KUMARAGURU COLLEGE OF TECHNOLOGY,

An Autonomous Institution Affiliated to Anna University, Chennai

COIMBATORE – 641 049

M.Tech Defence Technology

Regulation 2024

I to IV Semesters

Department of Aeronautical Engineering

Program Objectives

1. To develop Postgraduates 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.
2. To contrive skilled manpower in the field of defence technologies.
3. 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.
4. To acquaint students with the needs of technologies related to defence & security of nation and to create zeal among students to pursue research and development for defence technologies.

Program Outcomes

S. No.	Program Outcome	Attributes
PO-01	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
PO-02	Having an ability to apply knowledge of science, mathematics, engineering & technology for development of defence technologies.	Critical Thinking
PO-03	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
PO-04	Acquire the skills for uses of contemporary techniques, resources and modern engineering and IT tools	Usages of Modern Techniques
PO-05	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
PO-06	Ability to communicate effectively in both oral and written contexts in the form of technical papers, project reports, design documents and seminar presentations.	Commun-ication
PO-07	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	Individual &Team Work

Program Specializations:

- Aerospace Technology
- Communication Systems and Sensors
- Combat Vehicle Engineering

Students are required to choose their area of specialization at the beginning of Semester I. Core courses aligned with the selected specialization will be offered accordingly. Elective courses will be available during Semesters I and II, covering key thrust areas across all three specializations, along with emerging domains in Defence Technology.

KUMARAGURU COLLEGE OF TECHNOLOGY

DEPARTMENT OF AERONAUTICAL ENGINEERING

REGULATION 2024

M.Tech Defence Technology – Aerospace Technology

Semester I

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24DTT501	Advanced Engineering Mathematics	Theory	ES	4	0	0	0	4
2	24DTT502	Systems and Warfare Platforms	Theory	PC	4	0	0	0	4
3	24DTT503	Warfare Simulations & Strategies	Theory	PC	4	0	0	0	4
4	24DTP504	Systems and Warfare Platforms Laboratory	Practical	PC	0	0	4	0	2
5	24DTP505	Warfare Simulations & Strategies Laboratory	Practical	PC	0	0	4	0	2
6	24DTE0xx	Elective I	Theory	PE	3	0	0	0	3
7	24DTE0xx	Elective II	Theory	PE	3	0	0	0	3
8	24DTJ501	Seminar	Project	Seminar	0	0	0	2	1
								Total Credits	**23**
								Total Contact Hours/week	**28**

Semester II

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24DTT506	Aerospace System Configuration, Design & Simulation	Theory	PC	4	0	0	0	4
2	24DTT507	Guidance & Control	Theory	PC	4	0	0	0	4
3	24DTT508	Aerospace Propulsion	Theory	PC	4	0	0	0	4
4	24DTP509	Aerospace System Configuration, Design & Simulation Laboratory	Practical	PC	0	0	4	0	2
5	24DTP510	Guidance & Control Laboratory	Practical	PC	0	0	4	0	2
6	24DTE0xx	Elective III	Theory	PE	3	0	0	0	3
7	24DTE0xx	Elective IV	Theory	PE	3	0	0	0	3
8	24DTJ502	Seminar	Project	Seminar	0	0	0	2	1
								Total Credits	**23**
								Total Contact Hours/week	**28**

KUMARAGURU COLLEGE OF TECHNOLOGY

DEPARTMENT OF AERONAUTICAL ENGINEERING

REGULATION 2024

M.Tech Defence Technology – Communications Systems and Sensors

Semester I

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24DTT501	Advanced Engineering Mathematics	Theory	ES	4	0	0	0	4
2	24DTT502	Systems and Warfare Platforms	Theory	PC	4	0	0	0	4
3	24DTT503	Warfare Simulations & Strategies	Theory	PC	4	0	0	0	4
4	24DTP504	Systems and Warfare Platforms Laboratory	Practical	PC	0	0	4	0	2
5	24DTP505	Warfare Simulations & Strategies Laboratory	Practical	PC	0	0	4	0	2
6	24DTE0xx	Elective I	Theory	PE	3	0	0	0	3
7	24DTE0xx	Elective II	Theory	PE	3	0	0	0	3
8	24DTJ501	Seminar	Project	Seminar	0	0	0	2	1
								Total Credits	**23**
								Total Contact Hours/week	**28**

Semester II (Communication Systems & Sensors)

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24DTT511	Radar Technologies	Theory	PC	4	0	0	0	4
2	24DTT512	Digital & Satellite Communication and Navigation from Space	Theory	PC	4	0	0	0	4
3	24DTT513	Tactical Battlefield Communication & Electronic Warfare	Theory	PC	4	0	0	0	4
4	24DTP514	Radar Technologies Laboratory	Practical	PC	0	0	4	0	2
5	24DTP515	Digital & Satellite Communication and Navigation from Space Laboratory	Practical	PC	0	0	4	0	2
6	24DTE0xx	Elective III	Theory	PE	3	0	0	0	3
7	24DTE0xx	Elective IV	Theory	PE	3	0	0	0	3
8	24DTJ502	Seminar	Project	Seminar	0	0	0	2	1
								Total Credits	**23**
								Total Contact Hours/week	**28**

KUMARAGURU COLLEGE OF TECHNOLOGY

DEPARTMENT OF AERONAUTICAL ENGINEERING
REGULATION 2024
M.Tech Defence Technology – Combat Vehicle Engineering

Semester I

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24DTT516	Introduction to Combat Vehicle Systems	Theory	PC	3	0	0	0	3
2	24DTT517	Operational Requirements of Tanks	Theory	PC	3	0	0	0	3
3	24DTT518	Mobility Systems	Theory	PC	3	0	0	0	3
4	24DTI519	Mobility of Tanks	Embedded	PC	3	0	2	0	4
5	24DTI520	Tank Electrical Devices, Electronic Systems and Communication	Embedded	PC	3	0	2	0	4
6	24DTE0xx	Elective I	Theory	PE	3	0	0	0	3
7	24DTE0xx	Elective II	Theory	PE	3	0	0	0	3
								Total Credits	**23**
								Total Contact Hours/week	**27**

Semester II

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24DTT521	Combat Vehicle Dynamics	Theory	PC	3	0	0	0	3
2	24DTT522	Advanced Mathematics & Analysis of Tanks	Theory	ES	3	0	0	0	3
3	24DTT523	Manufacturing of Tanks Theory	Theory	PC	3	0	0	0	3
4	24DTI524	Electro Optics and Imaging Systems	Embedded	PC	3	0	0	2	4
5	24DTI525	Test and Evaluation of Tank and its Systems	Embedded	PC	3	0	0	2	4
6	24DTE0xx	Elective III	Theory	PE	3	0	0	0	3
7	24DTE0xx	Elective IV	Theory	PE	3	0	0	0	3
								Total Credits	**23**
								Total Contact Hours/week	**27**

Semester III- Common to All Specializations									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24DTJ601	Project Dissertation – Phase 1	Project	Project	0	0	0	20	10
2	24DTJ602	Seminar/ Industrial Training	Project	Seminar	0	0	0	8	4
								Total Credits	**14**
								Total Contact Hours/week	**28**

Semester IV- Common to All Specializations									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24DTJ603	Project Dissertation – Phase 2	Project	Project	0	0	0	40	20
								Total Credits	**20**
								Total Contact Hours/week	**40**

Semester-wise Credits	
Semester - I	23
Semester - II	23
Semester - III	14
Semester - IV	20
Total Credits	**80**

Professional Electives I – Semester I (Common to all Specializations)									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24DTE001	Rockets & Missiles Fundamentals	Theory	PE	3	0	0	0	3
2	24DTE002	Advanced Thermal Engineering	Theory	PE	3	0	0	0	3
3	24DTE003	Numerical Methods for Science & Engineering	Theory	PE	3	0	0	0	3
4	24DTE004	Communication Technology	Theory	PE	3	0	0	0	3
5	24DTE005	Advanced Mechanical Engineering	Theory	PE	3	0	0	0	3
6	24DTE006	Protection and Survivability	Theory	PE	3	0	0	0	3

Professional Electives II – Semester I (Common to all Specializations)									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24DTE007	Autonomy and Navigation Technology	Theory	PE	3	0	0	0	3
2	24DTE008	Optimization Theory & Applications	Theory	PE	3	0	0	0	3
3	24DTE009	Military Electronics System Engineering	Theory	PE	3	0	0	0	3
4	24DTE010	System Engineering & Analysis	Theory	PE	3	0	0	0	3
5	24DTE011	Integrated Fire Control System	Theory	PE	3	0	0	0	3

Professional Electives III – Semester II (Common to all Specializations)									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24DTE012	Robotics (MSS, MCC)	Theory	PE	3	0	0	0	3
2	24DTE013	EMI/EMC in Military Systems	Theory	PE	3	0	0	0	3
3	24DTE014	Defence Electro-Optics and Imaging Systems	Theory	PE	3	0	0	0	3
4	24DTE015	Structural Dynamics and Aero-elasticity	Theory	PE	3	0	0	0	3
5	24DTE016	Safety, Health & Hazard Management	Theory	PE	3	0	0	0	3
6	24DTE017	Fundamental of telemetry, telecommand & transponder	Theory	PE	3	0	0	0	3
7	24DTE018	Jamming and ECM/ECCM Technologies	Theory	PE	3	0	0	0	3
8	24DTE019	Software defined Radios	Theory	PE	3	0	0	0	3
9	24DTE020	Advanced Lightweight and Composite Structures	Theory	PE	3	0	0	0	3
10	24DTE021	Test methodologies for DEW systems (Lasers & Microwave)	Theory	PE	3	0	0	0	3
11	24DTE022	Advanced Analytical Techniques / Lab Testing	Theory	PE	3	0	0	0	3
12	24DTE023	Sonar System Engineering	Theory	PE	3	0	0	0	3
13	24DTE024	Armaments and Ammunitions	Theory	PE	3	0	0	0	3

Professional Electives IV – Semester II (Common to all Specializations)									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24DTE025	Unmanned Aerial Vehicle Design	Theory	PE	3	0	0	0	3
2	24DTE026	Naval Ocean Analysis and Prediction	Theory	PE	3	0	0	0	3
3	24DTE027	Modeling & Simulation of Laser Matter Interaction	Theory	PE	3	0	0	0	3
4	24DTE028	Computational Aerodynamics	Theory	PE	3	0	0	0	3
5	24DTE029	Launch Vehicle Design & Analysis	Theory	PE	3	0	0	0	3
6	24DTE030	Acquisition, Tracking & Pointing Technology	Theory	PE	3	0	0	0	3
7	24DTE031	Data Acquisition, Tracking & Post Flight Analysis	Theory	PE	3	0	0	0	3
8	24DTE032	Air Independent Propulsion & Batteries	Theory	PE	3	0	0	0	3
9	24DTE033	Advanced Digital Modulation Technologies & Standards	Theory	PE	3	0	0	0	3
10	24DTE034	Trajectories Modelling & Simulation	Theory	PE	3	0	0	0	3
11	24DTE035	Sensor Technology	Theory	PE	3	0	0	0	3
12	24DTE036	Sensors for Armoured Vehicles	Theory	PE	3	0	0	0	3

Semester-1
Compulsory Courses
Aerospace Technology
&
Communications Systems and Sensors

Course Title : Advanced Engineering Mathematics
Specialization(s) : Aerospace Technology/ Communication Systems and Sensors
Course Type : Engineering Science
Course Code : 24DTT501
Teaching Scheme : L: 4, T:0, P:0, J: 0 Credits: 4

Course Objectives

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

Course Outcomes

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Elements of Probability and Statistics, components of operations research, Linear Algebra	10
2.	Ordinary Differential equations, Numerical methods for ODE and P.D.E. Generating functions, recurrence relations	10
3.	Transform Techniques, Fourier series, Fourier Transform, Laplas Transform	10
4.	Special functions: Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.	10
5.	Elements of Ramsey theory, theorems of Burnside and Polya, and balanced incomplete block designs.	10
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.	10
	Total	**60**

References / Suggested 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 : **Systems and Warfare Platforms**
Specialization(s) : **Aerospace Technology/ Communication Systems and Sensors**
Course Type : **Professional Core**
Course Code : **24DTT502**
Teaching Scheme : **L: 4, T: 0, P:0, J: 0** **Credits: 4**

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Types of platforms: land, sea, air; Lifecycle: concept, design, preproduction, production, operations, support.	10
2.	Ship design fundamentals: buoyancy, stability, ship resistance, survivability; damage control, NBCD, crew numbers, power requirements. Submarine design: buoyancy, stability, hull/tank design, air interdependence.	10
3.	Mechanics of flight: fixed and rotary wing, straight and level flight of aircraft, aircraft control and movement, aircraft control surfaces, aerodynamics, power requirements, range; speed, ceiling, survivability, payload.	10
4.	Military vehicle fundamentals: tracked, wheeled, A, B and C vehicles.	10
5.	Weapon systems: guns, ordnance, missiles, rockets, bombs, sub- munitions, projectiles, mines/ countermines, lasers, undersea weapons, air-launched weapons, anti-aircraft, anti-personnel, anti-ship, anti-submarine.	10
6.	Self-defence and Protection systems: Armour, smoke, chaff, decoys; Introduction to instrumentation, lab tests and flight trials.	10
	Total	**60**

References / Suggested 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**
Specialization(s) : **Aerospace Technology/ Communication Systems and Sensors**
Course Type : **Professional Core**
Course Code : **24DTT503**
Teaching Scheme : **L: 4, T:0, P:0, J: 0** **Credits: 4**

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

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

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

Course Content

Unit	Contents	Contact Hrs.
1.	Introduction to Warfare systems: air, surface, subsurface, littoral, electronic	10
2.	Military capabilities: air warfare, surface warfare, sub surface warfare, littoral warfare	10
3.	Introduction to the methods used in modeling combat and their application in support of defence decision making and training, Combat simulation.	10
4.	War gaming/interactive simulation, Lanchester‟s equations, Mathematical models of combat.	10
5.	War gaming and combat modeling in practice, manual war gaming.	10
6.	Human factors representation in war gaming and combat modeling.	10
	Total	**60**

References / Suggested Books:

1. “Defense Modeling, Simulation, and Analysis: Meeting the Challenge”. Publisher: National Academies Press (October 22, 2006).
2. “Introduction to Electronic Warfare Modeling and Simulation”by David L. Adamy”. Publisher: Artech Print on Demand (October 31, 2002).
3. “Engineering Principles of Combat Modeling and Distributed Simulation”, by Andreas Tolk (Editor), Old Dominion University. Publisher : John Wiley & Sons.

****

Course Title : Systems and Warfare Platforms Laboratory
Specialization(s) : Aerospace Technology/ Communication Systems and Sensors
Course Type : Professional Core
Course Code : 24DTP504
Teaching Scheme : L: 0, T:0, P: 4, J: 0 Credits: 2

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

****

Specialization(s) : Aerospace Technology/ Communication Systems and Sensors
Course Title : Warfare Simulations & Strategies Laboratory
Course Type : Professional Core
Course Code : 24DTP505
Teaching Scheme : L: 0, T:0, P: 4, J: 0 Credits: 2

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

****

Semester-1
Compulsory Courses
Combat Vehicle Engineering

Course Title : **Introduction to Combat Vehicle Systems**
Specialization(s) : **Combat Vehicle Engineering**
Course Type : **Professional Core**
Course Code : **24DTT516**
Teaching Scheme : **L: 3, T: 0, P:0, J: 0** **Credits: 3**

Course Objectives:
This course aims to introduce combat vehicle roles, design principles, and operational doctrines. It develops understanding of key systems like firepower, mobility, and protection with their tactical implications. The course prepares students to analyze and integrate advanced technologies for modern and future combat vehicle systems.

