have to appear for the End Semester exams at DIAT.

Dissertation Work:

- Students have to carry out their Dissertation work at their respective organizations.
- Students have to choose one Guide/Supervisor from their organization and one from DIAT. The thesis topics shall be mutually agreed upon. Both the Supervisors/Guides will have to support and monitor the progress.
- Students have to submit Dissertation progress report in the 3rd and 4th semesters and Thesis in the 5th / Final Semester.
- At the end of the 3rd, 4th and 5th semesters, students have to appear for End Semester Examinations / Evaluation of submitted Report / Thesis, presentation on the completed work and a viva voce.

Note:

DIAT reserves the right to decide the number of seats to be filled under this category. By mere fulfilment of eligibility criteria does not guarantee the candidates to be shortlisted for written test / interview.

12. Program Structure & Syllabus

Semester-1

#	Course Type	Course Code	Course Name	Credits
1	Core	ISE 601	Introduction to Systems Engineering	3
2	Core	ISE 616	Introduction to Radar Systems & Engineering	3
3	MOOC /SWAYAM NPTEL	PGC 603	Research Methodology	3
4	Lab	ISE 661	Radar systems lab-I (Mathematical Tools for Radar Simulation and RF simulation of Radar and subsystems)	2
			Credits for first semester	11

Semester-2

#	Course Type	Course Code	Course Name	Credits
1	Core	ISE 617	RF Technology for Radars	3
2	Core	ISE 618	Radar Signal Generation, Reception, Digitization and Processing	3
3	Core	ISE 619	Mathematical Background for Radar	3
4	Lab	ISE 662	Radar systems lab-II (System / Sub-system live measurements and Advanced Radar Topics)	2
			Credits for second semester	11

Semester-3

#	Course Type	Course Code	Course Name	Credits
1	Core	ISE 620	Radar Software and Computing Systems	3
2	Core	ISE 621	Auxiliary Systems for Radars	3
3	MOOC/SWAYAM NPTEL		Professional Elective-1	3
4	Project	ISE 651	M.Tech. Dissertation Phase-I	10
			Credits for third semester	19

Semester-4

#	Course Type	Course Code	Course Name	Credits
1	Core	ISE 622	Radar Systems Integration, Testing and Performance Evaluation	3
2	Core	ISE 623	systems Engineering for Radar	3
3	MOOC/SWAYAM NPTEL		Professional elective - II	3
4	Project	ISE 652	M.Tech. Dissertation Phase-II	10
			Credits for fourth semester	19

Semester-5

#	Course Type	Course Code	Course Name	Credits
1	Project	ISE 653	M. Tech. Dissertation Phase III	20
			Credits for fifth semester	20

List of Professional Electives

#	Course Code	Course Name	Credits
1	MOOC / SWAYAM NPTEL	Space Environment and Its Effects on Orbital Spacecrafts	3
2		Applied Accelerated Artificial Intelligence	3
3		Real-Time Digital Signal Processing	3
4		Artificial Intelligence: Search Methods for Problem Solving	3
5		Neural Networks for Signal Processing	3
6		Passive Microwave Circuits, Devices, and Measurements	3
7		Industrial Engineering and Operations Research	3
8		Ergonomics Research Techniques	3
9		Risk-Based Engineering	3
10		Introduction to Photonics	3

Note:

1. In addition to the above listed elective courses, if the student is interested, he/she can take any other/relevant MOOC/SWAYAM NPTEL course(s) with the formal approval of the Department.
2. For Course: 1 credit is for 1 lecture
   For Laboratory: 1 credit is 2 hours
   Course Work: 40 Credits
   Dissertation/Thesis: 40 Credits
   Total Credits: 80
3. Laboratory work for Semesters 1 & 2 will be conducted at DIAT, for a total of two-three weeks during each semester.

Syllabus

Course Code & Title

RT X01 - Mathematical Background for Radar

Course Context

Radar is a probabilistic device with a detection Pd & Pfa. Radar Systems and Technology is a specialized course being conducted by Radar practitioners and the teams who are in the design and development of the Nation's Radars under production. To understand the Radar system design, the students must be familiar with the Mathematical background as applicable for system design, with the complexity of the nature of Radar, including Signal analysis, Probability, Statistical analysis and optimization of the parameters. This also includes some concepts on waveform designs and the mathematical treatment of the same. The course will cover the application-oriented features of mathematical concepts rather than theory from academic books.

