AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

DEPARTMENT OF AEROSPACE ENGINEERING

M. Tech. in DEFENCE TECHNOLOGY

CURRICULUM AND SYLLABI

(2023)

Curriculum 2023: M. Tech. in Defence Technology

Semester – 1

Course Code	Courses	Periods/Week			Total Credits
		L	T	P	
23DT601	Systems and Warfare Platforms	4	0	0	4
23DT602	Warfare Simulations & Strategies	4	0	0	4
23DT603	Advanced Engineering Mathematics	4	0	0	4
23DT681	Systems and Platforms Lab	0	0	3	1
23DT682	Warfare Simulations & Strategies Lab	0	0	3	1
EL-1 / 23DT604*	Elective 1(AT)/Radar Technologies (CSS)	3/4	-	-	3/4
EL-2 / 23DT605*	Elective 2(AT)/Advanced Communication Technologies (CSS)	3/4	-	-	3/4
	Total credits				20/22

AT: Aerospace Technology CSS: Communication Systems & Sensors

Semester-1 Elective Courses

Couse Code	Elective 1		Periods/Week		
		L	T	P	Total Credits
23DT631	Advanced Thermal Engineering	3	0	0	3
23DT632	Numerical Methods for Science & Engineering	3	0	0	3
23DT633	Advanced Solid Mechanics	3	0	0	3
23DT634	Flight Stability and Control	2	1	0	3
	Elective 2				
23DT641	Rockets & Missiles Fundamentals	3	0	0	3
23DT642	Optimization Theory & Applications	3	0	0	3
23DT643	Advanced Gas Dynamics	3	0	0	3
23DT644	Advanced Fluids Mechanics	3	0	0	3

Semester - 2

1. Aerospace Technology

Course Code	Compulsory Courses	Periods/Week			Total Credits
		L	T	P	
23DT611	Aerospace System Configuration, Design & Simulation	4	0	0	4
23DT612	Guidance, Navigation, and Control	4	0	0	4
23DT613	Aerospace Propulsion	4	0	0	4
23DT683	Computational Lab	0	0	3	1
23DT684	Guidance & Control Lab	0	0	3	1
	Elective Courses				
	Elective 1	3	0	0	3
	Elective 2	3	0	0	3
23DT697	Seminar	0	0	3	1
Total credits					21

2. Communication Systems & Sensors

Course Code	Compulsory Courses	Periods/Week			Total Credits
		L	T	P	
23DT614	Embedded Systems	3	1	0	4
23DT685	Radar Technologies Lab	0	0	3	1
23DT686	Embedded Systems Lab	0	0	3	1
	Elective Courses				
	Elective 1	3	0	0	3
	Elective 2	3	0	0	3
	Elective 3	3	0	0	3
	Elective 4	3	0	0	3
23DT698	Seminar	0	0	3	1
Total credits					19

Elective Courses offered for Semester 2 (Aerospace Technology)

Course Code	Elective Courses	Periods/Week			Total Credits
		L	T	P	
23DT651	Advanced Lightweight and Composite Structures	3	0	0	3
23DT652	Finite Element Methods for Defence Structures	3	0	0	3
23DT653	Launch Vehicle Design & Analysis	3	0	0	3
23DT654	Combustion	3	0	0	3
23DT655	Computational Fluid Dynamics for Defence Applications	3	0	0	3
23DT656	Structural Dynamics and Aero-elasticity	3	0	0	3
23DT657	Turbomachinery	3	0	0	3
23DT658	Unmanned Aerial Vehicle Design	3	0	0	3

Elective Courses offered for Semester 2 (Communication Systems & Sensors)

Course Code	Elective Courses	Periods/Week			Total Credits
		L	T	P	
23DT661	Digital and Satellite Communication and Navigation from Space	3	0	0	3
23DT662	Tactical Battle Field Communication and Electronic Warfare	3	0	0	3
23DT663	Software Defined Radio	3	0	0	3
23DT664	EMI/EMC in Military Systems	3	0	0	3
23DT665	Sensor Technology	3	0	0	3
23DT666	Avionics	3	0	0	3
23DT667	Fundamentals of Telemetry, Tele Command and Transponder	3	0	0	3
23DT668	Autonomous Navigation Technology	3	0	0	3
23DT669	Defence Electro Optics	3	0	0	3

Semester - 3

	Course	Credit
23DT798	Project Dissertation- Phase 1	14
	Total credits	14

Semester – 4

	Course	Credit
23DT799	Project Dissertation Phase-2	20
	Total credits	20

Total Credits = 75

Syllabus

Semester -1

Course Title : Systems and Warfare Platforms
Course Code : 23DT601
Teaching Scheme : L: 4, T: 0, P:0 Credits: 4

Course Objectives:

The main objective of the course is to provide knowledge to the students about various types of military platforms used in air, naval & land warfare. Students will also be apprised for weapon system and self-protection strategies and techniques.

Course Outcomes:

At the end of the course the student should be able to

- Understand types of warfare platform used for Army, Air and Marine and their design fundamentals.
- Understand the weapon systems like guns, ordnance, missiles projectiles, mines/ countermines, lasers, undersea weapons, air-launched weapons, anti-aircraft, anti-ship and anti-submarine.

Course Content:

Unit	Contents	Contact Hrs.
1.	Types of platforms: land, sea, air; Lifecycle: concept, design, pre-production, production, operations, support.	7
2.	Ship design fundamentals: buoyancy, stability, ship resistance, survivability; damage control, NBCD, crew numbers, power requirements. Submarine design: buoyancy, stability, hull/tank design, air interdependence.	7
3.	Mechanics of flight: fixed and rotary wing, straight and level flight of aircraft, aircraft control and movement, aircraft control surfaces, aerodynamics, power requirements, range; speed, ceiling, survivability, payload.	7
4.	Military vehicle fundamentals: tracked, wheeled, A, B and C vehicles.	7
5.	Weapon systems: guns, ordnance, missiles, rockets, bombs, sub- munitions, projectiles, mines/ countermines, lasers, undersea weapons, air-launched weapons, anti-aircraft, anti-personnel, anti-ship, anti-submarine.	6
6.	Self defence and Protection systems: Armour, smoke, chaff, decoys; Introduction to instrumentation, lab tests and flight trials.	6
Total		40

References / Suggested Books:

1. “Light And Heavy Vehicle Technology “, by Nunney. Publisher Elsevier.
2. “Practical approach to motor vehicle engineering and maintenance”, by Bon-nick Allan et. Al. Publisher: Yesdee.
3. “Automotive Vibration Control Technology: Fundamentals, Materials, Construc-tion, Simulation, and Applications”, by Trelleborg.
4. “An Introduction to Weapons Systems”, by Yacov Bar-Shlomo. Publisher : Create Space Independent Publishing Platform.
5. “Heavy Vehicle Mechanics”, by Ian Nicholson.Publisher : McGraw-Hill Educa-tion – Europe.
6. “Military Laser Technology for Defense: Technology for Revolutionizing 21st Century Warfare”, by Alastair D. McAulay. Publisher : Wiley-Interscience; 1st edition.
7. Literature / books suggested by respective course Lecturers.

Course Title : Warfare Simulations & Strategies
Course Code : 23DT602
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

Course Objectives:

The main objective of the course is to provide knowledge to the students about warfare system and affluent them with combat modeling using mathematical modeling.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the systems used in warfare scenario.
- Understand combat simulation & modelling
- Understand the war gaming simulation & modelling and human factor representation.

Course Content

Unit	Contents	Contact Hrs.
1.	Introduction to Warfare systems: air, surface, subsurface, littoral, electronic	7
2.	Military capabilities: air warfare, surface warfare, sub surface warfare, littoral warfare	7
3.	Introduction to the methods used in modeling combat and their application in support of defence decision making and training, Combat simulation.	7
4.	War gaming/interactive simulation, Lanchester's equations, Mathematical models of combat.	7
5.	War gaming and combat modeling in practice, manual war gaming.	6
6.	Human factors representation in war gaming and combat modeling.	6
Total		40

References / Suggested Books:

1. "Defense Modeling, Simulation, and Analysis: Meeting the Challenge". Pub-lisher: National Academies Press (October 22, 2006).
2. "Introduction to Electronic Warfare Modeling and Simulation"by David L. Adamy". Publisher : Artech Print on Demand (October 31, 2002).
3. "Engineering Principles of Combat Modeling and Distributed Simulation", by Andreas Tolk (Editor), Old Dominion University. Publisher : John Wiley & Sons.
4. Literature / books suggested by respective course Lecturers.

Course Title : Advanced Engineering Mathematics
Course Code : 23DT603
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students of probability theory, algebra, solutions of Differential equations, Transform techniques, special functions & their applications in the areas with defence relevance.