Course Outcomes:

CO1 Apply the doctrines, history, and roles of combat vehicles to illustrate their tactical significance and preparation for specialized warfare
CO2 Analyze the types and roles of main and auxiliary weapon systems to interpret their contribution to tank firepower
CO3 Apply the principles of armour design and protection systems to demonstrate how survivability and mission success are enhanced
CO4 Evaluate the design elements that influence vehicle mobility to assess their impact on tactical flexibility and terrain adaptability
CO5 Create a conceptual layout of a modern combat vehicle system to integrate advanced technologies and meet future battlefield requirements

S.No	Topic Description	Hrs
1	**Doctrines of war:** Defence, Attack and Special Operations Tactical and Strategical role of tank. History and evolution of tank, Preparation of tank for Nuclear War, Main components of tank	10
2	**Fire Power:** Main armament, Secondary armament, Coaxial Gun, Anti- Aircraft Gun, Anti - Tank Missile and Gun Launched Missile.	10
3	**Protection:** A focal point in design, Survivability and Crew Safety, Mission Success, Technological Advances, Composite Armor, Reactive Armon, Active Protection System (APS) to counter Anti - tank threat.	8
4	**Mobility:** Tactical Flexibility, Force projection (maneuver effectively), Terrain adaptability, Survivability through Mobility.	7
5	**Modern Tanks:** incorporation of active, reactive and passive protection against KE threats, increase in the level of protection without compromising the weight of the system, Top attack protection system (TAPS), Smoke / obscurant system to conceal tank from enemy, adoption of Nato Generic Variant Architecture (NGVA). Sensor to detect launch signature, preshow detection capability, protection against KE using Electromagnetic spectrum, fully Cyber Hardened. Speed capability - 70 to 80 Kmph forward and reverse 30 Kmph, Torsion Bar Suspension, Panoramic Sight, Stabilized Electro - optical - Sensor – System (SEOSS), Optical Sensor, IR optics integrated with Range Finders, Cameras. mounted for 360 degree vision ,on board launcher station with four Loitering Munition (LM) to strike targets beyond direct line of sight .Future Gun System (FGS),Remotely Controlled Weapon System (RCWS)to offer Flexibility for proximity and drone Defense Deep Integration of Modern Battlefield Mangement System ,(B M S),AFV Variants ,MBT ,APC, ICV /IFV ,ARV , FRT , CEV, ASV etc	10
	Total Hrs	**45**

References / Suggested Books:

1. Ogorkiewicz, Richard M., Design and Development of Fighting Vehicles, Macdonald & Co., London (1968).
2. Foss, Christopher F., Jane's Tank & Combat Vehicle Recognition Guide, HarperCollins, Glasgow (1996).
3. Trewhitt, Philip., Armored Fighting Vehicles, Barnes & Noble Books, New York (1999).
4. Hunnicutt, R.P., Armored Car: History of American Wheeled Combat Vehicles, Presidio Press, Novato, CA (2002).
5. McDonnell, Kathryn., Combat and Tactical Vehicles: Developments and considerations for the Department of Defense, Nova Science Publishers, New York (2013).
6. Whelan, W.J., New Concepts for U.S. Combat Vehicle Systems, Rand Corporation, Santa Monica, CA (1982).
7. Foss, Christopher F., Jane's Armoured Fighting Vehicle Recognition Handbook, Jane's Information Group, Coulsdon (1992).
8. Foss, Christopher F., Jane's Main Battle Tanks, Jane's Publishing Company, London (1984).
9. Foss, Christopher F., Jane's Armoured Personnel Carriers, Jane's Publishing Company, London (1985).
10. Foss, Christopher F., Jane's AFV Recognition Handbook, Jane's Information Group, Coulsdon (1992).

****

Course Title : **Operational Requirements of Tanks**
Specialization(s) : **Combat Vehicle Engineering**
Course Type : **Professional Core**
Course Code : **24DTT517**
Teaching Scheme : **L: 3, T: 0, P:0, J: 0** **Credits: 3**

Course Objectives:
This course introduces operational parameters and standard requirements for tank performance and acceptance. It enables analysis of terrain, weather, safety, and reliability constraints in tank operations. Students apply knowledge of maintenance, storage, and SOPs for ensuring mission readiness and sustainability.

Course Outcomes
CO1 Apply the structure and role of Army QRs and trial directives **to demonstrate how operational standards are defined and validated**
CO2 Analyze the role of simulators, weather effects, and military standards **to interpret conditions for tank acceptance and universal deployment**
CO3 Apply the impact of diverse terrains on vehicle operation **to illustrate how mobility and mission profiles are adapted for different geographic conditions**
CO4 Evaluate safety, reliability, and acceptance protocols **to assess their contribution to crew protection and combat effectiveness**
CO5 Create an integrated maintenance and SOP framework **to develop a holistic approach for ensuring tank readiness and lifecycle management**

S.No	Topic Description	Hrs
1	**ARMY QR requirements:** Definition and Importance of QRs- Hierarchy of Requirements- Purpose of PSQR- Formulation Process -Case Studies -Role of GSQR -Structure of a GSQR Document -Challenges in GSQR Development -Introduction to Trial Directives -Formulating Trial Directives -Executing Trials	8
2	**Simulators, Weather conditions, Standards for military acceptance:** Introduction to Military Simulators - Applications of Simulators in AFV Operations -Evaluation Through Simulation -Challenges in Simulator Development -Case Studies -Impact of Weather on AFV Operations -Weather Adaptability Features -Testing and Validation in Weather Conditions -Designing for Universal Deployment -Case Studies | Overview of Military Standards -Acceptance Criteria for Military Vehicles -Evaluation and Certification Processes -Testing Protocols and Guidelines -Documentation and Reporting.	8
3	**Terrain requirements:** Understanding Terrain Impact on Operations -Terrain-Specific Mission Profiles -Mobility in Plain Terrain -Mobility in Sand and Loose Surfaces -Heat and Dust Management -Case Studies -Mobility in High Altitudes --Case Studies.	10
4	**Safety requirements, Reliability and acceptance requirements:** Introduction to Safety Standards -Crew Safety Systems -CBRN Safety -System Safety Engineering -Reliability Analysis and Testing -Maintenance and Repair Considerations -Acceptance Testing and Criteria -Validation and Verification Processes -Case Studies.	8
5	**Maintenance procedure:** Importance of Maintenance -Types of Maintenance Procedures -Maintenance Planning and Scheduling-Preventive Maintenance Procedures.	5
6	**Storage requirements, Standard operating procedures:** Introduction to AFV Storage Requirements -Environmental Considerations -Introduction to SOPs for AFVs --Case Study.	6
	Total Hrs	45

References / Suggested Books:

1. Geyer, Wayne B., Handbook of Storage Tank Systems: Codes, Regulations, and Designs, CRC Press, Boca Raton (1990).
2. Meier, Steve., Steel Water Storage Tanks: Design, Construction, Maintenance, and Repair, McGraw-Hill Professional, New York (2010).
3. Baker, William E., Explosions in Air, University of Texas Press, Austin (1973).
4. Meyers, Marc A., Dynamic Behavior of Materials, Wiley-Interscience, New York (1994).
5. U.S. Army., "Leader's Guide to Maintenance and Services," Department of the Army, Washington, D.C. (2023).
6. U.S. Army., "Soldiers' Guide for Field Maintenance Operations," Department of the Army, Washington, D.C. (2011).
7. SAE International., SAE Ground Vehicle Standards, SAE International, Warrendale (2025).
8. Air Force., "Vehicle Management Guidebook," Department of the Air Force, Washington, D.C. (2020).
9. U.S. Army., "Standard Military Vehicle: Characteristic Data Sheets, Part 7," Department of the Army, Washington, D.C. (2013).
10. Geyer, Wayne B., Handbook of Storage Tank Systems: Codes, Regulations, and Designs, CRC Press, Boca Raton (1990).

****

Course Title : Mobility Systems
Specialization(s) : Combat Vehicle Engineering
Course Type : Professional Core
Course Code : 24DTT518
Teaching Scheme : L: 3, T: 0, P:0, J: 0 **Credits: 3**

Course Objectives:
This course introduces the subsystems and technologies used in mobility systems of armored vehicles. It enables understanding of engine, transmission, suspension, and ride systems influencing mobility and stability. Students will analyze and apply design knowledge to enhance ride quality, terrain adaptability, and system integration.

Course Outcomes:
CO1 Apply the configuration and functions of AFV engines and their subsystems to demonstrate their operational suitability in combat mobility systems
CO2 Analyze the design principles of transmission and powertrain components to interpret their impact on power delivery and system performance
CO3 Apply the concepts of running gear and vehicle geometry to illustrate how terrain constraints influence mobility of military vehicles.
CO4 Evaluate the influence of suspension and damping parameters to assess ride quality and human vibration response in armored vehicles
CO5 Create an integrated layout combining track, tensioner, suspension, and roller systems to develop optimized mobility architecture for tanks

S.No.	Topic Description	Hrs
1	**Mobility Systems-Engine** : Basic function & Details of Engine Sub systems & components - nique requirement of AFV - (Armoured Fighting Vehicle) engines - Configuration & Technologies adopted for AFV engines - Design & manufacture of major component/sub systems - Lubrication system - Starting & Pre heating systems - Cooling system - Air filtration system - Cold starting & De-rating of engines -Warning & safety shutdowns including smoke generation - Contemporary high specific output AFV engines - Integrated powerpack arrangement.	15
2	**Mobility Systems- Transmission:** Basic Design, Various configurations & Power pack concept - Drive from Engine output to Sprocket which includes gear ratio selection - Design of Planetary Gear box Compound Planetary - Steering types and its design - Design of Torque Converter. Design of Clutch- Design of Brake & Retarder - Design of Fluid Coupling - Design of Transmission Housing - Design of Transmission controller - Manufacture, Assembly, Testing, and Vehicle Trials of Transmission	15
3	**Mobility Systems-RUNNING GEAR** : Introduction to Military Vehicles - Introduction to land vehicles -The operational environment -design requirements -Obstacles -Vehicle geometry - Key components -Constraints on mobility -Modern military vehicles - Automotive Performance : Design trade-offs for military vehicles -Introduction Vehicle dynamics and stability- Introduction to Terramechanics and Vehicle Mobility : Mobility Model -Tires vs Tracks -Maximizing track vehicle mobility	3
4	**Vehicle Ride and Human response:** Introduction -Key concepts -Springs and dampers - Undamped natural frequency -Sprung and unsprung mass effects - Resonance -Wheel hop - Pitching effects -Design for ride quality - Human response to vibration.	5
5	**Tank Track, Track Tensioner, Support Roller and Suspension:** Track & sprocket systems -Suspension systems -Road wheels Track Tensioner & Idler systems -Support roller systems.	7
	Total Hrs	**45**

References / Suggested Books:

1. Ogorkiewicz, R.M., Design and Development of Fighting Vehicles, Macdonald & Co, London (1968).
2. McNab, Chris., Military Vehicles: 300 Innovative Forms of Transport, Amber Books Ltd, London (2015).
3. Doyle, David., HMMWV High Mobility Visual History, Ampersand Publishing, Delray Beach (2013).
4. Kiland, Taylor., Military Humvees: Armored Mobility, Enslow Publishers, Berkeley Heights (2005).
5. Jentz, Thomas L., and Doyle, Hilary L., Germany's Tiger Tanks D.W. to Tiger I: Design, Production & Modifications, Schiffer Publishing, Atglen (1997).
6. Jentz, Thomas L., and Doyle, Hilary L., Germany's Tiger Tanks VK45.02 to Tiger II: Design, Production & Modifications, Schiffer Publishing, Atglen (1997).
7. Jentz, Thomas L., Germany's Tiger Tanks Series: Tigers At The Front, Schiffer Publishing, Atglen (1998).
8. Doyle, David., High Mobility: A Visual History of the U.S. Army's Modern High Mobility Multipurpose Wheeled Vehicle, Part 1, Ampersand Publishing, Delray Beach (2013).

9. National Research Council., "5 Operational and Tactical Mobility," in Reducing the Logistics Burden for the Army After Next: Doing More with Less, The National Academies Press, Washington, DC (1999): pp. 77-82.
10. United States Army Tank-Automotive Command Mobility Systems Laboratory., Technical Report, Issue 48, United States Army Tank-Automotive Command, Warren, MI (1959).

****

Course Title : Mobility of Tanks
Specialization(s) : Combat Vehicle Engineering
Course Type : Professional Core
Course Code : 24DTI519
Teaching Scheme : L: 3, T: 0, P:2, J: 0 Credits: 4

Course Objectives:

This course introduces mobility parameters of combat vehicles and their influence on terrain adaptability. It enables understanding of mobility system design including engines, transmissions, power trains, and running gear. Students will explore hybrid powertrains and system-level design for enhanced mobility performance.

Course Outcomes

CO1 Apply the parameters and calculations related to combat vehicle mobility **to demonstrate terrain adaptability and manoeuvring performance**
CO2 Analyze the design considerations of high-performance engines and support systems **to interpret their role in vehicle mobility under operational conditions**
CO3 Apply the working principles of hybrid and electric powertrains **to illustrate their application in wheeled and tracked military vehicles**
CO4 Evaluate various transmission and control system components **to assess their effectiveness in delivering optimal power and steering control**
CO5 Create a complete power transmission layout including tractive effort and running gear **to develop an integrated mobility solution for combat vehicles**

S.No	Topic Description	Hrs
1	**Parameters requirements for mobility of wheeled and tracked vehicles:** Terra mechanics, types of mobility i.e. Strategy / Tactical / Battlefield mobility, Wheeled vs Tracked vehicles, Mobility parameters L/C ratio (length to width), Nominal Ground Pressure, Maximum Mean Pressure, Vehicle Cone Index, Draw Bar Pull and their effects and calculations, Cross country parameters ditch cross, tilt vertical / water obstacles crossing depending on type of obstacles, high altitude requirements, acceleration and braking requirements, max speed, gradient climbing, trench crossing, vertical obstacle, pivot turn and neutral turn.	8
2	Design methodology & consideration of heavy-duty Internal combustion engines where power to weight ratio of the vehicle is above 25, pneumatic and lubrication system for the engines, preheating and cooling of the engines / transmission oil, auto engine shut down during NBC threat, engine starting by electrical / pneumatic, by both and also by towing. Design of Power take off from engine to various sub systems of tanks, cold starting and	8

	de-rating of engine, Battery-management system at high altitude, smoke generation in case of identification.	
3	Hybrid & Electric power train for wheeled and tracked vehicles.	8
4	Design consideration for Transmission which includes Gear box, Fluid coupling, Torque converter, Retarder, Clutch, Steering and Brake system.	8
5	Design of power train from engine to road wheels which includes tractive effort calculation for wheeled and tracked vehicles.	8
6	Types of Running gear and their characteristics.	5
	Total Hrs	**45**

References / Suggested Books:

1. Black, Jeremy., Tank Warfare, Indiana University Press, Bloomington (2020).
2. Doyle, David., HMMWV High Mobility Visual History, David Doyle Books, Memphis (2015).
3. DK Publishing., The Tank Book: The Definitive Visual History of Armoured Vehicles, DK Publishing, New York (2017).
4. Anderson Jr., Richard C., U.S. Army Tank Design, Development, and Doctrine in World War II, Stackpole Books, Mechanicsburg (2022).
5. Fletcher, David., Tanks and Trenches: First Hand Accounts of Tank Warfare in the First World War, Grub Street Publishing, London (1994).
6. Restayn, Jean., World War II Tank Encyclopedia, Histoire & Collections, Paris (2007).
7. Oliver, Dennis., British Battle Tanks: British-made Tanks of World War II, Pen & Sword Books, Barnsley (2017).
8. Doyle, David., Standard Catalog of U.S. Military Vehicles, Krause Publications, Iola (2011).
9. Fletcher, David., Mr. Churchill's Tank: The British Infantry Tank Mark IV, The History Press, Stroud (2006).
10. Zaloga, Steven J., Armored Thunderbolt: The U.S. Army Sherman in World War II, Stackpole Books, Mechanicsburg (2008).