Course Objectives

1. Introduce Mathematical essentials for Radar system design and analysis.
2. Build an appreciation and provide insights into key mathematical concepts with application orientation to radars.
3. Provide an overview of statistical / probability concepts required for Radar Design development.
4. Introduce FFT, Convolution, Matched Filter concepts;

Course Content

Unit I: Introduction to Signals and Systems:
Mathematical representation and treatment of Signals and Systems; Randomness; Complex Numbers-Real and Imaginary parts of the Signal; Importance of Complex numbers for Radar signal analysis. Concept of Matched Filters;

Unit II: Basics of Transforms:
Time and Frequency domain analysis – Convolution, Discrete Fourier Transforms and FFT; Treatment of FFT from computation point; Filters – FIR, IIR; Impulse response;

Unit III Probability &Statistics:
Probability distributions, Gaussian Signal; Colored and White noise;

Unit IV: Signal acquisition and Signal Image:
Concepts of Signal acquisition – Signal sampling, under sampling; Image rejection and Multitap Filtering; Instantaneous bandwidth; Nyquist, oversampling, under sampling, Compressive sampling;

Unit V: Transformations, Triangulation, etc.
Coordinate systems, ENU, ECEF, XYZ, Geodetic systems; Transformations; Triangulation and Trilateration; Harmonization process;

Course Outcome

CO1: Understanding Radar from a Mathematical Angle
CO2: Radar Signal representation and relevance of Complex numbers for Radar Signal processing
CO3: Signal Analysis; Probability & Statistical concepts for Radar
CO4: Sampling and matched filter definition. Understanding Convolution, DFT and FFT as applicable to Radar

Text Books

1. Discrete Time Signal Processing by Alan V Oppenheim and Ronald W Schafer
2. Coordinates in Geodesy by Siegfried Heitz
3. Signal Analysis by Ronald L Allen and Duncan Mills
4. Probability and Random Processes by Geoffrey Grimmett and David Stirzaker
5. Coordinate Transformation: Step by step guide" by Jim Crume

Reference Books / Materials

1. Advanced Engineering Mathematics by Erwin Kreyszig

Course Code & Title

RT X02 - Introduction to Radar Systems and Engineering

Course Context

The course is aimed at giving a complete understanding of the Radar and being confident in all the terminology of Radars. The Radar architecture and the block diagram of a typical radar are presented. A student of this course is expected to understand the configuration of a Radar, and its constituents, including Antenna, RF & Microwave generators, Stable clock generation, Radar control, Radar reception and Signal processing, associated time-critical software/firmware for radar data processing. The aim is to present a comprehensive introduction of each subsystem, its role, and its interfaces at the top level. Each subsystem will be explained with its functionality and the criticality. Different types of Radar architectures, like Conventional Radars, Electronic Scanning Radars (Passive and Active), and Digital Beam forming Radars, are presented

Course Objectives

1. Introduction to Systems Engineering; Understanding QR; Compliance generation;
2. A typical Radar Architecture and Block Diagram explained.
3. All the subsystems are presented in detail with their interfaces and roles.
4. Different configurations of Radars and types of Radars are introduced.
5. Signal flow from end to end of the Radar system is depicted in detail.
6. Introduction to ancillary systems such as the Cooling System, Power Supply, and Mechanical subsystems.
7. Functions of Radar such as Surveillance, Tracking, Acquisition, and Passive Radars.