Course Outcomes

At the end of the course the student should be able to

- Know the methods for solving differential equations, generating functions.
- Understand basic concepts of Fourier Transform, Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution.
- Demonstrate MATLAB programming for engineering problems.
- Understand the utilization of mathematical methods for solving problems having relevance to defence applications.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to Probability and Statistics. Basic Probability theory, statistical distributions, binomial, Poisson, exponential and normal distributions.	8
2.	Introduction to Linear Algebra: Vector space, subspace, row, column and null spaces. Inner product, orthogonality. Gram-Schmidt process and least square approximation.	8
3.	Differential Equations: Ordinary Differential equations (second order), Numerical methods for ODE. PDE, Fourier series, Fourier transform and one-dimensional heat and wave equations.	8
4.	Special functions: Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.	8
5.	Introduction to graph theory: Graphs, degree, types of graphs, and introduction to Ramsey theory.	5
6.	Application areas with defence relevance range from mathematics to computer science.	5
Total		42

References / Suggested Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India Pvt. Ltd., 2011.
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.
3. Michael Greenberg, Advanced Engineering Mathematics, 2nd Edition, Pearson, 2011
4. Engineering Mathematics, Srimanta Pal and Subodh C Bhunia, Oxford university press, 2015.
5. Advanced Engineering Mathematics, Wylie and Barrett, 6th Edition, McGraw Hall India, 2015.

Course Title : Radar Technologies
Course Code : 23DT604
Teaching Scheme : L: 3, T: 1, P: 0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students about learning on the radar systems, radar parameters, radar environment, theory of detection and design of radar elements, different types of radars & their application.

Course Outcomes

At the end of the course the student should be able to:

- Understand the design of radar systems, solve range equations.
- Apply appropriate mathematical and computer models relevant to radar systems to calculate system performance, and assess the limitations of particular cases • Understand the major components of a modern radar system
- Learn basic radar signal processing techniques.
- Understand advanced radar techniques.
- Know the major functions and applications of a modern radar systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to RADAR, Radar parameters/definitions, radar equations.	6
2.	Radar cross section (RCS) & Theory of detection, Clutter.	6
3.	Atmospheric propagation, Surveillance and Tracking Radar, Radar Designs.	6
4.	Materials for Radar System design, Various types of Aerospace Radar Components – specifications and applications, Radar elements Design, Radar Transmitter design, Radar antenna design, Duplexer/TR switch & Radar Receiver. Millimetre wave propagation.	7
5.	Radar signals and networks, Radar signal processing chain, Pulse compression and micro-doppler processing, Tracking algorithms	7
6.	Phased array radar, Data processing for phased array radar, Airborne radar, imaging radar, Synthetic aperture radar, inverse synthic aperture radar, adaptive array processing.	8
Total		40

References / Suggested Books:

1. “Introduction to Radar Systems”,by M.I. Skolnik. Publisher: Tata Mcgraw hill edition, 2001.
2. “Radar Systems Analysis and Design using MATLAB”,by B.R.Mahafza. Publisher CRC Press, 2013.
3. “Monopulse Principles and Techniques”, by S.M.sherman and D.K.Barton. Publisher : Artech house, 2011
4. “Fundamentals of Radar Signal Processing”, by M.A.Richards. Publisher Tata Mcgraw hill.
5. “Ground Penetrating Radar: Theory and Applications”,by, Editor: H.M. Jolt. Publisher: Elsevier.
6. "Radar, Sonar And Navigation Engineering", by K. K Sharma. Publisher: S K Kataria& Sons.
7. Literature / books suggested by respective course Lecturers.

Course Title : Advanced Communication Technologies
Course Code : 23DT605
Teaching Scheme : L: 4, T: 0, P:0 Credits: 4

Course Objectives:
Provide insight to the advanced principles, design and application of Digital communication systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Elements of a communications system and their relationship to system performance. Review of Microwave Communications - Overview of satellite communications.	8
2.	Communications system components and functions, analog and digital communications systems, Satellite subsystems – AOCS - TTC&M - Power and communication subsystems - Computations and controlling by processors.	8
3.	Modulation transmission and reception; baseband and passband digital modulation; - Satellite multiple access schemes – FDMA - TDMA and CDMA - Spread spectrum concepts	8
4.	Comparison of multiple access schemes. - System, noise FEC techniques for mitigating channel errors.	8
5.	Propagation effects on signal transmission; end-to-end path calculations for RF systems including terrestrial ground links and satellite communications.	8
Total		40

References / Suggested Books:

1. “Satellite communication”, by T. Pratt, C. W. Bostian, J. E.Allnut. Publisher: John Willey and sons
2. “Satellite Communications Systems: systems, techniques and technology”, by G. Maral, M. Bousquet, Z. Sun. Publisher:John Willy and sons
3. “Satellite Communication Systems Engineering”by Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, , Prentice Hall/Pearson, 2007.

Course title : Systems and Warfare Platforms Lab
Course Code : 23DT681
Teaching Scheme : L: 0, T:0, P: 3 Credits: 1

Lab experiments will be added in consultation with DRDO labs considering the available facilities.

Course title : Warfare Simulations & Strategies lab
Course Code : 23DT682
Teaching Scheme : L: 0, T: 0, P: 3 Credits: 1

Lab experiments will be added in consultation with DRDO labs considering the available facilities.

Semester II

Semester – 2 (Compulsory Courses)

1. Aerospace Technology

Course Title : Aerospace System Configuration, Design and Simulation
Course Code : 23DT611
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

Course Objectives
The main objective of the course is to provide knowledge to the students about the process & techniques of aerospace system design, meeting the specified design requirements. They will also learn about carrying structural and aerodynamic analysis, performance evaluation of aircraft and stability analysis.

Course Outcomes:
At the end of the course the student should be able to:

- Understand the concept of missile system and its design requirements and process.
- Design an aerospace vehicle and articulate its benefits in written and verbal forms.
- Understand the methods for aero-elastic analysis, computational fluid analysis and advances in aero-dynamics.
- Understand the air to air, ground to air, air to ground weapon system, UAV mounted GW and UCAVs.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction (aero-elastic phenomena and design requirements), Introduction to missiles & systems, Design process.	6
2.	Structural requirement, Structural and aerodynamic stiffness, Static aero-elasticity: torsional divergence, Structural vibration and modal analysis.	6
3.	Aerodynamic loads on an oscillating lifting surface, Characteristics of flutter and important design parameters, Methods for aero-elastic analysis, Computational fluid dynamics, advances in aero dynamics (Hypersonic Flows and Aerodynamic Heating).	7
4.	Aircraft performance (cruising, climb, descent, takeoff, landing, maneuver, flight path).	7
5.	System's stability & control, aerodynamics control, Introduction to dynamic stability, first and second order responses, Equations of motion and modal characteristics.	7
6.	Introduction to air to air, ground to air, air to ground weapon systems, UAV mounted GW and UCAVs.	7

Total	40

References / Suggested Books:

1. "Aircraft design: a conceptual approach", by D. Raymer
2. "Flight Dynamics Principles", by Michael V. Cook
3. "Introduction to Structural Dynamics and Aeroelasticity", by Dewey H. Hodges, G. Alvin Pierce
4. "Airplane Aerodynamics and Performance", by Chuan Tau Edward Lan 5. "Fundamentals of Structural Dynamics", by Roy R. Craig Jr., Andrew J. Kurdila.
5. Literature / books suggested by respective course Lecturers.

Course Title : Guidance, Navigation and Control
Course Code : 23DT612
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students about fundamental of satellite navigation, navigation mathematics, principles of radio navigation, INS/GNSS integration and missile control methods.

Course Outcome:

At the end of the course the student should be able to:

- Understand the principles of satellite navigation, inertial navigation, radio positioning.
- Understand various aspects of designing a navigation system.
- Develop mathematical model of missile dynamics.
- Carry out simulation for aircraft/missile using mathematical tools like MATLAB.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to Navigation, Navigation Mathematics.	6
2.	GNSS: fundamentals, Signals, and Satellites: Fundamentals of Satellite Navigation, Inertial Navigation, Advanced satellite Navigation, Principles of radio Positioning, Terrestrial radio Navigation, Short-Range Positioning, Satellite Navigation Processing.	7
3.	Errors and Geometry, Dead Reckoning, Attitude, and Height Measurement, Feature matching, INS/GNSS Integration.	6
4.	Missile Control Methods: Aerodynamic and Thrust Vector Control, Polar and Cartesian Control.	6
5.	Mathematical Modeling of Missile Dynamics; Missile Actuators and Sensors. Roll and Roll Rate Stabilization.	8
6.	Design and Analysis of Lateral Autopilots, 6 DOF simulation for aircraft/missile using MATLAB	7
Total		40

References / Suggested Books:

1. "Modern Inertial Technology Navigation, Guidance, and Control", by Anthony Lawrence 2012. Publisher :Springer New York.
2. "The Global Positioning System & Inertial Navigation", by Jay Farrell. Publisher : McGraw-Hill Education (16 December 1998).
3. "MATLAB for Engineering Applications", by William Palm. Publisher : McGraw-Hill Education; 4th edition (February 6, 2018).

4. “Global Navigation Satellite Systems, Inertial Navigation, and Integration”, by Grewal, M. S., Andrews, A. P., Bartone, C. G. (2013). Publisher: John Wiley and Sons Inc.
5. “Principles of GNSS, inertial and multi-sensor integrated navigation systems”, by Groves, P. D. Publisher: Artech House.
6. “Optimal State Estimation”, by Kalman, H Infinity.
7. “Nonlinear Approaches”, by Simon, D. (2006). Publisher: Wiley-Interscience
8. Literature / books suggested by respective course Lecturers.

