M. TECH. DEFENCE TECHNOLOGY

(Duration: 2 Years)

CURRICULUM and SYLLABUS

(Applicable for Students admitted from Academic Year 2021-22)

DEPARTMENT OF AERONAUTICAL ENGINEERING

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

Motto:

To Make Every Man *a* Success *and* No Man *a* Failure

Vision:

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

Mission:

- *To create an ecosystem that promotes learning and world class research.*
- *To nurture creativity and innovation.*
- *To instill highest ethical standards and values.*
- *To pursue activities for the development of the Society.*
- *To develop national and international collaborations with institutes and industries of eminence.*
- *To enable graduates to become future leaders and innovators.*

Value Statement:

Integrity, Innovation, Internationalization.

S.No.	Program Outcome	Attributes

M.Tech Defence Technology

ABOUT THE COURSE:

The M.Tech. in defence technology courses has been designed to produce Post Graduates who will have the necessary theoretical & experimental knowledge, skill and aptitude in various defence technologies areas and pursue them to carry out R&D in defence.

The students will be provided valuable exposure & knowledge for various state of the art defence systems and contemporary technologies through class lectures & main thesis work with the collaboration of DRDO. During the program, the students would be given opportunities in carrying out their main thesis work in DRDO labs, Defence PSUs & Private Defence Industries. This collaborative effort of DRDO, AICTE and Industries will provide required knowledge to the students and create job opportunities for them.

PROGRAM OBJECTIVE:

- *To develop Post Graduates who have the necessary theoretical & experimental knowledge, skill and aptitude in defence technologies and systems and can get recruited in the various defence laboratories, defence public sector & private industries, ordnance factories and other similar sectors of the economy at national and international level.*

- *To contrive skilled manpower in the field of defence technologies.*

- *To enhance students" interaction with the senior, experienced manpower engaged in defence labs and defence industries and have real time knowledge / experience in the technology development, technology deployment and defence systems.*

- *To acquaint students for the needs of technologies related to defence & security of nation and to create zeal among students to pursue research and development for defence technologies.*

PO1	Acquire technical competence, comprehensive knowledge and understanding the methodologies and technologies associated with land, air & naval defence systems. Apply knowledge to identify, formulate and analyse complex engineering problems.	Scholarship of Knowledge
PO2	Having an ability to apply knowledge of science, mathematics, engineering & technology for development of defence technologies.	Critical Thinking
PO3	Having an ability to design a component, subsystem or a system applying all the relevant standards and with realistic constraints, including operational and environmental.	Research Skill
PO4	Acquire the skills for uses of contemporary techniques, resources and modern engineering and IT tools	Usages of Modern Techniques
PO5	An ability to identify, investigate, understand and analyse complex problems, apply creativity, carry out research /investigation and development work to solve practical problems related to defence technological issues.	Design, Development & Solutions
PO6	Ability to communicate effectively in both oral and written contexts in the form of technical papers, project reports, design documents and seminar presentations.	Communication
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	Individual &Team Work

PROGRAM OUTCOME:

PROGRAM STRUCTURE:

It is a 4-semester program with total 80 credits. It is having 4 specializations, as regard to the specializations, semester -1 will have common curriculum and semester 2 curriculum will be varied as per the specialization. Semester 3 & 4 includes dissertation and industrial training. The M.Tech. in Defence Technology will be having following specializations:

1. *Combat Vehicle Engineering*
2. *Aerospace Technology*
3. *Communication Systems & Sensors*
4. *High Energy Materials Technology*

Semester - 1:Courses will be same for all specializations.

Semester -2:Courses will be as per the selected specialization.

Semester - 3 &4:Projects and Industrial Training.

ELIGIBILITY CRITERIA:

Those who have pursued under graduation in following disciplines are eligible for taking up the M.Tech. Defence Technology courses:

1) Aerospace Engineering	26) Electronics and Computer Engineering
2) Aeronautical engineering	27) Electronics and Communication Engineering
3) Applied Electronics and Communication Engineering	28) Electronics and Computer Science
4) Applied Electronics and Instrumentation Engineering	29) Electronics and Control Systems
5) Chemical Technology	30) Electronics and Power Engineering
6) Chemical engineering	31) Electronics and Telecommunication
7) Computer Science & Engineering	32) Electronics, Instruments and Control Engineering
8) Computer and Communication Engineering	33) Electronics System Engineering
9) Computer Engineering	34) Instrumentation and Electronics
10) Computer Engineering and Applications	35) Instrumentation Engineering
11) Computer Networking	36) Marine Engineering
12) Computer Science and Information Technology	37) Marine Technology
13) Computer Science and Technology	38) Mechanical and Automation Engineering
14) Computer Technology	39) Mechatronics Engineering
15) Electrical and Computer Engineering	40) Mechanical engineering
16) Electrical and Electronics Engineering	41) Metallurgical and Materials Engineering

17) Electrical and Instrumentation Engineering	42) Military engineering
18) Electrical and Power Engineering	43) Optics and Opto-electronics
19) Electrical Engineering	44) Power Electronics Engineering
20) Electronics engineering	45) Radio, Physics and Electronics
21) Electrical, Electronics and Power Engineering	46) Software Engineering
22) Electronics and Communication engineering	47) Structural Engineering
23) Instrumentation engineering	48) Telecommunication Engineering
24) Electronics, Instrumentation and Control Engineering	
25) Electronics, Science and Engineering	

M.Tech - Defence Technology

SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
			SEMESTER- I						
1	BS	MAA0704	Advanced Engineering Mathematics	4	0	0	4	1	4
2	PC	DTB0701	Warfare Simulations & Strategies	4	0	0	4	1	4
3	PC	DTB0702	Systems and warfare Platforms	4	0	0	4	1	4
4	DE-I	DTB0751	Rockets and Missiles Fundamentals	3	0	0	3	1	3
5	DE-I	DTB0753	Communication Technology	3	0	0	3	1	3
6	DE-II	DTB0752	Autonomy and Navigation Technology	3	0	0	3	1	3
			PRACTICAL						
7	PC	DTB0731	Warfare Simulations & Strategies Lab	0	0	2	2	0	2
8	PC	DTB0732	Systems and Warfare Platforms Lab	0	0	2	2	0	2
9	BS	DTA0701	Seminar	0	0	1	1	0	1
			Total				23		23

L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours

SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
			SEMESTER- II (AEROSPACE TECHNOLOGY)						
1	BS	DTB0716	Aerospace System Configuration, Design & Simulation	4	0	0	4	1	4
2	PC	DTB0717	Guidance & control	4	0	0	4	1	4
3	PC	DTB0718	Aerospace Propulsion	4	0	0	4	1	4
4	DE	DTB0754	Structural Dynamics and Aero-Elasticity	3	0	0	3	1	3
6	DE	DTB0755	Elective 4	3	0	0	3	1	3
			PRACTICAL						
7	PC	DTB0741	Aerospace System Configuration, Design & Simulation Lab	0	0	2	2	0	2
8	PC	DTB0742	Guidance & control Lab	0	0	2	2	0	2

| 9 | BS | DTA0701 | Seminar | 0 | 0 | 1 | 1 | 0 | 1 |
| | | | **Total** | | | | 23 | | 23 |

L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours

	SEMESTER- II (COMMUNICATION SYSTEMS & SENSORS)								
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	DTD3703	Radar Technologies	4	0	0	4	1	4
2	PC	DTD3704	Digital & satellite Communication and Navigation from Space	4	0	0	4	1	4
3	PC	DTD3705	Tactical battlefield Communication & Electronic Warfare	4	0	0	4	1	4
4	DE	DE	Elective 3	3	0	0	3	1	3
6	DE	DE	Elective 4	3	0	0	3	1	3
			PRACTICAL						
7	PC	DTD3791	Radar Technologies Lab	0	0	2	2	0	2
8	PC	DTD3792	Digital & Satellite Communication and Navigation from Space Lab	0	0	2	2	0	2
9	BS	DTD3796	Seminar	0	0	1	1	0	1
			Total				23		23

L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours

	SEMESTER- III (COMMON FOR ALL SPECIALISATION)								
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
7	PC	DTA3797	Project - Phase 1	0	0	24	10	0	24
8	PC	DTA3798	Internship	0	0	8	4	0	8
			Total				14		

L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours

	SEMESTER- IV (COMMON FOR ALL SPECIALISATION)								
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH

1	PC	DTA3799	Project - Phase 2	0	0	40	20	0	40
			Total				20		0

L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING – SEMESTER WISE

SEM	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
ELECTIVE -1									
1	DE	DTB0751	Rockets & Missiles Fundamentals	3	0	0	3	1	3
1	DE		Advanced Thermal Engineering	3	0	0	3	1	3
1	DE		Numerical Methods for Science and Engineering	3	0	0	3	1	3
1	DE	DTB0753	Communication Technology	3	0	0	3	1	3
1	DE		Advanced Mechanical Engineering	3	0	0	3	1	3
ELECTIVE - 2									
1	DE	DTB0752	Autonomy and Navigation Technology	3	0	0	3	1	3
1	DE		Optimization Theory & Applications	3	0	0	3	1	3
1	DE		Military Electronics System Engineering	3	0	0	3	1	3
1	DE		System Engineering and Analysis	3	0	0	3	1	3
ELECTIVE - 3									
2	DE	DTA-3730	Robotics (MSS, MCC)	3	0	0	3	1	3
2	PC	DTA-3731	EMI/EMCIn Military Systems	3	0	0	3	1	3

2	DE	DTA-3732	Defence Electro-Optics and Imaging Systems	3	0	0	3	1	3
2	DE	DTA-3733	Structural Dynamics and Aero-Elasticity	3	0	0	3	1	3
2	DE	DTA-3734	Safety, Health & Hazard Management	3	0	0	3	1	3
2	DE	DTA-3735	Fundamental of Telemetry, Telecommand& Transponder	3	0	0	3	1	3
2	DE	DTA-3736	Jamming and ECM/ECCM Technologies	3	0	0	3	1	3
2	DE	DTA-3737	Software Defined Radios	3	0	0	3	1	3
2	DE	DTA-3738	Advanced Lightweight and Composite Structures	3	0	0	3	1	3
2	DE	DTA-3739	Test Methodologies for Dew Systems (Lasers & Microwave)	3	0	0	3	1	3
2	DE	DTA-3740	Advanced Analytical Techniques/Lab Testing	3	0	0	3	1	3
2	DE	DTA-3741	Sonar System Engineering	3	0	0	3	1	3
ELECTIVE - 4									
2	DE	DTA-3742	Unmanned Aerial Vehicle Design	3	0	0	3	1	3
2	DE	DTA-3743	Naval Ocean Analysis and Prediction	3	0	0	3	1	3
2	DE	DTA-3744	Modelling &Simulation Of Laser Matter Interaction	3	0	0	3	1	3
2	DE	DTA-3745	Computational Aerodynamics	3	0	0	3	1	3
2	DE	DTA-3746	Launch Vehicle Design & Analysis	3	0	0	3	1	3
2	DE	DTA-3747	Acquisition, Tracking & Pointing Technology	3	0	0	3	1	3

