AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

M. Tech in DEFENCE TECHNOLOGY

CURRICULAM & SYLLABI

(2025)

MTech - Defence Technology

Program Outcomes (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Program Specific Outcomes (PSOs)

PSO1: Acquire the necessary theoretical & experimental knowledge, skill and aptitude in defence technologies and systems, to be able to work in the related industry sectors

PSO2: Be acquainted with the needs of technologies related to defence & security of the nation and gain the skill and aptitude for taking up developmental work in the related domains.

CURRICULUM

Program Structure

It is a 4-semester program with total 70 credits. It is having 2 specializations, as regard to the specializations (**Aerospace Technology & Communication Systems and Sensors**), semester -1 will have common curriculum for both the specialization and semester 2 will be varied as per the specialization. Semester 3 & 4 includes dissertation and industrial training. The M.Tech. in Defence Technology will be having following specializations:

S. No.	Specialization
1.	Aerospace Technology (AT)
2.	Communication Systems & Sensors (CSS)

- Semester-1 courses will be same for all specializations.
- Semester-2 courses will be as per the selected specialization.

Syllabi

T : Tutorial; L : Lecture; P : Practical

Curriculum 2025: M Tech in Defence Technology

Semester 1 (Common for AT and CSS)

Course Code	Compulsory Courses	Periods/Week			Total Credits
		L	T	P	
25DT601	Systems and warfare Platforms	4	0	0	4
25DT602	Warfare Simulations & Strategies	3	0	0	3
25DT603	Advanced Engineering Mathematics	4	0	0	4
25DT681	Modelling and Simulation Lab	0	0	3	1
25DT682	Warfare Simulations & Strategies Lab	0	0	3	1
	Elective 1	3	0	0	3
	Elective 2	3	0	0	3
25AVP501	Mastery Over Mind	1	0	2	2
22ADM501	Glimpses of Indian Culture				P/F
23HU601	Career Competency – I	0	0	3	P/F
	Total credits				**21**

P= Pass F = Fail

Semester 1 Elective Courses (Electives 1 & 2)

Couse Code	Elective		Periods/Week		Total Credits
		L	T	P	
25DT631	Advanced Thermal Engineering	3	0	0	3
25DT632	Advanced Solid Mechanics	3	0	0	3
25DT633	Flight Stability and Control	3	0	0	3
25DT634	Rockets & Missiles Fundamentals	3	0	0	3
25DT635	Optimization Theory & Applications	3	0	0	3
25DT636	Advanced Gas Dynamics	3	0	0	3
25DT637	Advanced Fluid Dynamics	3	0	0	3
25DT638	Advanced Communication Technologies	3	0	0	3
25DT639	Military Electronics System Engineering	3	0	0	3

Semester 2

1. Aerospace Technology

Course Code	Compulsory Courses	Periods/Week			Total Credits
		L	T	P	
25DT611	Aerospace System Configuration, Design & Simulation	4	0	0	4
25DT612	Guidance, Navigation and control	4	0	0	4
25DT613	Aerospace Propulsion	4	0	0	4
25DT683	Computational Lab	0	0	3	1
25DT684	Guidance & Control Lab (Common Lab for AT & CSS)	0	0	3	1
	Elective 3	3	0	0	3
	Elective 4//MOOC*	3	0	0	3
25DT698	Seminar	0	0	1	1
23HU611	Career Competency – II	0	0	3	1
25RM607	Research Methodology	2	0	0	2
Total credits					**24**

***** Subject to approval of Chairperson

Elective Courses (3 & 4) offered in Semester 2 (Aerospace Technology)

Course Code	Elective Courses	Periods/Week			Total Credits
		L	T	P	
25DT641	Advanced Lightweight and Composite Structures	3	0	0	3
25DT642	Finite Element Methods for Defence Structures	3	0	0	3
25DT643	Launch Vehicle Design & Analysis	3	0	0	3
25DT644	Combustion	2	1	0	3
25DT645	Computational Fluid Dynamics for Defence Applications	3	0	0	3
25DT646	Structural Dynamics and Aero-elasticity	3	0	0	3
25DT647	Turbomachinery	2	1	0	3
25DT648	Unmanned Aerial Systems (Common Elective for AT & CSS)	2	0	2	3

2. Communication Systems & Sensors

Course Code	Compulsory Courses	Periods/Week			Total Credits
		L	T	P	
25DT614	Embedded System Design and Control	4	0	0	4
25DT615	Modern Radar Systems	4	0	0	4
25DT616	Avionics and Communication	4	0	0	4
25DT685	Defence Avionics Lab	0	0	3	1
25DT684	Guidance & control Lab (Common Lab for AT & CSS)	0	0	3	1
	Elective 3	3	0	0	3
	Elective 4//MOOC*	3	0	0	3
25DT698	Seminar	0	0	1	1
23HU611	Career Competency – II	0	0	3	1
25RM607	Research Methodology	2	0	0	2
Total credits					**24**

***** Subject to approval of Chairperson

Elective Courses (3 & 4) offered in Semester 2 (Communication Systems and Sensors)

Course Code	Elective Courses	Periods/Week			Total Credits
		L	T	P	
25DT651	Digital and Satellite Communication and Navigation from Space	3	0	0	3
25DT652	Tactical Battle Field Communication and Electronic Warfare	3	0	0	3
25DT653	Software Defined Radio	3	0	0	3
25DT654	EMI/EMC in Military Systems	3	0	0	3
25DT655	Sensor Technology	3	0	0	3
25DT656	Fundamentals of Telemetry, Tele Command and Transponder	3	0	0	3
25DT657	Autonomous Navigation Technology	3	0	0	3

25DT658	Defence Electro Optics	3	0	0	3
25DT648	Unmanned Aerial Systems (Common Elective for AT & CSS)	3	0	0	3

Semester – 3

	Course	**Credit**
25DT798	Project Dissertation- Phase 1	11
	Total credits	11

Semester – 4

	Course	**Credit**
25DT799	Project Dissertation Phase-2	14
	Total credits	14

Syllabus

Semester -1 – Aerospace Technologies (Core Courses)

Course Title : Systems and warfare Platforms
Course Code : 25DT601
Teaching Scheme : L: 4, T: 0, P:0 Credits: 4

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Types of platforms: land, sea, air; Lifecycle: concept, design, pre-production, production, operations, discussion of appropriate case study	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, payload.	10
4.	Military vehicle fundamentals: tracked, wheeled, A, B and C vehicles.	8
5.	Weapon systems: guns, ordnance, missiles, rockets, bombs, air-launched weapons, anti-aircraft, anti-personnel, anti-ship, anti-submarine.	6
6.	Self defence and Protection systems: Armour, smoke, chaff, decoys; Application of AI in self protection systems.	6
Total		50

References / Suggested Books:

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

Course Title : Warfare Simulations & Strategies
Course Code : 25DT602
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

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

Course Outcomes: At the end of the course the student should be able to:
- Understand the systems used in warfare scenario.
- Understand combat simulation & modelling
- Understand the war gaming simulation & modelling and human factor representation.

Course Content

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

References / Suggested Books:

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

Course Title : Advanced Engineering Mathematics
Course Code : 25DT603
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

Course Objectives

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

Course Outcomes

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to Probability and Statistics. Basic Probability theory, statistical distributions, binomial, Poisson, exponential and normal distributions.	10
2.	Introduction to Linear Algebra: Vector space, subspace, row, column and null spaces. Inner product, orthogonality. Gram-Schmidt process and least square approximation.	10
3.	Differential Equations: Ordinary Differential equations (second order), Numerical methods for ODE. PDE, Fourier series, Fourier transform and one-dimensional heat and wave equations.	10
4.	Special functions: Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.	8
5.	Introduction to graph theory: Graphs, degree, types of graphs, and introduction to Ramsey theory.	7
6.	Application areas with defence relevance range from mathematics to computer science.	5
Total		50

References / Suggested Books:

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

5. Advanced Engineering Mathematics, Wylie and Barrett, 6th Edition, McGraw Hall India, 2015.

Course Title : Modelling and Simulation Lab
Course Code : 25DT681
Teaching Scheme : L: 0, T:0, P:3 Credits: 1

Course Objectives
The main objective of the course is to provide knowledge to the students about mathematical modelling and simulation of dynamic systems.

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

- Understand significance of the mathematical modelling of the dynamic systems.
- Learn how to model the dynamic systems in MATLAB/SIMULINK
- Perform numerical simulations of dynamic system using MATLAB/SIMULINK.