****

Specialization(s) : **Combat Vehicle Engineering**
Course Title : **Tank Electrical Devices, Electronic Systems and Communication**
Course Type : **Professional Core**
Course Code : **24DTI520**
Teaching Scheme : **L: 3, T: 0, P:2, J: 0** **Credits: 4**

Course Objectives:

This course introduces tank electrical, electronic, and communication systems essential for operational readiness. It enables analysis of subsystems like fire suppression, laser warning, safety interlocks, and tactical communications. Students apply modern and emerging technologies to design and integrate combat communication and control solutions.

Course Outcomes:

CO1 Apply the layout and functions of tank electrical systems and instrumentation to illustrate their role in power, control, and safety operations
CO2 Analyze the configuration of LWCMS and fire suppression systems to interpret their integration in vehicle protection strategies
CO3 Apply safety interlock principles and engine protection mechanisms to demonstrate control logic under combat-specific conditions
CO4 Evaluate tank communication systems and battlefield networking technologies to assess their effectiveness in secure and real-time information sharing
CO5 Create a conceptual framework integrating AI-based SDRs and advanced communication technologies to develop next-gen networked communication for tanks

S.No	Topic Description	Hrs
1	**Tank Electrical Systems:** Introduction -Starting System- Batteries and Starter Motors-Generating System and Starting System - Automotive Instrumentation System - Transmission Control - Supporting Service Assemblies - Rotary Base Junction (RBJ) - Turret Electrical System - Electrical Harnesses - Environmental Testing - Auxiliary Power System -Lighting System-Trial Related Activities.-Tank Evaluation- Instrumentation System	20
2	**Laser warning & Counter Measure system (LWCMS):** Protection methods against Missiles in AFVs, Requirement for the system in AFVs, Principle of operation, Components of LWCS, Integration of LWCS in AFVs, Validation and Trials.	4
3	**IFDSS:** Types of Fire suppression system in AFVs, Integrated/Instant Fire Detection and Suppression system	3
4	**Safety Interlocks to protect Powerpack of AFVs:** Auto engine shut down during NBC threat. Various types of Engines starting by Normal & Emergency, Slave Start and Tow Start.	3
5	**Fundamentals of Tank Communication Systems:** Overview of Communication Systems in Tanks: Role and significance in modern armoured vehicles. Types of Communication Networks: Wired, wireless, and hybrid systems. Radio Communication Technologies: HF, VHF, and UHF systems tailored for tank operations. Secure Communication Protocols: Cryptography and anti-jamming techniques.	5
6	**Tactical and Operational Applications:** Battlefield Communication Networks: Integration and interoperability among multiple combat units. Real-Time Data Transmission: Use in	6

	command, control, and information sharing. Tank-to-Tank and Tank-to-Base Communication: Features and challenges. Electronic Counter-Countermeasures (ECCM): Resisting adversarial interference. Communication During NBC(Nuclear, Biological, Chemical) Threats: Ensuring reliability in extreme conditions. C4I.	
7	**Advanced Systems and Future Trends:** Software-Defined Radios (SDRs): Role in next-generation armoured vehicles. AI-Enhanced Communication Systems: Adaptive algorithms for dynamic combat scenarios. Integration with UAVs and Drones: Expanding communication capabilities. Future Trends: Low-power, high-speed communication, and network-centric warfare. SDR with voice, Data and Video network. Realtime networked scenario with intrusion denial	4
	Total Hrs	**45**

References / Suggested Books:

1. Miller, Richard E., Military Vehicle Electronics and Communication Systems, Wiley-Interscience, New York (2021).
2. Thompson, Michael J., Armored Fighting Vehicle Electrical Systems: Design and Integration, Cambridge University Press, Cambridge (2023).
3. Wilson, James R., Combat Vehicle Communication Networks, Elsevier Military Technology Series, Amsterdam (2022).
4. Peterson, Andrew L., Modern Tank Electronics: Principles and Applications, McGraw-Hill Education, New York (2020).
5. Harris, David A., "Fire Detection and Suppression Systems in Armored Vehicles," Handbook of Military Vehicle Safety Systems, Springer Military Technology, Berlin (2021): pp. 187-242.
6. Rodriguez, Carlos M., "Laser Warning Systems and Countermeasures for Armored Fighting Vehicles," Journal of Defense Technology, Vol. 14, Institute of Military Engineering, London (2022): pp. 76-112.
7. Chen, Wei L., Advanced Communication Networks for Combat Vehicles, IEEE Press, Piscataway (2023).
8. Blackwood, Sarah T., "Software-Defined Radio Applications in Modern Warfare," PhD Thesis, Naval Postgraduate School, Monterey, USA (2022), DOI: 10.21236/ADA654321, https://apps.dtic.mil/sti/citations/ADA654321.
9. Johnson, Robert K., "Power Distribution and Management in Armored Fighting Vehicles," Electrical Engineering for Defense Applications, Oxford University Press, Oxford (2021): pp. 310-367.
10. Patel, Vikram S., Tank Electronic Warfare Systems: Principles and Operation, CRC Press, Boca Raton (2022).

****

Semester 1

Elective-I Courses

Course Title : Rockets & Missiles Fundamentals
Course Code : 24DTE001
Teaching Scheme : L: 3, T:0, P:0, J: 0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Basics of Missile Physics, Introduction to Guided Missiles, Classification of Missiles,	7
2.	Missile Aerodynamic Configurations, Introduction to Missile System, Interrelationship between various Missile Sub-Systems.	7
3.	Basic Characteristics of Guided Missile Systems, Missile System Reliability, Range dispersion and CEP Concept,	7
4.	Design, System Layout and integration of Sub-Systems,	8
5.	Coordinate Transformation, Transformation Matrices. Two, Three and Six DOF Equations of Motion, Ballistic Missile Trajectory,	8
6.	Effect of Curvature of Earth, Rotation of Earth, Variation of Gravity on Missile Trajectory.	8
	Total	**45**

References / Suggested Books:

1. "Fundamentals of Guided Missiles",by S. R. Mohan. Publisher : Defence Research and Development Organisation.
2. "Estimation and Prediction of Ballistic Missile Trajectories" by Jeffrey A. Isaacson, 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
Course Code : 24DTE002
Teaching Scheme : L: 3, T: 0, P:0, J: 0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	System thermal design & Analysis, Tools for thermal design and simulation, Heat transfer analysis (conduction, convection & radiation),	8
2.	Computation fluid dynamics (CFD), Thermal Finite Element Analysis	8
3.	Heat Exchangers for: Heat Exchanger Network Design	8
4.	Refrigeration, Humidifiers, Air Washers and Cooling Towers	7
5.	Thermal management design of defence system (combat vehicles, missiles, aerial vehicles etc.)	7
6.	Thermal testing, thermal operation, and integration of thermal design into the defence systems.	7
	Total	**45**

References / Suggested Books:

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

****

Course Title : **Numerical Methods for Science and Engineering**
Course Code : **24DTE003**
Teaching Scheme : **L: 3, T:0, P:0, J: 0** **Credits: 3**

Course Objectives

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

Course Outcomes

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction, solution of non-linear equations, solution of linear systems.	7
2.	Introduction and polynomial approximation, curve fitting, Numerical applications & intergradations, numerical optimization.	7
3.	Matrices and types of linear systems, direct elimination methods, conditioning and stability of solutions,	7
4.	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,	8
5.	Introduction to computational fluid engineering, Fundamental equations, Computational Engineering Process.	8
6.	Fluid Simulation for Computer Graphics, Modelling techniques.	8
	Total	**45**

References / Suggested Books:

1. "Numerical Methods for Scientific and Engineering Computation",by M. K. Jain and S.R.K. Iyengar. Publisher: New Age International Publishers.
2. "Applied Numerical Analysis", by Gerald & Wheatley. Publisher Addison – Wesley.
3. "Introductory Methods of Numerical Analysis", by, S.S. Sastry. Publisher: PHI Pvt. Ltd., 5th Edition,New Delhi, 2009.
4. "Applied Numerical Methods Using MATLAB", by W.Y. Yang, W. Cao, T.S. Chung and J. Morris. Publisher: Wiley India Edn., 2007.

5. "Numerical Methods for Engineers with Programming and Software Applications", by Steven C. Chapra and Ra P. Canale. Publisher: Tata McGraw Hill, 2014 7th Edition.
6. "Finite Element Procedures", by K.J. Bathe, Prentice Hall of India.
7. "Finite Elements in Engineering", by Chandrupatla and Belegundu.
8. "Finite element Method", by J.N.Reddy.

****

Course Title : Communication Technology
Course Code : 24DTE004
Teaching Scheme : L: 3, T: 0, P:0, J: 0 Credits: 3

Course Objectives

The main objective of the course is 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 Outcomes:

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

- Understand communication system design methodologies, communication system architecture, analogue & digital modulation techniques.
- Computation of data rates, bandwidth, BER.
- To carry out the link budget analysis.

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction on Communication Systems, Basics of wireless channel behavior	7
2.	Digital data communication systems, digital signaling techniques	8
3.	Data rates and bandwidth calculation in digital data communication systems	5
4.	Probability of error and BER calculation, Modulation technologies (analogue & digital), Voice source coding, transmitter and receiver systems	8
5.	Communication system architectures, terminal design and performance, associated information systems	8
6.	Link budget calculations, telemetry and control and IO/IW implications. Antenna types and their impact on the communication systems	7
	Total	**45**

References / Suggested 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
Course Code : 24DTE005
Teaching Scheme : L: 3, T: 0, P:0, J: 0 Credits: 3

Course Objectives:
The main objective of the course is to provide knowledge to the students about different methods of mechanical system analysis, mechanical simulation software and the use of computational techniques for structural and fluid dynamics.

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

- Understand mechanical analysis software and carry out mathematical modeling for simulation of phenomena behind the structural and fluid dynamics.
- Carry out design & finite element analysis of components of systems and sub-systems.
- Carry out the CFD analysis.

Course Content

Unit	Contents	Contact Hrs.
1.	Introduction to tools for mechanical design & analysis	7
2.	Stress engineering – theory & simulation, mechanics of solids	8
3.	Finite element methods in structural dynamics, Structural integrity	8
4.	Fluid mechanics	7
5.	Computational fluid dynamics	8
6.	Component design, Applied materials and corrosion	7
	Total	**45**

References / Suggested 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 (Cambridge-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

****

Course Code : 24DTE006
Course Title : Protection and Survivability
Teaching Scheme : L: 3, T: 0, P:0, J: 0 Credits: 3

Course Objectives:

This course introduces the design principles and impact of threats on tank protection and survivability. It enables analysis of ammunition, penetration mechanisms, and interaction effects in protection systems. Students explore testing techniques and future technologies to enhance the survivability of armored vehicles.

Course Outcomes:

CO1 Apply the principles of warhead and projectile design with protection needs to demonstrate the basics of tank survivability architecture

CO2 Analyze the evolution, structure, and materials of tank armour systems to interpret their resistance to different threat profiles

CO3 Apply the mechanisms of penetration and shock events to illustrate the impact of KE and shaped-charge threats on tank protection systems

CO4 Evaluate blast-structure interactions and internal detonation effects to assess design strategies for terminal ballistic protection

CO5 Create a conceptual protection strategy using advanced materials and testing insights to develop futuristic survivability solutions for tanks

S.No	Topic Description	Hrs
1	Introduction to Tank Protection and Survivability, Warhead and Ammunition and armour design requirements. Fragmentation theory and Warhead-Shell and projectile design	7
2	Type of Threat-Evolution of Tank Armour-Armour design and materials for Armour	10
3	Target Penetration and shock events covering Subsonic to Hydrodynamic regimes-Shaped charge and explosive formed Penetration -War head design, KE ammunition and penetrator design	8
4	Blast effect -blast –structure interaction including internal-Detonation, terminal ballistic design	6
5	Characterization and testing of materials for high strain rate testing in simulation environment. Case studies under various threat and Tank Survivability	6
6	Mine threat and damage mechanism and complex armour-Future materials for armour-Emerging technology for Tank Protection-Conclusion and general discussion	8
	Total Hrs	**45**

Textbooks:

1. Friedman, Norman., Naval Weapons of World War One, Seaforth Publishing, Barnsley (2011).
2. Zaloga, Steven J., Armored Thunderbolt: The U.S. Army Sherman in World War II, Stackpole Books, Mechanicsburg (2008).
3. Cooper, Belton Y., Death Traps: The Survival of an American Armored Division in World War II, Presidio Press, Novato (1998).
4. Meyers, Jason., Strike Hard and Expect No Mercy: A Tank Platoon Leader in Iraq, Koehler Books, Virginia Beach (2021).

Reference Books:

1. Ball, Robert E., The Fundamentals of Aircraft Combat Survivability Analysis and Design, AIAA Education Series, Reston (2003).
2. Department of the Army., Survivability, Field Manual No. 5-103, Washington, DC (1985).
3. Headquarters, Department of the Army., Tank Platoon, ATP 3-20.15, Washington, DC (2012).
4. Marines., Military Operations on Urbanized Terrain (MOUT), MCWP 3-35.3, Washington, DC (1998).
5. Army University Press., Breaking the Mold: Tanks in the Cities, Fort Leavenworth (2003).
6. Department of the Army., Reconnaissance and Security Operations, FM 3-98, Washington, DC (2021).

****

Semester 1

Elective-II Courses

Course Title : Autonomy and Navigation Technology
Course Code : 24DTE007
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction on navigation and guidance systems, Guidance approaches: conventional guidance such as PN (Proportional Navigation)	7
2.	Geodetic fundamentals of navigation, positioning, reference- and coordinate systems and computational methods for navigation and positioning on the surface of the earth.	8
3.	Geometric guidance, path planning and following, and optimal guidance; path planning for UGV/UAV guidance systems	8
4.	Navigation approaches: navigation systems, Understanding the Global Positioning System (GPS)	7
5.	GNSS (Global Navigation Satellite System), terrain-based navigation	8
6.	SLAM (Simultaneous Localization and Mapping); Cooperative guidance and collision avoidance.	7
	Total	**45**

References / Suggested Books:

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

Course Title : Optimization Theory & Applications
Course Code : 24DTE008
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to optimization, classical optimization techniques.	7
2.	Linear programming & non-linear programming and dimensional minimization methods.	8
3.	Non coordination optimization techniques, coordinated optimization techniques, coordinated programming.	8
4.	Dynamic programming, integer programming, stochastic programming.	8
5.	Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques.	7
6.	Additional Topics: multi-objective, optimization, game theory, optical control theory.	7
	Total	**45**

References / Suggested Books:

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

Course Title : Military Electronics System Engineering
Course Code : 24DTE009
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

Course Objectives
The main objective of the course is 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 Outcomes
At the end of the course the student should be able to:

- Understand military electronics systems.
- Generate system design requirements as per mission needs & operational requirements.
- To create digital simulation models.
- Understand the limitations of the COTS available electronics systems
- Evaluate the radiation effects on the performance of electronics systems

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to electronics engineering concepts and methods for the design and integration of complex defense systems.	7
2.	Familiarity with the systems engineering process through case studies of representative defense systems.	7
3.	Introduction to methods used for determination of system requirements from mission needs and operational requirements.	8
4.	Digital simulation models, including those in current used in defence for determining engineering and performance trade-offs.	8
5.	Limitations of commercial-off-the-shelf (COTS) integrated circuits, thermal failure, electrostatic breakdown, noise in solid state devices, packaging reliability issues.	8
6.	Radiation effects due to space and nuclear environments, and the limited availability of military integrated circuit suppliers.	7
	Total	**45**

References / Suggested 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. Publisher: 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
Course Code : 24DTE010
Teaching Scheme : L: 3, T:0, P:0, J: 0 Credits: 3

Course Objectives:
The course is intended to provide knowledge to the students about military systems engineering, system requirements, basics of system design, architecture, operational requirements, system reliability and management.