Course Content

Unit I: Introduction to Radar Systems Engineering:
Systems Engineering and Lifecycle models; INCOSE Model; Comparison of other Models; Understanding QR from Users; Generation of Compliance; Baselines;

Unit II: Radar Definition:
Introduction to Radar System; History; EM-Wave propagation; Radar equations; Block diagram and typical Radar configuration; RCS of Target and introduction to Swerling models; Introduction to CW, FMCW, Pulsed, Pulsed Doppler Radars; Peak Power, Average Power; Range & Doppler resolution- Pulse expansion/compression;

Unit III: Radar System functions:
Multi-Function Radars and Multi-mode Radars - Surveillance, Tracking, Acquisition, Guidance; Imaging; Signal generation, amplification, transmission, reception; Baseband Digital conversion and processing;

Unit IV: Types of Radars:
Conventional Mechanically Steered Radar; Phased Array Radars – Passive, Semi-Active and Fully Active Phased Array Radars; Digital Array Radar architectures; Mono-static, Bi-static and Multi-static Radars; Passive Radar Systems; Platform-based Radar Systems – Ground, Naval, Airborne, Spaceborne, Transportable, Mobile Radars

Unit V: Subsystems of Radar:
Antenna and Radiating Elements, Transmitter, Exciter, Receiver, Signal Processor, Data Processor, Display and HMI; System Software and criticality; Power System, Cooling System, Mechanical Pedestal;

Course Outcome

CO1: Introduction to Radar
CO2: Radar Configuration & Architecture; Types of Radars; Phased Array Radars
CO3: Subsystems of Radar and their significance; Role of Software
CO4: Various Functions of a Radar such as Surveillance, Tracking, Acquisition;
CO5: Key Concepts – PRF, PRT, Dwell, Burst, Timing, Local Oscillators and Spectral Purity; Noise Figure;

Text Books

1. Airborne Radar by George Stimson.
2. Introduction to Radar Systems by MerylISkolnik.
3. Radar Systems Principles, Harold R. Raemer, CRC Press.

Reference Books / Materials

1. Principles of Modern Radar: Basic Principles by Mark Richards, Jim Scheer, and William Holm.
2. Radar Handbook by MerylISkolnik.
3. System Engineering and Analysis by Benjamin S Blanchard and Walter J Fabrycky.
4. System Engineering Principles and Practice by Alexander Kossiakoff, William N Sweet.
5. Radar: Principles, Technology Applications by Byron Edde

Course Code & Title

RT X03 - RF Technology for Radars

Course Context

Radar is a device that transmits the RF signal and receives the same signal back for digital processing; The RF is generated from a single clock for the entire antenna, either at a single point (like the Exciter) or generated at each of the transmitting/antenna elements in the most modern fully digital array radars. The low-power signal is amplified before transmission through the antenna. An antenna couples the signal to the transmitting elements and also provides the required gain for transmission. Similarly, in the reverse direction for the receive function, the signal is received by the antenna, and digitization is carried out either at the RF level or the IF, depending on the system architecture. The course aims to introduce the RF / Microwave signal concepts, generation, and transmission through antennas. RF Loss, RF Budget, Spectral purity and detailed analysis are presented as part of the course.

Course Objectives

1. Understand RF and Microwave concepts as applicable to Radars
2. RF Signal generation; Carrier frequency, up conversion and down conversion;
3. Antenna element and coupling characteristics;
4. RF Budget along the path and optimization of the same for various frequencies;
5. Concept of Monopulse; Digital generation of RF signals;
6. Super heterodyne receivers; LO generation; frequency planning;

Course Content

Unit I: EM wave propagation:
Introduction to Maxwell's equations; Fundamental concepts of RF and Microwave; Wave propagation; Frequency study and analysis for different kinds of radar applications;

Unit II: Antennas and Arrays:
Basic antenna characteristics; Antenna & Radiating Elements Design; Concepts of Phased Array; Beam steering; Digital beam forming and Fully digital Array Radars; T/R modules, RF Chain – Power Dividers/combiners; Phase shifting, attenuation; Beam steering Network;

Unit III: Key concepts of Radar:
Instantaneous Bandwidth; Oscillator and significance in system performance; Frequency Planning; Signal generation – STAMO, STALO, Phase Noise & Spectral Purity; Beam Stabilization; Noise Figure; Range Gates, Range Measurement and Angle Measurement; Range and Angle resolution; Power Aperture, Phase of signal, Gain and System loss;

Unit IV: RF Chain Design:
Signal Generation, Signal propagation, path loss, link budget calculation, Dynamic Range;

Unit V: Case Study:
(i) RF Design for Conventional Radar
(ii) RF Design for Active Phased Array Radar

Course Outcome

CO1: RF and Microwave signal understanding; light mathematical treatment
CO2: Understand the concept of Signal generation, LO, and Frequency planning
CO3: Analyze RF budget and path loss;
CO4: Understand the complete RF and Microwave chain of a Radar with two case studies.
CO5: Able to design a hypothetical radar RF chain.