Course Content:

Introduction to mathematical modelling – modelling of simple systems such as spring mass damper, pendulum, DC motor, etc. Introduction to MATLAB/SIMULINK.

Experiments/Hands on sessions:
1. Modeling and simulation of spring mass damper system.
2. Modeling and simulation of double pendulum.
3. Modeling simulation inverted pendulum on a moving cart.
4. Modeling and simulation of DC motor with speed controller and power source.
5. Control of inverted pendulum.

Open lab:
Students may choose the real life dynamic systems relevant to defense technology and perform modeling and simulation part of open Lab

References / Suggested Books:
1. “MATLAB for Engineering Applications”, by William Palm. Publisher : McGraw-Hill Education; 4th edition (February 6, 2018).
2. Literature / books suggested by respective course Lecturers.

Course title : Warfare simulations & Strategies lab
Course Code : 25DT682
Teaching Scheme : L: 0, T: 0, P: 3 Credits: 1

- Routines to generate Operational Lethality Index of any non-mobile weapon using T.N. Dupuy's Model described in the book Numbers, Prediction and War.
- Write routines to generate Operational Lethality Index of any mobile weapon using T.N. Dupuy's Model described in the book Numbers, Prediction and War.
- Development of simple petri net simulation using HPSim for simulating 3 or 4 different war scenarios between 3 weapon systems on BLUE SIDE and 2 weapon systems on RED SIDE. Using the results of the simulations generate Killer Victim matrices in all scenarios.
- Static analysis of emerging warfare.
- Using the **Net Assessment concepts**, carry out the impact of Pakistan's tactical nuclear weapons in the evolution of India-Pakistan nuclear balance in next 10-15 years.
- Implementation of basic **Adaptive Dynamic Model** of combat with ground lethality components

Course Title : Career Competency -I
Course Code : 23HU601
Teaching Scheme : L: 0, T: 0, P:3 Credits: (P/F)

Pre-requisite
An open mind and the urge for self-development, basic English language skills and knowledge of high school level arithmetic.

Course Objectives

- Help students transit from campus to corporate and enhance their soft skills
- Enable students to understand the importance of goal setting and time management skills
- Support them in developing their problem solving and reasoning skills
- Inspire students to enhance their diction, grammar and verbal reasoning skills

Course Outcomes

- **Soft Skills** - To develop positive mindset, communicate professionally, manage time effectively and set personal goals and achieve them.
- **Soft Skills** - To make formal and informal presentations with self-confidence.
- **Aptitude -** To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.
- **Aptitude** - To analyze, understand and apply suitable techniques to solve questions on logical reasoning and data analysis.
- **Verbal** - To infer the meaning of words and use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.
- **Verbal** - To identify the relationship between words using reasoning skills. To understand and analyze arguments and use inductive/deductive reasoning to arrive at conclusions and communicate ideas/perspectives convincingly.

Syllabus
Soft Skills
Introduction to ‘campus to corporate transition’: Communication and listening skills: communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication.
Assertiveness skills: the concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness.

Self-perception and self-confidence: locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence.
Goal setting: the concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals
Time management: the value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time management
Presentation skills: the process of presentation, adult learning principles, preparation and planning, practice, delivery, effective use of voice and body language, effective use of audio visual aids, dos and don'ts of effective presentation
Public speaking-an art, language fluency, the domain expertise (Business GK, Current affairs), self-confidence, the audience, learning principles, body language, energy level and conviction, student presentations in teams of five with debriefing

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misspelt words, commonly confused words and wrong form of words in English.
Grammar: Train students to understand the nuances of English Grammar and thereby enable them to spot grammatical errors and punctuation errors in sentences.
Reasoning: Stress the importance of understanding the relationship between words through analogy questions and learn logical reasoning through syllogism questions. Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.
Oral Communication Skills: Aid students in using the gift of the gab to improve their debating skills.
Writing Skills: Introduce formal written communication and keep the students informed about the etiquettes of email writing. Make students practise writing emails especially composing job application emails.

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.
Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.
Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.
Averages: Basics, and Weighted Average.
Time and Work: Basics, Pipes & Cistern, and Work Equivalence.
Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.
Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.
Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.
Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.
Logarithms, Inequalities and Modulus: Basics

References

Soft Skills

Communication and listening skills:

- Andrew J DuRbin, “Applied Psychology: Individual and organizational effectiveness”, Pearson- Merril Prentice Hall, 2004
- Michael G Aamodt, “An Applied Approach, 6th edition”, Wadsworth Cengage Learning, 2010
- Assertiveness skills:
- Robert Bolton, Dorothy Grover Bolton, “People Style at Work..and Beyond: Making Bad Relationships Good and Good”, Ridge Associates Inc., 2009
- John Hayes “Interpersonal skills at work”, Routledge, 2003
- Nord, W. R., Brief, A. P., Atieh, J. M., & Doherty, E. M., “Meanings of occupational work: A collection of essays (pp. 21- 64)”, Lexington, MA: Lexington Books, 1990
- Self-perception and self-confidence:
- Mark J Martinko, “Attribution theory: an organizational perspective”, St. Lucie, 1995
- Miles Hewstone, “Attribution Theory: Social and Functional Extensions”, Blackwell, 1983
- Time Management:
- Stephen Covey, “The habits of highly effective people”, Free press Revised edition, 2004
- Kenneth H Blanchard, “The 25 Best Time Management Tools & Techniques: How to Get More Done Without Driving Yourself Crazy” , Peak Performance Press, 1st edition 2005
- Kenneth H. Blanchard and Spencer Johnson, “The One Minute Manager” , William Morrow, 1984

Verbal

- Erica Meltzer, “The Ultimate Guide to SAT Grammar”
- Green, Sharon, and Ira K. Wolf, “Barron's New GRE”, Barron's Educational Series, 2011
- Jeff Kolby, Scott Thornburg & Kathleen Pierce, “Nova’s GRE Prep Course”
- Kaplan, “Kaplan New GRE Premier”, 2011-2012
- Kaplan’s GRE Comprehensive Programme
- Lewis Norman, “Word Power Made Easy”, Goyal Publishers, Reprint edition, 1 June 2011
- Manhattan Prep, “GRE Verbal Strategies Effective Strategies Practice from 99th Percentile Instructors”
- Pearson- “A Complete Manual for CAT”, 2013
- R.S. Aggarwal, “A Modern Approach to Verbal Reasoning”
- S. Upendran, “Know Your English”, Universities Press (India) Limited, 2015
- Sharon Weiner Green, Ira K. Wolf, “Barron's New GRE, 19th edition (Barron's GRE)”, 2019
- Wren & Martin, “English Grammar & Composition”
- www.bbc.co.uk/learningenglish
- www.cambridgeenglish.org
- www.englishforeveryone.org
- www.merriam-webster.com

Aptitude

- Arun Sharma, “How to Prepare for Quantitative Aptitude for the CAT Common Admission Test”, Tata Mc Graw Hills, 5th Edition, 2012
- Arun Sharma, “How to Prepare for Logical Reasoning for the CAT Common Admission Test”, Tata Mc Graw Hills, 2nd Edition, 2014
- Arun Sharma, “How to Prepare for Data Interpretation for the CAT Common Admission Test”, Tata Mc Graw Hills, 3rd Edition, 2015
- R.S. Aggarwal, “Quantitative Aptitude for Competitive Examinations”, S. Chand Publishing, 2015
- R.S. Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S. Chand Publishing, Revised -2015
- Sarvesh Verma, “Quantitative Aptitude-Quantum CAT” , Arihant Publications, 2016
- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

Semester 1 - Elective Courses (Electives 1 &2)

Course Title : Advanced Thermal Engineering
Course Code : 25DT631
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	System thermal design & Analysis, Tools for thermal design and simulation, Heat transfer analysis (conduction, convection & radiation),	10
2.	Computation fluid dynamics (CFD), Thermal Finite Element Analysis	10
3.	Heat Exchangers for: Heat Exchanger Network Design	8
4.	Refrigeration, Humidifiers, Air Washers and Cooling Towers	6
5.	Thermal management design of defence system (combat vehicles, missiles, aerial vehicles etc.)	6
6.	Thermal testing, thermal operation, and integration of thermal design into the defence systems.	5
Total		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.
7. Literature / books suggested by respective course Lecturers.