Course Title : Aerospace Propulsion
Course Code : 23DT613
Teaching Scheme : L: 4, T: 0, P: 0 Credits: 4

Course Objectives

The main objective of the course is to provide knowledge to the students about different criteria for the selection and evaluation of different types of propulsion systems, analysis of propulsion systems and the thermodynamics behind the critical parts of Aerospace system.

Course Outcomes

At the end of the course the student will have:

- Knowledge about thermodynamics and fluid dynamics behind the aerospace system.
- Understanding of Rocket motor design
- Understanding of different design aspects related to propulsion systems used in aerospace.

Course Content

Unit	Contents	Contact Hrs.
1.	Classification & mode of operation of various propulsion systems, basis thermodynamics & fluid Dynamics.	7
2.	Rocket motor design & analysis, Gas Turbine Engine design, GT engine efficiency, GT engine heat transfer & cooling.	8
3.	Aircraft performance, jet engine performance.	6
4.	Jet engine control (compressor performance, axial turbine performance, Fuel systems & pumps, airframe fuel systems, hydro-mechanical fuel metering, Electronics engine control)	7
5.	System integration	6
6.	Computational fluid dynamics (flow modelling strategies, physical modelling, finite difference equations, etc.)	6
Total		40

References / Suggested Books:

1. "Rocket Propulsion Elements", by George Paul Sutton and Oscar Biblarz. Pub-lisher: John Wiley & Sons
2. "Modern Engineering for Design of Liquid-Propellant Rocket Engines: Progress in Astronautics and Aeronautics Series" by Dieter K. Huzel, David H. Huang.
3. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" by H. Versteeg. Publisher : Pearson; 2nd edition.
4. "Computational Fluid Dynamics the Basics with Applications" by John D. Anderson, Jr. Publisher : McGraw Hill Education (1 July 2017)
5. "Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics", by C. S. Jog. Publisher : Cambridge University Press; 3rd edition.

6. “Parallel Processing for Jet Engine Control”’ by Thompson, Haydn A, Publisher: Springer- Verlag London
7. “Fundamentals of Machine Component Design”, by Robert C. Juvinall, Kurt M. Marshek. Publisher : John Wiley & Sons.
8. “Gas Turbines for Electric Power Generation”,by S. Can Gülen.
9. “Gas Turbine Theory “,by H.I.H. Saravanamuttoo , Prof G.F.C. Rogers , H. Co-hen. Publisher : Prentice Hall.
10. “Elements of Propulsion: Gas Turbines and Rockets” by Jack D. Mattingly, Keith Boyer. Publisher : American Institute of Aeronautics & Astronautics.

Course title : Computational Lab
Course Code : 23DT683
Teaching Scheme : L: 0, T: 0, P: 3 Credits: 1

Numerical Fluid Simulations
Experiments:

1. Introduction to ANSYS Fluent.
2. Simulation of incompressible flow over external objects such as flow over cylinder and flow over airfoil.
3. Simulation of compressible flow through nozzle, jet expansion study, and flow over nose cone.

Finite Element Simulations
Experiments:

4. Introduction to ABAQUS.
5. Bending & buckling of beams: Cantilever and simply supported. Stress analysis of Plate with holes and crack propagation
6. Stress Analysis of composite structures, modal analysis of plates & beams.

Course title : Guidance & Control lab
Course Code : 23DT684
Teaching Scheme : L: 0, T:0 , P: 3 Credits: 1

1. Vehicle Simulation using Matlab and Simulink.
2. Date acquisition and processing using flight simulator.
3. PID tuning of inverted rotary pendulum.
4. PID tuning for VTOL setup.

2. Communication Systems & Sensors

Course title **Embedded Systems**
Course Code **23DT614**
Teaching Scheme **L: 3, T:1, P: 0 Credits: 4**

Course Objective

Introduce the students to micro controllers, embedded systems and interfacing with real world data acquisition systems

Unit	Contents	Contact Hrs.
1.	Microcontroller fundamentals: ARM ASM programming and basic of C; IO Interfacing: LED and Switch	6
2.	Design and Development Process: Architecture, Microarchitecture, Design, Implementation, Verification and Validation	8
3.	Development Tools: Block Diagrams, Flow Charts, Call Graphs, Dataflow Graphs, Finite State Machines; The Parallel Interface: GPIO; The Serial Interface: UART, I2C, SPI	6
4.	PLL programming; Timer: SysTick; Fixed Point; Software: Structs, Stacks and Recursion; Device Driver: Interfacing with an Hitachi HD44780 display; IO Synchronization; Interrupts; DAC: Music Synthesis and Music Playback	8
5.	ADC: Real world interfacing and Data Acquisition. Significant labs include prototypes of actual embedded systems, e.g., Traffic Light Controller (FSM), LCD Device Driver (Hitachi HD44780), Digital Piano (DAC, Interrupts), Digital Vernier Caliper (ADC, Interrupts, LCD), Distributed Data Acquisition (Interrupts, ADC, LCD, UART).	8
6.	Capstone Design Project, A popular video game, e.g., Space Invaders, Connect-4, Pipe Dream, etc.	4
Total		40

References / Suggested Books:

1. Jonathan W Valvano, “Embedded Systems: Introduction to ARM® Cortex™-M Microcontrollers”, Fourth Edition, CreateSpace Independent Publishing Platform, 2013.

2. Joseph Yiu, “The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors”, Third Edition, Newnes, 2013.
3. Martin, “The Designer’s Guide to the Cortex-M Processor Family: A Tutorial Approach”, First Edition, Newnes, 2009.
4. Arnold S. Berger, “Embedded System Design”, First Edition, CRC Press, 2001.

Course title **Radar Technologies Lab**
Course Code **23DT685**
Teaching Scheme **L: 0, T:0, P: 3**
Credits: 1

1. Waveguide Characterization experiment
2. RCS determination of materials
3.Simulation Experiments employing Ansoft HFSS

Course title **: Embedded Systems Lab**
Course Code **: 23DT686**
Teaching Scheme **: L: 0, T:0, P: 3** **Credits: 1**

Each student in consultation with the faculty in-charge will select a topic related to embedded systems and applications and develop an embedded product/system following the embedded system design principle

Semester I

Elective – I Courses

Aerospace Technology

Course Title : Advanced Thermal Engineering
Course Code : 23DT631
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives

The main objective of the course is to provide knowledge to the students for the thermal management requirements / problems of the defence systems and thermal system design & simulation for the various air, land & naval defence systems utilized under different environmental conditions.

Course Outcomes:

At the end of the course the student should be able to

- Understand thermal design and simulations for system design.
- Carry out CFD simulations, design of heat exchangers, refrigeration.
- Understand the concept of thermal management requirement & design for defence systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	System thermal design & Analysis, Tools for thermal design and simulation, Heat transfer analysis (conduction, convection & radiation),	7
2.	Computation fluid dynamics (CFD), Thermal Finite Element Analysis	7
3.	Heat Exchangers for: Heat Exchanger Network Design	6
4.	Refrigeration, Humidifiers, Air Washers and Cooling Towers	5
5.	Thermal management design of defence system (combat vehicles, missiles, aerial vehicles etc.)	6
6.	Thermal testing, thermal operation, and integration of thermal design into the defence systems.	5
Total		36

References / Suggested Books:

1. “Fundamentals of Heat and Mass Transfer”, by Incropera and Dewitt. Publication: John Wiley.
2. “Convective Heat and Mass Transfer”, by W M Kays and M E Crawford. Publisher: McGraw-Hill publishing Company.
3. “Thermal Radiation Heat Transfer” by J Siegel and R Howell. Publisher: Elsevier.
4. “Manohar Prasad, Refrigeration and Air Conditioning”, 3rd Edition, New Age International, 2015.
5. “Computational Fluid Dynamics – The Basics with Applications”, by John D Anderson. Publisher :1st Edition, McGraw Hill, 2012.
6. “Thermal System Design and Simulation”, by P.L. Dhar, 1st Edition.
7. Literature / books suggested by respective course Lecturers.

Course Title : Numerical Methods for Science and Engineering
Course Code : 23DT632
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

Course Objectives

The main objective of the course is to provide knowledge to the students to develop numerical methods aided by technology to solve algebraic equations, calculate derivatives and integrals, curve fitting and optimization techniques. The course will also develop an understanding of the finite element analysis and computational fluid engineering.