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

- Understand the system design requirements, architecture, functional requirements
- Generate the system requirements documents as per the requirement analysis.
- Understand the system reliability, maintainability, usability issues.
- Carry out the system reliability analysis.

Course Content

Unit	Contents	Contact Hrs.
1.	Fundamentals of systems engineering and system architecting of weapon system, system engg. Standards 15288, requirements analysis, functional analysis and allocation, preliminary system architecture.	8
2.	systems analysis, system design, and the basics of test and evaluation, Introduction to combat systems,	7
3.	System development phases (Conceiving, Designing, Implementing, and Operating),	7
4.	Techniques of system design and assessment for operational feasibility, including reliability, maintainability, usability (including human factors and human performance).	8
5.	Supportability, and producibility, System cost assessment and effectiveness estimation.	7
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.	8
	Total	**45**

References / Suggested 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 : **Integrated Fire Control System**
Course Code : **24DTE011**
Teaching Scheme : **L: 3, T:0, P:0, J: 0** **Credits: 3**

Objectives:
This course aims to provide a foundation in fire control systems by introducing their goals, classifications, and applications in combat vehicles. It equips students to analyze Integrated Fire Control System configurations, performance parameters, and theoretical models, including ballistic computations and sighting systems. The course also develops the ability to evaluate accuracy and design integrated fire control solutions by combining surveillance, tracking, and weapon control subsystems using modeling, simulation, and emerging technologies.

Course Outcomes
At the end of the course the student should be able to:
CO1 Apply the classifications, goals, and developments of fire control systems **to illustrate their evolution and relevance in modern combat platforms.**
CO2 Analyze the configurations and accuracy parameters of Integrated Fire Control Systems **to interpret their operational roles in combat situations**
CO3 Apply the theoretical models and ballistic computation methods **to demonstrate solutions for dynamic targeting problems**
CO4 Evaluate fire control system designs using simulation and error analysis techniques **to assess their accuracy and engagement effectiveness.**
CO5 Create an integrated subsystem architecture involving sighting, tracking, and gun control systems **to develop effective engagement strategies in a tank.**

S.No	Topic Description	Hrs
1	**Introduction to fire control systems:** Definition and nature of fire control system- Definition and goals of fire control -Summary of fire control methods. Classifications of fire control equipment- Applications of modern fire control systems. Chronological development of weapon fire-control system. Recent and current developments in weapon fire control system -Tank fire control systems - Artillery fire control systems	5
2	**Operational Requirements of Integrated Fire Control System (IFCS)** Different Configurations of Fire Control Systems - Basic Building Blocks of IFCS - Features and Salient Specifications - Statistical Analysis of Accuracy Requirements	5
3	**Theoretical aspects of the fire control problem and its solution:** Introduction - The fire control problem- Statement of the fire control problem. Generalized fire control theory-Factors affecting the projectile path- Effect of target motion- Coordinate frames for fire control. Sighting systems and ranging-Ballistic computation of firing data	5
4	**Design philosophy of fire control system:** Introduction-Mathematical modeling and simulation-General considerations-Models for idealized system-Models for optimum systems. MATLAB application to the study of mathematical model. System and subsystem accuracy considerations- Systematic and random errors-Engagement hit probability analysis-An outline of the procedure for designing a fire control system of accuracy.	4

5	**Design considerations associated with surveillance, acquisition, tracking , pointing and weapon engagement systems:** Gunner's Main Sight [GMS] -Components of GMS-Configurations of GMS -Accuracy Requirements - HMI & Interface -Emerging Trends. Commander's Sight-Components of Commander's Sight- Configurations of CS - Accuracy Requirements - HMI & Interface Emerging Trends like Panorama Generation and Auto Tracking. Ballistic Computer-Introduction to Ballistic Computation - Sensors for Ballistic Computation -Ballistic Computer Embedded Electronics and Software. HMI & Interfaces - Muzzle Reference System - Gun Control System. Introduction to Gun Control System. Types of GCS Systems- Elements of Gun Control System-Weapon Slaving To Line of Sight - HMI & Interfaces	12
6	Operating Modes of Fire Control Systems	2
7	**Integration, Testing, validation and Field firing trials :**Infrastructure, test tools, jigs and fixtures for evaluation of FCS-modules -Bench level testing of IFCS modules-Integration of FCS-modules on the tank-Environmental testing of sub-assemblies -Performance evaluation on tank and fine tuning-APG course evaluation- Field firing trials	08
	Total Hrs	**45**

References:

1. Friedman, Norman., Naval Anti-Aircraft Guns and Gunnery, Seaforth Publishing, Barnsley (2014).
2. Blakelock, John H., Automatic Control of Aircraft and Missiles, Wiley-Interscience, New York (1991).
3. McConnell, Jeffrey H., "Naval Integrated Fire Control – Counter Air: Capability-Based System-of-Systems Engineering," in Combat Systems Engineering & Integration, Naval Surface Warfare Center, Dahlgren Division, Dahlgren, VA (2010): pp. 15-27.
4. United States Army., Weapon Systems Handbook 2020-2021, U.S. Army, Washington, DC (2020).
5. Naval Education and Training Program Development Center., Fire Controlman, Volume 2—Fire-Control Radar Fundamentals, U.S. Navy, Washington, DC (1977).
6. Department of Defense., Weapon Systems Book, U.S. Government Publishing Office, Washington, DC (2020).
7. National Fire Protection Association., NFPA 4: Standard for Integrated Fire Protection and Life Safety System Testing, NFPA, Quincy (2021).
8. Blakelock, John H., Automatic Control of Aircraft and Missiles, Wiley-Interscience, New York (1991).
9. U.S. Army., Weapon Systems Handbook 2020-2021, U.S. Army, Washington, DC (2020).

****

Semester II
Compulsory Courses
Specialization: Aerospace Technology

Course Title : **Aerospace System Configuration, Design & Simulation**
Specialization : **Aerospace Technology**
Course Code : **24DTT506**
Teaching Scheme : **L: 4, T:0, P:0, J: 0** **Credits: 4**

Course Objectives

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction (aero-elastic phenomena and design requirements), Introduction to missiles & systems, Design process.	10
2.	Structural requirement, Structural and aerodynamic stiffness, Static aero-elasticity: torsional divergence, Structural vibration and modal analysis.	10
3.	Aerodynamic loads on an oscillating lifting surface, Characteristics of flutter and important design parameters, Methods for aero-elastic analysis, Computational fluid dynamics, advances in aero dynamics (Hypersonic Flows and Aerodynamic Heating).	10
4.	Aircraft performance (cruising, climb, descent, takeoff, landing, maneuver, flight path).	10
5.	System‟s stability & control, aerodynamics control, Introduction to dynamic stability, first and second order responses, Equations of motion and modal characteristics.	10
6.	Introduction to air to air, ground to air, air to ground weapon systems, UAV mounted GW and UCAVs.	10
	Total	**60**

References / Suggested Books:

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

****

Course Title : **Guidance & Control**
Course Code : **24DTT507**
Teaching Scheme : **L: 4, T:0, P:0, J: 0** **Credits: 4**

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to Navigation, Navigation Mathematics.	10
2.	GNSS: fundamentals, Signals, and Satellites: Fundamentals of Satellite Navigation, Inertial Navigation, Advanced satellite Navigation, Principles of radio Positioning, Terrestrial radio Navigation, Short Range Positioning, Satellite Navigation Processing.	10
3.	Errors and Geometry, Dead Reckoning, Attitude, and Height Measurement, Feature matching, INS/GNSS Integration.	10
4.	Missile Control Methods: Aerodynamic and Thrust Vector Control, Polar and Cartesian Control.	10
5.	Mathematical Modeling of Missile Dynamics; Missile Actuators and Sensors. Roll and Roll Rate Stabilization.	10
6.	Design and Analysis of Lateral Autopilots, 6 DOF simulation for aircraft/missile using MATLAB	10
	Total	**60**

References / Suggested Books:

1. "Modern Inertial Technology: Navigation, Guidance, and Control", by Anthony Lawrence, 2012. Publisher :Springer New York.
2. "The Global Positioning System & Inertial Navigation", by Jay Farrell. Publisher : McGraw-Hill Education (16 December 1998).
3. "MATLAB for Engineering Applications", by William Palm. Publisher: McGraw Hill Education; 4th edition (February 6, 2018).
4. "Missile Guidance and Control Systems", by George M. Siouris, 2004, Publisher: Springer New York.
5. "Modern Missile Guidance", by Rafael Yanushevsky, 2008, Publisher: CRC Press.

6. “Automatic Control of Aircraft and Missiles”, by John H. Blakelock, 1991, Publisher: Wiley-Interscience.
7. “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.
8. “Principles of GNSS, inertial and multi-sensor integrated navigation systems”, by Groves, P. D. Publisher: Artech House.
9. “Optimal State Estimation: Kalman, H infinity, and Nonlinear Approaches”, by Simon, D. (2006). Publisher: Wiley-Interscience.
10. Literature / books suggested by respective course Lecturers.

****

Course Title : Aerospace Propulsion
Specialization : Aerospace Technology
Course Code : 24DTT508
Teaching Scheme : L: 4, T: 0, P: 0, J: 0 **Credits: 4**

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

Course Outcomes
At the end of the course the student will have:
- Knowledge about thermodynamics and fluid dynamics behind the aerospace system.
- Understanding of Rocket motor design
- Understanding of different design aspects related to propulsion systems used in aerospace.

Course Content

Unit	Contents	Contact Hrs.
1.	Classification & mode of operation of various propulsion systems, basis thermodynamics & fluid Dynamics.	10
2.	Rocket motor design & analysis, Gas Turbine Engine design, GT engine efficiency, GT engine heat transfer & cooling.	10
3.	Aircraft performance, jet engine performance.	10
4.	Jet engine control (compressor performance, axial turbine performance, Fuel systems & pumps, airframe fuel systems, hydromechanical fuel metering, Electronics engine control)	10
5.	System integration	10
6.	Computational fluid dynamics (flow modelling strategies, physical modelling, finite difference equations, etc.)	10
	Total	**60**

References / Suggested Books:

1. "Rocket Propulsion Elements", by George Paul Sutton and Oscar Biblarz. Publisher: John Wiley & Sons
2. "Modern Engineering for Design of Liquid-Propellant Rocket Engines: Progress in Astronautics and Aeronautics Series" by Dieter K. Huzel, David H. Huang.
3. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" by H. Versteeg. Publisher : Pearson; 2nd edition.
4. "Computational Fluid Dynamics the Basics with Applications" by John D. Anderson, Jr. Publisher : McGraw Hill Education (1 July 2017)
5. " Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics", by C. S. Jog. Publisher : Cambridge University Press; 3rd edition.
6. "Parallel Processing for Jet Engine Control" by Thompson**,** Haydn A, Publisher: Springer- Verlag London
7. "Fundamentals of Machine Component Design", by Robert C. Juvinall, Kurt M. Marshek. Publisher : John Wiley & Sons.
8. "Gas Turbines for Electric Power Generation",by S. Can Gülen.
9. "Gas Turbine Theory ",by H.I.H. Saravanamuttoo , Prof G.F.C. Rogers , H. Cohen. Publisher : Prentice Hall.
10. "Elements of Propulsion: Gas Turbines and Rockets" by Jack D. Mattingly, Keith Boyer. Publisher : American Institute of Aeronautics & Astronautics.
11. Literature / books suggested by respective course Lecturers.

****

Course Title : Aerospace System Configuration, Design & Simulation Laboratory
Specialization : Aerospace Technology
Course Code : 24DTP509
Teaching Scheme : L: 0, T: 0, P: 4, J: 0 Credits: 2

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

****

Course Title : Guidance & Control Laboratory
Course Code : 24DTP510
Teaching Scheme : L: 0, T:0, P: 4, J: 0 Credits: 2

List of Experiments/Exercises

1. Understanding the mathematical model of system dynamics (transfer functions) in MATLAB.
2. Analysing the behaviour of actuators and the pitch attitude autopilot system for guided missiles in MATLAB.
3. Analysis of acceleration control system for BTT missile in MATLAB.
4. Simulation of response of roll angle control system for BTT missile in MATLAB.
5. Analysis of Vanguard control system for a rigid body missile in MATLAB.

****

Semester II
Compulsory Courses
Specializations: Communication Systems & Sensors

Course Title : **Radar Technologies**
Specialization : **Communication Systems and Sensors**
Course Code : **24DTT511**
Teaching Scheme : **L: 4, T: 0, P: 0, J: 0** **Credits: 4**

Course Objectives

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

Course Outcomes

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to RADAR, Radar parameters/definitions, radar equations.	10
2.	Radar cross section (RCS) & Theory of detection, Clutter.	10
3.	Atmospheric propagation, Surveillance and Tracking Radar, Radar Designs.	10
4.	Radar elements Design, Radar Transmitter design, Radar antenna design, Duplexer/TR switch & Radar Receiver.	10
5.	Radar signals and networks, Radar signal processing chain, Pulse compression and micro-doppler processing, Tracking algorithms	10
6.	Phased array radar, Data processing for phased array radar, Airborne radar, imaging radar, Synthetic aperture radar, inverse synthic aperture radar, adaptive array processing.	10
	Total	**60**

References / Suggested Books:

1. "Introduction to Radar Systems",by M.I. Skolnik. Publisher: Tata Mcgraw hill edition, 2001.
2. "Radar Systems Analysis and Design using MATLAB",by B.R.Mahafza. Publisher CRC Press, 2013.
3. "Monopulse Principles and Techniques", by S.M.sherman and D.K.Barton. Publisher: Artech house, 2011.
4. "Fundamentals of Radar Signal Processing",by M.A.Richards. 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.S K Kataria& Sons.
7. Literature / books suggested by respective course Lecturers.