Course Title : Advanced Solid Mechanics

Course Code : 25DT632
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Analysis of Stresses and Strains in rectangular and polar coordinates: Cauchy's formula, Principal stresses and principal strains, Stress-strain relationship for isotropic, orthotropic and anisotropic materials- 3D Mohr's Circle, Octahedral Stresses, Hydrostatic and deviatoric stress.	8
2.	Euler – Bernoulli and Timoshenko beam theories, bi-directional bending ,Unsymmetrical Bending, Bending of curved Beams,	8
3.	Torsion of solid circular bar, Torsion of non-circular shafts, Prandtl stress function, St. Venant warping function, Shear Center- torsion in narrow rectangular section - Theories of Failures	8
4.	Elastic stability - Euler's buckling load, beam column, eigenvalue problem	8
5.	General symmetric sections, and thin-walled sections, flexural shear flows (FSF), FSF in thin-walled open sections, shear center in open sections.	7
6.	Torsional shear flows (TSF) in thin-walled open sections, TSF in thin-walled closed sections (single and multiple cells) and warping in open and closed thin-walled sections,	6
Total		45

References / Suggested Books:

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

Course Title : Flight Stability and Control
Course Code : 25DT633
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

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

Course Outcomes

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

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

Course Content

Unit	Contents	Contact Hrs.
1.	Review of Static stability and Introduction to Dynamic Stability, Review: Body Axis, Stability Axis, Earth Axis – Euler Angles – Transformation between axis	7
2.	Aircraft Equations of Motion- Aircraft Trim: Steady level flight - Coupled and decoupled trim analysis, and Steady level turn,	9
3.	Small Perturbation Theory: Linear Equations of Motion, Stability Derivatives, Longitudinal and Lateral Modes – Concept and Physics – Characteristic Equation	9
4.	State Space Modelling – Response analysis - Transfer Function Approach	7
5.	Flying and Handling Qualities	5
6.	Autopilots – Stability Augmentation System (SAS). Longitudinal Stability Augmentation, Lateral Stability Augmentation – Autopilot Design. Active Control Technology(ACT)	8
	Total	45

References / Suggested Books:

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

Course Title : Rockets & Missiles Fundamentals
Course Code : 25DT634
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Fundamentals of Rocket Propulsion, Types of Rockets, Mult staging	6
2.	Basics of Missile Physics, Classification of Missiles, Missile Aerodynamic Configurations, Introduction to Missile System, Interrelationship between various Missile Sub-Systems.	8
3.	Basic Characteristics of Guided Missile Systems, Missile System Reliability, Range dispersion and CEP Concept,	8
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.	7
Total		45

References / Suggested Books:

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

Course Title : Optimization theory & applications
Course Code : 25DT635
Teaching Scheme : L: 3, T:0 , P: 0 Credits: 3

Course Objectives

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

Course Outcomes

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to optimization, classical optimization techniques.	8
2.	Linear programming & non linear programming and dimensional minimization methods.	9
3.	Non coordination optimization techniques, coordinated optimization techniques, coordinated programming.	9
4.	Dynamic programming, integer programming, stochastic programming.	7
5.	Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques.	6
6.	Additional Topics: multi-objective, optimization, game theory, optical control theory.	6
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. MOSSIAM Series on Optimization”,by Amir Becker.
5. “Dynamic Programming and Optimal Control (VolumeI) “ by Dimitri P. Bertsekas. Publisher :Athena Scientic, 2005.

6. “Optimization Theory and Applications”, by SS Rao.

Course Title : Advanced Gas Dynamics
Course Code : 25DT636
Teaching Scheme: L: 3, T:0, P: 0 Credits: 3

Course Objectives:

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Overview of one-dimensional models for normal shock, Fanno flow and Rayleigh flow. Oblique shocks and expansion waves	9
2.	Analysis of detached shocks and their impact on the flow field, applications of detached shock analysis; Shock-shock interaction and shock-boundary layer interaction, shock-induced separation.	7
3.	Shock-expansion methods for airfoils; design and functioning of supersonic wind tunnel; Incomplete expansion, shock structures in under-expanded and over-expanded jets	6
4.	Axisymmetric nozzle design using method of characteristics; Heat transfer in high speed flows, Introduction to methods of analysis in conduction, convection and radiation applied to high speed flow	8
5.	Shock-induced heating, thermal shielding; Introduction to hypersonic aerodynamics, equilibrium and non-equilibrium flows,	8
6.	Variation of transport properties of gases, Viscous interactions, aerothermodynamics of hypersonic re-entry vehicles	7
Total		45

References / Suggested Books

1. JD Anderson, “Modern Compressible Flow with Historical Perspective”, McGraw Hill, 2012.
2. John J Bertin “Hypersonic Aerothermodynamics”, AIAA Education Series, 1994.

3. John David Anderson, “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series, AIAA 2006

Course Title : Advanced Fluid Dynamics
Course Code : 25DT637
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

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

Course Outcomes

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

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

Course Content

Unit	Contents	Contact Hrs.
1.	Fluid Mechanics: Continuum Hypothesis, Transport Phenomenon, Perfect gas, static equilibrium of compressible medium	7
2.	Cartesian tensor: Rules & operators, operations, Second order tensor and its representations	7
3.	Reynolds Transport Theorem, Conservation Laws: Mass, Momentum and Energy, Some exact solutions of Navier-Stokes Equation-Steady Flows	10
4.	Potential Flows: Incompressible and Compressible Flows	6
5.	Boundary layer Theory: Laminar Boundary layer and Turbulent Boundary layer	6
6.	Introduction to Turbulence flows: Instabilities, RANS Equations and closure problem	9
	Total	45

References / Suggested Books:

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

Course Title : Advanced Communication Technologies
Course Code : 25DT638
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Elements of a communications system and their relationship to system performance. Review of Microwave Communications - Overview of satellite communications.	9
2.	Communications system components and functions, analog and digital communications systems, Satellite subsystems – AOCS - TTC&M - Power and communication subsystems - Computations and controlling by processors.	10
3.	Modulation transmission and reception; baseband and passband digital modulation; - Satellite multiple access schemes – FDMA - TDMA and CDMA - Spread spectrum concepts	10
4.	Comparison of multiple access schemes. - System, noise FEC techniques for mitigating channel errors.	8
5.	Propagation effects on signal transmission; end-to-end path calculations for RF systems including terrestrial ground links and satellite communications.	8
Total		45

References / Suggested Books:

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

Course Title : Military Electronics System Engineering
Course Code : 25DT639
Teaching Scheme : L: 3, T:0 , P: 0 Credits: 3

Course Objectives

The main objective of the course is to provide knowledge to the students about the learning of the electronics systems requirement for military environment, generation of system requirements, limitations of COTS equipment and radiation effects on the electronic systems.

Course Outcome

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

- Understand the 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 system

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.	7
4.	Digital simulation models, including those in current used in defence for determining engineering and performance trade-offs.	9
5.	Limitations of commercial-off-the-shelf (COTS) integrated circuits, thermal failure, electrostatic breakdown, noise in solid state devices, packaging reliability issues.	9
6.	Radiation effects due to space and nuclear environments, and the limited availability of military integrated circuit suppliers.	6
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.

Semester 2 - Core Courses (Aerospace Technology)

Course Title : Aerospace System Configuration, Design and Simulation
Course Code : 25DT611
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction (aero-elastic phenomena and design requirements), Introduction to missiles & systems, Design process.	8
2.	Structural requirement, Structural and aerodynamic stiffness, Static aero-elasticity: torsional divergence, Structural vibration and modal analysis.	8
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).	9
4.	Aircraft performance (cruising, climb, descent, takeoff, landing, maneuver, flight path).	8
5.	System’s stability & control, aerodynamics control, Introduction to dynamic stability, first and second order responses, Equations of motion and modal characteristics.	9
6.	Introduction to air to air, ground to air, air to ground weapon systems, UAV mounted GW and UCAVs.	8
Total		50

References / Suggested Books:

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

Course Title : Guidance, Navigation and Control
Course Code : 25DT612
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

Course Objectives

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

Course Outcome:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to Navigation, Navigation Mathematics.	8
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.	8
4.	Missile Control Methods: Aerodynamic and Thrust Vector Control, Polar and Cartesian Control.	8
5.	Mathematical Modeling of Missile Dynamics; Missile Actuators and Sensors. Roll and Roll Rate Stabilization.	9
6.	Design and Analysis of Lateral Autopilots, 6 DOF simulation for aircraft/missile using MATLAB, Application of Machine Learning in Control System.	8
Total		50

References / Suggested Books:

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

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

Course Title : Aerospace Propulsion
Course Code : 25DT613
Teaching Scheme : L: 4, T:0, P:0 Credits: 4

Course Objectives

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

Course Outcomes

At the end of the course the student will have:

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

Course Content

Unit	Contents	Contact Hrs.
1.	Classification & mode of operation of various propulsion systems, basis thermodynamics & fluid Dynamics.	9
2.	Rocket motor design & analysis, Gas Turbine Engine design, GT engine efficiency, GT engine heat transfer & cooling.	10
3.	Aircraft performance, jet engine performance.	8
4.	Jet engine control (compressor performance, axial turbine performance, Fuel systems & pumps, airframe fuel systems, hydro-mechanical fuel metering, Electronics engine control)	9
5.	System integration	7
6.	Computational fluid dynamics (flow modelling strategies, physical modelling, finite difference equations, etc.)	7
Total		50

References / Suggested Books:

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

7. “Fundamentals of Machine Component Design”, by Robert C. Juvinall, Kurt M. Marshek. Publisher : John Wiley & Sons.
8. “Gas Turbines for Electric Power Generation”,by S. Can Gülen.
9. “Gas Turbine Theory “,by H.I.H. Saravanamuttoo , Prof G.F.C. Rogers , H. Co-hen. Publisher : Prentice Hall.
10. “Elements of Propulsion: Gas Turbines and Rockets” by Jack D. Mattingly, Keith Boyer. Publisher : American Institute of Aeronautics & Astronautics.
11. Literature / books suggested by respective course Lecturers.