Text Books

1. Radar RF Circuit Design by Nickolas Kingsley, Joseph R Guerci
2. Microwave Engineering by David Pozar

Reference Books / Materials

1. RF Circuit Design for Wireless Applications by UlrichL Rohde et al.
2. Microwave and RF Design: A Systems Approach by Michael Steer
3. Microwave, Radar and RF Engineering by Prakash Kumar Chaturvedi
4. Antenna Theory – Analysis and Design by CA Balanis

Course Code & Title

RT X04 - Radar Signal Generation, Reception, Digitization and Processing

Course Context

The goal of this course is to understand how to generate a Radar baseband signal digitally and upconvert for transmission; Different waveforms such LFM, Phase coded, Barker, Frank etc. are discussed; Concept of Pulse, Dwell and Burst are discussed; DDS based LFM generation is introduced; In the receive path, various stages of down conversion and conversion to IF for digitization using ADC, Signal sample schemes viz. Nyquist, Under sampling, Over Sampling, compressive sampling are described; The signal processing steps such as pulse compression, MTI, CFAR, Doppler processing, Centroiding, Monopulse, Magnitude etc. for extracting the target detections is presented; Introduction to Radar data processing, Filtering is presented with qualitative treatment of Kalman filter; The target plot data is extracted and various fields of the plot report are discussed for transmission to next level processing;

Course Objectives

1. Understand the concept of waveform generation; Concepts of LFM, Barker, Frank, Polyphase code; Pulse compression.
2. Learn about dwell, burst, pulse, integration – coherent and noncoherent; coherent processing; Digitization using ADCs and sampling concepts;
3. Understand the Signal processing steps along with mathematical treatment – Pulse compression, MTI, CFAR, Magnitude, Doppler, Monopulse etc.; Architecture of a typical signal processor – GPGPU and FPGA-based.
4. Understanding the data links, handling high-speed data and real-time data transmission for signal processing
5. Learn on basic concepts of Radar data processing, Kalman filter and plot/track data extraction and sending to the next level;

Course Content

Unit I: Introduction:
Waveforms and types: PRT, PRF, LPRF, MPRF, HPRF; Dwell, Burst; Timing generation; Matched Filtering & Pulse compression concepts; characteristics of LFM, Barker, Frank, Polyphase coded waveforms; Digital synthesis of the same; Ambiguity Diagram – Range Doppler Visibility & Mismatched Filtering

Unit II: Digitization Principles:
ADC sampling; Filters; ENOB and linearity; SFDR; down conversion; example architecture; multi-channel data and channel synchronization; Channel imbalance (gain and phase);

Unit III: Signal Processing:
Data formatting; Digital signal processing algorithms – Pulse compression, MTI, Magnitude, CFAR, Doppler processing; Platform motion compensation; Monopulse; Clutter, Noise and Multipath handling; coherent and non-coherent integration; Principles of ECCM Techniques;

Unit IV: Radar Data processing (RDP):
Plot Data validation; data correlation; Filtering using Alpha-Beta and Kalman Filters; Data extraction and transmission;

Unit V: Case study:
Signal Processing Architectures Signal processor architectures and hardware platforms – FPGA, GPGPU, Multi-processors, SoC; typical software flow;

Course Outcome

CO1: Learn Digital Signal generation and up conversion; Pulse, Dwell, burst concepts understanding; CO2: Various waveforms like LFM, Polyphase code etc.., generation and their characteristics / utility; CO3: Understand a typical signal processor chain in the radar and architecture; Implementation aspects on platforms like FPGA, GPGPU, Multi-processor; criticality of software/firmware;
CO4: Plot data extraction and Filter implementation concepts;