2	DE	DTA-3748	Data Acquisition, Tracking & Post Flight Analysis	3	0	0	3	1	3
2	DE	DTA-3749	Air Independent Propulsion and Batteries	3	0	0	3	1	3
2	DE	DTA-3750	Advanced Digital Modulation Technologies & Standards	3	0	0	3	1	3
2	DE	DTA-3751	Trajectories Modelling & Simulation	3	0	0	3	1	3
2	DE	DTA-3752	Sensor Technology	3	0	0	3	1	3

COURSE TITLE	ADVANCED ENGINEERING MATHEMATICS			CREDITS	4
COURSE CODE	MAA0704	COURSE CATEGORY	DE	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about probability theory, algebra, solutions of Differential equations, Transform techniques, special functions & their applications in the areas with defence relevance.
Course Outcome	Upon completion of this course, the students will be able to 1. Know the methods for solving differential equations, generating functions. 2. Understand basic concepts of Fourier Transform, Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution. 3. Demonstrate MATLAB programming for engineering problems. 4. Understand the utilization of mathematical methods for solving problems having relevance to defence applications.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	3	-	3	3	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	3	-	3	2	-	-
CO-4	3	3	-	3	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:		(7)
Elements of Probability and Statistics, components of operations research, Linear Algebra.	CO-1 BTL-3	

MODULE 2:		(7)
Ordinary Differential equations, Numerical methods for ODE and P.D.E. Generating functions, recurrence relations.	CO-2 BTL-3	

MODULE 3:		(7)
Transform Techniques, Fourier series, Fourier Transform, Laplace Transform	CO-2 BTL-3	

MODULE 4:		(6)

Special functions: Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.	CO-3 BTL-3

MODULE 5:	(6)
Elements of Ramsey theory, theorems of Burnside and Polya, and balanced incomplete block designs.	CO-3 BTL-3

MODULE6:	(6)
Application areas with defence relevance range from mathematics to computer science and operations research, applications in probability, game theory, network design, coding theory, and experimental design.	CO-4 BTL-4

REFERENCE BOOKS	
1.	"Advanced engineering mathematics", by Kreyszig. Publisher: Wiley.
2.	"Advanced engineering mathematics", by Jain/Iyenger. Publisher: Narosa.
3.	"Advanced engineering mathematics",by Taneja. Publisher: I K international .
4.	"Advanced engineering mathematics", by Alan Jeffery. Publisher: Academic Press.
5.	"Advanced engineering mathematics", by Peter V. O"Neil. Publisher: Cengage Learning.

COURSE TITLE	WARFARE SIMULATIONS & STRATEGIES				CREDITS	4
COURSE CODE	DTB0701	COURSE CATEGORY		DE	L-T-P-S	4-0-0-0
Version	1.0	Approval Details		23 ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about warfare system and affluent them with combat modeling using mathematical modeling.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the systems used in warfare scenario. 2. Understand combat simulation & modelling 3. Understand the war gaming simulation & modelling and human factor representation.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	2	-	-	-	-
CO-2	3	2	3	3	3	-	-
CO-3	3	2	3	3	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(7)
Types of platforms: land, sea, air; Lifecycle: concept, design, pre-production, production, operations, support.	CO-1 BTL-2

MODULE 2:	(7)
Military capabilities: air warfare, surface warfare, sub surface warfare, littoral warfare	CO-2 BTL-2

MODULE 3:	(7)
Introduction to the methods used in modeling combat and their application in support of defence decision making and training, Combat simulation.	CO-2 BTL-3

MODULE 4:	(7)

War gaming/interactive simulation, Lanchester"s equations, Mathematical models of combat.	**CO-2,3** **BTL-4**
MODULE 5:	**(6)**
War gaming and combat modeling in practice, manual war gaming.	**CO-3** **BTL-4**
MODULE 6:	**(6)**
Human factors representation in war gaming and combat modeling.	**CO-3** **BTL-4**

REFERENCE BOOKS	
1.	"DefenseModeling, Simulation, and Analysis: Meeting the Challenge". Publish-er: 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 An-dreasTolk (Editor), Old Dominion University. Publisher : John Wiley & Sons.
4.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	SYSTEMS AND WARFARE PLATFORMS			CREDITS		4
COURSE CODE	DTB0702	COURSE CATEGORY		DE	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL		BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	1. To provide knowledge to the students about various types of military platforms used in air, naval & land warfare. 2. Students will also be apprised for weapon system and self-protection strategies and techniques.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand types of warfare platform used for Army, Air and Marine and their design fundamentals. 2. Understand the weapon systems like guns, ordnance, missiles projectiles, mines/ countermines, lasers, undersea weapons, air-launched weapons, anti-aircraft, anti-ship and anti-submarine.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	-	3	2	2	-
CO-2	3	-	-	3	-	2	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(7)
Types of platforms: land, sea, air; Lifecycle: concept, design, pre-production, production, operations, support.	CO-1 BTL-2

MODULE 2:	(7)
Ship design fundamentals: buoyancy, stability, ship resistance, survivability; damage control, NBCD, crew numbers, power requirements. Submarine design: buoyancy, stability, hull/tank design, air interdependence.	CO-1 BTL-3

MODULE 3:	(7)
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.	CO-1 BTL-3

MODULE 4:	(6)

Military vehicle fundamentals: tracked, wheeled, A, B and C vehicles.	CO-1 BTL-2

MODULE 5:	(6)
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.	CO-2 BTL-2

MODULE6:	(6)
Self defence and Protection systems: Armour, smoke, chaff, decoys; Introduction to instrumentation, lab tests and flight trials.	CO-2 BTL-2

REFERENCE BOOKS	
1.	"Light And Heavy Vehicle Technology ", by Nunney. Publisher Elsevier.
2.	"Practical approach to motor vehicle engineering and maintenance", by Bonnick Allan et. Al. Publisher: Yesdee.
3.	"Automotive Vibration Control Technology: Fundamentals, Materials, Construction, 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 Education – Europe.
6.	"Military Laser Technology for Defense: Technology for Revolutionizing 21st Century Warfare", by Alastair D. McAulay. Publisher: Wiley-Interscience; 1st edition.

COURSE TITLE	WARFARE SIMULATIONS & STRATEGIES LAB			CREDITS	2
COURSE CODE	DTB0731	COURSE CATEGORY	DE	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
LIST OF EXPERIMENTS					
1.	*Lab experiments will be added in consultation with DRDO labs considering the available facilities.*				CO-BTL-3

COURSE TITLE	SYSTEMS AND WARFARE PLATFORMS LAB			CREDITS	2
COURSE CODE	DTB0732	COURSE CATEGORY	DE	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	
Course Outcome	Upon completion of this course, the students will be able to

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1							
CO-2							
CO-3							

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

1.	*Lab experiments will be added in consultation with DRDO labs considering the available facilities.*	CO- BTL-

SEMESTER I - ELECTIVE -1 COURSES

COURSE TITLE	ROCKETS & MISSILES FUNDAMENTALS			CREDITS	3
COURSE CODE	DTB0751	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about missile system, classification of missiles, aerodynamics of missiles, subsystems and missile trajectory.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand basics of missile physics as well as the engineering aspects of missile integration. 2. Understand physics behind guided missiles and aero dynamics of missiles. 3. Characterization of sub-systems used in missiles.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	-	2	2	-	-
CO-2	3	-	-	2	2	-	-
CO-3	-	-	3	2	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(5)
Basics of Missile Physics, Introduction to Guided Missiles, Classification of Missiles.	**CO-1** **BTL-2**

MODULE 2:	(5)
Missile Aerodynamic Configurations, Introduction to Missile System, Interrelationship between various Missile Sub-Systems.	**CO-2** **BTL-2**

MODULE 3:	(5)
Basic Characteristics of Guided Missile Systems, Missile System Reliability, Range dispersion and CEP Concept,	**CO-2** **BTL-2**

MODULE 4:	(7)
Design, System Layout and integration of Sub-Systems.	CO-3 BTL-4
MODULE 5:	(7)
Coordinate Transformation, Transformation Matrices. Two, Three and Six DOF Equations of Motion, Ballistic Missile Trajectory.	CO-3 BTL-3
MODULE6:	(7)
Effect of Curvature of Earth, Rotation of Earth, Variation of Gravity on Missile Trajectory.	CO-3 BTL-2

REFERENCE 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.

COURSE TITLE		**ADVANCED THERMAL ENGINEERING**		**CREDITS**	**3**
COURSE CODE		**COURSE CATEGORY**	DE	**L-T-P-S**	3-0-0-0
Version	1.0	**Approval Details**	23 ACM, 06.02.2021	**LEARNING LEVEL**	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand thermal design and simulations for system design. 2. Carry out CFD simulations, design of heat exchangers, refrigeration. 3. Understand the concept of thermal management requirement & design for defence systems.

Prerequisites:

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	3	-	3	3	-	-
CO-2	-	-	-	3	3	-	-
CO-3	3	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	**(7)**
System thermal design & Analysis, Tools for thermal design and simulation, Heat transfer analysis (conduction, convection & radiation).	**CO-1** **BTL-3**

MODULE 2:	**(7)**
Computation fluid dynamics (CFD), Thermal Finite Element Analysis	**CO-2** **BTL-4**

MODULE 3:	**(6)**
Heat Exchangers for: Heat Exchanger Network Design.	**CO-2** **BTL-4**

MODULE 4:	**(5)**

Refrigeration, Humidifiers, Air Washers and Cooling Towers.	CO-2 BTL-4
MODULE 5:	**(6)**
Thermal management design of defence system (combat vehicles, missiles, aerial vehicles etc.)	CO-3 BTL-4
MODULE 6:	**(5)**
Thermal testing, thermal operation, and integration of thermal design into the defence systems.	CO-3 BTL-4
REFERENCE 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.