Course title : Computational Lab
Course Code : 25DT683
Teaching Scheme : L: 0, T: 0, P: 3 Credits: 1

Numerical Fluid Simulations

Experiments:

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

Finite Element Simulations

Experiments:

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

Course Title : Guidance and Control Lab
Course Code : 25DT684
Teaching Scheme : L: 0, T:0, P:3 Credits: 1

Course Objectives

The main objective of the course is to provide knowledge to the students about design and development of guidance and control methods for linear and nonlinear dynamic systems.

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

- Analyse transient behaviour of the closed loop system.
- Analyse steady state behaviour of the closed loop system.
- Simulation of PN guidance of missile.
- Design and tuning of PID controller

Experiments/Hands on sessions:

1. Analysis of transient and steady state behavior of various dynamic systems for various inputs.
2. Simulation of PN guidance of missile.
3. Design PID controller for different dynamic systems.
4. Design and development of PID controller inverted pendulum on a moving cart.
5. Design a position and speed controller for DC motor.
6. Design a controller for thrust vector system and validate the same.
7. Design an altitude controller for VTOL UAV.

Open lab:
Students may choose the real life dynamic systems relevant to defense technology and develop a guidance and controller system as a part of open Lab

References / Suggested Books:

3. Literature / books suggested by respective course Lecturers.

Course Title : Career Competency II
Course Code : 23HU611
Teaching Scheme : L: 0, T: 0, P:3 Credits: 1

Pre-requisite: Willingness to learn, team spirit, basic English language and communication skills and knowledge of high school level arithmetic.

Course Objectives

- Help students to understand the importance of interpersonal skills and team work
- Prepare the students for effective group discussions and interviews participation.
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively by using the correct diction, grammar and verbal reasoning skills

Course Outcomes

Soft Skills - To demonstrate good interpersonal skills, solve problems and effectively participate in group discussions.
Soft Skills - To write technical resume and perform effectively in interviews.
Aptitude - To identify, investigate and arrive at appropriate strategies to solve questions on arithmetic by managing time effectively.
Aptitude - To investigate, understand and use appropriate techniques to solve questions on logical reasoning and data analysis by managing time effectively.
Verbal - To be able to use diction that is more refined and appropriate and to be competent in knowledge of grammar to correct/improve sentences
Verbal - To be able to examine, interpret and investigate passages and to be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

Syllabus

Soft Skills

Interpersonal skill: ability to manage conflict, flexibility, empathetic listening, assertiveness, stress management, problem solving, understanding one's own interpersonal needs, role of effective team work in organizations

Group problem solving: the process, the challenges, the skills and knowledge required for the same.

Conflict management: the concept, its impact and importance in personal and professional lives, (activity to identify personal style of conflict management, developing insights that helps in future conflict management situations.)

Team building and working effectively in teams: the concept of groups (teams), different stages of group formation, process of team building, group dynamics, characteristics of

effective team, role of leadership in team effectiveness. (Exercise to demonstrate the process of emergence of leadership in a group, debrief and reflection), group discussions.

Interview skills: what is the purpose of a job interview, types of job interviews, how to prepare for an interview, dos and don'ts of interview, One on one mock interview sessions with each student.

Verbal

Vocabulary: Help students understand the usage of words in different contexts. Stress the importance of using refined language through idioms and phrasal verbs.

Grammar: Enable students to identify poorly constructed sentences or incorrect sentences and improvise or correct them.

Reasoning: Facilitate the student to tap her/his reasoning skills through critical reasoning questions and logical ordering of sentences.

Reading Comprehension: Enlighten students on the different strategies involved in tackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

Aptitude

Sequence and Series:

Basics, AP, GP, HP, and Special Series.

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem. Logical Reasoning I: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning. Logical Reasoning II: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

References

Soft Skills

Team Building

- Thomas L.Quick, ”Successful team building”, AMACOM Div American Mgmt Assn, 1992
- Brian Cole Miller, “Quick Team-Building Activities for Busy Managers: 50 Exercises That Get Results in Just 15 Minutes”, AMACOM; 1 edition, 2003.
- Patrick Lencioni, “The Five Dysfunctions of a Team: A Leadership Fable”, JosseyBass, 1st Edition, 2002

Verbal

- “GMAT Official Guide” by the Graduate Management Admission Council, 2019
- Arun Sharma, “How to Prepare for Verbal Ability And Reading Comprehension For CAT”
- Joern Meissner, “Turbocharge Your GMAT Sentence Correction Study Guide”, 2012
- Kaplan, “Kaplan GMAT 2012 & 13”
- Kaplan, “New GMAT Premier”, Kaplan Publishing, U.K., 2013
- Manhattan Prep, “Critical Reasoning 6th Edition GMAT”
- Manhattan Prep, “Sentence Correction 6th Edition GMAT”
- Mike Barrett “SAT Prep Black Book The Most Effective SAT Strategies Ever Published”
- Mike Bryon, “Verbal Reasoning Test Workbook Unbeatable Practice for Verbal Ability, English Usage and Interpretation and Judgement Tests”
- www.bristol.ac.uk/arts/skills/grammar/grammar_tutorial/page_55.htm
- www.campusgate.co.in

Aptitude

- Arun Sharma, “How to Prepare for Quantitative Aptitude for the CAT Common Admission Test”, Tata Mc Graw Hills, 5th Edition, 2012
- Arun Sharma, “How to Prepare for Logical Reasoning for the CAT Common Admission Test”, Tata Mc Graw Hills, 2nd Edition , 2014
- Arun Sharma, “How to Prepare for Data Interpretation for the CAT Common Admission Test”, Tata Mc Graw Hills, 3nd Edition , 2015
- R.S. Aggarwal, “Quantitative Aptitude For Competitive Examinations”, S. Chand Publishing, 2015
- R.S. Aggarwal, “A Modern Approach To Verbal & Non-Verbal Reasoning”, S. Chand Publishing , Revised -2015
- Sarvesh Verma, “Quantitative Aptitude-Quantum CAT” , Arihant Publications , 2016
- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

Course Title : Research Methodology
Course Code : 25RM607
Teaching Scheme : L: 2, T: 0, P:0 Credits: 2

Course Objectives

- To enable students to define research problems, review, analyse as well as to evaluate literature and possibly to formulate effective solutions.
- To prepare students either for a research thesis or for an industry-based project.
- To provide oral and written communication skills.
- To inculcate a strict adherence to the principles of research ethics and values

Course Outcomes

- Understand the basic concepts of research and its methodologies
- Understand and apply the process of searching for, selecting and critically analysing research articles and papers
- Formulate and evaluate research questions and apply the process of designing a research study and interpreting the outcomes of the study
- Write and present a research report and thesis.

Syllabus

Meaning of Research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research - Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.

Problem Formulation, Understanding Modeling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes.

Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results.

Preparation of Dissertation and Research Papers, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Tables and illustrations and Citation.

Intellectual property rights (IPR) – patents – copyrights - Trademarks - Ethics of Research, Scientific Misconduct - Forms of Scientific Misconduct – Plagiarism - Unscientific practices in thesis work.