Text Books

1. Fundamentals of Radar Signal Processing by Mark Richards
2. Principles of Modern Radar: Volume 1 - Basic Principle by Mark Richards, Jim Scheer, William Holm
3. Airborne Radar by Stimson
4. Introduction to Radar Systems by MeryllSkolnik

Reference Books / Materials

1. Radar Handbook by MeryllSkolnik
2. Tracking and KalmanFilterMade Easy by Eli Brookner

Course Code & Title

RT X05 – Radar Software and Computing Systems

Course Context

Software plays a very critical role in the modern radar systems design and realization. Most of the functions in a Radar are achieved either through Firmware and/or Software. Radar control, Signal Processing, Digitization, Waveform generation and Display, including HMI, are the major software/firmware functions. Computer networking is also extensively used in modern radar systems for communication among the subsystems and for transmitting the data to the external interfaces for utilization of the data and integration into a larger system. The software design, development, testing and integration activities are significant in the success of a Radar development. Real-time operations with strict timing constraints in a multi-tasking, multi-processor environment have to be given importance. The course aims to introduce the various software components and their functions, along with the criticalities to be considered. Software interface design, IRS, and IDD are also brought out in a subtle way to give qualitative treatment to the software and firmware for Radar Systems.

Course Objectives

1. Introduction to Radar software Systems and Architecture; Real-time systems, multitasking and multi-processing concepts; Computer networking and other communication interfaces;
2. Learning about typical Radar Software components (CSCIs) and their functions;
3. Learning about typical Radar Firmware components and their functions;
4. Software interface requirements and description
5. Understanding the Real-time and time-criticality in radar systems, Software / Firmware;

Course Content

Unit I: Fundamentals of Real-time software:
Real-time systems, multi-tasking and multi-processing concepts;

Unit II: Radar System Software- Introduction:
Radar System functions; Software system context and block diagrams; Allocation of functions to Software and Firmware. Software Components of Radar Systems; Firmware components of Radar; Computing platforms for Radar systems; Choice of operating system and programming languages; Computer networking and other communication interfaces; Highspeed data interfaces; protocols;

Unit III: Radar software architecture, subsystem functions and detailed function mapping to Subsystems:
List of all Software components - Radar Controller & Scheduler, Data Processor, Display, Maintenance Computer; Functional allocation to sub-systems and interfaces between subsystems; Typical Firmware components and interaction with other system elements;

Unit IV: Radar Firmware:
Waveform and Timing generation; Signal processing schemes; High speed data handling; real-time constraints;

Unit V: Software Integration &Testing:
Simulators; Radar control software integration along with timing generation; HMI integration; Radar software and firmware test methodologies – introduction; Software standards and certification requirements;

Course Outcome

CO1: Radar system software architecture understanding
CO2: Functional mapping of radar functions to software and subsystems;
CO3: Understand the time-critical nature of radar software; multi-task, multi-processor systems
CO4: Understand high-performance requirements of Radar and high-speed data handling;
CO5: Learn concepts of radar software and firmware testing along with simulators; certification process.

Text Books

1. Modern Operating Systems, TaunenBaum
2. Modern Operating Systems, William Stallings

Reference Books / Materials

1. Software Engineering, Pressman
2. Object-Oriented Systems Design, Grady Booch
3. Advanced C – Tips and Techniques, Paul Anderson and Gail Anderson

Course Code & Title

RT X06 - Auxiliary Systems for Radars

Course Context

A radar is a multi-disciplinary system with integration of various hardware elements ranging from mechanical, electrical, Communication, Electronics, Software and firmware. Pedestal assembly, power system and power supplies, Cooling system are the critical auxiliaries. To get the required performance as per design, it is essential to follow the assigned tolerances at every stage. The non- compliance of the system parameters could be mainly due to these auxiliary systems, which are often not given adequate importance. The pedestal levelling issues, instrumentation/measurement accuracies play an important role. As the EM energy is generated through transmitting devices, the efficiency of the device is always less than 50%. The unused electrical power is dissipated as heat, which needs to be effectively removed, where the cooling system becomes critical along with the cooling circuitry and medium. For large radar systems, a set of DG sets needs to be employed to provide captive power and also to ensure high reliability in the operational fields. Also, the antenna electronics are typically fed by DC, which necessitates a bulky rectifier or individual power converters for AC to DC and also DC to DC. The objective of the course is to introduce all these auxiliary systems and enable the students to think comprehensively about the radar design and development rather than only limiting to electronics; For deployment of large systems, even civil infrastructure matters, as proper hard standing is essential for unhindered operation of the radar in the long run against vagaries of earth and its stability and environment.