COURSE TITLE	NUMERICAL METHODS FOR SCIENCE & ENGINEERING		CREDITS	3
COURSE CODE		COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	1. 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. 2. The course will also develop an understanding of the finite element analysis and computational fluid engineering.
Course Outcome	Upon completion of this course, the students will be able to 1. Use the numerical techniques (algorithms) to find the solution (approximate) algebraic equations and system of equations. 2. Fit the data using interpolation technique and spline methods. 3. Use to finite element analysis, interpretation of analysis results. 4. Understanding of computational engineering process.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	3	2	-	-	-	-
CO-2	3	3	-	3	-	-	-
CO-3	3	3	2	3	-	-	-
CO-4	3	3	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:		(5)
Introduction, solution of non-linear equations, solution of linear systems.	CO-1 BTL-3	

MODULE 2:		(5)
Introduction and polynomial approximation, curve fitting, Numerical applications & intergradations, numerical optimization.	CO-2 BTL-3	

MODULE 3:	(5)

Matrices and types of linear systems, direct elimination methods, conditioning and stability of solutions.	CO-3 BTL-3

MODULE 4:	**(7)**
Introduction to Finite Element Analysis (FEA) simulation software, Pre- and Post-Processing, Free mesh and Mapped mesh techniques, Quality checks on nodes and elements, Boundary conditions.	CO-4 BTL-4

MODULE 5:	**(7)**
Introduction to computational fluid engineering, Fundamental equations, Computational Engineering Process.	CO-4 BTL-3

MODULE6:	**(7)**
Fluid Simulation for Computer Graphics, Modelling techniques.	CO-5 BTL-4

REFERENCE 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.

COURSE TITLE		**COMMUNICATION TECHNOLOGY**			CREDITS	**3**
COURSE CODE	**DTB0753**	COURSE CATEGORY		DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details		23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about communication system design, calculation of bandwidth and signal-to-noise ratio of a signal, digital communication systems, performance evaluation, explain the concepts of link budget and multiple accesses as it applies to wireless communication.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand communication system design methodologies, communication system architecture, analogue & digital modulation techniques. 2. Computation of data rates, bandwidth, BER. 3. To carry out the link budget analysis.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	-	2	3	-	-
CO-2	3	-	-	2	3	-	-
CO-3	3	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	**(6)**
Introduction on Communication Systems, Basics of wireless channel behavior.	**CO-1 BTL-2**

MODULE 2:	**(6)**
Digital data communication systems, digital signaling techniques.	**CO-1 BTL-2**

MODULE 3:	**(5)**
Data rates and bandwidth calculation in digital data communication systems.	**CO-2 BTL-3**

MODULE 4:	**(7)**
Probability of error and BER calculation, Modulation technologies (analogue & digital), Voice source coding, transmitter and receiver systems.	**CO-2 BTL-3**

MODULE 5:	(7)
Communication system architectures, terminal design and performance, associated information systems.	**CO-1,2** **BTL-3**

MODULE 6:	(5)
Link budget calculations, telemetry and control and IO/IW implications. Antenna types and their impact on the communication systems.	**CO-3** **BTL-3**

REFERENCE BOOKS	
1.	"Fundamentals of communication systems," by Proakis and Salehi. Publisher: Pearson.
2.	"Communication Systems", by Simon Haykin and Michael Moher. Publisher: Wiley.
3.	"Modern digital and analog communication systems," by B.P. Lathi and Zhi Ding. Publisher: Oxford University Press.

COURSE TITLE	ADVANCED MECHANICAL ENGINEERING			CREDITS	3
COURSE CODE		COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about different methods of mechanical system analysis, mechanical simulation soft-ware and use of computational techniques for structural and fluid dynamics.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand mechanical analysis software and carry out mathematical modeling for simulation of phenomena behind the structural and fluid dynamics. 2. Carry out design & finite element analysis of components of systems and sub-systems. 3. Carry out the CFD analysis.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	3	3	-	-
CO-2	3	2	-	3	3	-	-
CO-3	3	2	-	3	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: (5)	
Introduction to tools for mechanical design & analysis	CO-1 BTL-2

MODULE 2: (7)	
Stress engineering – theory & simulation, mechanics of solids	CO-1 BTL-2

MODULE 3: (7)	
Finite element methods in structural dynamics, Structural integrity	CO-2 BTL-3

MODULE 4: (5)	
Fluid mechanics	CO-2 BTL-3

| MODULE 5:   (7) | |

Computational fluid dynamics	CO-3 BTL-3

MODULE 6: (5)

Component design, Applied materials and corrosion	CO-3 BTL-3

REFERENCE BOOKS	
1.	"An Introduction to Computational Fluid Dynamics: The Finite Volume Method " by H. Versteeg. Publisher: Pearson.
2.	"Computational Fluid Dynamics the Basics with Applications", by John D. Ander Jr. Publisher: McGraw Hill Education (1 July 2017)
3.	"Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cam-bridge-iisc)" by C. S. Jog. Publisher: Cambridge University Press.
4.	Fundamentals of Machine Component Design", by Robert C. Juvinall, Kurt M. Marshek. Publisher: John Wiley & Sons

SEMESTER I - ELECTIVE – 2 COURSES

COURSE TITLE	AUTONOMY AND NAVIGATION TECHNOLOGY			CREDITS	3
COURSE CODE	DTB0752	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about technology of modern navigation systems, particularly satellite-based systems, UAV guidance systems, GPS, SLAM.
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basic principle of operation of a global navigation satellite system 2. Understand the navigation systems and derive the navigation equations. 3. Carry out path planning the UGV / UAV. 4. Solve the equations for calculating a position estimate from a given satellite constellation.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	2	-	3	-	-
CO-2	3	-	3	-	3	-	-
CO-3	3	-	2	-	3	-	-
CO-4	3	-	-	-	3	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(6)
Introduction on navigation and guidance systems, Guidance approaches: conventional guidance such as PN (Proportional Navigation)	CO-1 BTL-3

MODULE 2:	(7)
Geodetic fundamentals of navigation, positioning, reference- and coordinate systems and computational methods for navigation and positioning on the surface of the earth.	CO-2 BTL-3

MODULE 3:	(7)
Geometric guidance, path planning and following, and optimal guidance; path planning for UGV/UAV guidance systems	CO-3 BTL-3

MODULE 4:	(5)
Navigation approaches: navigation systems, Understanding the Global Positioning System (GPS)	CO-1,3 BTL-3

MODULE 5:	(6)
GNSS (Global Navigation Satellite System), terrain based navigation.	CO-3 BTL-3

MODULE 6:	(5)
SLAM (Simultaneous Localization and Mapping); Cooperative guidance and collision avoidance.	CO-4 BTL-3

REFERENCE 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.

COURSE TITLE	OPTIMIZATION THEORY & APPLICATIONS			CREDITS	3
COURSE CODE		COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	1. To provide knowledge to the students on the numerical optimization algorithms. 2. To cover the concepts of optimization methods and algorithms developed for solving various types of optimization problems. 3. 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 Outcome	Upon completion of this course, the students will be able to 1. Understand mathematical modeling and the formulation of optimization problems. 2. Create programs based on different optimization algorithms using IT tools, such as MATLAB etc. 3. Understand theory about linear programming, integer programming, and stochastic programming 4. Understand the process of finalizing design of engineering systems by applying the numerical optimization.

Prerequisites:

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	-	-	1	-	-
CO-2	3	-	2	-	3	-	-
CO-3	3	-	2	-	3	-	-
CO-4	3	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(6)
Introduction to optimization, classical optimization techniques.	CO-1 BTL-1

MODULE 2:	(7)
Linear programming &non-linear programming and dimensional minimization methods.	CO-2 BTL-2

MODULE 3:	(7)
Non coordination optimization techniques, coordinated optimization techniques, coordinated programming.	**CO-2** **BTL-3**

MODULE 4:	(6)
Dynamic programming, integer programming, stochastic programming.	**CO-3** **BTL-3**

MODULE 5:	(5)
Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques.	**CO-3** **BTL-3**

MODULE6:	(5)
Additional Topics: multi-objective, optimization, game theory, optical control theory.	**CO-4** **BTL-2**

REFERENCE 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. MOS-SIAM 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.

COURSE TITLE	MILITARY ELECTRONICS SYSTEM ENGINEERING			CREDITS		3
COURSE CODE		COURSE CATEGORY		DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL		BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about the learning of the electronics systems requirement for military environment, generation of system requirements, limitations of COTS equipment and radiation effects on the electronic systems.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the military electronics systems. 2. Generate system design requirements as per mission needs & operational requirements. 3. To create digital simulation models. 4. Understand the limitations of the COTS available electronics systems. 5. Evaluate the radiation effects on the performance of electronics systems.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	1	1	1	1	1	1	1
CO-2	3	-	-	2	-	-	-
CO-3	3	-	2	-	-	-	-
CO-4	3	-	-	3	-	-	-
CO-5	3	-	-	3	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(5)
Introduction to electronics engineering concepts and methods for the design and integration of complex defense systems.	CO-1 BTL-2

MODULE 2:	(5)
Familiarity with the systems engineering process through case studies of representative defense systems.	CO-2 BTL-2

MODULE 3:	(6)
Introduction to methods used for determination of system requirements from mission needs and operational requirements.	CO-2 BTL-3

MODULE 4:	(7)
Digital simulation models, including those in current used in defence for determining engineering and performance trade-offs.	CO-3 BTL-4

MODULE 5:	(7)
Limitations of commercial-off-the-shelf (COTS) integrated circuits, thermal failure, electrostatic breakdown, noise in solid state devices, packaging reliability issues.	CO-3 BTL-3

MODULE 6:	(6)
Radiation effects due to space and nuclear environments, and the limited availability of military integrated circuit suppliers.	CO-4 BTL-3

REFERENCE BOOKS	
1.	"Introduction to Electronic Defense Systems", by Neri Filippo. Publisher: Artech House Publishers.
2.	"Military Handbook of Electronic Reliability design", by US Department of Defence.
3.	"Defence Electronics Standards and Quality Assurance", by Ray Tricker. Pub-: Elsevier
4.	"Handbook of Defence Electronics and Optronics: Fundamentals, Technologies and Systems", by Anil K. Maini. Publisher: John Wiley & Sons Ltd
5.	"Digital Simulation Methods", by M.G. Hartley. Publisher : P. Peregrinus Ltd
6.	"Analysis and Simulation of Noise in Nonlinear Electronic Circuits and Systems", By Alper Demir. Publisher : Springer.

COURSE TITLE	SYSTEM ENGINEERING & ANALYSIS			CREDITS	3
COURSE CODE		COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	To provide knowledge to the students about the military systems engineering, system requirements, basics of system design, architecture, operational requirements, system reliability and management.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the system design requirements, architecture, functional requirements 2. Generate the system requirements documents as per the requirement analysis. 3. Understand the system reliability, maintainability, usability issues. 4. Carry out the system reliability analysis.