References / Suggested Books:

1. Bordens, K. S. and Abbott, B. B., “Research Design and Methods – A Process Approach”, 11th Edition, McGraw-Hill, 2022.
2. Roy Sabo and Edward Boone, “Statistical Research Methods: A Guide for Non Statisticians”, Springer, 2013.
3. Davis, M., Davis K., and Dunagan M., “Scientific Papers and Presentations”, 3rd Edition,Elsevier Inc., 2013.
4. Ron Iphofen (Ed), “Handbook of Research Ethics and Scientific Integrity”, Springer, 2020.
5. Elsevier, “Ethics in Research & Publication”, https://www.elsevier.com/ data/assets/pdf_file/0008/653885/Ethics-in-research-and-publication-brochure.pdf

Semester 2 – Elective Courses 3 & 4 (Aerospace Technology)

Course Title : Advanced Lightweight and Composite Structures
Course Code : 25DT641
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Review of Strength of Materials, Introduction to Aerospace Materials – Metal Alloys and Fiber Reinforced Composite	8
2.	Introduction to different types of constructions: Monocoque, Semi-Monocoque, Truss, and Corrugated shell	8
3.	Introduction to Aircraft and Missile Structural Components: Spars; Ribs; Stringer; Longerons	8
4.	Analysis of stress; Analysis of strain	9
5.	Material Constitutive Relations	6
6.	Failure Theories; Fatigue theory	6
Total		45

References / Suggested Books:

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

Course Title : Finite Element Methods for Defence Structures
Course Code : 25DT642
Teaching Scheme : L: 3, T: 0, P:0 Credits: 3

Course Objectives:

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to Finite Element Analysis, Finite Element Formulation Techniques- Virtual Work and Variational Principle, Galerkin Method, Displacement Approach, Stiffness Matrix and Boundary Conditions.	7
2.	Introduction to different types of elements, formation of shape function for various elements, Coordinate systems, convergence criteria.	8
3.	Analysis of Frame Structures- Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis	9
4.	Formulation of Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity and Static Condensation Lecture	7
5.	Finite Element Formulation of Axisymmetric Element, 3 Dimensional Elements and Isoparametric Elements. Numerical Integration.	8
6.	Applications of FEM- Modelling and analysis of various defence related structures like plates, shells, cylindrical members and general by using FE software.	6
Total		45

References / Suggested Books:

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

Course Title : Launch Vehicle Design & Analysis
Course Code : 25DT643
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Unit	Contents	Contact Hrs.
1.	Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices.	8
2.	Performance analysis, operating characteristics and propellant selection criteria for air breathing and solid	7
3.	Liquid and nuclear rocket motor propulsion systems.	9
4.	Advanced cycles and concepts are presented. Design of components and subsystems	9
5.	FE modelling: Idealization, Discretization, Meshing and Post Processing,	7
6.	Tracking and controlling errors, Nonlinear analysis in FEM, Launch dynamic analysis.	5
Total		45

References / Suggested Books:

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

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

Course Title : Combustion
Course Code : 25DT644
Teaching Scheme : L: 2, T:1, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Thermodynamics of Combustion: First law analysis and limitations, Dissociation and equilibrium, Gibbs free energy; Chemical kinetics, Combustion waves, stirred reactors	8
2.	Premixed flames: flame velocity, analytical models and flammability limits; Diffusion flames: droplet combustion, analytical models for droplet combustion	7
3.	Aircraft combustors, geometry, combustor sizing; Injection, Ignition and flame stabilization, flame holding in high speed combustion systems; Combustion instabilities, active and passive control of instabilities	6
4.	Methods of combustor cooling; Combustion and flame stabilization in afterburners	8
5.	Combustion in rockets, Combustion of Solid propellants, liquid propellants and hybrid propellants, Types of instabilities in rocket combustion,	8
6.	Design study: Combustors for Aero Engine & Rocket engine; Combustion in advanced propulsion systems: Introduction to supersonic combustion, the challenges, methods for mixing enhancement and flame stabilization	8
Total		45

References / Suggested Books:

1. Stephen Turns, “An Introduction to Combustion: Concepts and Applications”, 2nd Edition, McGraw-Hill, 1999.
2. Eugene L. Keating , “Applied Combustion”, Second Edition, CRC Press, 2007.
3. Chung K. Law, “Combustion Physics”, Cambridge University Press, 2010.
4. Kenneth Kuan-yun Kuo, “Principles of Combustion”, 2nd Edition, Wiley, 2005

Course Title : Computational Fluid Dynamics for Defence Applications
Course Code : 25DT645
Teaching Scheme : L: 3, T:0, P:0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Unit	Contents	Contact Hrs.
1.	Introduction to fluid mechanics & heat transfer,	7
2.	Introduction to numerical analysis, Discretisation approaches: finite difference, and finite volume, Stability of numerical method.	8
3.	Numerical Method for Convection-Diffusion Problems: Central Differencing, Upwind Differencing, Power- Law Differencing, Quick and TVD Schemes with their Assessments	8
4.	Introduction to Spectral methods - Staggered and Collocated Grids – Introduction to Solution Algorithms: SIMPLE, SIMPLER, SIMPLEC and PISO Algorithms.	9
5.	Introduction to Grid Generation: Body Conforming Grids, Algebraic and Elliptic Grids, 2D Unstructured Grids	7
6.	CFD analysis of compressible & in-compressible flow, turbulence modelling,	6
Total		45

References / Suggested Books:

1. “A Textbook of Heat Transfer Paperback”, by S.P. Sukhatme. Publisher: Universities Press.
2. “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, by H. Versteeg. Publisher : Pearson.
3. “Computational Fluid Dynamics the Basics with Applications”, by John D. Anderson, Jr. Publisher : McGraw Hill Education.

4. “Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cambridge-iisc)”, by C.
5. S. Jog. Publisher : Cambridge University Press; 3rd edition.
6. “Numerical Modeling and Computer Simulation”, Edited by DraganCvetković, publisher intechopen.
7. Literature / books suggested by respective course Lecturers.

Course Title : Structural Dynamics and Aero-elasticity
Course Code : 25DT646
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Principles and methods of computational structural dynamics and vibration analysis.	8
2.	Introduction to dynamic analysis using the finite element method, Calculation of modal parameters.	8
3.	System dynamic response via mode superposition, frequency response, model reduction, and structural synthesis techniques, Fatigue analysis.	9
4.	Introduction to aero-elasticity, Aerodynamic Loading, Bending Moment, Sectional properties of Aerofoil, V-n Diagram,	8
5.	Basic theory of linear elastic fracture mechanics; strain energy release rate;	7
6.	Applications to delamination crack growth in polymer composite laminates, Damage tolerance issues in composites	5
Total		45

References / Suggested Books:

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

5. “Introduction to Structural Dynamics and Aeroelasticity”, by Dewey H. Hodges and G. Alvin Pierce. Publisher: Cambridge University Press.
6. Literature / books suggested by respective course Lecturers.

Course Title : Turbomachinery
Course Code : 25DT647
Teaching Scheme : L: 2, T:1, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction reviews about turbo machinery sub-system Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction.	7
2.	Dimensionless parameters for Turbomachines. Concept of specific speed, shape number, axial, radial, and mixed flow machines, and similarity laws.	7
3.	Axial flow compressors: Introduction; Aero-Thermodynamics of flow through an Axial flow Compressor stage; Losses in axial flow compressor stage; Losses and Blade performance estimation; Secondary flows (3-D); Tip leakage flow and scrubbing; Simple three-dimensional flow analysis; rotating stall and surging.	6
4.	Centrifugal Compressors: Introduction; Elements of centrifugal compressor/ fan; Inlet Duct Impeller; Slip factor; Concept of Rothalpy; Modified work done; Incidence and lag angles; Diffuser ; Centrifugal Compressor Characteristics; Surging; Chocking; Rotating stall; Design	8
5.	Axial flow turbines – Introduction; Turbine stage; Turbine Blade 2-D (cascade) analysis Work Done; Degree of Reaction; Losses and Efficiency; Flow Passage; Subsonic, transonic and supersonic turbines, Multi-staging of Turbine; Exit flow conditions	6
6.	Turbine Cooling; Turbine Blade design – Turbine Profiles : Airfoil Data and Profile construction. Radial flow turbines: Thermodynamics and Aerodynamics of radial turbines; Radial Turbine Characteristics; Losses and efficiency; Design of radial turbine.	6
7.	Aero-thermodynamics of Compressor-Turbine Systems; Aerodynamic and thermodynamic performance parameters; Optimization techniques for compressor-turbine matching.	5
Total		**45**

References / Suggested Books:

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

Course Title : Unmanned Aerial Systems
Course Code : 25DT648
Teaching Scheme : L:2 , T: 0, P:2 Credits: 3

Course Objectives:

- To impart fundamental knowledge of unmanned aerial systems (UAS), focusing on fixed wing, multirotor, flapping wing UAV, Simulation & control, Sensor systems.
- To enable students to model simulation & control setup from the flight dynamics principles and to carryout stability analysis and classic autopilot simulations.
- To impart the idea of autonomous aerial vehicles, levels of autonomy, sensor and methods.