Course Outcomes

At the end of the course the student should be able to:

- Use the numerical techniques (algorithms) to find the solution (approximate) algebraic equations and system of equations.
- Fit the data using interpolation technique and spline methods.
- Use to finite element analysis, interpretation of analysis results.
- Understanding of computational engineering process.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction, solution of non-linear equations, solution of linear systems.	5
2.	Introduction and polynomial approximation, curve fitting, Numerical applications & intergradations, numerical optimization.	5
3.	Matrices and types of linear systems, direct elimination methods, conditioning and stability of solutions,	5
4.	Introduction to Finite Element Analysis (FEA) simulation software, Pre- and PostProcessing, Free mesh and Mapped mesh techniques, Quality checks on nodes and elements, Boundary conditions,	7
5.	Introduction to computational fluid engineering, Fundamental equations, Computational Engineering Process.	7
6.	Fluid Simulation for Computer Graphics, Modelling techniques.	7
Total		36

References / Suggested Books:

1. "Numerical Methods for Scientific and Engineering Computation", by M. K. Jain and S.R.K. Iyengar. Publisher: New Age International Publishers.
2. "Applied Numerical Analysis", by Gerald & Wheatley. Publisher Addison – Wesley.
3. "Introductory Methods of Numerical Analysis", by, S.S. Sastry. Publisher: PHI Pvt. Ltd., 5th Edition,New Delhi, 2009.
4. "Applied Numerical Methods Using MATLAB", by W.Y. Yang, W. Cao, T.S. Chung and J. Morris. Publisher: Wiley India Edn., 2007.
5. "Numerical Methods for Engineers with Programming and Software Applications", by Steven C. Chapra and Ra P. Canale. Publisher: Tata McGraw Hill, 2014 7th Edition.
6. "Finite Element Procedures", by K.J. Bathe, Prentice Hall of India.

7. “Finite Elements in Engineering”, by Chandrupatla and Belegundu.
8. “Finite element Method”, by J.N.Reddy.
9. Literature / books suggested by respective course Lecturers.

Course Title : Advanced Solid Mechanics
Course Code : 23DT633
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

To study and analyse the behaviour of various defence structural members under different load conditions.

Course Outcomes:

At the end of the course the student should be able to

- Understand the concepts of stress and strain at a point as well as the stress-strain relationships for different materials.
- Determine and illustrate principal stresses, maximum shearing stress, and the stresses acting on a structural member.
- Calculate the stresses and strains associated with thin-walled structures subjected to various loads.
- Understand the concept of elastic buckling.

Course Content:

Unit	Contents	Contact Hrs.
1.	Analysis of Stresses and Strains in rectangular and polar coordinates: Cauchy's formula, Principal stresses and principal strains, Stress-strain relationship for isotropic, orthotropic and anisotropic materials- 3D Mohr's Circle, Octahedral Stresses, Hydrostatic and deviatoric stress.	7
2.	Euler – Bernoulli and Timoshenko beam theories, bi-directional bending ,Unsymmetrical Bending, Bending of curved Beams,	6
3.	Torsion of solid circular bar, Torsion of non-circular shafts, Prandtl stress function, St. Venant warping function, Shear Center- torsion in narrow rectangular section - Theories of Failures	6
4.	Elastic stability - Euler's buckling load, beam column, eigenvalue problem	6
5.	General symmetric sections, and thin-walled sections, flexural shear flows (FSF), FSF in thin-walled open sections, shear center in open sections.	5
6.	Torsional shear flows (TSF) in thin-walled open sections, TSF in thin-walled closed sections (single and multiple cells) and warping in open and closed thin-walled sections,	6
Total		36

References / Suggested Books:

1. "Advanced Mechanics of Materials" A.P. Boresi, R.J. Schmidt, John Wiley & Sons, Inc., 6th Edition, ISBN: 0471438812.
2. "Mechanics of Aircraft structures", C. T. Sun, 3rd Edition, John Wiley & sons, New York, 2021.
3. "Strength of Materials" Timoshenko S., 3Ed., Part 1and 2 Advanced Theory and Problems, 2002.
4. "Advanced mechanics of solids " L. S. Srinath, 3rd Edition, McGraw-Hill, 2009.

Course Title : Flight Stability and Control
Course Code : 23DT634
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

The main objective of the course is to provide knowledge to the students about dynamics of flying vehicles, modelling and simulation, and control of flying vehicles.

Course Outcomes

At the end of the course the student should be able to

- Understand flight dynamics of a general flying platform.
- Carry out response simulation of flying vehicle using simple flight dynamic models.
- Carry out stability analysis of flying vehicle using linearized models.
- Understand the fundamentals of autopilot.

Course Content

Unit	Contents	Contact Hrs.
1.	Review of Static stability and Introduction to Dynamic Stability, Review: Body Axis, Stability Axis, Earth Axis – Euler Angles – Transformation between axis	5
2.	Aircraft Equations of Motion- Aircraft Trim: Steady level flight - Coupled and decoupled trim analysis, and Steady level turn,	7
3.	Small Perturbation Theory: Linear Equations of Motion, Stability Derivatives, Longitudinal and Lateral Modes – Concept and Physics – Characteristic Equation	7
4.	State Space Modelling – Response analysis - Transfer Function Approach	5
5.	Flying and Handling Qualities	4
6.	Autopilots – Stability Augmentation System (SAS). Longitudinal Stability Augmentation, Lateral Stability Augmentation – Autopilot Design. Active Control Technology(ACT)	7
	Total	35

References / Suggested Books:

1. M.V. Cook, Flight Dynamics Principles, “A Linear Systems Approach to Aircraft Stability and Control,” 3rd Edition, Elsevier, 2013.
2. Robert C Nelson, "Introduction to Flight Stability and Automatic Control,” 2nd Edition, McGraw-Hill, 1998.
3. Warren F Philips, “Mechanics of Flight”, Wiley, 2004.
4. Literature / books suggested by respective course Lecturers.

Semester I

Elective – II Courses

Aerospace Technology

Course Title : Rockets & Missiles Fundamentals
Course Code : 23DT641
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

Course Objectives:
The main objective of the course is to provide knowledge to the students about missile system, classification of missiles, aerodynamics of missiles, subsystems and missile trajectory.

Course Outcomes:
At the end of the course the student should be able to

- Understand basics of missile and rockets as well as the engineering aspects of missile integration.
- Understand physics behind guided missiles and aero dynamics of missiles.
- Characterization of sub-systems used in missiles.

Course Content:

Unit	Contents	Contact Hrs.
1.	Fundamenntals of Rocket Propulsion, Types of Rockets, Multistaging]	3
2.	Basics of Missile Physics, Classification of Missiles, Missile Aerodynamic Configurations, Introduction to Missile System, Interrelationship between various Missile Sub-Systems.	5
3.	Basic Characteristics of Guided Missile Systems, Missile System Reliability, Range dispersion and CEP Concept,	5
4.	Design, System Layout and integration of Sub-Systems,	7
5.	Coordinate Transformation, Transformation Matrices. Two, Three and Six DOF Equations of Motion, Ballistic Missile Trajectory,	7
6.	Effect of Curvature of Earth, Rotation of Earth, Variation of Gravity on Missile Trajectory.	7
Total		39

References / Suggested Books:

1. "Fundamentals of Guided Missiles",by S. R. Mohan. Publisher : Defence Re-search and Development Organisation.
2. "Estimation and Prediction of Ballistic Missile Trajectories" by Jeffrey A. Isaac-son, David R. Vaughan.Publisher : RAND (29 May 1996)
3. "Introduction to Modern Algebra and Matrix Theory", by O. Schreier, E. Sperner, Martin David, Melvin Hausner. Publisher : Dover Publications.
4. Literature / books suggested by respective course Lecturers.

Course Title : Optimization Theory & Applications
Course Code : 23DT642

Teaching Scheme: L: 3, T:0 , P: 0 Credits: 3

Course Objectives

The main objective of the course is to provide knowledge to the students on the numerical optimization algorithms. The course objective is to cover the concepts of optimization methods and algorithms developed for solving various types of optimization problems. Apply the mathematical results and numerical techniques of optimization theory to various Engineering and Analytics problems and applications in both theoretical and applied research areas.

Course Outcomes

At the end of the course the student should be able to

- Understand mathematical modelling and the formulation of optimization problems.
- Create programs based on different optimization algorithms using IT tools, such as MATLAB etc.
- Understand theory about linear programming, integer programming, and stochastic programming
- Understand the process of finalizing design of engineering systems by applying the numerical optimization.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to optimization, classical optimization techniques.	6
2.	Linear programming & non linear programming and dimensional minimization methods.	7
3.	Non coordination optimization techniques, coordinated optimization techniques, coordinated programming.	7
4.	Dynamic programming, integer programming, stochastic programming.	6
5.	Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques.	5
6.	Additional Topics: multi-objective, optimization, game theory, optical control theory.	5
Total		36

References / Suggested Books:

1. "Numerical Optimization", by Jorge Nocedal and Stephen J.Write. Publisher: Springer, 2006.
2. "Practical methods of Optimization" by R.Fletcher. Publisher : Wiley, 1987.
3. "Iterative method for optimization" by C. T. Kelley. Publisher : SIAM, 1999.
4. "Introduction to Nonlinear Optimization:Theory, Algorithm, and Applicationwith MATLAB. MOSSIAM Series on Optimization",by Amir Becker.
5. "Dynamic Programming and Optimal Control (VolumeI) " by Dimitri P. Bertsekas. Publisher : Athena Scientic, 2005.
6. "Optimization Theory and Applications", by SS Rao.
7. Literature / books suggested by respective course Lecturers.