CO, PO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	-	-	-	-	-
CO-2	3	3	-	-	-	-	-
CO-3	3	3	2	-	-	-	-
CO-4	3	3	-	-	4	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:		(5)
Fundamentals of systems engineering and system architecting of weapon system, system engineering. standards 15288, requirements analysis, functional analysis and allocation, preliminary system architecture.	CO-1 BTL-3	

MODULE 2:		(5)
Systems analysis, system design, and the basics of test and evaluation, Introduction to combat systems,	CO-2 BTL-3	

MODULE 3:		(6)
System development phases (Conceiving, Designing, Implementing, and Operating),	CO-2 BTL-	

MODULE 4:		(7)

Techniques of system design and assessment for operational feasibility, including reliability, maintainability, usability (including human factors and human performance).	CO-3 BTL-3

MODULE 5:	**(7)**
Supportability, and producibility, System cost assessment and effectiveness estimation.	CO-3 BTL-3

MODULE 6:	**(6)**
Reliability analysis and management (basic tools and methods of reliability for developing complex systems including electronic components, mechanical components, and software), *redundancy, graceful degradation, fault tolerance, MTBF.*	CO-4 BTL-3

REFERENCE BOOKS	
1.	"The Engineering Design of Systems: Models and Methods", by Buede D.M.2. Publisher: John Wiley & Sons Inc.
2.	"Systems engineering fundamentals", by Defense Acquisition University Pressfort Belvoir, Virginia
3.	"System Analysis Design and Development", by Charles S. Wasson. Publisher : Wiley Series in System Engineering and Management.
4.	"Principles of Planned Maintenance", by Clifton R H. Publisher: McGraw Hill, New York.
5.	"An introduction to Reliability and Maintainability Engineering", by Ebling CE. Tata Mc Graw Hill.
6.	"Reliability Engineering", by Srinath L S. Publisher : Affiliated East-West Press Limited, New Delhi, 2002.
7.	"Engineering Maintainability", by Dhillon B S. Publisher : Prentice Hall of India.

COURSE TITLE	AEROSPACE SYSTEM CONFIGURATION, DESIGN & SIMULATION		CREDITS		4
COURSE CODE		COURSE CATEGORY	BS	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the concept of missile system and its design requirements and process. 2. Design an aerospace vehicle and articulate its benefits in written and verbal forms. 3. Understand the methods for aero-elastic analysis, computational fluid analysis and advances in aero-dynamics. 4. Understand the air to air, ground to air, air to ground weapon system, UAV mounted GW and UCAVs.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	1	3	-	-	2	2
CO-2	3	3	3	2	2	3	2
CO-3	3	1	-	-	-	-	-
C0-4	3	1	-	-	-	-	-

MODULE 1:		(6)
Introduction (aero-elastic phenomena and design requirements), Introduction to missiles & systems, Design process.		CO-1 BTL-3
MODULE 2:		(6)
Structural requirement, Structural and aerodynamic stiffness, Static aero-elasticity: torsional divergence, Structural vibration and modal analysis.		CO-2 BTL-3
MODULE 3:		(7)
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).		CO-2 BTL-3
MODULE 4:		(7)
Aircraft performance (cruising, climb, descent, takeoff, landing, maneuver, flight path).		CO-3 BTL-3

MODULE 5:		(7)
System's stability & control, aerodynamics control, Introduction to dynamic stability, first and second order responses, Equations of motion and modal characteristics.		CO-3 BTL-3
MODULE6:		(7)
Introduction to air to air, ground to air, air to ground weapon systems, UAV mounted GW and UCAVs.		CO-4 BTL-4
REFERENCE BOOKS		
1.	"Aircraft design: a conceptual approach", by D. Raymer	
2.	"Flight Dynamics Principles", by Michael V. Cook	
3.	"IntroductiontoStructuralDynamicsandAeroelasticity",byDeweyH.Hodges,G.AlvinPierce	
4.	"Airplane Aerodynamics and Performance", by Chuan Tau Edward Lan	
5.	"Fundamentals of Structural Dynamics", by Roy R. Craig Jr., Andrew J. Kurdila.	
6.	Literature / books suggested by respective course Lecturers.	

COURSE TITLE	GUIDANCE & CONTROL			CREDITS		4
COURSE CODE		COURSE CATEGORY		PC	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL		BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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	Upon completion of this course, the students will be able to 1. Understand the principles of satellite navigation, inertial navigation, radio positioning. 2. Understand various aspects of designing a navigation system. 3. Develop mathematical model of missile dynamics. 4. Carry out simulation for aircraft/missile using mathematical tools like MATLAB.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	-	-	-	-	-	-
CO-2	3	-	2	-	2	-	-
CO-3	3	2	3	-	3	2	2
C0-4	3	3	3	3	3	2	3

MODULE 1:	(6)
Introduction to Navigation, Navigation Mathematics.	CO-1 BTL-3

MODULE 2:	(7)
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.	CO-2 BTL-3

MODULE 3:	(6)
Errors and Geometry, Dead Reckoning, Attitude, and Height Measurement, Feature matching, INS/GNSS Integration.	CO-2 BTL-3

MODULE 4:	(6)
Missile Control Methods: Aerodynamic and Thrust Vector Control, Polar and Cartesian Control.	CO-3 BTL-3

MODULE 5:	(8)
Mathematical Modeling of Missile Dynamics; Missile Actuators and Sensors. Roll and Roll Rate Stabilization.	CO-3 BTL-3

MODULE6:	(7)

Design and Analysis of Lateral Autopilots, 6 DOF simulation for aircraft/missile using MATLAB	CO-4 BTL-4

REFERENCE 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			CREDITS	4
COURSE CODE		COURSE CATEGORY	PC	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Knowledge about thermodynamics and fluid dynamics behind the aerospace system. 2. Understanding of Rocket motor design 3. Understanding of different design aspects related to propulsion systems used in aerospace.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	1	-	-	-	-
CO-2	3	2	1	-	-	-	-
CO-3	3	2	1	-	-	-	-

MODULE 1:	(7)
Classification & mode of operation of various propulsion systems, basis thermodynamics & fluid Dynamics.	CO-1 BTL-3

MODULE 2:	(8)
Rocket motor design & analysis, Gas Turbine Engine design, GT engine efficiency, GT engine heat transfer & cooling.	CO-2 BTL-3

MODULE 3:	(6)
Aircraft performance, jet engine performance.	CO-2 BTL-3

MODULE 4:	(7)
Jet engine control (compressor performance, axial turbine performance, Fuel systems & pumps, airframe fuel systems, hydro-mechanical fuel metering, Electronics engine control)	CO-3 BTL-3

MODULE 5:	(6)
System integration	CO-3 BTL-3

MODULE6:	(6)

Computational fluid dynamics (flow modelling strategies, physical modelling, finite difference equations, etc.)	CO-4 BTL-4

REFERENCE 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. An-derson, 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.

COURSE TITLE	AEROSPACE SYSTEM CONFIGURATION, DESIGN & SIMULATION LAB			CREDITS	2
COURSE CODE		COURSE CATEGORY	DE	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
LIST OF EXPERIMENTS					
1.		*Lab experiments will be added in consultation with DRDO labs considering the available facilities.*			CO- BTL-

COURSE TITLE		GUIDANCE & CONTROL LAB			CREDITS	2
COURSE CODE		COURSE CATEGORY		DE	L-T-P-S	0-0-2-0
Version	1.0	Approval Details		23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
LIST OF EXPERIMENTS						
1.		*Lab experiments will be added in consultation with DRDO labs considering the available facilities.*				CO- BTL-

COURSE TITLE	Radar Technologies			CREDITS	3
COURSE CODE	DTD3703	COURSE CATEGORY	DE	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the design of radar systems, solve range equations. 2. Apply appropriate mathematical and computer models relevant to radar systems to calculate system performance, and assess the limitations of particular cases 3. Understand the major components of a modern radar system 4. Learn basic radar signal processing techniques. 5. Understand advanced radar techniques. 6. Know the major functions and applications of a modern radar systems.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	1	-	1	-	-
CO-2	3	2	1	-	-	-	-
CO-3	3	2	1	-	-	-	-
CO-4	3						
CO-5	3	2	1	-	-	-	-
CO-6	3	2	1	-	-	-	-

MODULE 1:	(6)

Introduction to RADAR, Radar parameters/definitions, radar equations.	CO-1 BTL-3

MODULE 2:	(6)

Radar cross section (RCS) & Theory of detection, Clutter.	CO-2 BTL-3

MODULE 3:	(6)

Atmospheric propagation, Surveillance and Tracking Radar, Radar Designs.	CO-2 BTL-

MODULE 4:	(7)

Radar elements Design, Radar Transmitter design, Radar antenna design, Duplexer/TR switch & Radar Receiver.	CO-3 BTL-3	
MODULE 5:		**(7)**
Radar signals and networks, Radar signal processing chain, Pulse compression and micro-doppler processing, Tracking algorithms	CO-3 BTL-3	
MODULE 6:		**(8)**
Phased array radar, Data processing for phased array radar, Airborne radar, imaging radar, Synthetic aperture radar, inverse synthic aperture radar, adaptive array processing.	CO-4 BTL-3	

REFERENCE 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	Digital & satellite Communication and Navigation from Space			CREDITS	3
COURSE CODE	DTD3704	COURSE CATEGORY	DE	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the communication techniques 2. Evaluate the performance of communication systems 3. Design the analogue and digital communication systems 4. Understand and analyse the signal transmission effects 5. Understand the different types of navigation techniques

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	3	3	3	3	2	3
CO-3	3	2	3	2	2	2	2
CO-4	3	2	-	2	2	1	-
CO-5	3	2	-	-	-	-	-

MODULE 1:	(6)
Elements of a communications system and their relationship to system performance.	CO-1 BTL-3

MODULE 2:	(7)
Free space optical communication, Fiber optics communication, Wireless/cellular communications.	CO-2 BTL-3

MODULE 3:	(7)
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,	CO-2 BTL-

MODULE 4:	(7)
Modulation transmission and reception; baseband and passband digital modulation; system, noise, transmission lines, waveguides and antennas, FEC techniques for mitigating channel errors.	CO-3 BTL-3

MODULE 5:		(7)
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.	CO-3 BTL-3	
MODULE 6:		**(6)**
Navigation techniques from space regarding functioning of GPS, GLONASS, IRNSS & Galileo	CO-4 BTL-3	