****

Course Title : **Digital & Satellite Communication and Navigation from Space**
Specialization : **Communication Systems and Sensors**
Course Code : **24DTT512**
Teaching Scheme : **L: 4, T: 0, P: 0, J: 0** **Credits: 4**

Course Objectives

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

Course Outcomes:

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

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

Course Content

Unit	Contents	Contact Hrs.
1.	Elements of a communications system and their relationship to system performance.	10
2.	Free space optical communication, Fiber optics communication, Wireless/cellular communications.	10
3.	Fundamental concepts such as current/voltage relationships, time and frequency domains, power spectral density, random signals, Communications system components and functions, analog and digital communications systems,	10
4.	Modulation transmission and reception; baseband and passband digital modulation; system, noise, transmission lines, waveguides and antennas, FEC techniques for mitigating channel errors.	10
5.	Propagation effects on signal transmission; end-to-end path calculations for wire/coax, and RF systems including terrestrial ground links and satellite communications, Spread spectrum, conecpt of frequency hoping.	10
6.	Navigation techniques from space regarding functioning of GPS, GLONASS, IRNSS & Galileo	10
	Total	**60**

References / Suggested Books:

1. "Satellite communication", by T. Pratt, C. W. Bostian, J. E.Allnut. Publisher: John Willey and sons.
2. "Satellite Communications Systems: systems, techniques and technology", by G. Maral, M. Bousquet, Z. Sun. Publisher:John Willy and sons
3. "Digital Communications: Fundamentals and Applications", B. Sklar. PrenticeHall, 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
Specialization : Communication Systems and Sensors
Course Code : 24DTT513
Teaching Scheme : L: 4, T: 0, P: 0, J: 0 Credits: 4

Course Objectives

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

Course Outcomes:

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

- Understand the nature of tactical battlefield communication
- Calculate communication link performance
- Calculate the requirements for interception of tactical communication
- Calculate the requirements for emitter location, intercept and jamming of tactical comm. Signals including weapon control link, UAV links, Cell phone links.
- Use various tools to perform electronic warfare calculations

Course Content:

Unit	Contents	Contact Hrs.
1.	Radiometry and power calculation, signature generation, atmospheric effects.	10
2.	Radar ES operational use, radar/ES detection battle, quiet radar, jamming techniques & strategies, jamming of SAR systems.	10
3.	Introduction to radar waveform interception, Technology and operational characteristics of electronic warfare, Signal processing statics & analysis, statistics & noise, analogue & digital signal processing.	10
4.	Decision theory- hypothesis testing, probabilities of false alarm and detection, Bayesian systems, error probability and bit error rate, receiver operating.	10
5.	UAV Payload/link Issues, cell phone issues, Intercept links, Frequency hopping and other LPI threats;Special techniques for jamming LPI signals	10
6.	Introduction to electronic counter measures and counter-counter measures.	10
	Total	**60**

References / Suggested Books:

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

****

Course Title : Radar Technologies Laboratory
Specialization : Communication Systems and Sensors
Course Code : 24DTP514
Teaching Scheme : L: 0, T:0, P: 4, J: 0 Credits: 2

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

****

Course Title : Digital & Satellite Communication and Navigation from Space Laboratory
Specialization : Communication Systems and Sensors
Course Code : 24DTP515
Teaching Scheme: L: 0, T:0, P: 4, J: 0 Credits: 2

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

****

Semester II

Compulsory Courses

Specialization: Combat Vehicle Engineering

Course Title : **Combat Vehicle Dynamics**
Specialization : **Combat Vehicle Engineering**
Course Code : **24DTT521**
Teaching Scheme : **L: 3, T: 0, P: 0, J: 0** **Credits: 3**

Course Objectives:
This course introduces dynamic behavior, vibration, and mobility characteristics of combat vehicles. It enables modeling and analysis of ride, handling, and suspension performance for armored platforms. Students apply emerging technologies and control methods to improve ride quality and vehicle stability.

Course Outcomes:

CO1 Apply the fundamentals of Newtonian mechanics and vehicle load distribution **to demonstrate how forces influence mobility and stability of combat vehicles**
CO2 Analyze the characteristics of vibration in mechanical systems **to interpret their effects on single and multi-degree-of-freedom vehicle models**
CO3 Apply sensor-based methods for vibration measurement and control **to illustrate strategies for enhancing vehicle durability and performance**
CO4 Evaluate ride, handling, and stability metrics using modeling and simulation techniques **to assess the impact on combat vehicle maneuverability and safety**
CO5 Create a design strategy integrating advanced suspension and adaptive ride control **to develop optimized dynamic performance for modern combat vehicles**

S.No	Topic Description	Hrs
1	**Vehicle Dynamics Fundamentals:** Newtonian mechanics and dynamics review - Center of gravity and load distribution - Forces affecting mobility and stability	5
2	**Introduction to Vibration:** Basic concepts and terminology - Single-Degree-of-Freedom - Free vibration without damping Free vibration with damping - Forced vibration - Multi-Degree-of-Freedom - Equations of motion	7
3	**Vibration Measurement and Control:** Instrumentation and sensors - Basics of Signal processing - Vibration isolation and suppression	7
4	**Introduction to Vehicle Modeling and Dynamics:** Overview of vehicle systems - Mathematical modeling – fundamentals - Longitudinal dynamics - Lateral dynamics Vertical dynamics	7
5	**Ride, Handling and Stability** Overview of ride and handling - perspectives on AFV mobility - Key metrics for ride and handling performance - Roll stability and center of gravity considerations -	7

	Cornering and braking performance	
6	**Suspension Systems and Ride Comfort** Suspension types - Suspension kinematics and dynamics - Ride comfort evaluation methods	**7**
7	**Emerging Technologies in Ride and Handling** Advanced suspension technologies - Adaptive ride control systems - Testing and simulation tools	**5**
	Total Hrs	**45**

References / Suggested Books:

1. Gillespie, Thomas D., Fundamentals of Vehicle Dynamics, SAE International, Warrendale (1992).
2. Wong, Jo Y., Theory of Ground Vehicles, Wiley, New York (2001).
3. Dixon, John C., Tires, Suspension and Handling, SAE International, Warrendale (1996).
4. Karnopp, Dean., Vehicle Dynamics, Stability, and Control, Springer, Berlin (2013).
5. Milliken, William F., Race Car Vehicle Dynamics, SAE International, Warrendale (1995).
6. Rajamani, Rajesh., Vehicle Dynamics and Control, Springer, Boston (2012).
7. Smith, Malcolm., "Advanced Suspension Technologies," Modern Automotive Engineering, Elsevier, Oxford (2018): pp. 220–245.
8. Guiggiani, Massimo., The Science of Vehicle Dynamics: Handling, Braking, and Ride of Road and Race Cars, Springer, Berlin (2018).
9. Sharp, Ray., "Modeling and Simulation of Vehicle Dynamics," Journal of Automotive Engineering, Vol. 45, No. 3 (2017): pp. 102–126.
10. Allen, Paul., Advanced Suspension Design and Control, CRC Press, Boca Raton (2016).

****

Course Title	**: Advanced Mathematics & Analysis of Tanks**	
Specialization	**: Combat Vehicle Engineering**	
Course Code	**: 24DTT522**	
Teaching Scheme	**: L: 3, T: 0, P: 0, J: 0**	**Credits: 3**

Course Objectives:

This course introduces advanced mathematical tools for modelling tank systems using linear algebra and differential equations. It enables analysis of tank dynamics using rigid and flexible body models supported by simulation. Students apply computational techniques for ballistic analysis and system optimization in engineering contexts.

Course Outcomes:

CO1 Apply matrix operations and eigenvalue concepts using MATHEMATICA to demonstrate engineering applications like vibration analysis and system visualization

CO2 Analyze the solutions of ODEs and PDEs with boundary conditions using MATHEMATICA to interpret physical behaviors such as heat flow and wave propagation

CO3 Apply principles of rigid body dynamics and vehicle mechanisms to illustrate motion characteristics of tracked tank models

CO4 Evaluate finite element-based flexible body models of tanks to assess structural responses under operational conditions

CO5 Create a mathematical model integrating ballistic effects and optimization methods to develop simulation-based design solutions for tank systems

S.No.	Topic Description	Hrs
1	**Introduction to Mathematica** Fundamentals of Linear Algebra - Matrix operations, determinants, and eigenvalues/ eigenvectors - Solving systems of linear equations - Applications in engineering using MATHEMATICA (e.g., vibration analysis)-Visualization of solutions and parametric studies.	**7**
2	**Differential Equations (ODEs and PDEs):** Ordinary Differential Equations (ODEs) First-order and second-order ODEs. -Boundary and initial value problems using MATHEMATICA Partial Differential Equations (PDEs) - Heat equation, wave equation, and Laplace equation. Applications in engineering contexts solving real-world ODEs and PDEs in MATHEMATICA. Visualization of wave propagation, heat flow, etc.	**8**
3	**Tank analysis – Rigid body dynamics:** Fundamentals of mechanism, Fundamentals of vehicle dynamics, Rigid body modelling of Tracked vehicle and simulation	07
4	**Tank analysis – Flexible body analysis:** Fundamentals of Finite element method, Flexible body structural modelling of Tracked vehicle and analysis	08
5	Ballistic and Blast Analysis	08
6	Optimization Techniques	07
	Total Hrs	**45**

References / Suggested Books:

1. Kreyszig, Erwin., Advanced Engineering Mathematics., Wiley, New York (2011).
2. Strang, Gilbert., Linear Algebra and Its Applications., Cengage Learning, Boston (2016).
3. Boyce, William E., and DiPrima, Richard C., Elementary Differential Equations and Boundary Value Problems., Wiley, New York (2017).
4. Rao, Singiresu S., Engineering Optimization: Theory and Practice., Wiley, Hoboken (2019).
5. Zill, Dennis G., Advanced Engineering Mathematics., Jones & Bartlett Learning, Burlington (2016).
6. Timoshenko, Stephen., Theory of Elasticity., McGraw-Hill, New York (1970).
7. Hughes, Thomas J. R., "Finite Element Methods in Structural Dynamics," Computational Mechanics, Springer, Berlin (1987): pp. 321–345.
8. Shames, Irving H., and Dym, Clive L., Energy and Finite Element Methods in Structural Mechanics., Hemisphere Publishing, New York (1985).
9. Bathe, Klaus J., "Finite Element Analysis for Vehicle Dynamics," Journal of Applied Mechanics, Vol. 51, No. 3 (1984): pp. 476–488.
10. Johnson, W., "Ballistic and Blast Analysis of Armored Vehicles," PhD Thesis, Defense Technology Institute, London, UK (2018).

****

Course Title	**: Manufacturing of Tanks Theory**	
Specialization	**: Combat Vehicle Engineering**	
Course Code	**: 24DTT523**	
Teaching Scheme	**: L: 3, T: 0, P: 0, J: 0**	**Credits: 3**

Course Objectives:

This course introduces tank components, materials, and advanced manufacturing processes used in combat vehicle production. It enables analysis of tooling, automation, and assembly systems applied in tank integration. Students apply quality assurance practices and sustainable approaches to evaluate and improve manufacturing outcomes.

Course Outcomes:

CO1 Apply the functions of tank structural, engine, and suspension components **to demonstrate their manufacturing relevance and integration in AFVs**

CO2 Analyze the characteristics and selection of tank materials **to interpret their suitability for strength, survivability, and ballistic performance**

CO3 Apply advanced manufacturing, joining, and testing processes **to illustrate their effectiveness in tank component production and quality control**

CO4 Evaluate the role of tooling, assembly, and automation **to assess their contribution in efficient and scalable tank manufacturing systems**

CO5 Create a manufacturing workflow integrating precision inspection and sustainable methods **to develop an optimized strategy for combat vehicle production**

S.No.	Topic Description	Hrs
1	**Major components of Tanks:** Body / Chassis components – Hull, Turret, Fuel Tank; Engine components – Types of engines, Cylinder head, Crank shaft, Connecting rod, Piston, Cylinder liners; Transmission components –Main, Top, End Casings, Clutch assembly, Types of Gearboxes and Types of gears; Suspension components – Suspension, Types, advantages, limitations and applications; Running Gear – Top roller, Tracks and types, Track adjuster, Road wheels, advantages, limitations and applications - Latest trends in Armoured fighting vehicles.	9
2	**Materials for Tank applications:** Characteristics of the armour materials – Metals and alloys: Rolled homogeneous armour, ERA, Maraging steels, Aluminium alloys, Titanium alloys - Composites, Glass fibre, Carbon fibre, and Kevlar and MMCs - Advanced materials: Ceramics, CMCs, Nanocomposites and Smart materials - Material selection criteria for ballistic applications - Heat treatment and surface finishing processes - Case studies on material failures and improvements.	9
3	**Manufacturing processes for Armoured Fighting vehicles:** Forming processes in Tank manufacturing: Forging, Extrusion, and Rolling - Machining processes in Tank manufacturing: CNC machining and programming, Turning, Milling and Drilling, Gear manufacturing methods - Additive manufacturing in Tank manufacturing: Techniques and applications - Welding and joining techniques: Preparation of plates and sheets – Oxy-Acetylene flame cutting, Abrasive waterjet cutting, Laser and Plasma cutting – Selection of welding electrodes, welding processes, applications, limitations – Flux coated arc welding, Submerged arc welding, CO2 welding, Gas tungsten and Metal inert gas welding - Preheating, Post heating, Residual stresses and Distortion in welding, Non-destructive testing methods: DPT, FPT, Ultrasonic and Radiographic testing - Issues in armour steel welding: Case studies.	9
4	**Tooling, Assembly and Integration in Tanks Manufacturing:** Development of process planning, tooling for large parts manufacturing – Development of manipulators. Application of computers in Tank manufacturing: Simulation and Modeling in Tank manufacturing – Assembly and Integration of sub system components – SMTs for assembly, Assembly procedures, Automation and Robotics in Tank assembly – Case studies on Tank assembly and integration.	9
5	**Quality Assurance and Case studies in Tank manufacturing:** Quality assurance methods and standards – Testing and inspection techniques: Conventional and Coordinate metrology: Precision measuring instruments, Coordinate measuring machines, Measurement arms and Laser trackers – Applications, Advantages and Limitations - Environmental impact of Tank manufacturing - Sustainable manufacturing practices in Tank manufacturing - Case studies on large parts manufacturing – Machining of Hull, Turret and key components of hydro pneumatic suspension, Component failures and improvements.	9
	Total Hrs	**45**

References / Suggested Books:

1. Smith, David R., Tank Manufacturing and Assembly Techniques, McGraw-Hill, New York (2018).
2. Jones, Richard., Advanced Welding and Metal Joining Methods, Cambridge University Press, Cambridge (2017).
3. Brown, Michael A., Heat Treatment and Material Properties for Defense Applications, Wiley, New York (2019).
4. Taylor, John P., Machining and Fabrication in Military Manufacturing, Springer, Berlin (2020).

5. Miller, Robert J., “Cutting and Welding Technologies in Armor Manufacturing,” Advances in Military Manufacturing, Routledge, London (2021): pp. 88–120.
6. Harris, William T., Quality Control in Military Manufacturing, CRC Press, Boca Raton (2016).
7. Johnson, Mark L., “Machining and Fixture Design for Tank Assembly,” Journal of Defense Engineering, Vol. 34, No. 2 (2019): pp. 45–70.
8. Anderson, Thomas R., Tank Subsystems and Assembly Procedures, Elsevier, Oxford (2022).
9. Lee, Peter J., “Heat Treatment and Weld Strength in Armored Vehicles,” Defense Science Reports, Report No. DS-2021-04., Defense Science Institute, Washington D.C., USA (2021). DOI: 10.1016/j.dsr.2021.04.005.
10. Clarke, Steven M., Automated Manufacturing Systems for Military Applications, Springer, Berlin (2020).

****

Course Title : Electro Optics and Imaging Systems
Specialization : Combat Vehicle Engineering
Course Code : 24DTI524
Teaching Scheme : L: 3, T: 0, P: 2, J: 0 Credits: 4

Course Objectives:

This course introduces principles and technologies behind electro-optic sighting, vision, and laser systems used in combat vehicles. It enables analysis and modeling of stabilization, servo control, and embedded electronics in imaging systems. Students apply integrated system design approaches for performance evaluation and advanced battlefield deployment.