Course Content:

Unit	Contents	Contact Hrs.
1.	UAV –Definition & nomenclature, classification of UAV, difference between fixed wing vs rotary wing vs hybrid configuration UAV, components- propellers, Batteries, BLDC, IC & jet engine, Flight controllers (Pixhawk) & Flight computers (Raspberry Pi)	9
2.	UAV equations of motion – coordinate systems, Euler angles, coordinate transforms, Kinematics and dynamics equations for Fixed wing UAV and multirotor UAV	9
3.	Control System Basics: Stability, transient response, PID, LQR & MPC control Design. Modelling and Simulation of UAV in MATLAB Simulink	9
4.	Classic Autopilot Simulation in MATLAB Simulink – altitude hold, position hold, trajectory tracking .	9
5.	Introduction to Autonomy, Levels of autonomy, UAV Sensors (camera, LIDAR, GPS), Sensor fusion, Sense & Avoid, SLAM, VSLAM. Swarm of UAV.	9
Total		45

References / Suggested Books:

1. Sadraey, Mohammad H. *Design of unmanned aerial systems*. John Wiley & Sons, 2020.
2. Valavanis, Kimon P., ed. "Advances in unmanned aerial vehicles: state of the art and the road to autonomy." (2008).
3. Quan, Quan, Xunhua Dai, and Shuai Wang. *Multicopter design and control practice: a series experiments based on MATLAB and Pixhawk*. Springer Nature, 2020.
4. Ogata, Katsuhiko. *Modern control engineering*. India: Prentice Hall, 2009.
5. Nelson, Robert C. *Flight stability and automatic control*. Vol. 2. New York: WCB/McGraw Hill, 1998.

Semester 2 - Core Courses (Communication Systems and Sensors)

Course Title : Embedded System Design and Control
Course Code : 25DT614
Teaching Scheme : L: 4, T: 0, P:0 Credits: 4

Course Objectives

- To impart fundamental knowledge of embedded systems, focusing on ARM Cortex microcontroller architecture, peripheral programming, and application development.

- To develop competency in programming TMS320F28335 Delfino DSP for real-time control, signal processing, and PWM-based applications.
- To enable students to design and implement sensor interfacing, real-time data acquisition, and DSP-based control strategies for power converters and electric drive applications.

Course Content

Unit	Contents	Contact Hrs.
1.	Introduction to embedded systems – Hardware & Software Components. Embedded system design process. Architecture of ARM Cortex Microcontroller – Peripherals – Ports, Timers, PWM, ADC, UART, SPI, I2C – Application development – Bare-metal Programming, Rapid Prototyping with libraries.	17
2.	Architecture of TMS320F28335 Delfino Digital Signal Processor – Code Composer Studio development environment – Embedded C programming of GPIO – Timers – Enhanced PWM (ePWM) – QEP – CAN – Implementation of sine PWM and space vector PWM.	17
3.	Interfacing analog and digital sensors – Real-time waveform acquisition and data display – Basic motor control using PWM – Real-time waveform sampling and PI-based closed-loop control – Speed and position control using QEP feedback - Pulse generation techniques for various power converters – DSP-based control for electric drive applications – Case studies from industrial automation, electric vehicles, or renewable energy systems.	16
Total		50

Reference/Suggested Books:

1. ARM Cortex Microcontroller Reference Manual.
2. TMS320F28335 Delfino Technical Reference Manual.
3. Raj Kamal, *"Microcontrollers: Architecture, Programming, Interfacing and System Design"*, 2nd Edition, Pearson Education, 2011.
4. Michael D. Tidwell, *"Digital Signal Processing and Applications with the TMS320F28335"*, 1st Edition, Wiley, 2009.
5. Carmine Noviello, "*Mastering STM32*", 1st Edition, Independently Published, 2017

6. B Venkataramani and M Bhaskar, “Digital Signal Processors: Architecture, Programming and Applications”, 2nd Edition Tata McGraw Hill, 2017.
7. Donald Norris, “*Programming with STM32: Getting Started with the Nucleo Board and C/C++*”, 1st Edition, McGraw-Hill Education, 2018.

Course Title : Modern Radar Systems
Course Code : 25DT615
Teaching Scheme : L: 4, T: 0, P:0 Credits: 4

Course Objectives

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

Course Outcomes

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction to RADAR, Radar parameters/definitions, radar equations.	8
2.	Radar Equation, Radar Cross section; CW Radar, FMCW Radar Pulsed Radar Principles, Clutter Analysis, MTI Improvement Factor, Pulsed Doppler Radar,	8
3.	Tracking Radar, Angular resolution, Monopulse Technique Detection Theory: Match Filtering, Radar Ambiguity Function; Imaging Radar: Resolution Concept, Pulse Compression, Synthetic Aperture Processing, ISAR Imaging	8
4.	Probability of False Alarm and Detection, Modified Radar Range Equation with Swirling Models, Ground Penetrating Radar for close sensing	9
5.	Radar Tomography and Radar based Microwave Imaging Emerging and Modern Applications of Radar Principles Radar cross section (RCS) & Theory of detection, Clutter. Atmospheric propagation, Surveillance and Tracking Radar	8
6.	Radar Designs .Materials for Radar System design, Various types of Aerospace Radar Components – specifications and applications, Radar elements Design, Radar Transmitter design, Radar antenna design, Duplexer/TR switch & Radar Receiver	9
Total		50

References / Suggested Books:

1. “Introduction to Radar Systems”,by M.I. Skolnik. Publisher: Tata Mcgraw hill edition, 2001.
2. “Radar Systems Analysis and Design using MATLAB”,by B.R.Mahafza. Publisher CRC Press, 2013.
3. “Monopulse Principles and Techniques”, by S.M.sherman and D.K.Barton. Publisher : Artech house, 2011
4. “Fundamentals of Radar Signal Processing”, by M.A.Richards. Publisher Tata Mcgraw hill.

5. “Ground Penetrating Radar: Theory and Applications”,by, Editor: H.M. Jolt. Publisher: Elsevier.
6. "Radar, Sonar And Navigation Engineering", by K. K Sharma. Publisher: S K Kataria& Sons.
7. Literature / books suggested by respective course Lecturers.

Course Title : Avionics and Communication
Course Code : 25DT616
Teaching Scheme : L: 4, T: 0, P:0 Credits: 4

Course Objectives:

Provide insight to the advanced principles of avionics systems used in aircrafts and UAVs

Unit	Content	Contact hours
1	**Introduction to Avionics**: Importance and role of avionics, Avionics system architecture, avionic environment – Air Data Systems: Air Data Information and its use, Air data laws, sensors and computations, Applications	10
2	**Communication systems:** Communications system components and function: Block diagram, Transmitter, Receiver, Modulation and demodulation, analog and digital communications systems Aircraft Communication systems: VHF, HF, UHF	10
3	**Navigation system**: Basic principles, Radio Navigation Aids: Instrument Landing System, Very High Frequency Omni Range, Automatic Direction Finder, Distance Measuring Equipment, Satellite Navigation: GPS, GNSS	10
4	**Inertial Navigation system**: Inertial Navigation and sensors - Gyro: principle of operation- Coriolis vibrating mass Gyro, Sagnac effect Gyro, Accelerometer: principle of operation- MEMS accelerometer, Barometric-altimeter, Magnetometer.	10
5	**Autopilots and flight management systems** Introduction to Autopilot, Flight management system, Importance of unmanned air vehicles, UAV avionics	10
Total		50

References / Suggested Books:

1. R.P.G Collinson, “Introduction to Avionics systems”, 4th edition, Springer, 2023.
2. Frenzel Louis, “Principles of Electronic Communication Systems”, 4th Edition, McGraw-Hill, 2015.
3. Kayton And Fried, “Avionics Navigation Systems”, 2nd edition, Wiley, 2009.
4. Dale R. Cundy, Rick S. Brown, “Introduction to Avionics”, Prentice Hall, 1997.