Course Title : Advanced Gas Dynamics
Course Code: 23DT643
Teaching Scheme: L: 2, T:1, P: 0 **Credits: 3**

Course Objectives:

The course is intended to provide introduction to the impact of compressibility on fluid flow along with the pertinent applications of high speed flows withe shocks, expansion waves, area change, heat transfer and friction.

Course Outcomes: At the end of the course the student should be able to:

- Analyze the impact of shock waves and expansion fans
- Analyze shock reflection and interaction
- Use shock expansion methods for simple shapes
- Analyze flow through CD nozzles
- Comprehend the physics of hypersonic flows

Course Content:

Unit	Contents	Contact Hrs.
1.	Overview of one-dimensional models for normal shock, Fanno flow and Rayleigh flow. Oblique shocks and expansion waves	7
2.	Analysis of detached shocks and their impact on the flow field, applications of detached shock analysis; Shock-shock interaction and shock-boundary layer interaction, shock-induced separation	4
3.	Shock-expansion methods for airfoils; design and functioning of supersonic wind tunnel; Incomplete expansion, shock structures in under-expanded and over-expanded jets	5
4.	Axisymmetric nozzle design using method of characteristics; Heat transfer in high speed flows, Introduction to methods of analysis in conduction, convection and radiation applied to high speed flow	7
5.	Shock-induced heating, thermal shielding; Introduction to hypersonic aerodynamics, equilibrium and non-equilibrium flows,	7
6.	Variation of transport properties of gases, Viscous interactions, aerothermodynamics of hypersonic re-entry vehicles	6
Total		**36**

References / Suggested Books

1. JD Anderson, "Modern Compressible Flow with Historical Perspective", McGraw Hill, 2012.
2. John J Bertin "Hypersonic Aerothermodynamics", AIAA Education Series, 1994.
3. John David Anderson, "Hypersonic and High Temperature Gas Dynamics", AIAA Education Series, AIAA 2006

Course Title : Advanced Fluid Mechanics
Course Code : 23DT644
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

The main objective of the course is to provide knowledge to the students about the details of fluid kinematics, and differential and integral formulation of fluid motion: Navier Stokes Equations. Potential Flows, Effect of pressure gradient on boundary layer, flow separation, and the basics of flow instability and turbulence.

Course Outcomes

At the end of the course the student should be able to

- Understand the fluid kinematics and formulate using tensor calculus.
- Formulate and solve differential equations of motions including Navier Stokes Equations to solve problems in fluid mechanics.
- Formulate the potential flow to solve fluid mechanics problem.
- Understand the effect of pressure gradient on boundary layer, flow separation, and the basics of flow instability and turbulence.

Course Content

Unit	Contents	Contact Hrs.
1.	Fluid Mechanics: Continuum Hypothesis, Transport Phenomenon, Perfect gas, static equilibrium of compressible medium	5
2.	Cartesian tensor: Rules & operators, operations, Second order tensor and its representations	5
3.	Reynolds Transport Theorem, Conservation Laws: Mass, Momentum and Energy, Some exact solutions of Navier-Stokes Equation-Steady Flows	9
4.	Potential Flows: Incompressible and Compressible Flows	5
5.	Boundary layer Theory: Laminar Boundary layer and Turbulent Boundary layer	5
6.	Introduction to Turbulence flows: Instabilities, RANS Equations and closure problem	7
	Total	36

References / Suggested Books:

1. Fluid Mechanics: by Pijush K. Kundu, Ira M. Cohen, David R Dowling, Academic Press
2. Introduction to Fluid Mechanics and Fluid Machines: by S. K. Som, Gautam Biswas and Suman Chakraborty, McGraw-Hill Education
3. Fluid Mechanics: by F. M White, McGraw-Hill Education. I
4. Introduction to Fluid Mechanics by R. Fox and A. MacDonald, John Wiley and Sons.

Semester II – Aerospace Technology Elective Courses

Course Title : Advanced Lightweight and Composite Structures
Course Code : 23DT651
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

The main objectives of this course is to impart thorough knowledge of advanced composite materials, their manufacturing techniques and to develop mathematical models & design structures made of composites. Basic understanding of structures used in airborne systems like missiles and aircrafts& their performance under static and dynamic loading, including crash and bird strike will also be covered.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the design of advanced structures and lightweight materials for aerospace materials.
- Understand the numerical and analytical skills in structural mechanics for both composite and metallic components.
- Apply knowledge to solve real engineering problems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Review of Strength of Materials, Introduction to Aerospace Materials – Metal Alloys and Fiber Reinforced Composite	6
2.	Introduction to different types of constructions: Monocoque, Semi-Monocoque, Truss, and Corrugated shell	7
3.	Introduction to Aircraft and Missile Structural Components: Spars; Ribs; Stringer; Longerons	6
4.	Analysis of stress; Analysis of strain	7
5.	Material Constitutive Relations	5
6.	Failure Theories; Fatigue theory	5
Total		36

References / Suggested Books:

1. "Composite Structures Safety Management", by Dr. Bjorn Backman. Publisher : Elsevier Science.
2. "Composite Structures: Design, Mechanics, Analysis, Manufacturing and Testing", by Manoj Kumar Buragohain. Publisher : CRC Press.
3. "Lightweight Composite Structures in Transport: Design, Manufacturing, Analy-sis and Performance", by James Njuguna Woodhead Publishing, 2016

4. "Structural and Stress Analysis", by T.H.G. Megson. Publisher: Butterworth-Heinemann.
5. Literature / books suggested by respective course Lecturers.

Course Title : Finite Element Methods for Defence Structures
Course Code : 23DT652
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

To learn the theory and applications of finite elements that represent engineering structures and appreciate the use of FEM to a range of engineering problems.

Course Outcomes:

At the end of the course the student should be able to

- Understand the concepts of nodes and elements.
- Develop stiffness matrices for spring, truss, beam, plane stress problems and three-dimensional problems using the concept of direct equilibrium and potential energy methods.
- Calculate consistent loads on structures and application of numerical integration.
- Understand the application FEM in different structures related to defence applications.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to Finite Element Analysis, Finite Element Formulation Techniques- Virtual Work and Variational Principle, Galerkin Method, Displacement Approach, Stiffness Matrix and Boundary Conditions.	5
2.	Introduction to different types of elements, formation of shape function for various elements, Coordinate systems, convergence criteria.	6
3.	Analysis of Frame Structures- Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis	7
4.	Formulation of Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity and Static Condensation Lecture	5
5.	Finite Element Formulation of Axisymmetric Element, 3 Dimensional Elements and Isoparametric Elements. Numerical Integration.	7
6.	Applications of FEM- Modelling and analysis of various defence related structures like plates, shells, cylindrical members and general by using FE software.	6
Total		36

References / Suggested Books:

1. “Finite Element Analysis “, C.S. Krishnamoorthy, , Tata McGraw-Hill
2. “Fundamentals of Finite Element Analysis “, V. David V. Hutton, McGraw Hill
3. “Introduction to the Finite Element Method: Theory, Programming and Applications”, Erik G. Thompson, John Wiley
4. “Introduction to Finite Element Analysis - Theory and Application “, H. C. Martin and G. F. Carey, New York, McGraw-
5. “Finite Element Procedures”, K. J. Bathe, , Prentice-Hall of India, New Delhi
6. “Finite Element Analysis”, S.S. Rao, Elsevier Butterworth-Heinemann

Course Title : Launch Vehicle Design & Analysis
Course Code : 23DT653
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

Course Objectives:

The course is intended to provide learning on the launch vehicle design and analysis, components and subsystems of the launch vehicle, propulsion systems.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the launch vehicle requirements, its functioning.
- Design and analysis of launch vehicles.
- Understand the propellant requirement for launch vehicles.

Unit	Contents	Contact Hrs.
1.	Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices.	6
2.	Performance analysis, operating characteristics and propellant selection criteria for air breathing and solid	5
3.	Liquid and nuclear rocket motor propulsion systems.	7
4.	Advanced cycles and concepts are presented. Design of components and subsystems	7
5.	FE modelling: Idealization, Discretization, Meshing and Post Processing,	6
6.	Tracking and controlling errors, Nonlinear analysis in FEM, Launch dynamic analysis.	5
Total		36

References / Suggested Books:

1. "Design of Rockets and Space Launch Vehicles", by Don Edberg, Willie Costa. Publisher : American Institute of Aeronauti cs & Ast. (August 21, 2020)
2. "Modern Engineering for Design of Liquid Propellant Rocket Engines (Progress in Astronautics and Aeronautics)", by Dieter K Huzel, David H Huang. Publish-er : AIAA (American Institute of Aeronautics & Astronautics); Revised, Subsequent edition.
3. "Fundamentals of Astrodynamics 1st Edition", by Roger R. Bate, Donald D. Mueller. Publisher: The American Design Ethic, MIT, USA.
4. "Commercial Launch Vehicle Design", by Nickolay Mykola Zosimovych. Pub-lisher: Lap Lambert Academic Publishing.

5. "Space Vehicle Design, Second Edition", by Michael D. Griffin and James R. French. Publisher The American Institute of Aeronautics and Astronautics, Inc. Literature / books suggested by respective course Lecturers.