REFERENCE 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			CREDITS	3
COURSE CODE	DTD3705	COURSE CATEGORY	DE	L-T-P-S	4-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the nature of tactical battlefield communication 2. Calculate communication link performance 3. Calculate the requirements for interception of tactical communication 4. Calculate the requirements for emitter location, intercept and jamming of tactical comm. Signals including weapon control link, UAV links, Cell phone links. 5. Use various tools to perform electronic warfare calculations

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	3	-	2	2	2	3
CO-3	3	3	3	2	2	2	1
CO-4	3	2	2	2	2	2	1
CO-5	3	2	2	2	2	2	1

MODULE 1:	(6)
Radiometry and power calculation, signature generation, atmospheric effects.	CO-1 BTL-3
MODULE 2:	**(6)**
Radar ES operational use, radar/ES detection battle, quiet radar, jamming techniques & strategies, jamming of SAR systems.	CO-2 BTL-3
MODULE 3:	**(7)**
Introduction to radar waveform interception, Technology and operational characteristics of electronic warfare, Signal processing statics & analysis, statistics & noise, analogue & digital signal processing.	CO-2 BTL-
MODULE 4:	**(7)**

Decision theory- hypothesis testing, probabilities of false alarm and detection, Bayesian systems, error probability and bit error rate, receiver operating.	CO-3 BTL-3

MODULE 5:	**(7)**
UAV Payload/link Issues, cell phone issues, Intercept links, Frequency hopping and other LPI threats;Special techniques for jamming LPI signals	CO-3 BTL-3

MODULE 6:	**(7)**
Introduction to electronic counter measures and counter-counter measures.	CO-4 BTL-3

REFERENCE 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	RADAR TECHNOLOGIES LAB			CREDITS		2
COURSE CODE	DTD3791	COURSE CATEGORY	PC	L-T-P-S		0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL		BTL-3
LIST OF EXPERIMENTS						
2.	*Lab experiments will be added in consultation with DRDO labs considering the available facilities.*					CO- BTL-

COURSE TITLE	DIGITAL & SATELLITE COMMUNICATION AND NAVIGATION FROM SPACE LAB			CREDITS	2
COURSE CODE	DTD3792	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3
LIST OF EXPERIMENTS					
2.	*Lab experiments will be added in consultation with DRDO labs considering the available facilities.*				CO- BTL-

COURSE TITLE	Robotics (MSS, MCC)				CREDITS	3
COURSE CODE	DTA-3730	COURSE CATEGORY		DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide learning on the basic concepts of robotics by exposing students to a broad range of topics with emphasis on basics of manipulators, coordinate transformation and kinematics, trajectory planning, control techniques, sensors and devices, robot applications and economics analysis.
Course Outcome	Upon completion of this course, the students will be able to 1. Use matrix algebra and Lie algebra for computing the kinematics of robots. 2. Calculate the forward kinematics and inverse kinematics of serial and parallel robots. 3. Calculate the Jacobian for serial and parallel robot. 4. To do the path planning for a robotic system. 5. To use software tools for analysis and design of robotic systems.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	3	2	2	2	2	2
CO-3	3	2	-	-	-	-	-
CO-4	3	2	2	2	2	2	1
CO-5	3	3	3	3	3	2	2

MODULE 1:		(7)
Fundamentals of land-based robotic systems covering the areas of locomotion, manipulation, grasping, sensory perception, and teleoperation.		CO-1 BTL-3
MODULE 2:		**(5)**
Kinematics, dynamics, manipulability, motion/force control, real-time programming, controller architecture, motion planning, navigation, and sensor integration, Control system design.		CO-2 BTL-3
MODULE 3:		**(4)**
Transformation of coordinates, Kinematics and inverse kinematics, Jacobians.		CO-2 BTL-

MODULE 4:	(7)
Modelling Control, Proportional (P), Proportional-Integral (PI), Proportional-Integral-Derivative (PID) and Model Based Predictive Controller (MPC)	CO-3 BTL-3

MODULE 5:	(7)
Feedback Control System, Motion and path planning, Collision avoidance and navigation	CO-3 BTL-3

MODULE 6:	(6)
Fundamental of AI, Programming methods for robotics, Human-Robot interaction.	CO-4 BTL-3

REFERENCE BOOKS	
1.	Text Book: Introduction to Robotics by S.K. Saha (Tata McGraw-Hill, New Delhi, India 2008, 1st Reprint 2009)
2.	"Introduction to Robitcs: Mechanics and Control", by Craig, J.J. Publisher : Pear-son, Delhi.
3.	"Fundamentals of Robotics: Analysis and Control", by Schilling Robert J. Pub-lisher : Prentice- Hall, 1990.
4.	"An Introduction to Robotics Analysis, Systems, Applications", by Niku Saeed B. Publisher: Prentice-Hall, 2001.
5.	Stuart Russell and Peter Norvig, Publisher: Prentice Hall
6.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	EMI/EMC in Military Systems			CREDITS	3
COURSE CODE	DTA-3731	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the concept of EMI / EMC protection of equipment 2. Identify and prevent the common EMI/EMC problems in military systems. 3. Understand the Design impact (by requirement) of military EMC specifications. 4. Understand EMI/EMC troubleshooting tips and techniques. 5. Learn generate EMI/EMC requirements document.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	2	2	2
CO-3	3	2	-	-	-	-	-
CO-4	3	2	-	-	2	2	3
CO-5	3	3	2	-	2	3	3

MODULE 1:	(6)
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,	CO-1 BTL-3

MODULE 2:	(6)
EMC requirements for electronic systems, Non-ideal Behaviors of Components; EMI Measurements: Basic principles of EMI measurements, EMI measuring instruments;	CO-2 BTL-3

MODULE 3:	(6)
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	CO-2 BTL-

MODULE 4:	(5)
EMC Standard and Regulations: National and Intentional standardizing organizations, Frequency assignment, Spectrum conversation;	CO-3 BTL-3

MODULE 5:	(7)
EMC Design and Interconnection Techniques: Cable routing and connection, Component selection and mounting, PCB design (Trace routing, Impedance control, decoupling, Zoning and grounding);	CO-3 BTL-3
MODULE 6:	**(6)**
EMC analysis and detection techniques: Using tools for signal integrity analysis, Study eye diagrams for communication systems.	CO-4 BTL-3

REFERENCE 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	Defence Electro-Optics and Imaging Systems			CREDITS	3
COURSE CODE	DTA-3732	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 application.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the technology and principles underpinning electro-optic devices and systems. 2. Apply their knowledge to practical electro-optic design and acquisition problems. 3. Understand the trade-offs in electro-optic systems design.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	3	2	1	2	2	2
CO-3	3	2	2	-	-	-	-

MODULE 1:	(6)
Principles of radiometry, The human eye, Visible band optical sighting systems.	CO-1 BTL-3

MODULE 2:	(6)
Camera systems, Image intensifiers, Missile seekers.	CO-2 BTL-3

MODULE 3:	(6)
Electro-optic countermeasures.	CO-2 BTL-

MODULE 4:	(7)
Thermal imagers, II cameras, Hyper-spectral imaging, Digital image processing.	CO-3 BTL-3

MODULE 5:	(5)
EO sensors for Lasers and laser DEW	CO-3 BTL-3

MODULE 6:	(6)
Electro-optic protection measures.	CO-4 BTL-3

REFERENCE BOOKS	
1.	"Systems engineering analysis of electro-optical and Infra red 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.

COURSE TITLE	Structural Dynamics and Aero-Elasticity			CREDITS	3
COURSE CODE	DTA-3733	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand vibrations and fluid dynamics behind the aerospace system. 2. Understand of different design aspects related to loading in aerospace system. 3. Do the system dynamic analysis using finite element methods.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	2	2	2	2	2	2

MODULE 1:	(6)
Principles and methods of computational structural dynamics and vibration analysis.	CO-1 BTL-3

MODULE 2:	(6)
Introduction to dynamic analysis using the finite element method, Calculation of modal parameters.	CO-2 BTL-3

MODULE 3:	(6)
System dynamic response via mode superposition, frequency response, model reduction, and structural synthesis techniques, Fatigue analysis.	CO-2 BTL-

MODULE 4:	(7)
Introduction to aero-elasticity, Aerodynamic Loading, Bending Moment, Sectional properties of Aerofoil, V-n Diagram,	CO-3 BTL-3

MODULE 5:	(5)
Basic theory of linear elastic fracture mechanics; strain energy release rate;	CO-3 BTL-3

MODULE 6:	(6)
Applications to delamination crack growth in polymer composite laminates, Damage tolerance issues in composites	CO-4 BTL-3

REFERENCE 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	Safety, Health & Hazard Management			CREDITS	3
COURSE CODE	DTA-3734	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The main objectives of the course will be to inculcate a holistic approach towards safety health and hazard management. The course will provide understanding on the safety & hazard management of the toxic chemicals, gases, explosives etc.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand chemical safety standards, fire safety, hazard management. 2. Handle toxic liquids & gases, explosives. 3. Understand the NBC warfare safety, health & environment safety.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	1	2
CO-2	3	2	-	-	1	2	2
CO-3	3	2	-	-	1	2	2

MODULE 1:	(6)
Chemical Safety: Standards and regulations of chemical safety in Industries or Laboratories, Storage of hazardous chemicals, Compatibility and classification codes, Chemical risk analysis and management	CO-1 BTL-3

MODULE 2:	(4)
Fire triangle and Handling of Toxic, Industrial Gases	CO-2 BTL-3

MODULE 3:	(7)
Hazard Management: HAZOP and HAZAN techniques, Hazard in manufacture, Hazard prevention measures, Disposal of hazardous materials;	CO-2 BTL-

MODULE 4:	(7)
Warfare: Classifications of explosives based on hazards, Nuclear, biological and chemical warfare safety;	CO-3 BTL-3

MODULE 5:	(6)
Health: Assessment of human factors, Health & Environment safety	CO-3 BTL-3