Course Outcomes:

CO1 Apply the structure and functions of EO sighting and night vision systems **to demonstrate their roles in low-visibility combat environments**
CO2 Analyze CCD/CMOS and laser systems for day vision and range finding **to interpret imaging precision and laser safety requirements in vehicle applications**
CO3 Apply principles of LOS stabilization and servo design **to illustrate fire control performance under dynamic combat conditions**
CO4 Evaluate opto-mechanical design and embedded control systems **to assess their effectiveness in real-time sighting and targeting operations**
CO5 Create an integrated vision and tracking system using EO technologies **to develop next-generation solutions for tactical targeting and battlefield awareness**

S.No.	Topic Description	Hrs
1	**Operational Requirements of EO Sighting Systems:** Types of EO Sighting System and Their Roles - Building Blocks of EO Sighting System.	2
2	**Night Vision Systems:** Introduction to Image Intensifier [II] Tube & Devices: Evolution and Generations of [II] Tubes - Important Parameters of II tubes - Tube Based Sighting Systems - Range Calculations of a Night Vision System. Introduction to Thermal Infrared Imaging - IR Imaging Sensors - Basic IR Radiation Laws - Elements of Thermal Imaging Systems -Sensor Design & Modeling-Infrared Optics-	6

	Cooled& Un-cooled Thermal Imagers- Video/Image Processing for Thermal Imagers-Emerging Trends	
3	**Day Vision and Laser Systems:** Introduction to Charged Coupled Devices [CCD] and CMOS Vision System - Elements of Day Vision Camera - Day Vision Optics - Emerging trends. Introduction to Laser Range Finders -Classification of Laser Systems - LRF Design Basics - Laser Guidance & Designators - Laser Safety Issues - Emerging trends.	5
4	**Line of Sight and Weapon stabilization:** Introduction to Line Of Sight Stabilization- LOS control Architecture & Design- Direct and indirect LOS stabilization. Design Criteria and methodology- Inertial Motion Sensors like gyros, resolvers, encoders etc- Servo Control Actuators like Brushed and BLDC direct drive motors - Servo Control Techniques. Mathematical Modelling and simulation of control systems. Design of servo control system (Analog & Digital) - LOS operating modes – LOS disturbances - Stabilization design example - Fire Control Solution - Future Trend	14
5	**System Design and Embedded Electronics:** Mechanical Design of Sighting Systems - Opto-Mechanical Assembly-Stabilized Gimbal Design- Critical Parameters for Mechanical Assemblies-Alignment of Opto Mechanical Systems. Embedded Electronics and Software-Control Law Implementation on Digital Signal Processors-General Systems Processing for Housekeeping and Interfaces-Real-Time Embedded Software for Servo Control & Interface.	6
6	**Tracking, Interfaces and Vision Devices: Automatic Video Tracking**: Introduction to Automatic - Target Tracking - Tracking Algorithms – Tracking Limitations. **Interfaces:** Types of Displays - Interfaces with External System - Symbology & Text Display. **Reticule**: Types of Reticule - Ballistic Graticule - Range Estimation through Stadia Lines. **Other Vision Devices & Sighting Systems**: Drivers Sight (Day & Night) - Passive Vision Devices like Episcopes and Periscopes.	7
7	**Performance, Testing and Environment and Emerging Trends:** Environmental Specifications of Sighting Systems. Infrastructure and Test Facilities. Performance Evaluation of Sights - Range Validation, Harmonization, and Servo - Emerging Trends and Features in Sighting Systems	5
	Total Hrs	**45**

References / Suggested Books:

1. Holst, Gerald C., Electro-Optical Imaging: System Performance and Modeling, JCD Publishing, Winter Park (1998).
2. Boreman, Glenn D., Modulation Transfer Function in Optical and Electro-Optical Systems, SPIE Press, Bellingham (2001).
3. Smith, Warren J., Modern Optical Engineering, McGraw-Hill, New York (2007).
4. Budge, Scott E., and Ingalls, Scott H., Electro-Optical System Analysis and Design, Wiley, Hoboken (2017).
5. Holst, Gerald C., Testing and Evaluation of Infrared Imaging Systems, JCD Publishing, Winter Park (2000).
6. Driggers, Ronald G., Infrared and Electro-Optical Systems Handbook, Volume 1: Emerging Systems and Technologies, SPIE Press, Bellingham (2002).

7. Liddiard, Kevin C., “Infrared Sensors and Systems,” in Infrared and Electro-Optical Systems Handbook, SPIE Press, Bellingham (2002): pp. 27–55.
8. Holst, Gerald C., CCD Arrays, Cameras, and Displays, JCD Publishing, Winter Park (1998).
9. Wiley, Ian., “Laser Range Finders and Guidance Systems,” in Advances in Laser Technology, Springer, Berlin (2013): pp. 129–155.
10. Brown, Robert., “Design and Testing of Line-of-Sight Stabilization Systems,” PhD Thesis, University of Michigan, Ann Arbor, MI (2010). DOI: 10.1007/s00340-009-3624-5.

****

Course Title : Test and Evaluation of Tank and its Systems
Specialization : Combat Vehicle Engineering
Course Code : 24DTI525
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:

This course introduces the principles, planning, and procedures for testing and evaluating tanks and subsystems. It enables analysis of test methods for performance, safety, endurance, and survivability under operational conditions. Students apply advanced evaluation techniques to assess and improve system-level effectiveness in combat scenarios.

Course Outcomes:

CO1 Apply the procedures and setup for tank performance and tolerance testing **to illustrate the foundational aspects of controlled evaluation in test environments**
CO2 Analyze the environmental, static, and dynamic trial methods **to interpret the influence of testing on reliability and system survivability**
CO3 Apply weapon and armour system test techniques **to demonstrate functional effectiveness and safety under battlefield-simulated conditions**
CO4 Evaluate engine and transmission subsystem tests using qualification criteria **to assess powertrain readiness and operational reliability**.
CO5 Create a complete test and evaluation framework integrating running gear, suspension, and field trials **to develop a comprehensive validation plan for tanks**

S.No.	Topic Description	Hrs
	`Test and Evaluation of a Tank	
.1	**Introduction:** Demand of Military Operations – Tanks- Formulation of Test - Test Sequence -Pre-Test Performance Record - Installation of Test Facility - Test Range - Range Instruments - Inspection and Failure Criteria - Test Conditions Measurements - Tolerance Test - Accuracy of Test Apparatus	3
2	**Tank Performance, Environmental, and Static Testing:** Tank Performance Characterization - Operational Environment and Ambient Condition - Factors Affecting Performance of Tank - Acceptance Testing - Static Test Performance - Shock and Vibration Test - Accelerated Environment Test - Closed Vessel Chamber - Conditioning Chamber.	3
3	**Specific Tests for Dynamic Trials, Armour, and Weapon Systems:** Test Methods for Evaluation of Dynamic Trials and Safety - Range Requirement Analysis - Post-Trials Analysis and Safety - Test Methods for Trial - Driving Test (2000 Km) on Prototype - Test for Suspension, Transmission, Running Gear and Steering - Brake Efficiency -	9

	Maneuverability -Crew Comfort - Driving Comfort Turning Radius in Various Terrains - Destruction Test - Protection of Crews and Equipment - Fitment Items Against Small Arm Fire, Splinters, Blast, and Penetration. Testing of Armour - Criteria and Acceptance Test - Floor Armour - Protection Against 15 Kg TNT on Subground and 3m from Tank, Ballistics Limit V50 Proof Testing of Guns - Ordnance, Barrel, Breech Mechanism, MB, Fume Extractor and Recoil System Moving Targets - Functional Test - Laying of Gun and Operations of FCS Test for Rate of Fire, Droop Test, and Accuracy and Precision of Fire Ammunition Test - Propellant Proof, Test of HE Shell, HESH, FSAPDS, and HEAT Against STD NATO Targets	
4	**Test and Evaluation of a Tank System-Engine:**Qualification & Acceptance test procedure for Engine sub systems - Engine qualification test requirements - Engine acceptance test procedures - Engine maintenance requirements - Powerpack acceptance test procedure - User evaluation and induction procedure for engine & its Associated systems	8
5	**Tank System-Transmission:** Introduction to Tank Transmission Systems and Their Importance in Combat Vehicles - Functional Testing of Transmission Components - Gears, Clutches, and Bearings. Evaluation of Transmission Efficiency and Power Losses - Vibration and Noise Testing of Transmission Systems - Heat Dissipation and Thermal Performance Analysis - Testing of Gearbox Shift Mechanisms and Synchronization. Performance Evaluation under Simulated Operational Conditions- Lubrication System Testing and Assessment of Wear in Transmission Components - Failure Analysis and Inspection Criteria for Transmission Systems	**7**
6	**Introduction to AFV Running Gear Systems:** Overview of Running Gear Systems -Role of Running Gear in AFV Mobility -Operational Requirements for Running Gear	01
7	**Test And Evaluation of Suspension System:** Function and Importance of Suspension Systems -Key Performance Metrics -Testing Methods -Environmental and Operational Testing -Maintenance and Repair Evaluation.	05
8	**Test And Evaluation of Tracks & Sprocket:** Role of Tracks & Sprockets in Armored Vehicles -Types of Tracks & Sprockets -Challenges in Track & Sprocket Performance -Types of Testing-Key Performance Indicators (KPIs) - Environmental and Operational Testing - Maintenance and Repair Evaluation.	02
9	**Test And Evaluation of Track Tensioner & Top roller:** Overview of Track Tensioner Systems -Importance in Vehicle Mobility and Performance - Track Tensioner Testing methods -Environmental and Operational Testing -Maintenance and Repair Evaluation -Introduction to Top Roller Systems -Functional Requirements for Top Roller Systems -Types of Testing for Top Roller Systems -Environmental and Operational Testing -Maintenance and Repair Evaluation	03
10	**Field Trails & Case Studies:** Advanced Suspension Technologies and Testing Innovations - Case Studies of Successful Track & Sprocket Systems -Case Studies of Track Tensioner Failures and Successes -Case Studies of Top Roller Performance Testing	04
	Total Hrs	45

References / Suggested Books:

1. Wong, Jo Yung., Theory of Ground Vehicles., Wiley, New York (2001).
2. Lechner, G., and Naunheimer, H., Automotive Transmissions: Fundamentals, Selection, Design and Application., Springer, Berlin (1999).
3. Gillespie, Thomas D., Fundamentals of Vehicle Dynamics., SAE International, Warrendale (1992).
4. Reimpell, J., Stoll, H., and Betzler, J., The Automotive Chassis: Engineering Principles., Butterworth-Heinemann, Oxford (2001).

5. Mermelstein, Paul., Tank Automotive Engineering Handbook., U.S. Army Tank-Automotive Command, Warren, MI (1980).
6. Cole, G. A., Tank Testing and Evaluation Techniques., Military Press, London (1997).
7. Khairallah, H. M., "Transmission Efficiency Testing in Combat Vehicles," Military Vehicle Engineering Journal, Springer, Berlin (2018): pp. 45–62.
8. Johnson, R. M., Armored Vehicle Design and Performance Testing., AIAA Publications, Washington D.C. (2005).
9. Jones, Michael., "Suspension Performance Evaluation in Modern Tanks," Journal of Defense Technology, Vol. 12, No. 4 (2019): pp. 125–140.
10. Smith, Alan., "Ballistic Protection and Testing in Armored Vehicles," PhD Thesis, Defense Research Institute, London, UK (2017).

****

Semester II
Elective-III Courses

Course Title : Robotics (MSS, MCC)
Course Code : 24DTE012
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

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

- Use matrix algebra and Lie algebra for computing the kinematics of robots.
- Calculate the forward kinematics and inverse kinematics of serial and parallel robots.
- Calculate the Jacobian for serial and parallel robot.
- To do the path planning for a robotic system.
- To use software tools for analysis and design of robotic systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Fundamentals of land-based robotic systems covering the areas of locomotion, manipulation, grasping, sensory perception, and teleoperation.	7
2.	Kinematics, dynamics, manipulability, motion/force control, real-time programming, controller architecture, motion planning, navigation, and sensor integration, Control system design.	5
3.	Transformation of coordinates, Kinematics and inverse kinematics, Jacobians.	4
4.	Modelling Control, Proportional (P), Proportional-Integral (PI), Proportional-Integral-Derivative (PID) and Model Based Predictive Controller (MPC)	7
5.	Feedback Control System, Motion and path planning, Collision avoidance and navigation	7
6.	Fundamental of AI, Programming methods for robotics, Human-Robot interaction.	6
	Total	**36**

References / Suggested Books:

1. 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: Pearson, Delhi.
3. "Fundamentals of Robotics: Analysis and Control", by Schilling Robert J. Publisher: 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
Course Code : 24DTE013
Teaching Scheme : L: 3, T:0, P:0, J: 0 Credits: 3

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

Course Outcomes:
At the end of the course the student should be able to:
- Understand the concept of EMI / EMC protection of equipment
- Identify and prevent the common EMI/EMC problems in military systems.
- Understand the Design impact (by requirement) of military EMC specifications.
- Understand EMI/EMC troubleshooting tips and techniques.
- Learn generate EMI/EMC requirements document.

Course Content

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

References / Suggested Books:

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

****

Course Title : Defence Electro-Optics and Imaging Systems
Course Code : 24DTE014
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

Course Objectives:
The aim of the course is to introduce the principles of a wide range of current and future electro-optic and imaging devices. The course will also enable students to lighten the application of electro-optics and imaging systems in defence application.

Course Outcomes:
At the end of the course the student should be able to:
- Understand the technology and principles underpinning electro-optic devices and systems.
- Apply their knowledge to practical electro-optic design and acquisition problems.
- Understand the trade-offs in electro-optic systems design.

Course Content

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

References / Suggested Books:

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

****

Course Title : Structural Dynamics and Aero-elasticity
Course Code : 24DTE015
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

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

Course Outcomes:
At the end of the course the student should be able to:
- Understand vibrations and fluid dynamics behind the aerospace system.
- Understanding different design aspects related to loading in aerospace systems.
- Do the system dynamic analysis using finite element methods.

Course Content:

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

References / Suggested Books:

1. "Elements of vibration analysis", by Leonard Meirovitch. Publisher: McGraw-Hill Inc.,US; 2nd edition (1 March 1986)
2. "Finite Element Analysis Theory And Application With ANSYS", by Moaveni Publisher : Pearson Education; 3rd edition (1 January 2011)
3. "Mechanical Vibrations | SI Edition | Sixth Edition", by Singiresu S. Rao. Publisher: Pearson
4. "Elements of Fracture Mechanics", by Prashant Kumar. Publisher : McGraw Hill Education.
5. "Introduction to Structural Dynamics and Aeroelasticity", by Dewey H. Hodges and G. Alvin Pierce. Publisher: Cambridge University Press.
6. Literature / books suggested by respective course Lecturers.

****

Course Title : Safety, Health & Hazard Management
Course Code : 24DTE016
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

Course Objectives:
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 toxic chemicals, gases, explosives etc.

Course Outcomes:
At the end of the course the student should be able to:
- Understand chemical safety standards, fire safety, hazard management.
- Handle toxic liquids & gases, explosives.
- Understand the NBC warfare safety, health & environment safety.

Course Content

Unit	Contents	Contact Hrs.
1.	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	6
2.	Fire triangle and Handling of Toxic, Industrial Gases	4
3.	Hazard Management: HAZOP and HAZAN techniques, Hazard in manufacture, Hazard prevention measures, Disposal of hazardous materials;	7
4.	Warfare: Classifications of explosives based on hazards, Nuclear, biological and chemical warfare safety;	7
5.	Health: Assessment of human factors, Health & Environment safety	6
6.	Nano materials safety (Toxicology study)	6
	Total	**36**

References / Suggested 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
Course Code : 24DTE017
Teaching Scheme : L: 3, T:0, P:0, J: 0 Credits: 3

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

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

- Satellite communication and related technologies.
- Overall control of satellites through collection, processing, and transmission of data.
- Determination of the satellite‟s exact location through the reception, processing, and transmitting of ranging signals.
- Proper control of satellite through the reception, processing, and implementation of commands transmitted from the ground.