Course Title : Combustion
Course Code : 23DT654
Teaching Scheme : L: 2, T:1, P: 0 Credits: 3

Course Objectives:

The course is intended to provide introduction to the basic concepts of combustion and their applications specific to aerospace propulsion systems including aircraft combustors ad rocket thrust chambers.

Course Outcomes:

At the end of the course the student should be able to:

- Use energy equation and Gibb's function to analyze combustion process
- Comprehend the importance of flammability limits & flame stabilization in combustion systems
- Analyze droplet combustion
- Carry out design calculations for aircraft combustors and rocket thrust chambers

Course Content:

Unit	Contents	Contact Hrs.
1.	Thermodynamics of Combustion: First law analysis and limitations, Dissociation and equilibrium, Gibbs free energy; Chemical kinetics, Combustion waves, stirred reactors	7
2.	Premixed flames: flame velocity, analytical models and flammability limits; Diffusion flames: droplet combustion, analytical models for droplet combustion	5
3.	Aircraft combustors, geometry, combustor sizing; Injection, Ignition and flame stabilization, flame holding in high speed combustion systems; Combustion instabilities, active and passive control of instabilities	4
4.	Methods of combustor cooling; Combustion and flame stabilization in afterburners	7
5.	Combustion in rockets, Combustion of Solid propellants, liquid propellants and hybrid propellants, Types of instabilities in rocket combustion,	7
6.	Design study: Combustors for Aero Engine & Rocket engine; Combustion in advanced propulsion systems: Introduction to supersonic combustion, the challenges, methods for mixing enhancement and flame stabilization	6
Total		36

References / Suggested Books:

1. Stephen Turns, "An Introduction to Combustion: Concepts and Applications", 2nd Edition, McGraw-Hill, 1999.
2. Eugene L. Keating , "Applied Combustion", Second Edition, CRC Press, 2007.
3. Chung K. Law, "Combustion Physics", Cambridge University Press, 2010.

4. Kenneth Kuan-yun Kuo, “Principles of Combustion”, 2nd Edition, Wiley, 2005

Course Title : Computational Fluid Dynamics for Defence Applications
Course Code : 23DT655
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

Course Objectives:

The course is intended to provide learning on the computational aerodynamics, numerical methods for solving systems of equations, numerical modelling of fluids, CFD analysis, turbulence modelling.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the CFD analysis, fluid mechanics, heat transfer analysis, numerical modelling of fluids.
- Generate numerical model related to fluid dynamics
- To do the pre and post processing of CFD analysis.

Unit	Contents	Contact Hrs.
1.	Introduction to fluid mechanics & heat transfer,	5
2.	Introduction to numerical analysis, Discretisation approaches: finite difference, and finite volume, Stability of numerical method.	6
3.	Numerical Method for Convection-Diffusion Problems: Central Differencing, Upwind Differencing, Power- Law Differencing, Quick and TVD Schemes with their Assessments	6
4.	Introduction to Spectral methods - Staggered and Collocated Grids – Introduction to Solution Algorithms: SIMPLE, SIMPLER, SIMPLEC and PISO Algorithms.	7
5.	Introduction to Grid Generation: Body Conforming Grids, Algebraic and Elliptic Grids, 2D Unstructured Grids	6
6.	CFD analysis of compressible & in-compressible flow, turbulence modelling,	6
Total		36

References / Suggested Books:

1. “A Textbook of Heat Transfer Paperback”, by S.P. Sukhatme. Publisher: Universities Press.
2. “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, by H. Versteeg. Publisher : Pearson.
3. “Computational Fluid Dynamics the Basics with Applications”, by John D. Anderson, Jr. Publisher : McGraw Hill Education.
4. “Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cambridge-iisc)”, by C.
5. S. Jog. Publisher : Cambridge University Press; 3rd edition.

6. "Numerical Modeling and Computer Simulation", Edited by DraganCvetković, publisher intechopen.
7. Literature / books suggested by respective course Lecturers.

Course Title : Structural Dynamics and Aero-elasticity
Course Code : 23DT656
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

The course is intended to provide learning on the mathematics behind the computational analysis, Different methods of analysis, Mathematical modeling of the various phenomena related to vibration analysis, various failure criteria and theory related to elastic fracture.

Course Outcomes:

At the end of the course the student should be able to:

- Understand vibrations and fluid dynamics behind the aerospace system.
- Understand of different design aspects related to loading in aerospace system.
- Do the system dynamic analysis using finite element methods.

Course Content:

Unit	Contents	Contact Hrs.
1.	Principles and methods of computational structural dynamics and vibration analysis.	6
2.	Introduction to dynamic analysis using the finite element method, Calculation of modal parameters.	6
3.	System dynamic response via mode superposition, frequency response, model reduction, and structural synthesis techniques, Fatigue analysis.	7
4.	Introduction to aero-elasticity, Aerodynamic Loading, Bending Moment, Sectional properties of Aerofoil, V-n Diagram,	6
5.	Basic theory of linear elastic fracture mechanics; strain energy release rate;	6
6.	Applications to delamination crack growth in polymer composite laminates, Damage tolerance issues in composites	5
Total		36

References / Suggested Books:

1. "Elements of vibration analysis", by Leonard Meirovitch. Publisher : McGraw-Hill Inc.,US; 2nd edition (1 March 1986)
2. "Finite Element Analysis Theory And Application With ANSYS", by Moaveni Publisher : Pearson Education; 3rd edition (1 January 2011)
3. "Mechanical Vibrations | SI Edition | Sixth Edition", by Singiresu S. Rao. Publisher: Pearson
4. "Elements of Fracture Mechanics", by Prashant Kumar. Publisher : McGraw Hill Education.

5. “Introduction to Structural Dynamics and Aeroelasticity”, by Dewey H. Hodges and G. Alvin Pierce. Publisher: Cambridge University Press.

6. Literature / books suggested by respective course Lecturers.

Course Title : Turbomachinery
Course Code: 23DT657
Teaching Scheme: L: 2, T:1, P: 0 **Credits: 3**

Course Objectives:

The course is intended to enable the students to do design calculations for turbines and compressors as well as to carry out calculation of various performance parameters.

Course Outcomes:

At the end of the course the student should be able to:

- Draw velocity triangles for turbomachines
- Determine the key performance parameters for turbines and combustors
- Analyze flow through axial and radial turbomachines
- Carry out design calculations for turbines and compressors

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction reviews about turbo machinery sub-system Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction.	6
2.	Dimensionless parameters for Turbomachines. Concept of specific speed, shape number, axial, radial, and mixed flow machines, and similarity laws.	5
3.	Axial flow compressors: Introduction; Aero-Thermodynamics of flow through an Axial flow Compressor stage; Losses in axial flow compressor stage; Losses and Blade performance estimation; Secondary flows (3-D); Tip leakage flow and scrubbing; Simple three-dimensional flow analysis; rotating stall and surging.	4
4.	Centrifugal Compressors: Introduction; Elements of centrifugal compressor/ fan; Inlet Duct Impeller; Slip factor; Concept of Rothalpy; Modified work done; Incidence and lag angles; Diffuser ; Centrifugal Compressor Characteristics; Surging; Chocking; Rotating stall; Design	6
5.	Axial flow turbines – Introduction; Turbine stage; Turbine Blade 2-D (cascade) analysis Work Done; Degree of Reaction; Losses and Efficiency; Flow Passage; Subsonic, transonic and supersonic turbines, Multi-staging of Turbine; Exit flow conditions	5
6.	Turbine Cooling; Turbine Blade design – Turbine Profiles : Airfoil Data and Profile construction. Radial flow turbines: Thermodynamics and Aerodynamics of radial turbines; Radial Turbine Characteristics; Losses and efficiency; Design of radial turbine.	5
7.	Aero-thermodynamics of Compressor-Turbine Systems; Aerodynamic and thermodynamic performance parameters; Optimization techniques for compressor-turbine matching.	5
Total		**36**

References / Suggested Books:

1. IGTI/ASME; The design of Gas Turbine Engines Thermodynamics and Aerodynamics (chapter 8 and 10), 2005.
2. Oates Gordon C; Aerothermodynamics of Aircraft Engine Components; AIAA series, 1985.
3. Dixon S. L. “Fluid Mechanics & Thermodynamics of Turbomachinery”, 6/e, Elsevier, 2012.
4. Principles of Turbo Machines/DG Shepherd / Macmillan, 1961.
5. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill, 4th Edition, 2011.
6. William W. Peng “Fundamentals of Turbomachinery” , John Wiley & Sons, 2007.

Course Title : Unmanned Aerial Vehicle Design
Course Code : 23DT658
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

The course is intended to provide the understanding of the initial designing and sizing process for rapidly growing fixed – wing UAV technology, integrated with its performance and stability analysis, airsafety issues, airworthiness and prototype testing.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the design requirements, design parameters of UAV.
- Perform the aerodynamic analysis, performance and stability analysis.
- Understand the performance testing of the UAVs.
- Understand the airworthiness and safety requirements of UAV.