MODULE 6:	(6)
Nano materials safety (Toxicology study)	CO-4 BTL-3

REFERENCE BOOKS	
1.	"Occupational Health and Safety Management A Practical Approach", by Charles D. Reese. Publisher : CRC Press.
2.	"Occupational and Environmental Safety and Health", Arezes, P.M., Baptista, J.S., Barroso, M.P., Carneiro, P., Cordeiro, P., Costa, N., Melo, R.B., Abreu dos Santos Baptista, J.M., Perestrelo, G. (Eds.). Publisher : Springers, 2019
3.	"Handbook of Occupational Safety and Health", by S. Z. Mansdorf. Publisher : Wiley.
4.	"Institution of Chemical Engineers", by Trevor Kletz"Hazop and Hazan
5.	"Handbook Of Toxicology Of Chemical Warfare Agents", by Ramesh C. Gupta 2nd Edition Elsevier, 2015
6.	"Nanomaterials Safety Toxicity And Health Hazards", by Shyamasree Ghosh De Gruyter.
7.	"Hazardous Chemicals Handbook", by Phillip Carson, Clive Mumford Butterworth-Heinemann.
8.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	FUNDAMENTAL OF TELEMETRY, TELECOMMAND & TRANSPONDER			CREDITS	3
COURSE CODE	DTA-3735	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Satellite communication and related technologies. 2. Overall control of satellites through collection, processing, and transmission of data. 3. Determination of the satellite's exact location through the reception, processing, and transmitting of ranging signals. 4. Proper control of satellite through the reception, processing, and implementation of commands transmitted from the ground.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	2	-	2	2	2	2
CO-4	3	2	-	2	2	2	3

MODULE 1:	(6)

Fundamental of satellite communication, different modulation and multiplexing schemes.	CO-1 BTL-3

MODULE 2:	(6)

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.	CO-2 BTL-3

MODULE 3:	(6)

Satellite Packet Communications, Tracking and Telemetry.	CO-2 BTL-

MODULE 4:	(6)

Doppler and Electro-Optical methods of tracking, Airborne Missile.	CO-3 BTL-3

MODULE 5:	(6)
Signal Processing: Processing of Signal, Data Acquisition and Reduction.	**CO-3** **BTL-3**
MODULE 6:	(6)
Introduction to satellite communication, transponders.	**CO-4** **BTL-3**

REFERENCE 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
6.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	JAMMING AND ECM/ECCM TECHNOLOGIES			CREDITS	3
COURSE CODE	DTA-3736	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide learning on the concept of jamming, frequency matching, continuous interference, factors affecting ECM, basic principle of noise jamming, different types of jamming systems, ECM techniques, and ECCM.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the concept of electronic attacks. 2. Understand the principles and the practical applications of current and evolving electronic jamming technology 3. Understand the different types of electronic counter measures and counter – counter measures.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	2	-	-	-	-	-

MODULE 1:		(7)
Principals of Electronic Attack (EA), Jamming-to-Signal Ratio, Jamming Types Burn-Through, Cover Jamming, Range Deceptive Jamming, Inverse Gain Jamming.	CO-1	BTL-2
MODULE 2:		**(6)**
Repeater Jamming Equations, Noise Jamming vs. Deception, Repeater vs. Transponder, Side lobe Jamming vs. Main lobe Jamming.	CO-1	BTL-2
MODULE 3:		**(5)**
Stand-Off Jamming, Escort Jamming, Self-Protection Jamming, ECM techniques, On- Board ECM Systems, Off-Board ECM Systems.	CO-2	BTL-3
MODULE 4:		**(6)**

Infrared Countermeasures (IRCM), Off-Board ECM Systems, Communications Countermeasures (COM-ECM), Electro-Optic Counter Measure (EOCM) Systems.	**CO-2** **BTL-3**
MODULE 5:	**(6)**
Airborne Tactical Jamming System, Shipboard Self-Defense System, EA/Susceptibility against Weapon Systems. Search Radar Counter-Countermeasures, Tracking Radar.	**CO-1,2** **BTL-3**
MODULE 6:	**(6)**
Counter-Countermeasures, Infrared Counter-Countermeasures, Communications Counter-Countermeasures.	**CO-3** **BTL-3**

REFERENCE BOOKS	
1.	"Electronic Countermeasure and Electronic Counter-Countermeasure", by Bahman Zohuri.
2.	"Fundamentals of Electronic Warfare 2001", by S.A. Vakin , L.N. Shustov, R.H. Dunwell.
3.	"Fundamentals of Electronic Warfare 2001", by S.A. Vakin , L.N. Shustov, R.H. Dunwell.
4.	"Electronic Warfare & Radar Systems Engineering Handbook" 2013, Naval Air Warfare Center Weapons Division.
5.	"EW 101: A First Course in Electronic Warfare (Artech House Radar Library)", 1st Edition

COURSE TITLE	**SOFTWARE DEFINED RADIOS**			CREDITS	**3**
COURSE CODE	DTA-3737	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the concept, application of SDRs. 2. Understand of analog RF components as front end block in implementation of SDR. 3. Gain knowledge of digital hardware architectures and its development techniques. 4. Gain knowledge of software development for embedded wireless systems.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	2	-	-	-	-	-
CO-4	3	2	-	-	-	-	-

MODULE 1:		**(6)**
SDR introduction, major standards, SDR architecture, SDR enablers, advantage / disadvantages, Applications.		**CO-1** **BTL-2**
MODULE 2:		**(6)**
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.		**CO-1** **BTL-2**
MODULE 3:		**(6)**
SDR Hardware, super-heterodyne architecture, homodyne architecture, advantages & disadvantages, Software for SDR, Processing architecture for SDR.		**CO-2** **BTL-3**
MODULE 4:		**(6)**
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		**CO-2** **BTL-3**

processing..	
MODULE 5:	**(7)**
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).	**CO-1,2** **BTL-3**
MODULE 6:	**(5)**
Case studies in software radio design, Introduction and a Historical perspective	**CO-3** **BTL-3**

REFERENCE 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.

COURSE TITLE	ADVANCED LIGHT WEIGHT AND COMPOSITE STRUCTURES			CREDITS	3
COURSE CODE	DTA-3738	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The main objective 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 Outcome	Upon completion of this course, the students will be able to 1. Understand the design of advanced structures and lightweight materials for aerospace materials. 2. Understand the numerical and analytical skills in structural mechanics for both composite and metallic components. 3. Apply knowledge to solve real engineering problems.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	2	2	2	2	2
CO-3	3	2	2	2	2	2	2

MODULE 1:	(6)
Review of Strength of Materials, Introduction to Aerospace Materials — Metal Alloys and Fiber Reinforced Composite.	CO-1 BTL-2

MODULE 2:	(7)
Introduction to different types of constructions: Monocoque, Semi-Monocoque, Truss, and Corrugated shell.	CO-1 BTL-2

MODULE 3:	(6)
Introduction to Aircraft and Missile Structural Components: Spars; Ribs; Stringer; Longerons.	CO-2 BTL-3

MODULE 4:	(7)
Analysis of stress; Analysis of strain.	CO-2 BTL-3

MODULE 5:	(5)
Material Constitutive Relations.	CO-1,2 BTL-3

MODULE 6:	(5)
Failure Theories; Fatigue theory.	CO-3 BTL-3

REFERENCE 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.

COURSE TITLE	**TEST METHODOLOGIES FOR DEW SYSTEMS**			CREDITS	3
COURSE CODE	DTA-3739	**COURSE CATEGORY**	DE	**L-T-P-S**	3-0-0-0
Version	1.0	**Approval Details**	**23 ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide learning on the testing requirements, characterization, system performance testing procedures, test setups, safety standards, safety tools of laser and microwave based DEW systems.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the characterization and testing requirements of DEW systems. 2. Carry out the indoors & outdoors system performance testing. 3. Understand the safety issues, safety standards, handling high power sources.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	1	1	2
CO-3	3	2	-	-	-	-	2

MODULE 1:		(6)
Testing requirements of DEW system, types of testing, laser effect testing on target, system output testing.	**CO-1** **BTL-2**	

MODULE 2:		(7)
System performance testing, System outdoor test & measurement instruments.	**CO-1** **BTL-2**	

MODULE 3:		(5)
Laser testing issues, Laser safety, Laser safety standards, laser safety tools.	**CO-2** **BTL-3**	

MODULE 4:		(5)
Microwave system testing Impedance measurement, S-Parameters and the Smith Chart.	**CO-2** **BTL-3**	

MODULE 5:		(7)

Power Measurement, Noise Figure and Phase Noise measurement, Frequency measurements (Spectrum Analysis), Gain Compression and Intermodulation, Network Analysis.	**CO-1,2** **BTL-3**

MODULE 6:	**(6)**
Microwave subsystem / system characterization techniques. HPM safety tools, safety standards.	**CO-3** **BTL-3**

REFERENCE BOOKS	
1.	"An Introduction to Microwave Measurements", by Ananjan Basu.

COURSE TITLE	ADVANCED ANALYTICAL TECHNIQUES/LAB TESTING		CREDITS		3
COURSE CODE	DTA-3740	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The main objective of the course is to impart an in-depth knowledge of material characterization by all the conventional well established techniques used worldwide. The course provides understanding on the material characterization, having main focus on polymeric techniques, chromatography and Spectroscopy.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand different characterization techniques. 2. Apply appropriate analytical technique for a particular material organic/inorganic/ nanomaterial/polymer etc.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	1	1	2

MODULE 1:	(4)
Instrumental Analysis: Qualitative analysis.	CO-1 BTL-2

MODULE 2:	(4)
Genesis of instrumental analysis, hyphenated techniques.	CO-1 BTL-2

MODULE 3:	(8)
Polymeric Techniques: Rheology Techniques, Molecular weight determination; Thermal Techniques: Thermo Gravimetry (TG), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC).	CO-2 BTL-3

MODULE 4:	(8)
Chromatographic Techniques: Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Thin Layer Chromatography (TLC), Ion chromatography.	CO-2 BTL-3

MODULE 5:	(8)

Spectroscopy: Ultra Violet-Visible Spectroscopy UV-VIS, Infra-Red spectroscopy (IR), Nuclear Magnetic Resonance (NMR), Mass spectroscopy, Atomic Absorption Spectroscopy (AAS).	**CO-1,2** **BTL-3**

MODULE 6:	**(4)**
XRD and SEM techniques, Sensitivity studies	**CO-3** **BTL-3**

REFERENCE BOOKS	
1.	"Fundamentals of molecular spectroscopy" by C. N. Banwell. Publisher : McGraw Hills.
2.	"Introduction to Spectroscopy" by Donald L. Pavia, Gary M. Lampman, and George S. Kriz. Publisher: Cengage Learning, 2014.
3.	"Chromatography: Concepts and Contrasts" by James M. Miller. Publisher : Wiley.
4.	"Chromatography: Principles and Instrumentation", by Mark F. Vitha. Publisher: Wiley.
5.	"Elements of X-Ray Diffraction" by B.D. Cullity Deceased, S.R. Stock. Publisher : Pearson.
6.	"Electron Microscopy: Principles and Fundamentals" by S. Amelinckx, Dirk van Dyck, J. van Landuyt, Gustaaf van Tendeloo. Publisher : Wiley.
7.	"Polymer Characterization: Physical Techniques", by Dan Campbell, Richard A. Pethrick, Jim R. White 2nd Edition. Publisher CRC Press.