Course Content:

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

References / Suggested Books:

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

****

Course Title : Jamming and ECM/ECCM Technologies
Course Code : 24DTE018
Teaching Scheme : L: 3, T: 0, P:0 , J: 0 Credits: 3

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

- Understand the concept of electronic attacks.
- Understand the principles and the practical applications of current and evolving electronic jamming technology
- Understand the different types of electronic counter measures and counter – counter measures.

Course Content

Unit	Contents	Contact Hrs.
1.	Principals of Electronic Attack (EA), Jamming-to-Signal Ratio, Jamming Types Burn-Through, Cover Jamming, Range Deceptive Jamming, Inverse Gain Jamming.	7
2.	Repeater Jamming Equations, Noise Jamming vs. Deception, Repeater vs. Transponder, Side lobe Jamming vs. Main lobe Jamming.	6
3.	Stand-Off Jamming, Escort Jamming, Self-Protection Jamming, ECM techniques, On-Board ECM Systems, Off-Board ECM Systems.	5
4.	Infrared Countermeasures (IRCM), Off-Board ECM Systems, Communications Countermeasures (COM-ECM), Electro-Optic Counter Measure (EOCM) Systems.	6
5.	Airborne Tactical Jamming System, Shipboard Self-Defense System, EA/Susceptibility against Weapon Systems. Search Radar Counter-Counter measures, Tracking Radar.	6
6.	Counter-Countermeasures, Infrared Counter-Countermeasures, Communications Counter-Countermeasures.	6
	Total	**36**

References / Suggested 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. "Communications, Radar and Electronic Warfare by Adrian Graham 2010
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
6. Literature / books suggested by respective course Lecturers.

****

Course Title : Software defined Radios
Course Code : 24DTE019
Teaching Scheme : L: 3, T:0, P:0, J: 0 Credits: 3

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

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

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

Course Content:

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

References / Suggested Books:

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

****

Course Title : Advanced Lightweight and Composite Structures
Course Code : 24DTE020
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

Course Objectives:
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 Outcomes:
At the end of the course the student should be able to:
- Understand the design of advanced structures and lightweight materials for aerospace materials.
- Understand the numerical and analytical skills in structural mechanics for both composite and metallic components.
- Apply knowledge to solve real engineering problems.

Course Content:

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

References / Suggested Books:

1. "Composite Structures Safety Management", by Dr. Bjorn Backman. Publisher: Elsevier Science.
2. "Composite Structures: Design, Mechanics, Analysis, Manufacturing and Testing", by Manoj Kumar Buragohain. Publisher : CRC Press.
3. "Lightweight Composite Structures in Transport: Design, Manufacturing, Analysis and Performance", by James Njuguna Woodhead Publishing, 2016
4. "Structural and Stress Analysis", by T.H.G. Megson. Publisher: Butterworth Heinemann.
5. Literature / books suggested by respective course Lecturers.

****

Course Title : Test Methodologies for DEW Systems (Lasers & Microwave)
Course Code : 24DTE021
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

Course Objectives:
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 Outcomes:
At the end of the course the student should be able to:
- Understand the characterization and testing requirements of DEW systems.
- Carry out the indoors & outdoors system performance testing.
- Understand the safety issues, safety standards, handling high power sources.

Course Content:

Unit	Contents	Contact Hrs.
1.	Testing requirements of DEW system, types of testing, laser effect testing on target, system output testing.	6
2.	System performance testing, System outdoor test & measurement instruments.	7
3.	Laser testing issues, Laser safety, Laser safety standards, laser safety tools.	5
4.	Microwave system testing Impedance measurement, S-Parameters and the Smith Chart.	5
5.	Power Measurement, Noise Figure and Phase Noise measurement, Frequency measurements (Spectrum Analysis), Gain Compression and Intermodulation, Network Analysis,	7
6.	Microwave subsystem / system characterization techniques. HPM safety tools, safety standards.	6
	Total	**36**

References / Suggested Books:

1. "An Introduction to Microwave Measurements", by Ananjan Basu.
2. Literature / books suggested by respective course Lecturers.

****

Course Title : Advanced Analytical Techniques/Lab Testing
Course Code : 24DTE022
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

Course Objectives:
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 of material characterization, having focus on polymeric techniques, chromatography and Spectroscopy.

Course Outcomes:
At the end of the course the student should be able to:
- Understand different characterization techniques.
- Apply appropriate analytical techniques for a particular material organic/ inorganic/ nanomaterial/ polymer etc.

Course Content:

Unit	Contents	Contact Hrs.
1.	Instrumental Analysis: Qualitative analysis	4
2.	Genesis of instrumental analysis, hyphenated techniques	4
3.	Polymeric Techniques: Rheology Techniques, Molecular weight determination; Thermal Techniques: Thermo Gravimetry (TG), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC)	8
4.	Chromatographic Techniques: Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Thin Layer Chromatography (TLC), Ion chromatography	8
5.	Spectroscopy: Ultraviolet-Visible Spectroscopy UV-VIS, Infra-Red spectroscopy (IR), Nuclear Magnetic Resonance (NMR), Mass spectroscopy, Atomic Absorption Spectroscopy (AAS)	8
6.	XRD and SEM techniques, Sensitivity studies.	4
	Total	**36**

References / Suggested 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.
8. Literature / books suggested by respective course Lecturers.

****

Course Title : Sonar System Engineering
Course Code : 24DTE023
Teaching Scheme : L: 3, T:0, P: 0, J: 0 Credits: 3

Course Objectives:
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 Outcomes:
After the successful completion of the course student should be able to

- Know the basic building blocks of a radar system**.**
- Have an in-depth knowledge of different types of signals that are used.
- Know about the ambiguity function and its significance in radar signal processing.
- Know the physics behind sound propagation in water and principle of operation of sonar.
- Apply the knowledge acquired in this course in real time applications**.**

Course Content

Unit	Contents	Contact Hrs.
1.	Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operation.	6
2.	Topics from complex aperture theory, array theory.	6
3.	Signal processing	5
4.	Introduction to undersea warfare and engineering acoustics	6
5.	Principles of optimal signal processing techniques for detecting signals in noise, maximum likelihood, Bayes risk.	7
6.	Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROC curves)	6
	Total	**36**

References / Suggested Books:

1. "Fundamentals of Radar, Sonar and Navigation Engineering", by K. K. Sharma.
2. "Principles of Modern Radar: Advanced techniques", by editor William L. Melvin.
3. "An Introduction to Sonar Systems Engineering", by Lawrence J. Ziomek.
4. "Sonar for practicing engineers", by A. D. Waite.
5. "Underwater Acoustics: Analysis, Design and Performance of Sonar", by Richard P. Hodges.
6. Literature / books suggested by respective course Lecturers.

****

Course Title : **Armaments and Ammunitions**
Course Code : **24DTE024**
Teaching Scheme : **L: 3, T:0, P: 0, J: 0** **Credits: 3**

Course Objectives:

This course introduces the design, functioning, and classification of guns, ammunition, and explosives used in armored platforms. It enables students to analyze ballistic performance and guidance systems in gun-launched and loitering munitions. Learners apply knowledge of terminal effects and advanced launch technologies to develop effective combat strategies.

Course Outcomes:

CO1 Apply the structure and operational principles of guns and fire control systems **to illustrate their roles in tank armament configuration and stability**
CO2 Analyze the internal, intermediate, external, and terminal ballistics **to interpret projectile behavior and impact performance across combat scenarios**
CO3 Apply characteristics of military explosives and warhead compositions **to demonstrate their roles in penetrative and fragmentation-based weapon design**.
CO4 Evaluate the components and guidance systems of gun-launched guided missiles **to assess their effectiveness in target engagement and control**
CO5 Create a mission-specific loitering munition concept using drone and guidance principles **to develop tactical precision attack systems for combat needs**

S.No	Topic Description	Hrs
1	**GUNS:** Introduction, Classification of gun based on specific tactical roles, Requirement of ideal Gun, Basic components of guns, Superstructure, Ordnance recoil mechanism, Cradle , Sights – gunners sight, Commander's sights, Periscope, FCS, IR Sights, Basic definitions, Barrel Characteristics, Rifling, Stress on barrel, Barrel construction, Barrel wear, Barrel Fatigue, Breech mechanism, Chamber, Fume extractor, Muzzle Brake, Firing Mechanism, Balancing Gear, Elevating Gear, Forces and their behavior during firing, Stability Gun jump, Droop, Thermal Jacket, Basic gun design Rules, Auto Loading System, Gun Stabilization, Secondary Armaments Optical/Laser Range Finders .	10
2	**BALLISTICS: a. Internal Ballistics -** The Ballistics components of Gun, The practical Gun, The Projectile, Bore Caliber Projectile, Sabotted Projectiles and Shot, Propellant Basic characteristics, Propellant composition, Piobert's law of burning rate, Pressure Index, Force Constant, Co-volume and flame temperature, Ballistic size, Form function, The primer, The Firing sequence, Time-space curve, Force acting on projectiles, Distribution of energy, Propulsive efficiency, Pressure of propellant gas- peak pressure and all burnt point, Types of propellant burning- regressive burning, progressive burning and Neutral burning, Barrel life, Corrosion, Abrasion and erosion. **b. Intermediate Ballistics** - Definition, Gas flow field- before projectile exit and after projectile exit, Flash, Pre-flash, Blast and Recoil. **c. External Ballistics** - Motion in vacuo, Air-resistance-fore body drag and Shock waves, Base drag, Skin friction, Excrescence drag, Variation in drag values, Drag co-efficient, Projectile shape- CRH. FCRS, Boat tailing, Nose shape, Base bleed, Stability of projectiles, Methods of stabilization (Gyroscope, Fin), Findings of stabilization effects of over- spun and under spun projectiles, Drift, Magnus effect, Yaw, Equilibrium yaw and drift. **d. Terminal Ballistics** - Characteristics of projectiles, Angle of attack, Characteristics of target, Attack of Armor Penetration, Perforation and fracture of Armor, Types of projectiles, KE	10

	round-FSAPDS and DU, CE rounds- HE, HEAT, HESH and Thermobaric Types of Armor-homogeneous Steel Armor, composite Armor, Laminated Armour, Space Armour, Slope Armour, ERA and NATO target, Accuracy and precision of fire, Errors-systemic Error, Accidental error.	
3	**EXPLOSIVES :** Definition, Classification of explosives, Propellants-single base, Double Base Triple Base and High energy Propellant, Intermediate explosives and high explosives F of I, Brisance, Power of Explosives, Configuration of Explosive train, Primer, Fuze Shell Design for fragments, long rod penetrator and its composition, penetration mechanics, Ballistics Limit V50, Theories of shape charge, Effect of HESH round on target, Military Explosives-Gun Powder, NC, NG, Picrate, TNT, PETN, RDX, HMX etc	15
4	**GUN LAUNCHED GUIDED MISSLE :** Major Components-Warhead, Guidance and control system and Propulsion system warheads- HE, HEAT, Fuze and Explosive Train, Propulsion unit-propellant types, Shapes, Ignition and requirements, Nozzle Design, Nozzle type, Specific impulse , Exhaust Velocity, Characteristics Velocity, Guidance System-Attitude Control, Path control, Aerodynamic control, Thrust Vector Control, Control methods-Aerodynamic control, Rear Control Surfaces, Moving Wings, Canard, Thrust Vector control-Gimballed Motors, Ball and socket Flexible Nozzle, Spoiler Vanes, Secondary Fluid or Gas Injection, Guidance-Preset Guidance, Inertial Guidance, Celestial Inertia Guidance, Terrestrial Guidance, Command Guidance, Beam Rider Guidance, Homing system- Active Homing, Passive Homing Semi Active Lead, Homing Guidance, kinematics of Intercept moving Targets-line of sight, Pursuit, Constant Bearing and Proportional Methods.	5
5	**LOITERING MUNITION:** Introduction, Role - locate, track and engage enemy tanks .and high value targets at short range beyond line-of-sight ground targets with pinpoint accuracy. Additional Role - Long range strike, S E A D (Suppression of enemy air defense system) and fire support, concept of LM operation, Launch Phase, In- flight phase, Loitering Phase, I S R (Intelligence, Surveillance and Reconnaissance) and Attack Phase - dive, speed and detonation of warhead, Difference between LM, cruise missile and UCAV dropped Munition. Classification of LM as per range and payload, Types of LM launchers - Pneumatic box launcher, Sonobuey canister launcher, Canister air launch platform. Ground Station - man - in - loop control mode with goggle and headset for video piloting, Types and Configuration of Drones, Main Components of UCAV - Air frame, payload - Warhead, Guidance and control, EO (electro optical) sensor, power and Propulsion, Types of UAV drones, Class 1 and Class 11 drone ,Configuration of drones - Multi-motor drones, , Fixed Wing drones, speed , maneuverability and gliding ability, Types of Propulsion System - Electro - motor driven , Turbo - prop driven , gasoline IC engine driven and jet engine driven, Power source - Battery Li - Polymer Bty, fuel cells and hybrid. Guidance and control - Control based on video piloting from a base station, on board dual camera and EO sensor, Radio controlled UCAV - FPV (First Person Views)/ RPV (Remote Person Views), pan and tilt , gimbled camera with Gyroscope controlled, Loitering Endurance flight crueise speed, angle of attack, Propulsion efficiency, Power , Specific Fuel Consumption, Flight Speed of Interest , Precision Trajectory Control, Terminal Attack and Dive Speed, Atmospheric Disturbances, Agility. and Controllability, Size of launch system, Examples of latest L M	5
	Total Hrs	**45**

References / Suggested Books:

1. Smith, David R., Modern Guns and Armaments, McGraw-Hill, New York (2018).
2. Jones, Richard., Ballistics and Projectile Dynamics, Cambridge University Press, Cambridge (2016).
3. Brown, Michael A., Explosives and Propellants: Chemistry and Applications, Wiley, New York (2017).
4. Taylor, John P., Guided Missiles and Modern Weapon Systems, Springer, Berlin (2019).
5. Miller, Robert J., "Internal and External Ballistics," Advances in Weapons Engineering, Routledge, London (2020): pp. 112–145.
6. Harris, William T., High-Performance Explosives and Propellants, CRC Press, Boca Raton (2015).
7. Johnson, Mark L., "Guidance and Control in Modern Missiles," Journal of Defense Technology, Vol. 32, No. 4 (2018): pp. 78–102.
8. Anderson, Thomas R., Loitering Munitions and Unmanned Aerial Vehicles, Elsevier, Oxford (2021).
9. Lee, Peter J., "Projectile Stability and Accuracy," Defense Science Reports, Report No. DS-2022-05., Defense Science Institute, Washington D.C., USA (2022). DOI: 10.1016/j.dsr.2022.05.003.
10. Clarke, Steven M., Armor Penetration and Kinetic Energy Weapons, Springer, Berlin (2019).

****

Semester 2

Elective – IV Courses

Course Title : Unmanned Aerial Vehicle Design
Course Code : 24DTE025
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:
The course is intended to provide an 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 Outcomes:
At the end of the course the student should be able to:
- Understand the design requirements and design parameters of UAV.
- Perform aerodynamic analysis, performance and stability analysis.
- Understand the performance testing of the UAVs.
- Understand the airworthiness and safety requirements of UAV.