Course Objectives

1. Understand various auxiliary systems of a radar and their functions
2. Learn about the intricacies of mechanical hardware and their design, including compensating mechanisms;
3. Understand cooling requirements; design considerations; cooling system design and cooling flow interfaces;
4. Power supply requirements, criticalities; design considerations for power distribution and power converters;
5. Safety and protection mechanisms; civil infrastructure requirements; instrumentation needs;

Course Content

Unit I: Mechanical System:
Pedestal, antenna, level mechanism; Static and dynamic analysis; survivability; alignment and bias estimation / correction; harmonization concepts; material selection; rotary joints;

Unit II: Thermal engineering and Cooling systems:
Thermal contributors and subsystems; Thermal calculations; Cooling system requirements and redundancy; Cooling circuit and medium (air, liquid…); Safety and protection mechanism; reliability;

Unit III: Power System:
Calculation of electrical Power requirements for a Radar; Power system considerations and design; power conversion (AC to DC, DC to DC); control and efficiency; surge protection and capacitor design; Power sequencing;

Unit IV: Civil infrastructure &Safety:
Infrastructure, construction, lightning protection; Radiation Safety; Radomes;

Unit V: Miscellaneous:
INS; GPS; maintenance issues; packaging and dimensions; Transportation; SWaP optimization; Quality Requirements;

Course Outcome

CO1: Describe the need for auxiliary systems and their criticality.
CO2: Understanding Mechanical and Thermal Needs.

CO3: Analyze Power System requirements and power distribution, understanding efficiency and surge design
CO4: Understand the requirement of proper civil infrastructure;
CO5: Knowledge on other measurement instruments such as INS, GPS and integrated operation; Packaging;

Text Books

1. A Textbook of Electrical Technology Volume 2: AC and DC Machines (In S.I. Units) - by B L Theraja and A K Theraja
2. Power Electronics Devices, Circuits, and Applications, Muhammad H. Rashid, Pearson Publisher.
3. Basic Mechanical Engineering Paperback – by Dr D.S. Kumar
4. Vibration Analysis for Electronic Equipment- Dave S. Steinberg
5. Cooling Techniques for Electronic Equipment -Dave S. Steinberg

Reference Books

1. Statics and Dynamics of Structures by Kam Tim Chau
2. Blake's design of Mechanical Joints by Harold Josephs and Ronald Huston
3. Design and Optimization of Thermal Systems by Yogesh Jaluria
4. Mechanical Engineering Design-Shigley
5. Power Electronics: Converters, Applications and Design by Ned Mohan
6. Construction Inspection Handbook: Quality Assurance and Quality Control by Paul S, Chinowsky.
7. Global Positioning Systems, Inertial Navigation and Integration by Mohiner S Grewal et al
8. Heat transfer: A practical approach- Yunus a Cengel
9. Material selection for mechanical design- M Ashby
10. The Theory of Machines - Bevan Thomas

Course Code & Title

RT X07 – Radar Systems Integration, Testing and Performance Evaluation

Course Context

Radar System Integration, leading to System testing and performance assurance, is a major task in ensuring the delivery of a working radar. Various tests need to be carried out at module level, subsystem level and integrated system level; Performance of the entire Radar can be assured only when all the constituents are in agreement with the design; Testing at each subsystem and characterization is a must activity. The antenna, after assembly, has to be subjected to collimation and calibration to ensure the antenna is performing as expected and is giving the required beam patterns and beam pointing errors. The performance of the system has to be measured against known conditions; The course aims at giving insights into these aspects as well.

Course Objectives

1. Understand the fundamentals of the testing system and subsystems.
2. List out test cases and test procedures; define pass/fail criteria.
3. Antenna calibration and pattern measurements.
4. Performance evaluation.