COURSE TITLE		SONAR SYSTEM ENGINEERING		CREDITS		3
COURSE CODE		DTA-3741	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version		1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The objective of the course is to provide an in-depth understanding of underwater acoustic principles, sonar technology and applications, hardware and software design engineers new to sonar system design.
Course Outcome	Upon completion of this course, the students will be able to 1. Know the basic building blocks of a radar system. 2. Have an in-depth knowledge on different types of signals that are used. 3. Know about the ambiguity function and its significance in radar signal processing. 4. Know the physics behind sound propagation in water and principle of operation of sonar. 5. Apply the knowledge acquired in this course in real time applications.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	2	-	-	-	-	-
CO-4	3	2	-	-	-	-	-
CO-5	3	3	-	-	-	-	-

MODULE 1:		(6)
Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operation.		CO-1 BTL-2

MODULE 2:		(6)
Topics from complex aperture theory, array theory.		CO-1 BTL-2

MODULE 3:		(5)
Signal processing		CO-2 BTL-3

MODULE 4:		(6)

Introduction to undersea warfare and engineering acoustics.	CO-2 BTL-3

MODULE 5:	**(7)**
Principles of optimal signal processing techniques for detecting signals in noise, maximum likelihood, Bayes risk.	**CO-1,2** **BTL-3**

MODULE 6:	**(6)**
Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROC curves).	**CO-3** **BTL-3**

REFERENCE BOOKS	
1.	"Fundamentals of Radar, Sonar and Navigation Engineering", by K. K. Sharma.
2.	"Principles of Modern Radar: Advanced techniques", by editor William L. Mel-vin.
3.	"Principles of Modern Radar: Advanced techniques", by editor William L. Mel-vin.
4.	"Sonar for practicing engineers", by A. D. Waite.
5.	"Underwater Acoustics: Analysis, Design and Performance of Sonar", by Rich-ard P. Hodges.

COURSE TITLE	UNMANNED AERIAL VEHICLE DESIGN			CREDITS	3
COURSE CODE	DTA-3742	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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, air- safety issues, airworthiness and prototype testing.
Course Outcome	Upon completion of this course, the students will be able to a. Understand the design requirements, design parameters of UAV. b. Perform the aerodynamic analysis, performance and stability analysis. c. Understand the performance testing of the UAVs. d. Understand the airworthiness and safety requirements of UAV.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	2	-	-	-	-	-
CO-4	3	2	-	-	-	-	-

MODULE 1:	(6)
UAV design Requirements, design parameters, design algorithms, Certification approaches: aircrafts and UAVs. Airworthiness of aircrafts and UAVs.	CO-1 BTL-3

MODULE 2:	(6)
Air safety issues. Handling qualities. Maneuverability requirements. Aircraft design; UAV system design. UAV system identification	CO-2 BTL-3

MODULE 3:	(7)
UAV aerodynamics, structures and propulsion, performance and stability analysis.	CO-2 BTL-

MODULE 4:	(6)
UAV project life cycles. Stages of Aircraft design. Initial sizing: aircrafts and of UAVs.	CO-3 BTL-3

MODULE 5:	(5)
Ground control systems. Ground and flight testing of UAVs. UAV guidance and Navigation. Design for reliability.	CO-3 BTL-3

MODULE 6:		(6)
Wind Tunnel Testing, Aerodynamic Characterization through Wind Tunnel Testing.		CO-4 BTL-3
REFERENCE 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.	

COURSE TITLE	NAVAL OCEAN ANALYSIS AND PREDICTION			CREDITS	3
COURSE CODE	DTA-3743	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide understanding of the science and art of Naval Ocean. They will learn methods of analysis of ocean data, to model Naval ocean, to generate global ocean circulation prediction system, Shallow Water Analysis and Forecast System (SWAFS).
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the design requirements, design parameters of UAV. 2. Perform the aerodynamic analysis, performance and stability analysis. 3. Understand the performance testing of the UAVs. 4. Understand the airworthiness and safety requirements of UAV.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	-
CO-3	3	2	-	-	-	-	-
CO-4	3	2	-	-	-	-	-

MODULE 1:	(6)
Advanced knowledge of the Indian Navy ocean analysis and prediction systems.	CO-1 BTL-3

MODULE 2:	(5)
Naval Ocean Modeling Program (NOMP), Naval ocean data systems.	CO-2 BTL-3

MODULE 3:	(6)
Atmospheric forcing systems, data assimilation systems.	CO-2 BTL-

MODULE 4:	(6)
Optimal Thermal Interpolation System (OTIS), Thermal Ocean Prediction Systems (TOPS).	CO-3 BTL-3

MODULE 5:	(6)
Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formula for estimating air-sea fluxes.	CO-3 BTL-3

MODULE 6:	(6)
The global ocean circulation prediction system, Shallow Water Analysis and Forecast System (SWAFS), Knowledge of ocean eddies.	**CO-4** **BTL-3**

REFERENCE BOOKS	
1.	Indian Navy: Ocean of opportunities (Defence Series Books) Author: by PRANAV ZOPE
2.	Elements of Ocean Engineering. Author Robert E. Randall
3.	Ocean Modelling for Beginners - Using Open-Source Software. Author Jochen Kaempf.
4.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	MODELLING &SIMULATION OF LASER MATTER INTERACTION			CREDITS		3
COURSE CODE	DTA-3744	COURSE CATEGORY	DE	L-T-P-S		3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL		BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide understanding on the high power laser beam interaction with metals and composite materials, physics based models for the lethality modelling, damage mechanism & damage threshold measurement techniques and performance evaluation of high power laser systems.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand of the laser matter interaction. 2. Develop physics-based model for evaluation of effect of laser on metals and composites. 3. Understand the laser parameter measurement techniques. 4. Analyse the performance of high-power laser systems.

MODULE 1: (6)

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	2	-	-	-	-
CO-2	3	2	-	2	-	1	2
CO-3	3	2	-	-	-	-	-
CO-4	3	2	2	2	2	1	2

Laser beam characteristics, Laser lethality modeling & simulation with metal targets & composite materials..	CO-1 BTL-3

MODULE 2: (5)

Physics based models for vulnerability assessment, Effect of laser on metals & composite materials.	CO-2 BTL-3

MODULE 3: (6)

Measurement and Characterization of Damage Thresholds, Mechanisms of Damage, Exposure Limits and Their Interpretation.	CO-2 BTL-

MODULE 4: (6)

Analysis Tools for the Estimation of Hazards, Laser parameters measurement techniques.	CO-3 BTL-3

MODULE 5: (7)

Tools to analyse and predict Laser System performance under different conditions like	CO-3 BTL-3

land, sea air, etc.	
MODULE 6:	**(6)**
Introduction of full scale end to end modeling of laser system performance.	**CO-4** **BTL-3**

REFERENCE BOOKS	
1.	"High Power Laser-Matter Interaction", by Mulser, Peter, Bauer, Dieter. Publisher : Springer.
2.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	COMPUTATIONAL AERODYNAMICS				CREDITS	3
COURSE CODE	DTA-3745	COURSE CATEGORY	DE		L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the CFD analysis, fluid mechanics, heat transfer analysis, numerical modelling of fluids. 2. Generate numerical model related to fluid dynamics 3. To do the pre and post processing of CFD analysis.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	3	3	3	2	2
CO-3	3	2	3	3	3	2	2

MODULE 1:	(5)
Introduction to fluid mechanics & heat transfer.	CO-1 BTL-3

MODULE 2:	(6)
Introduction to numerical analysis, Discretization approaches: finite difference, finite volume, finite element and spectral methods,	CO-2 BTL-3

MODULE 3:	(6)
Numerical methods for algebraic equations/systems of equations, Numerical schemes for hyperbolic, parabolic and elliptic systems and for fluid dynamics.	CO-2 BTL-

MODULE 4:	(7)
CFD analysis.	CO-3 BTL-3

MODULE 5:	(6)
Numerical modelling of compressible & in-compressible flow, turbulence modelling	CO-3 BTL-3

MODULE 6:	(6)

Grid generation/CAD, data analysis and uncertainties	CO-4 BTL-3

REFERENCE BOOKS	
1.	"A Textbook of Heat Transfer Paperback", by S.P.Sukhatme. Publisher: Univer-sities 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. An-derson, Jr. Publisher : McGraw Hill Education
4.	"Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cambridge-iisc)", by C. S. Jog. Publisher : Cambridge University Press; 3rd edi-tion.
5.	"Numerical Modeling and Computer Simulation", Edited by DraganCvetković, publisher intechopen.
6.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	LAUNCH VEHICLE DESIGN & ANALYSIS			CREDITS	3
COURSE CODE	DTA-3746	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide learning on the launch vehicle design and analysis, components and subsystems of the launch vehicle, propulsion systems.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the launch vehicle requirements, its functioning. 2. Design and analysis of launch vehicles. 3. Understand the propellant requirement for launch vehicles.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	3	-	2	2	2
CO-3	3	2	-	-	-	-	-

MODULE 1:		(6)
Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices.		CO-1 BTL-3

MODULE 2:		(5)
Performance analysis, operating characteristics and propellant selection criteria for air breathing and solid.		CO-2 BTL-3

MODULE 3:		(7)
Liquid and nuclear rocket motor propulsion systems.		CO-2 BTL-

MODULE 4:		(7)
Advanced cycles and concepts are presented. Design of components and subsystems		CO-3 BTL-3

MODULE 5:		(6)
FE modelling: Idealization, Discretization, Meshing and Post Processing.		CO-3 BTL-3

MODULE 6:		(5)

Tracking and controlling errors, Nonlinear analysis in FEM, Launch dynamic analysis.	**CO-4** **BTL-3**

REFERENCE 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, Subse-quent 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.
6.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	ACQUISITION, TRACKING & POINTING TECHNOLOGY			CREDITS		3
COURSE CODE	DTA-3747	COURSE CATEGORY	DE	L-T-P-S		3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL		BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide learning on the acquisition, tracking & pointing technologies, development of tracking algorithms, design and analysis of tracking systems.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the concepts and basic systems requirements tracking systems. 2. Understand the system configurations and critical component characteristics required in the design of stabilized pointing and tracking systems, along with an introduction to some more advanced concepts. 3. Understand the control system and algorithm techniques and practices commonly utilized in the design of tracking systems.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	1	-	-
CO-2	3	2	-	-	1	-	-
CO-3	3	2	-	-	1	-	-

MODULE 1:	(6)
Acquisition, tracking, and pointing (ATP) design for military systems	CO-1 BTL-3