Course Title : Defence Avionics Lab.
Course Code : 25DT685
Teaching Scheme : L: 0, T:0, P: 3 Credits: 1

Course Objectives: To provide exposure on aerospace sensors and its control systems

Course Plan:

Objectives are achieved through:

1. Lab experiments

2. Mini Projects related to Control, Electronics, and Autopilot.

Experiments:

1. Validate time domain specifications of first-order systems.
2. Validate time domain specifications of second-order systems.
3. Design of PD controller for a given transfer function
4. Design of PI controller for a given transfer function
5. Design of Luenberger observer and Kalman filter
6. Acceleration measurement and position estimation.
7. Angular rate measurement and attitude measurement.
8. INS/GPS integration for position estimation
9. Stabilization of multicopter.

References / Suggested Books

1. Norman S. Nise, “Control Systems Engineering,” 6th edition, Wiley India, 2012.
2. R.P.G Collinson, “Introduction to Avionics”, Springer, 2002.
3. R. C. Nelson, “Flight Stability and Automatic Control,” 2nd Edition, McGraw Hill, 2017.
4. Ogata, K., “Modern Control Engineering,” 5th edition, Prentice Hall, 2010.
5. B. N. Pamidi, “Performance, Stability, Dynamics, and Control of Airplanes,” 3rd edition, American Institute of Aeronautics and Astronautics, 2015.

Course Title : Guidance and Control Lab
Course Code : 25DT684
Teaching Scheme : L: 0, T:0, P:3 Credits: 1

Course Objectives
The main objective of the course is to provide knowledge to the students about design and development of guidance and control methods for linear and nonlinear dynamic systems.

Course Outcome:

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

- Analyse transient behaviour of the closed loop system.
- Analyse steady state behaviour of the closed loop system.
- Simulation of PN guidance of missile.
- Design and tuning of PID controller

Experiments/Hands on sessions:

1. Analysis of transient and steady state behavior of various dynamic systems for various inputs.
2. Simulation of PN guidance of missile.
3. Design PID controller for different dynamic systems.
4. Design and development of PID controller inverted pendulum on a moving cart.
5. Design a position and speed controller for DC motor.
6. Design a controller for thrust vector system and validate the same.
7. Design an altitude controller for VTOL UAV.

Open lab:
Students may choose the real-life dynamic systems relevant to defence technology and develop a guidance and controller system as a part of open Lab

References / Suggested Books:

1. Literature / books suggested by respective course Lecturers.

Semester 2- Elective Courses 3 & 4 (Communication Systems and Sensors)

Course Title : Digital & Satellite Communication and Navigation from Space
Course Code : 25DT651
Teaching Scheme : L:3 , T: 0, P:0 Credits: 3

Course Objectives

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

Course Outcomes:

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

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

Course Content

Unit	Contents	Contact Hrs.
1.	Elements of a communications system and their relationship to system performance.	6
2.	Free space optical communication, Fiber optics communication, Wireless/cellular communications.	8
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,	8
4.	Modulation transmission and reception; baseband and passband digital modulation; system, noise, transmission lines, waveguides and antennas, FEC techniques for mitigating channel errors.	8
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.	8
6.	Navigation techniques from space regarding functioning of GPS, GLONASS, IRNSS &Galileo	7
Total		45

References / Suggested Books:

1. “Satellite communication”, by T. Pratt, C. W. Bostian, J. E.Allnut. Publisher: John Willey and sons
2. “Satellite Communications Systems: systems, techniques and technology”, by G. Maral, M. Bousquet, Z. Sun. Publisher:John Willy and sons

3. “Digital Communications: Fundamentals and Applications”, B. Sklar . Prentice-Hall, Inc.
4. “Understanding of GPS/GNSS: Principles and Applications”,by E. Kaplan and C. Hegarty. Publisher:
Artech House Publishers.
5. Literature / books suggested by respective course Lecturers.

Course Title **:Tactical Battlefield Communication & Electronic Warfare**
Course Code **:25DT652**
Teaching Scheme **:L: 3, T:0, P: 0** **Credits: 3**

Course Objectives

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Radiometry and power calculation, signature generation, atmospheric effects.	7
2.	Radar ES operational use, radar/ES detection battle, quiet radar, jamming techniques & strategies, jamming of SAR systems.	7
3.	Introduction to radar waveform interception, Technology and operational characteristics of electronic warfare, Signal processing statics & analysis, statistics & noise, analogue & digital signal processing.	8
4.	Decision theory- hypothesis testing, probabilities of false alarm and detection, Bayesian systems, error probability and bit error rate, receiver operating.	8
5.	UAV Payload/link Issues, cell phone issues, Intercept links, Frequency hopping and other LPI threats;Special techniques for jamming LPI signals	8
6.	Introduction to electronic counter measures and counter-counter measures.	7
Total		45

References / Suggested Books:

1. “Tactical Battlefield Communications Electronic Warfare”, by David Adamy 2008 2. “Military Communications in the Future Battlefield”, by Marko Suojanen.

3. “Electronic Warfare for the Digitized Battlefield”, by Michael Frater, Michael Ryan.
4. Literature / books suggested by respective course Lecturers.

Course Title : Software Defined Radio
Course Code : 25DT653
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	SDR introduction, major standards, SDR architecture, SDR enablers, advantage / disadvantages, Applications.	8
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.	8
3.	SDR Hardware, super-heterodyne architecture, homodyne architecture, advantages & disadvantages, Software for SDR, Processing architecture for SDR.	8
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..	8
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, AI based SDR	6
Total		45

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 : Elsevier.

3. “Digital Techniques in Frequency Synthesis”, by B.G.Golderg. Publisher: McGraw-Hill.
4. “Multirate Signal Processing”, by N.J.Fliege. Publisher: John Wiley and sons.
5. Literature / books suggested by respective course Lecturers.

Course Title : EMI/EMC in Military Systems
Course Code : 25DT654
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

- Understand the concept of EMI / EMC protection of equipment
- Identify and prevent the common EMI/EMC problems in military systems.
- Understand the Design impact (by requirement) of military EMC specifications.
- Understand EMI/EMC troubleshooting tips and techniques.
- Learn generate EMI/EMC requirements document

Course Content

Unit	Contents	Contact Hrs.
1.	Basic Concepts: Definition of EMI/EMC and EMP, Classification of EMI/EMC, Sources of EMI, EMI coupling modes, ESD Phenomena and effects, Transient phenomena and suppression,	8
2.	EMC requirements for electronic systems, Non-ideal Behaviors of Components; EMI Measurements: Basic principles of EMI measurements, EMI measuring instruments;	8
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	8
4.	EMC Standard and Regulations: National and Intentional standardizing organizations, Frequency assignment, Spectrum conversation;	6
5.	EMC Design and Interconnection Techniques: Cable routing and connection, Component selection and mounting, PCB design (Trace routing, Impedance control, decoupling, Zoning and grounding);	8
6.	EMC analysis and detection techniques: Using tools for signal integrity analysis, Study eye diagrams for communication systems.	7
Total		45

References / Suggested Books:

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

4. Literature / books suggested by respective course Lecturers.

Course Title : Sensor Technology
Course Code : 25DT655
Teaching Scheme : L: 3, T: 0, P: 0 Credits: 3

Course Objectives:

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Physical principles underlying the sensor systems needed for satellites and tactical aircraft, as well as limitations imposed by the atmosphere and operating environment on these systems and their communication links,	8
2.	Phased array and pulsed compressed radars, imaging synthetic aperture and inverse synthetic aperture radars	7
3.	Atmospheric propagation of signal. Noise resources and thermal radiation	7
4.	Principles of semiconductor devices. Optical and infrared imaging detector systems.	9
5.	Detector resolution limitations and bandwidth requirements, Relationship between signals and noise.	7
6.	The characteristics of critical sensor functions (including detection, estimation, imaging, and tracking).	7
Total		45

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 : Fundamental of telemetry, telecommand& transponder
Course Code : 25DT656
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

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

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Fundamental of satellite communication, different modulation and multiplexing schemes.	6
2.	Satellite Telemetry, Tracking and Tele-command, Multiple Access Techniques Telemetry, Data Transmission, Methods of Modulation, Time Division and Frequency Division Multiplexing, FDMA, TDMA, CDMA and DAMA, Coding Schemes.	8
3.	Satellite Packet Communications, Tracking and Telemetry.	8
4.	Doppler and Electro-Optical methods of tracking, Airborne Missile.	8
5.	Signal Processing: Processing of Signal, Data Acquisition and Reduction.	8
6.	Introduction to satellite communication, transponders.	7
Total		45

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 : Autonomous and Navigation Technology
Course Code : 25DT657
Teaching Scheme : L: 3, T: 0, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

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

Course Content:

Unit	Contents	Contact Hrs.
1.	Introduction on navigation and guidance systems, Guidance approaches: conventional guidance such as PN (Proportional Navigation)	7
2.	Geodetic fundamentals of navigation, positioning, reference- and coordinate systems and computational methods for navigation and positioning on the surface of the earth.	9
3.	Geometric guidance, path planning and following, and optimal guidance; path planning for UGV/UAV guidance systems	9
4.	Navigation approaches: navigation systems, Understanding the Global Positioning System (GPS)	7
5.	GNSS (Global Navigation Satellite System), terrain based navigation	7
6.	SLAM (Simultaneous Localization and Mapping); Cooperative guidance and collision avoidance.	6
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.
5. Literature / books suggested by respective course Lecturers.