Course Content:

Unit	Contents	Contact Hrs.
1.	UAV design Requirements, design parameters, design algorithms, Certification approaches: aircrafts and UAVs. Airworthiness of aircrafts and UAVs.	6
2.	Air safety issues. Handling qualities. Maneuverability requirements. Aircraft design; UAV system design. UAV system identification	6
3.	UAV aerodynamics, structures and propulsion, performance and stability analysis.	7
4.	UAV project life cycles. Stages of Aircraft design. Initial sizing: aircrafts and of UAVs.	6
5.	Ground control systems. Ground and flight testing of UAVs. UAV guidance and Navigation. Design for reliability.	5
6.	Wind Tunnel Testing, Aerodynamic Characterization through Wind Tunnel Testing.	6
Total		36

References / Suggested Books:

1. "Introduction to Flight", by John D. Anderson
2. "Performance, Stability, Dynamics, and Control of Airplanes", by Bandu N. Pamadi.
3. "Aircraft performance and design", by John D. Anderson.
4. "Unmanned Aircraft Design A review of fundamentals", by Mohammad H. Sadraey.
5. "Aircraft Design : A Conceptual Approach", by Daniel P. Raymer.
6. "Unmanned Aircraft Systems : UAVs Design Development and Deployment", by Reg Austin.
7. "Small Unmanned Fixed-wing Aircraft Design: A Practical Approach", by Andrew J. Keane and James P. Scanlan.
8. Literature / books suggested by respective course Lecturers.

Semester II – Communication Systems & Sensors
Elective Courses

Course Title **Digital & Satellite Communication and Navigation from Space**
Course Code **23DT661**
Teaching Scheme **L: 3, T: 0, P:0** **Credits: 3**

Course Objectives

The main objective of the course is to provide knowledge to the students on the analogue and digital communication systems, optical communication, satellite communications systems, modulations techniques, signal propagation effects, navigation techniques.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the communication techniques

- Evaluate the performance of communication systems
- Design the analogue and digital communication systems
- Understand and analyse the signal transmission effects
- Understand the different types of navigation techniques
-

Course Content

Unit	Contents	Contact Hrs.
1.	Elements of a communications system and their relationship to system performance.	5
2.	Free space optical communication, Fiber optics communication, Wireless/cellular communications.	6
3.	Fundamental concepts such as current/voltage relationships, time and frequency domains, power spectral density, random signals, Communications system components and functions, analog and digital communications systems,	6
4.	Modulation transmission and reception; baseband and passband digital modulation; system, noise, transmission lines, waveguides and antennas, FEC techniques for mitigating channel errors.	6
5.	Propagation effects on signal transmission; end-to-end path calculations for wire/coax, and RF systems including terrestrial ground links and satellite communications, Spread spectrum, conecpt of frequency hoping.	7
6.	Navigation techniques from space regarding functioning of GPS, GLONASS, IRNSS & Galileo	6
Total		36

References / Suggested Books:

1. "Satellite communication", by T. Pratt, C. W. Bostian, J. E.Allnut. Publisher: John Willey and sons
2. "Satellite Communications Systems: systems, techniques and technology", by G. Maral, M. Bousquet, Z. Sun. Publisher:John Willy and sons
3. "Digital Communications: Fundamentals and Applications", B. Sklar . Prentice-Hall, Inc.
4. "Understanding of GPS/GNSS: Principles and Applications",by E. Kaplan and C. Hegarty. Publisher: Artech House Publishers.
5. Literature / books suggested by respective course Lecturers.

Course Title	**Tactical Battlefield Communication & Electronic Warfare**	
Course Code	**23DT662**	
Teaching Scheme	**L: 3, T: 0, P:0**	**Credits: 3**

Course Objectives

The main objective of the course is to provide knowledge to the students on the techniques for setting up intercept and jamming links for Electronic Warfare (EW) against ground to ground enemy communication signals, UAV command and data links, cell phone links and weapon control links, techniques for predicting intercept and jamming performance.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the nature of tactical battlefield communication
- Calculate communication link performance
- Calculate the requirements for interception of tactical communication

- Calculate the requirements for emitter location, intercept and jamming of tactical comm. signals including weapon control link, UAV links, Cell phone links.
- Use various tools to perform electronic warfare calculations

Course Content:

Unit	Contents	Contact Hrs.
1.	Radiometry and power calculation, signature generation, atmospheric effects.	5
2.	Radar ES operational use, radar/ES detection battle, quiet radar, jamming techniques & strategies, jamming of SAR systems.	5
3.	Introduction to radar waveform interception, Technology and operational characteristics of electronic warfare, Signal processing statics & analysis, statistics & noise, analogue & digital signal processing.	6
4.	Decision theory- hypothesis testing, probabilities of false alarm and detection, Bayesian systems, error probability and bit error rate, receiver operating.	7
5.	UAV Payload/link Issues, cell phone issues, Intercept links, Frequency hopping and other LPI threats;Special techniques for jamming LPI signals	7
6.	Introduction to electronic counter measures and counter-counter measures.	6
Total		36

References / Suggested Books:

1. "Tactical Battlefield Communications Electronic Warfare", by David Adamy 2008
2. "Military Communications in the Future Battlefield", by Marko Suojanen.
3. "Electronic Warfare for the Digitized Battlefield", by Michael Frater, Michael Ryan.
4. Literature / books suggested by respective course Lecturers.

Course Title : Software Defined Radio
Course Code : 23DT663
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

The course is intended to provide understanding of the fundamental of software defined radios, different aspects of SDRs, practical scenarios along with knowledge of different SDR hardware and software.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the concept, application of SDRs.
- Understand of analog RF components as front end block in implementation of SDR.
- Gain knowledge of digital hardware architectures and its development techniques.
- Gain knowledge of software development for embedded wireless systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	SDR introduction, major standards, SDR architecture, SDR enablers, advantage / disadvantages, Applications.	6
2.	Waveform platform bifurcation, red – black separation, digital modulation- advanced linear and non-linear bandwidth efficient modulations. Bandwidth and power efficiency, peak to average power, error vector magnitude and error probability.	6
3.	SDR Hardware, super-heterodyne architecture, homodyne architecture, advantages & disadvantages, Software for SDR, Processing architecture for SDR.	6
4.	RF channels, receiver channel equalization, multiple access techniques Frequency, time and code division techniques as well as carrier sensing, Wireless sensor networks and beam steering in azimuth and elevation, receiver analogue signal processing, receiver digital signal processing..	6
5.	Source and channel coding (Source and channel coding, sampling, entropy, data compression, voice coding, block and convolution coding, turbo coding, space-time coding and trellis coding).	7
6.	Case studies in software radio design, Introduction and a Historical perspective	5
Total		36

References / Suggested Books:

1. "Software Radio, (A modern approach to radio engineering)", by Jeffery H.Reed Publisher : PHI PTR.
2. "RF and Digital Signal Processing for Software Defined Radio", by John J. Rouphael. Publisher : Elesiver.
3. "Digital Techniques in Frequency Synthesis", by B.G.Golderg. Publisher: McGraw-Hill.
4. "Multirate Signal Processing", by N.J.Fliege. Publisher: John Wiley and sons.
5. Literature / books suggested by respective course Lecturers.

Course Title : EMI/EMC in Military Systems
Course Code : 23DT664
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

The course is intended to provide learning on the basic concepts of EMI/EMC design, techniques for prevention of electronic equipment through good EMI/EMC design techniques – grounding, shielding, cable management, and power interface design, troubleshooting techniques, EMI/EMC standards.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the concept of EMI / EMC protection of equipment
- Identify and prevent the common EMI/EMC problems in military systems.
- Understand the Design impact (by requirement) of military EMC specifications.

- Understand EMI/EMC troubleshooting tips and techniques.
- Learn generate EMI/EMC requirements document

Course Content

Unit	Contents	Contact Hrs.
1.	Basic Concepts: Definition of EMI/EMC and EMP, Classification of EMI/EMC, Sources of EMI, EMI coupling modes, ESD Phenomena and effects, Transient phenomena and suppression,	6
2.	EMC requirements for electronic systems, Non-ideal Behaviors of Components; EMI Measurements: Basic principles of EMI measurements, EMI measuring instruments;	6
3.	EMI Control Methods: Conducted and radiated emissions and susceptibility, Crosstalk and shielding, Grounding, Bonding, Filtering, EMI gasket, Isolation transformer, opto isolator; Faraday cage, isolation of shelters	6
4.	EMC Standard and Regulations: National and Intentional standardizing organizations, Frequency assignment, Spectrum conversation;	5
5.	EMC Design and Interconnection Techniques: Cable routing and connection, Component selection and mounting, PCB design (Trace routing, Impedance control, decoupling, Zoning and grounding);	7
6.	EMC analysis and detection techniques: Using tools for signal integrity analysis, Study eye diagrams for communication systems.	6
Total		36

References / Suggested Books:

1. "EMI/EMC Computational Modeling Handbook", by brucearchambeault, Omar M. Ramahi, et al.
2. "EMI/EMC Computational Modeling Handbook: 630 (The Springer International Series in Engineering and Computer Science)", by Bruce R. Archambeault, Omar M. Ramahi, et al.
3. "A practical approach to electromagnetic compatibility", by Chetan Kathalay
4. Literature / books suggested by respective course Lecturers.