MODULE 2:	(6)
Target tracking and related mathematics, SNR requirement, the Johnson criteria, probability of estimation, detection criteria.	CO-2 BTL-3

MODULE 3:	(6)
Tracking algorithms, track filters, multi target tracking.	CO-2 BTL-

MODULE 4:	(7)
Electronic countermeasures against modern target tracking radars.	CO-3 BTL-3

MODULE 5:	(6)
Multiplatform-multi-sensor-multi target tracking	CO-3 BTL-3

MODULE 6:	(5)
Doppler and Electro-Optical methods of tracking.	**CO-4** **BTL-3**

REFERENCE BOOKS	
1.	"Acquisition, Tracking, Pointing, and Laser Systems Technologies XXI (Pro-ceedings of SPIE)" 30 October 2007 by Steven L. Chodos (Editor), William E. Thompson (Editor).
2.	"Acquisition, Tracking, and Pointing, January 2017 In book: Free Space Optical Communication", by Hemani Kaushal, Vk Jain and SubratKar. Publisher: Springer India.
3.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	DATA ACQUISITION, TRACKING & POST FLIGHT ANALYSIS			CREDITS	3
COURSE CODE	DTA-3748	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide learning on the various aspects of flight trials, measurements & calibration, Generation & analysis of Data..
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the interfaces used in data acquisition and standalone instruments to real-world signals. 2. Understand the Sensors and transducers, Data acquisition hardware and data acquisition software 3. Carry out Post flight analysis.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	1	-	-
CO-2	3	2	1	-	1	-	-
CO-3	3	2	-	-	2	2	2

MODULE 1:	(4)
Importance of Flight Trials in Missile Development, Facilities, Safety Requirements.	CO-1 BTL-3

MODULE 2:	(6)
Methods of Measurement, Introduction to Measuring Instruments: Functional elements of an instrument.	CO-2 BTL-3

MODULE 3:	(6)
Static and Dynamic Characteristics, Zero, First and Second order of Instruments and their response.	CO-2 BTL-

MODULE 4:	(5)
Calibration of Instruments.	CO-3 BTL-3

MODULE 5:	(8)
Sensors and Transducers: Passive and Active types, their uses in measurement of acceleration, angle, vibration, pressure, flow and temperature, strain etc.	CO-3 BTL-3

MODULE 6:	(7)
Methods for post flight data analysis.	CO-4 BTL-3

REFERENCE BOOKS	
1.	"Advances in Missile Guidance, Control, and Estimation: 47 (Automation and Control Engineering)", by editors S.N. Balakrishnan, A. Tsourdos, B.A. White.
2.	"CalibrationHandbookofMeasuringInstruments1stEdition",byAlessandroBrunelli. Publisher International Society of Automation.
3.	"Calibration Book", by Janne Kivilaakso, Antero Pitkäkoski Jori Valli, Mike Johnson, Nobuo Inamoto Arja Aukia Masaki Saito. Publisher: VaisalaOyj.
4.	"Sensors and Transducers", by Patranabis D. Publisher : Prentice Hall India Learning Private Limited.
5.	"Sensors and Transducers Paperback", by Ian Sinclair. Publisher : Elsevier.
6.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	AIR INDEPENDENT PROPULSION AND BATTERIES			CREDITS		3
COURSE CODE	DTA-3749	COURSE CATEGORY	DE	L-T-P-S		3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL		BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide learning on the air independent propulsion systems, hybrid electric vehicles, power requirement of the vehicles, energy storage systems.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the requirements of air independent propulsion systems. 2. Design and analysis Energy storage systems for hybrid electric vehicles.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	1	-	-
CO-2	3	2	3	-	2	2	2

MODULE 1:	(6)
Introduction to Hybrid Electric Vehicles: Impact of modern drive-trains on energy supplies;	CO-1 BTL-3

MODULE 2:	(7)
Hybrid Electric Drive-trains: hybrid traction, various hybrid drive-train topologies, power flow control, fuel efficiency analysis;	CO-2 BTL-3

MODULE 3:	(7)
Electric Drive-trains: electric traction, electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	CO-2 BTL-

MODULE 4:	(6)
Electric Propulsion unit: electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, drive system efficiency;	CO-3 BTL-3

MODULE 5:	(6)
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles.	CO-3 BTL-3

MODULE 6:	(6)
Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.	CO-4 BTL-3

REFERENCE BOOKS

1.	"Hybrid Electric Vehicles: Principles and Applications with Practical Perspec-tives", by Chris Mi, M. Abul Masrur. Publisher: Wiley.
2.	"Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theo-ry, and Design, Second Edition (Power Electronics and Applications Series)", by Mehrdad Ehsani, YiminGao, Ali Emadi, Publisher : Standards media.
3.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	ADVANCED DIGITAL MODULATION TECHNOLOGIES & STANDARDS			CREDITS	3
COURSE CODE	DTA-3750	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The objective of this course is to provide knowledge on the engineering principles, theories and practices of a digital communication system. The course will deal with the design principles of transmitter and receiver so as to establish a reliable communication link.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the design digital communication systems. 2. Understand the transmitter, receiver communications system models, voice source coding–pulse code modulation, delta modulation and vocoders. 3. Understand the requirement of cellular communication.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	1	-	-
CO-2	3	2	-	-	1	-	-
CO-3	3	2	-	-	2	-	-

MODULE 1:	(6)
Design of digital communication system, transmitter and receiver communications system model	CO-1 BTL-3

MODULE 2:	(6)
Voice source coding– pulse code modulation, delta modulation, vocoders.	CO-2 BTL-3

MODULE 3:	(8)
Digital modulation – Amplitude-shift, Frequency-shift, Phase-shift, differential phase-shift, Quadrature phase-shift, Quadrature phase-shift, and Minimum-shift keying, Quadrature amplitude modulation	CO-2 BTL-

MODULE 4:	(6)
Communications channel – Multipath effects, fading and diversity, models of Egli and Murphy	CO-3 BTL-3

MODULE 5:	(5)
Receivers – super heterodyne systems, balanced and unbalanced mixers, frequency synthesizers, Link budget analysis	CO-3 BTL-3

MODULE 6:	(5)

	Introduction to cellular communication – CDMA, OFDM, MIMO, Introduction to digital modulation standards.	CO-4 BTL-3

REFERENCE BOOKS	
1.	"Communication Systems", by, Haykin, S. Publisher : John Wiley & Sons.
2.	"Modern Digital and Analog Communication Systems", by, Lathi, B.P. and Ding, Z. Publisher: Oxford University Press.
3.	"Signal Processing for Wireless Communication Systems", by H. Vincent Poor, Lang Tong Publisher : Springers
4.	"Digital Communication: Fundamentals and Applications", by Sklar, B., and Ray, P.K. Dorling Kindersley.
5.	"Communication Systems: An Introduction to Signals and Noise in Electrical Communication", by Carlson, A.B., Crilly, P.B. and Rutledge, J.C Publisher: McGraw-Hill.
6.	"Detection, Estimation and Modulation Theory Part I", by Van Trees, H.L. Pub-lisher : Wiley Inter science.
7.	"Information Theory, Coding and Cryptography", by Bose, R. Tata McGraw-Hill.
8.	"Digital Communication", by Barry, J.R., Lee, E.A. and Messerschmitt, D.G.Kluwer.
9.	"Principles of Digital Transmission: Wireless Applications", by Benedetto, S. and Biglieri, E. Publisher : Springer
10.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	TRAJECTORIES MODELLING & SIMULATION			CREDITS	3
COURSE CODE	DTA-3751	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	The course is intended to provide the understanding of flight dynamics, trajectory design analysis, flight performance analysis and practical implications of trajectory planning.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the flight trajectories design requirements. 2. Evaluate and predict the flight performance for different trajectories. 3. Understand the practical implications while trajectory design. 4. Carry out MATLAB based simulation for trajectory modelling.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	2	-	-	-	-
CO-2	3	2	2	2	2	2	2
CO-3	3	2	-	-	-	-	-
CO-4	3	2	2	2	2	2	2

MODULE 1:		(6)
Flight Dynamics, Flight envelope limitations. Aerodynamic sizing-equations of motion. Accuracy of simplified equations of motion, orbital mechanics.		CO-1 BTL-3

MODULE 2:		(7)
Role of rocket propulsion in orbital trajectories and maneuvers, Maximizing missile flight performance. Benefits of flight trajectory shaping.		CO-2 BTL-3

MODULE 3:		(7)
Flight performance prediction of boost, climb, cruise, coast, steady descent, ballistic, maneuvering, divert, and homing flight.		CO-2 BTL-

MODULE 4:		(5)
Practical implementation of integrated trajectory planning, Agility in maneuvering trajectories.		CO-3 BTL-3

MODULE 5:		(5)
Multiplier theory and its use in solving practical problems covered from a real-time computational viewpoint, No-fly zones and engineering requirements, formulation as a mathematical mixture of state and decision-variable constraints.		CO-3 BTL-3

MODULE 6:	(6)
Extensive MATLAB-based mini-projects.	**CO-4** **BTL-3**

REFERENCE BOOKS	
1.	"Flight Dynamics", by Robert F. Stengel. Publisher : Princeton University Press.
2.	Literature / books suggested by respective course Lecturers.

COURSE TITLE	SENSOR TECHNOLOGY			CREDITS	3
COURSE CODE	DTA-3752	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Objective	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 Outcome	Upon completion of this course, the students will be able to 1. Understand the basic principles of sensor systems required for satellites and tactical aircraft. 2. Understand the atmospheric propagation and its impact on the performance of sensors 3. Troubleshoot, repair/replace a faulty sensor in optimize process efficiency.

CO, PO Mapping

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	-	-	-	-	-
CO-2	3	2	-	-	-	-	2
CO-3	3	2	-	-	2	2	2

MODULE 1:	(6)
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.	CO-1 BTL-3

MODULE 2:	(5)
Phased array and pulsed compressed radars, imaging synthetic aperture and inverse synthetic aperture radars.	CO-2 BTL-3

MODULE 3:	(5)
Atmospheric propagation of signal. Noise resources and thermal radiation.	CO-2 BTL-

MODULE 4:	(8)
Principles of semiconductor devices. Optical and infrared imaging detector systems.	CO-3 BTL-3

MODULE 5:	(6)
Detector resolution limitations and bandwidth requirements, Relationship between signals and noise.	CO-3 BTL-3

MODULE 6:	(6)
The characteristics of critical sensor functions (including detection, estimation, imaging, and tracking).	**CO-4** **BTL-3**

REFERENCE 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.