Course Title : Defence Electro-Optics
Course Code : 25DT658
Teaching Scheme : L: 3, T:0, P: 0 Credits: 3

Course Objectives:

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

Course Outcomes:

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

- Understand the technology and principles underpinning electro-optic devices and systems.
- Apply their knowledge to practical electro-optic design and acquisition prob-lems.
- 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.	8
2.	Camera systems, Image intensifiers, Missile seekers.	8
3.	Electro-optic countermeasures.	8
4.	Thermal imagers, II cameras, Hyper-spectral imaging, Digital image processing.	8
5.	EO sensors for Lasers and laser DEW	6
6.	Electro-optic protection measures.	7
	Total	45

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.

25AVP501 MASTERY OVER MIND 1-0-2-2

COURSE OBECTIVES

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction introduces immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony. With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

COURSE OUTCOME

After successful completion of the course, students will be able to:	
S.No.	**Course Outcomes**
1.	Understand the scientific benefits of meditation. (CO1)
2.	Explain the science behind meditation and its effects on physical and mental well-being (CO2).
3.	Understand the meditation techniques to cultivate emotional intelligence and improve relationships (CO3).
4.	Learn and practice MAOM meditation in daily life (CO4).
5.	To apply the effect of meditation to compassion-driven action (CO5)

Syllabus:

Scientific benefits of Meditation (CO1)

Scientific benefits of meditation, exploring its effects on physical and mental wellbeing.

Learn about the different types of meditation practices, the essential elements of meditation, and the empirical evidence supporting its benefits.

Video resource-Swami Atmanandamrita Puri

Science Behind Meditation (CO2)

A: A preliminary understanding of the Science of meditation. What can modern science tell us about this

tradition-based method?

B: How meditation helps humanity according to what we know from scientific research

Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)

Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). Mata

Amritanandamayi Mission Trust.

Role of Meditation in Emotional intelligence (CO3)

Learn how meditation practices can enhance self-awareness, self-regulation, motivation, empathy, and social skills, leading to improved relationships and decision-making. Improve communication, emotional intelligence, and interpersonal skills. Logical and analytical reasoning

Practicing MA OM Meditation in Daily Life (CO4)

Guided Meditation Sessions following scripts provided (Level One to Level Five)

Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)

Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata

Amritanandamayi Mission Trust.

Meditation and Compassion-driven Action (CO5)

Understand how meditation can help to motivate compassion-driven action.

Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior:What do we (not) know? Current Opinion in Psychology, 44, 151-156.

Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritanandamyi Mission Trust.

Textbooks / References:

1. Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019

2. Swami Amritaswarupananda Puri," The Color of Rainbow "published by MAM, Amritapuri. 3. Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019

4. R Nagarathna et al, "New Perspectives in Stress Management "Swami Vivekananda Yoga Prakashana publications, Jan 1986

5. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019

6. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018

7. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.

8. Mata Amritanandamayi Devi "Compassion: The only way to Peace:Paris Speech", MA Center, April 2016.

9. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.

10. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

GLIMPSES OF INDIAN CULTURE

P/F

22ADM501: GLIMPSES OF INDIAN CULTURE

A. Prerequisite: nil

B. Nature of Course: Theory

C. Course Objectives:

- The course "Glimpses of Indian Culture" aims to provide students with a comprehensive understanding of various aspects of Indian culture, with a focus on its spiritual, philosophical, and religious dimensions.
- Through an exploration of the chapters from the provided book, students will gain insights into the foundational principles, practices, and symbols that shape the diverse cultural landscape of India
- Aligned with the Indian Knowledge Systems (IKS) framework outlined in the National Education Policy, this course serves as an introduction to the vast reservoir of wisdom and knowledge rooted in Indian heritage.
- By engaging with the chapters in the book, students will develop a holistic appreciation for the rich tapestry of Indian culture, spanning from its philosophical underpinnings to its artistic expressions, rituals, and societal values.
- This course aims to cultivate cultural sensitivity, critical thinking, and a deeper understanding of the diverse spiritual and cultural traditions that have shaped India's identity over millennia.

D. Course Outcomes: After successful completion of the course, Students will be able to:

CO	Course Outcomes	Knowledge level [Bloom's Taxonomy]
CO01	**Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India.** Statement: Demonstrate the ability to remember essential terms, concepts, and principles discussed in the chapters on Sanatana Dharma, scriptures, and cultural aspects.	Remembering
CO02	**Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy.** Statement: Understand the profound meanings of Īśvara, Guru, Avatara, and Karma, elucidating their importance in shaping Indian cultural thought.	Understanding
CO03	**Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios.** Statement: Utilize insights from Purusharthas, Sanyasa, and Yajna to navigate ethical dilemmas and make informed decisions**.**	Applying
CO04	**Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture.**	Analyzing

	Statement: Deconstruct the layers of symbolism in various cultural aspects, including Nataraja representation and temple architecture, unraveling their deep meanings.	
CO05	**Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape.** Statement: Assess the role of temples in preserving cultural heritage and critically examine the diversity of cultural and spiritual systems in India.	Evaluating
CO06	**Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.** Statement: Create expressive projects that capture the essence of Sanatana Dharma, convey the practices of sadhana, and portray the cultural meanings of symbols.	Creating

POs Programme Outcomes	**COs**
PO1: Engineering Knowledge **PO2: Problem Analysis** **PO3: Design/Development of Solutions** **PO4: Conduct Investigations of complex problems** **PO5: Modern tools usage** **PO6: Engineer and Society** **PO7: Environment and Sustainability** **PO8: Ethics** **PO9: Individual & Teamwork** **PO10: Communication** **PO11: Project management & Finance** **PO12: Lifelong learning** **B.Tech. EEE Programme Specific Outcome (PSO)** **PSO1:** Awareness of Future Technology: Develop solutions for future systems using smart technologies. **PSO2:** Research and Innovation: Identify engineering challenges, approach using cutting edge research tools and execute innovative solutions.	• CO 1: Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India. • CO 2: Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy • CO 3: Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios. • CO 4: Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture. • CO 5: Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape. • CO 6: Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.

E. CO-PO Mapping: [affinity[#]: 3 – high; 2- moderate; 1- slightly]

COs	**Program Outcomes [POs]**												**Program Specific Outcomes [PSOs]***	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO01	-	-	-	-	-	-	-	2	-	-	-	3	-	-
CO02	-	-	-	-	-	1	-	2	-	-	-	3	-	-
CO03	-	-	-		-	3	3	3	2	-	-	2	-	-
CO04	-	-	-	-	-	3	-	-	-	-	-	3	-	-
CO05	-	-	-	-	-	2	3	-	-	-	-	2	-	-
CO06	-	-	-	-	-	2	2	2	2	-	-	3	-	-
Total														
Average														

F. SYLLABUS **GLIMPSES OF INDIAN CULTURE** **[P/F]**

Course Syllabus

Chapter 1	-	*What is Sanatana Dharma*
Chapter 2	-	*The Heritage ofScriptures*
Chapter 3	-	*The idea of Īśvara*
Chapter 4	-	*Guru Tattva and Avatara Tattva*
Chapter 5	-	*Theory of Karma*
Chapter 6	-	*Purusharthas*
Chapter 7	-	*Sanyasa*
Chapter 8	-	*Yajna*
Chapter 9	-	*Symbolism*
Chapter 10	-	*Understanding Nataraja*
Chapter 11	-	*Temples: The Cradle of Culture*
Chapter 12	-	*Other Heterodox Systems in India*
Chapter 13	-	*Sadhana*

GLIMPSES OF INDIAN CULTURE

Reference Books:

The Eternal Truth by Mata Amritanandamayi Devi
Temples: Centers for Spiritual Practice by Mata Amritanandamayi Devi
All About Hinduism by Swami Sivananda
Art of God Symbolism by Swami Chinmayananda
Temples in India by Swami Sivananda

G. Evaluation Pattern: 60:40

Component	**Weightage**	**Remarks**
Internal	60	-
External	40	-
TOTAL	100	