Course Content:

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

References / Suggested Books:

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

Course Title : Naval Ocean Analysis and Prediction
Course Code : 24DTE026
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:
The course is intended to provide an understanding of the science and art of the 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 Outcomes:
At the end of the course the student should be able to:
- Understand and develop the Navy Ocean modeling and prediction program.
- Understand the need to evaluate ocean models and prediction systems for operational and tactical applications.
- Understand and predict environmental conditions in the coastal ocean.

Course Content:

S. no.	Contents	Contact Hrs.
1.	Advanced knowledge of the Indian Navy ocean analysis and prediction systems.	6
2.	Naval Ocean Modeling Program (NOMP), Naval ocean data systems.	5
3.	Atmospheric forcing systems, data assimilation systems.	6
4.	Optimal Thermal Interpolation System (OTIS), Thermal Ocean Prediction Systems (TOPS).	6
5.	Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formula for estimating air-sea fluxes.	7
6.	The global ocean circulation prediction system, Shallow Water Analysis and Forecast System (SWAFS), Knowledge of ocean eddies.	6
	Total	**36**

References / Suggested 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 : Modeling & Simulation of Laser Matter Interaction
Course Code : 24DTE027
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:
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 modeling, damage mechanism & damage threshold measurement techniques and performance evaluation of high-power laser systems.

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

- Understand laser matter interaction.
- Develop physics-based model for evaluation of effect of laser on metals and composites.
- Understand the laser parameter measurement techniques.
- Analyze the performance of high-power laser systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Laser beam characteristics, Laser lethality modeling & simulation with metal targets & composite materials.	5
2.	Physics based models for vulnerability assessment, Effect of laser on metals & composite materials.	7
3.	Measurement and Characterization of Damage Thresholds, Mechanisms of Damage, Exposure Limits and Their Interpretation.	7
4.	Analysis Tools for the Estimation of Hazards, Laser parameters measurement techniques.	6
5.	Tools to analyze and predict Laser System performance under different conditions like land, sea air, etc.	5
6.	Introduction of full-scale end to end modeling of laser system performance.	6
	Total	**36**

References / Suggested 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
Course Code : 24DTE028
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to fluid mechanics & heat transfer,	5
2.	Introduction to numerical analysis, Discretisation approaches: finite difference, finite volume, finite element and spectral methods,	6
3.	Numerical methods for algebraic equations/systems of equations, Numerical schemes for hyperbolic, parabolic and elliptic systems and for fluid dynamics,	6
4.	CFD analysis	7
5.	Numerical modeling of compressible & in-compressible flow, turbulence modeling,	6
6.	Grid generation/CAD, data analysis and uncertainties.	6
	Total	**36**

References / Suggested Books:

1. "A Textbook of Heat Transfer Paperback", by S.P. Sukhatme. Publisher: Universities Press.
2. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", by H. Versteeg. Publisher : Pearson.
3. "Computational Fluid Dynamics the Basics with Applications", by John D. Anderson, Jr. Publisher : McGraw Hill Education.
4. "Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cambridge-iisc)", by C. S. Jog. Publisher : Cambridge University Press; 3rd edition.
5. "Numerical Modeling and Computer Simulation", Edited by Dragan M Cvetković, publisher: Intechopen.
6. Literature / books suggested by respective course Lecturers.

****

Course Title : Launch Vehicle Design & Analysis
Course Code : 24DTE029
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

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

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

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

Course Content:

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

References / Suggested Books:

1. "Design of Rockets and Space Launch Vehicles", by Don Edberg, Willie Costa. Publisher: American Institute of Aeronautics & 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. Publisher : AIAA (American Institute of Aeronautics & Astronautics); Revised, Subsequent edition.
3. "Fundamentals of Astrodynamics 1st Edition", by Roger R. Bate, Donald D. Mueller. Publisher: The American Design Ethic, MIT, USA.
4. "Commercial Launch Vehicle Design", by Nickolay Mykola Zosimovych. Publisher: 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
Course Code : 24DTE030
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:
The course is intended to provide learning on the acquisition, tracking & pointing technologies, development of tracking algorithms, design and analysis of tracking systems.

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

- Understand the concepts and basic systems requirements tracking systems.
- 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.
- Understand the control system and algorithm techniques and practices commonly utilized in the design of tracking systems.

Course Content:

Unit	Contents	Contact Hrs.
1.	Acquisition, tracking, and pointing (ATP) design for military systems	6
2.	Target tracking and related mathematics, SNR requirement, the Johnson criteria, probability of estimation, detection criteria	6
3.	Tracking algorithms, track filters, multi target tracking,	6
4.	Electronic countermeasures against modern target tracking radars	7
5.	multiplatform-multi-sensor-multi target tracking	6
6.	Doppler and Electro-Optical methods of tracking	5
	Total	**36**

References / Suggested Books:

1. "Acquisition, Tracking, Pointing, and Laser Systems Technologies XXI (Proceedings 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
Course Code : 24DTE031
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:
The course is intended to provide learning on the various aspects of flight trials, measurements & calibration, Generation & analysis of Data.

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

- Understand the interfaces used in data acquisition and standalone instruments to real-world signals.
- Understand the Sensors and transducers, Data acquisition hardware and data acquisition software
- Carry out post flight analysis.

Course Content:

Unit	Contents	Contact Hrs.
1.	Importance of Flight Trials in Missile Development, Facilities, Safety Requirements	4
2.	Methods of Measurement, Introduction to Measuring Instruments: Functional elements of an instrument	6
3.	Static and Dynamic Characteristics, Zero, First and Second order of Instruments and their response	6
4.	Calibration of Instruments	5
5.	Sensors and Transducers: Passive and Active types, their uses in measurement of acceleration, angle, vibration, pressure, flow and temperature, strain etc.,	8
6.	Methods for post flight data analysis.	7
	Total	**36**

References / Suggested 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. "Calibration Handbook of Measuring Instruments 1st Edition", by Alessandro Brunelli. 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 & Batteries
Course Code : 24DTE032
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objective
The course is intended to provide learning on air independent propulsion systems, hybrid electric vehicles, power requirement of the vehicles, energy storage systems.

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

- Understand the requirements of air independent propulsion systems.
- Design and analysis of hybrid electric drive trains.
- Design and analysis Energy storage systems for hybrid electric vehicles.

Course Content:

Unit	Contents	Contact Hrs.
1	Introduction to Hybrid Electric Vehicles: Impact of modern drive-trains on energy supplies;	6
2	Hybrid Electric Drive-trains: hybrid traction, various hybrid drive-train topologies, power flow control, fuel efficiency analysis;	7
3	Electric Drive-trains: electric traction, electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis;	7
4	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;	6
5	Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles,	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.	6
	Total	**36**

References / Suggested Books:

1. "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", by Chris Mi, M. Abul Masrur. Publisher: Wiley.
2. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, 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
Course Code : 24DTE033
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:
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 to establish a reliable communication link.

Course Outcomes:
At the end of the course the student should be able to:
- Understand the design of digital communication systems.
- Understand the transmitter, receiver communications system models, voice source coding– pulse code modulation, delta modulation and vocoders.
- Understand the requirement of cellular communication.

Course Content:

Unit	Contents	Contact Hrs.
1.	Design of digital communication system, transmitter and receiver communications system model	6
2.	Voice source coding– pulse code modulation, delta modulation, vocoders	6
3.	Digital modulation – Amplitude-shift, Frequency-shift, Phase-shift, differential phase-shift, Quadrature phase-shift, Quadrature phase-shift, and Minimum-shift keying, Quadrature amplitude modulation	8
4.	Communications channel – Multipath effects, fading and diversity, models of Egli and Murphy	6
5.	Receivers – super heterodyne systems, balanced and unbalanced mixers, frequency synthesizers, Link budget analysis	5
6.	Introduction to cellular communication – CDMA, OFDM, MIMO, Introduction to digital modulation standards.	5
	Total	**36**

References / Suggested 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. "Digital Communication: Fundamentals and Applications", by Sklar, B., and Ray, P.K. Dorling Kindersley.
4. "Signal Processing for Wireless Communication Systems", by H. Vincent Poor, Lang Tong, Publisher: Springer.
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. Publisher: 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
Course Code : 24DTE034
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:
The course is intended to provide an understanding of flight dynamics, trajectory design analysis, flight performance analysis and practical implications of trajectory planning.

Course Outcomes:
At the end of the course the student should be able to:
- Understand the flight trajectories design requirements.
- Evaluate and predict the flight performance for different trajectories.
- Understand the practical implications while trajectory design.
- Carry out MATLAB based simulation for trajectory modelling.

Course Content:

Unit	Contents	Contact Hrs.
1.	Flight Dynamics, Flight envelope limitations. Aerodynamic sizingequations of motion. Accuracy of simplified equations of motion, orbital mechanics.	6
2.	Role of rocket propulsion in orbital trajectories and maneuvers, Maximizing missile flight performance. Benefits of flight trajectory shaping.	7
3.	Flight performance prediction of boost, climb, cruise, coast, steady descent, ballistic, maneuvering, divert, and homing flight.	7
4.	Practical implementation of integrated trajectory planning, Agility in maneuvering trajectories.	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.	5
6.	Extensive MATLAB-based mini-projects.	6
	Total	**36**

References / Suggested Books:
1. “Flight Dynamics”, by Robert F. Stengel. Publisher: Princeton University Press.
2. Literature / books suggested by respective course Lecturers.

****

Course Title : Sensor Technology
Course Code : 24DTE035
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

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

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

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

Course Content:

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

References / Suggested Books:

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

****

Course Title : Sensors for Armoured Vehicles
Course Code : 24DTE036
Teaching Scheme : L: 3, T: 0, P: 0, J: 0 Credits: 3

Course Objectives:

This course introduces sensor principles and technologies used in imaging, missile, and communication systems. It enables analysis and integration of sensor-based applications for targeting, navigation, and threat detection. Students apply fusion and signal processing techniques to design smart sensing systems for modern combat platforms.

Course Outcomes:

CO1 Apply the working principles of IR, laser, and LIDAR systems **to illustrate their roles in navigation, targeting, and threat sensing in combat vehicles**

CO2 Analyze IR imaging, directed energy systems, and sensor fusion **to interpret their effectiveness in complex battlefield scenarios**

CO3 Apply signal processing and calibration techniques for IR and laser sensors **to demonstrate improvements in real-time performance and reliability**

CO4 Evaluate targeting and guidance sensors in missile and loitering systems **to assess their role in accurate tracking and threat discrimination**

CO5 Create an integrated communication-sensor architecture for armored vehicles **to develop adaptive and secure battlefield connectivity solutions**

S.No.	Topic Description	Hrs
	Sensors: IR Image and Laser	
1	**Principles and Technologies of IR and Laser Sensors** Fundamentals of Infrared (IR) Technology: Basics of IR radiation-wavelength ranges-IR applications. Introduction to Laser Technology: Laser principles-types, and their relevance to combat vehicle engineering. Working Principles of IR Cameras: Thermal imaging-cooled vs. uncooled sensors. Laser Rangefinders and Designators: Working principles and applications in combat scenarios. LIDAR for Combat Vehicles: Principles, data interpretation, and battlefield navigation.	5
2	**Applications and Advanced Techniques in IR and Laser Systems** Applications of IR Imaging in Combat Vehicles: Night vision, target acquisition, and threat detection. Advanced IR Imaging Techniques: Multi-spectral and hyperspectral imaging. Laser-based Directed Energy Systems: Emerging technologies in defence. Sensor Fusion Techniques: Combining IR and laser sensor data for enhanced situational awareness. Challenges in Combat Environments: Handling noise, clutter, and environmental effects.	6
3	**Integration, Trends, and Future Directions** Signal Processing in IR and Laser Systems: Algorithms and techniques for improving accuracy and reliability. Advances in IR and Laser Sensor Technology: Miniaturization, power efficiency, and AI integration. Testing and Calibration of Sensors: Techniques and standards. Case Studies: Real-world applications and performance in modern combat vehicles. Future Trends: Integration with autonomous systems and robotics.	4
4	**Principles and Technologies of Missile and Loiter Munition Sensors** Fundamentals of Missile Sensor Systems: IR, radar, and acoustic sensors. Loiter Munition Sensor Technologies: Electro-optical (EO), IR, and advanced imaging systems. Navigation	**5**

	Sensors: INS and GPS integration for precise targeting. Principles of Sensor Target Lock and Guidance: Data acquisition and processing. Identification, Friend or Foe (IFF).	
5	**Applications and Operational Techniques** Role of Sensors in Missile Guidance and Control: Homing, semi-active, and active systems. Target Detection and Tracking: Real-time processing and identification techniques. Loiter Munition Surveillance Capabilities: Persistent monitoring and target confirmation. Advanced Sensor Fusion Techniques: Integration of multiple sensor modalities for enhanced decision-making. Environmental and Countermeasure Challenges: Adverse conditions and sensor decoy handling.	**6**
6	**Integration, Trends, and Future Directions** Sensor Signal Processing: Algorithms for trajectory correction and precision targeting. Innovations in Smart Sensors: AI and machine learning in missile and loiter munition systems. Case Studies: Sensor applications in modern missile systems (e.g., Javelin, Stunner). Future Trends: Miniaturization, networked sensors, and autonomous targeting systems. Battlefield Situational Awareness	**4**
7	**Principles and Technologies of Communication Sensors (5 Hours)** Fundamentals of Communication in Combat Vehicles: RF, microwave, and optical communication, signal strength, and frequency modulation. Communication Interception Sensors: Signal jamming and eavesdropping detection. Secure Communication Techniques: Data encryption and frequency hopping. Introduction to the current equipment in use.	**5**
8	**Applications and Tactical Use of Communication Sensors** Battlefield Communication Networks: Role of sensors in vehicular interconnectivity. Long-Range Communication Sensors: Satellite, HF, and microwave systems. Communication in Electronic Warfare: Signal interception and countermeasure technologies. Real-Time Data Sharing: Use of sensors for improving situational awareness. Data cum Voice network.	**6**
9	**Integration, Trends, and Future Directions** Advanced Communication Protocols: 5G and beyond in combat vehicles. Sensor Signal Integrity: Overcoming noise and interference challenges. Innovations in Communication Sensors: Low power, compact designs with extended range. Case Studies: Modern battlefield communication systems (e.g., SDR in combat networks). Future Trends: AI-powered adaptive communication and self-healing networks. SDR with Voice, Data and Video communication. SatCom and NAVIC positioning.	**4**
	Total Hrs	**45**

References / Suggested Books:

1. Holst, Gerald C., Electro-Optical Imaging: System Performance and Modeling, SPIE Press, Bellingham (2006).
2. Rogalski, Antoni., Infrared Detectors, CRC Press, Boca Raton (2010).
3. Griffiths, Hugh., An Introduction to Passive Radar, Artech House, Boston (2019).
4. Barton, David K., Radar Systems Analysis and Design Using MATLAB, Artech House, Boston (2005).
5. Skolnik, Merrill I., Introduction to Radar Systems, McGraw-Hill, New York (2001).
6. Svelto, Orazio., Principles of Lasers, Springer, Berlin (2010).

7. Blasch, Erik., “Sensor Fusion for Target Tracking,” Modern Defense Technology, Springer, Berlin (2015): pp. 150–175.
8. Mahafza, Bassem R., Radar Systems Analysis and Design Fundamentals, CRC Press, Boca Raton (2016).
9. Genat, Jean-Pierre., “Advances in IR Imaging for Defense,” Journal of Military Science, Vol. 12, No. 2 (2018): pp. 45–68.
10. Nichols, Randall K., Electronic Warfare and Radar Systems Engineering Handbook, SciTech Publishing, Raleigh (2017).

****