Course Content

Unit I: Introduction to Test Cases and Test Procedures:
Test cases and procedures; critical sub-system test cases and procedures (Exciter, Receiver, Signal Processor, TRM modules… etc.); test reports; System to Sub-System Test case mapping;

Unit II: System Integration:
Power & cooling integration; Timing integration; Data interface check for all subsystems – Antenna, Radar computer, Exciter/receiver, HMI; Antenna integration;

Unit III: Antenna Calibration:
Collimation and Calibration definitions; NFTR integration; Antenna calibration; Phase and Gain matching process; Pattern measurement; Beam pointing errors;

Unit IV: System Integration Evaluation:
Data handling, recording and analysis of the test data at each stage; Testing with Target simulator - BITE, Beacon, RTS, RES; Profile planning for Testing with actual targets and execution;

Unit V: Performance Analysis of System:
Definition, Range, Angle resolution, Angle accuracy, RCS, etc. Introduction to tools design and development for performance analysis; Concepts of System qualification.

Course Outcome

CO1: Describe the System performance analysis
CO2: Subsystem testing and System Testing; test cases definition
CO3: Performance analysis concepts and tools; an example case;

Text Books

1. Fundamentals of Radar Signal Processing by Mark Richards
2. Principles of Modern Radar: Volume 2-Advanced Techniques by Mark Richards, Jim Scheer, William Holm
3. Airborne Radar by Stimson

4. Radar Systems Principles, Harold R. Raemer, CRC Press

Reference Books

1. "System Safety Skeptic" by Terry L Hardy., Author House 2010
2. "Engineering a Safer World: Systems Thinking Applied to Safety" by Nancy G. Leveson, MIT Press, 2012.
3. "Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment is an Aerospace Recommended Practice from SAE," ARP4761.
4. "System Reliability Theory: Models, Statistical Methods & Applications", Marvin Rausand and ArnljotHoyland, John Wiley & Sons, 2004
5. Radar Signal Analysis and Processing using MATLAB by Bassem R Mahafza

Course Code & Title

RT X08 - Systems Engineering for Radar

Course Context

This course typically covers the design, development, and operation of Radar Systems, including subsystem design; understanding QR and its compliance. Integrates multiple engineering disciplines to ensure the successful performance of a Radar in its intended mission. Generation of System Specification document, Templates for PDR document, Test plan generation, Test procedure and Test reports; typical user trials and system withdrawal concepts are presented; Maintenance and Obsolescence concepts are introduced.

Course Objectives

1. Understand the fundamental concepts of Radar design and engineering.
2. Study the radar environment, including operational requirements, thermal effects and EM environment.
3. Learn about key Radar subsystems and functional requirements, specification mapping;
4. Study Radar operational and maintenance requirements and mission analysis; internal and external communications with respect to the application of Radars.

Course Content

Unit I: Introduction:
System engineering aspects of generic Radar; System engineering, Test & Evaluation management; Requirement engineering; MoEs&MoPs; QR analysis & compliance - an example; Baselines definition;

Unit II: Mission Functions and System Analysis:
Design decisions and constraints; Documents and their typical contents;

Unit III: System Interfaces:
Radar inter-element and intra-element Communications - ICD, IRS, IDD; External Interfaces;

Unit IV: System Integration:
Introduction to the complexity of Radar integration; Various stages of integration; SIP generation; Various steps and time required; generating an integration plan;

Unit V: System documentation:
Documentation Plan; Formats and Traceability; configuration management.

Course Outcome

CO1: Understand the Radar Environment: Demonstrate knowledge of the radar operational environment and field operations; QR compliance;
CO2: Radar design considerations; alternate analysis;
CO3: System documentation and traceability.
CO4: Internal and external interfaces definition and design. ICD, IRS, IDD;

Text Books

1. System Engineering and Analysis by Benjamin S Blanchard and Walter J Fabrycky
2. System Engineering Principles and Practice by Alexander Kossiakoff, William N Sweet
3. Radar Systems Principles, Harold R. Raemer, CRC Press

Reference Books / Materials

1. System Engineering Management by Benjamin S Blanchard