Course Title : Sensor Technology
Course Code : 23DT665
Teaching Scheme : L: 3, T: 0, P: 0 Credits: 3

Course Objectives:

The main objective of the course is to provide learning on the basic physical principles and characteristic features in sensor technology, design, function and applications of different sensors.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the basic principles of sensor systems required for satellites and tactical aircraft.
  • Understand the atmospheric propagation and its impact on the performance of sensors
- Troubleshoot, repair/replace a faulty sensor in optimize process efficiency.

Course Content:

Unit	Contents	Contact Hrs.
1.	Physical principles underlying the sensor systems needed for satellites and tactical aircraft, as well as limitations imposed by the atmosphere and operating environment on these systems and their communication links,	6
2.	Phased array and pulsed compressed radars, imaging synthetic aperture and inverse synthetic aperture radars	5
3.	Atmospheric propagation of signal. Noise resources and thermal radiation	5
4.	Principles of semiconductor devices. Optical and infrared imaging detector systems.	8
5.	Detector resolution limitations and bandwidth requirements, Relationship between signals and noise.	6
6.	The characteristics of critical sensor functions (including detection, estimation, imaging, and tracking).	6
Total		36

References / Suggested Books:

1. "Handbook of Modern Sensors", by Jacob Fraden. Publisher : Springer.
2. "Micro sensors, Principles and Applications", by J. W. Gardner. Publisher : Wiley.
3. "Semiconductor Sensors", by S. M. Sze. Publisher : Wiley.
4. Literature / books suggested by respective course Lecturers.

Course Title : Avionics
Course Code : 23DT666
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives

To introduce students to basic avionics systems used in aircrafts and UAVs

Course Outcomes

CO1: Learn the importance, subsystems and environmental specifications of Avionics systems.
CO2: Be able to derive air data laws and explain its use in air data computer.
CO3: Gain insight to the working principle of an embedded systems with applications in avionics.
CO4: Comprehend basic elements of electronic communication systems and its applicability to radio navigational aids.

CO5: Learn the working principle of Inertial sensors like gyros and accelerators and its use in inertial navigation systems.
CO6: Understand the basic principle of autopilot and UAV systems.

Unit	Contents	Contact Hrs.
1.	Introduction: Importance and role of avionics, the avionic environment – Air Data Systems: Air Data Information and its use, Air data laws, sensors and computations.	6
2.	Embedded systems: Basic hardware building blocks of a typical embedded system – Software concepts relevant to avionics: Interrupts and Real Time Operating Systems	6
3.	Case studies illustrating importance of embedded systems in avionics – Introduction to electronic communication systems – Utility of Radio Navigation Aids	6
4.	Inertial sensors and systems: Laser and MEMS Gyros, Accelerometers, Attitude Heading Reference System	6
5.	Navigation Systems: Basic principles, Inertial Navigation, Strapped-down inertial systems	6
6.	Introduction to Autopilot and UAV Avionics. Safe disposal of electronic waste	6
Total		36

References / Suggested Books:

1. R.P.G Collinson, "Introduction to Avionics systems", 4th edition, Springer, 2023.
2. Kayton And Fried, "Avionics Navigation Systems", 2nd edition, Wiley, 2009.
3. Frank Vahid ,Tony Givargis, "Embedded System Design", Wiley, 2006.

Course Title : Fundamentals of Telemetry, Telecomm and Transponder
Course Code : 23DT667
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

The main objectives of the course will be to provide knowledge of the students about the satellite communication, telemetry, modulation techniques, target tracking, signal processing of communication systems.

Course Outcomes:
The students will have in depth knowledge on:

- Satellite communication and related technologies.
- Overall control of satellites through collection, processing, and transmission of data.
- Determination of the satellite's exact location through the reception, processing, and transmitting of ranging signals.

- Proper control of satellite through the reception, processing, and implementation of commands transmitted from the ground.

Course Content:

Unit	Contents	Contact Hrs.
1.	Fundamental of satellite communication, different modulation and multiplexing schemes.	6
2.	Satellite Telemetry, Tracking and Tele-command, Multiple Access Techniques Telemetry, Data Transmission, Methods of Modulation, Time Division and Frequency Division Multiplexing, FDMA, TDMA, CDMA and DAMA, Coding Schemes.	6
3.	Satellite Packet Communications, Tracking and Telemetry.	6
4.	Doppler and Electro-Optical methods of tracking, Airborne Missile.	6
5.	Signal Processing: Processing of Signal, Data Acquisition and Reduction.	6
6.	Introduction to satellite communication, transponders.	6
Total		36

References / Suggested Books:

1. “Spacecraft TT&C and Information Transmission Theory and Technologies”, by, Jiaxing Liu. Publisher : Springer, 2014
2. “Introduction to PCM Telemetering Systems”, by Stephen Horan. Publisher: CRC Press
3. "Satellite Communications Systems: Systems, Techniques and Technology”, by Gerard Maral, Michel Bousquet, Zhili Sun. Publisher : Wiley, 2020
4. "Satellite Communications”, by Timothy Pratt, Jeremy E. Allnutt, 3rd Edition Publisher : Wiley.
5. “Principles of Modern Communication Systems”, by Samuel O. Agbo , Matthew N. O. Sadiku 2017

Course Title : Autonomous and Navigation Technology
Course Code : 23DT668
Teaching Scheme : L: 3, T: 0, P: 0 Credits: 3

Course Objectives:

The main objective of the course is to provide knowledge to the students about technology of modern navigation systems, particularly satellite-based systems, UAV guidance systems, GPS, SLAM.

Course Outcomes:

At the end of the course the student should be able to:

- Describe the basic principle of operation of a global navigation satellite system
- Understand the navigation systems and derive the navigation equations.
- Carry out path planning the UGV / UAV.
- Solve the equations for calculating a position estimate from a given satellite constellation.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction on navigation and guidance systems, Guidance approaches: conventional guidance such as PN (Proportional Navigation)	6
2.	Geodetic fundamentals of navigation, positioning, reference- and coordinate systems and computational methods for navigation and positioning on the surface of the earth.	7
3.	Geometric guidance, path planning and following, and optimal guidance; path planning for UGV/UAV guidance systems	7
4.	Navigation approaches: navigation systems, Understanding the Global Positioning System (GPS)	5
5.	GNSS (Global Navigation Satellite System), terrain based navigation	6
6.	SLAM (Simultaneous Localization and Mapping); Cooperative guidance and collision avoidance.	5
Total		36

References / Suggested Books:

1. "Global Navigation Satellite Systems: Insights Into GPS", by Bhatta, B., Glonass, Galileo, Compass, and Others. Publisher : BS Publications, New Delhi 2010.
2. "Global Positioning Systems, Inertial Navigation, and Integration", by Grewal, M. S., Weill, L. R., Andrews, A. P., Publisher: John Wiley & Sons, New York, 2006.
3. "GNSS – Global Navigation Satellite Systems", by Verlag Wien. Hofmann-Wellenhof, B., Lichtenegger, H., Wasle, E.. Publisher: Springer 2008.
4. "Global Positioning System Theory and Practice", Hofmann-Wellenhof, B., Lichtenegger, H., Verlag Wien, Collins, J. Publisher: Springer 2001.
5. Literature / books suggested by respective course Lecturers.

Course Title : Defence Electro-Optics
Course Code : 23DT669
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

The aim of the course is to provide an introduction to the principles of wide range of current and future electro-optic and imaging devices. Course will also to enable students to light on application of electro optics and imaging system in defence ap-plication.

Course Outcomes:

At the end of the course the student should be able to:

- Understand the technology and principles underpinning electro-optic devices and systems.
- Apply their knowledge to practical electro-optic design and acquisition problems.
- Understand the trade-offs in electro-optic systems design.

Course Content

Unit	Contents	Contact Hrs.
1.	Principles of radiometry, The human eye, Visible band optical sighting systems.	6
2.	Camera systems, Image intensifiers, Missile seekers.	6
3.	Electro-optic countermeasures.	6
4.	Thermal imagers, II cameras, Hyper-spectral imaging, Digital image processing.	7
5.	EO sensors for Lasers and laser DEW	5
6.	Electro-optic protection measures.	6
	Total	36

References / Suggested Books:

1. "Systems engineering analysis of electro-optical and Infrared system", by William Wolfgang Arrasmith.
2. "Introduction to Infrared and Electro-Optical Systems", by Author Ronald G. Driggers Ronald G. Driggers.
3. "Handbook of Defence Electronics and Optronics: Fundamentals, Technologies and Systems", by Author(s): Anil K. Maini
4. "Building Electro-Optical Systems: Making It all Work", by Author Philip C. D. Hobbs.
5. "Electro-Optical Instrumentation: Sensing and Measuring with Lasers", by Author Silvano Donati.
6. "Electro-optical systems design, Analysis and testing", by Author Michael C. Dudzik.
7. Literature / books suggested by respective course Lecturers.