

PAAVAI ENGINEERING COLLEGE, NAMAKKAL- 637018
(AUTONOMOUS)
B.E. AERONAUTICAL ENGINEERING
REGULATIONS 2023
(CHOICE BASED CREDIT SYSTEM)
(Applicable to the students admitted during the academic year
2023- 2024 onwards)

CURRICULUM

SEMESTER I

S.No	Category	Course Code	Course Title	L	T	P	C
1			Induction Programme				
Theory							
2	HS	GE23101	தமிழர்மரபு/Heritage of Tamils	1	0	0	1
3	BS	MA23101	Matrices and Calculus	3	1	0	4
4	BS	PH23103	Materials Science	3	0	0	3
5	ES	ME23101	Engineering Graphics	2	0	2	3
6	ES	CS23101	Problem Solving and Python Programming	3	0	0	3
TheorywithLaboratory							
7	HS	EN23101	Communication Skills for Engineers I	2	0	2	3
Practical							
8	BS	PH23106	Materials Science Laboratory	0	0	2	1
9	ES	GE23103	Civil and Mechanical Engineering Practices Laboratory	0	0	2	1
10	ES	CS23103	Problem Solving and Python Programming Laboratory	0	0	4	2
TOTAL				14	1	12	21

SEMESTER II

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	HS	GE23201	தமிழரும் தொழில்நுட்பமும்/ Tamils and Technology	1	0	0	1
2	BS	MA23201	Complex Variables and Differential Equations	3	1	0	4
3	BS	CH23202	Chemistry for Engineers	3	0	0	3
4	ES	ME23202	Engineering Mechanics	3	0	0	3
5	ES	EE23201	Basic Electrical and Electronics Engineering	3	0	0	3
Theory with Laboratory							
6	HS	EN23201	Communication Skills for Engineers II	2	0	2	3
Practical							
7	BS	CH23204	Chemistry Laboratory	0	0	2	1
8	ES	GE23202	Electrical and Electronics Engineering Practices Laboratory	0	0	2	1
9	ES	ME23203	Computer Aided Drafting Laboratory	0	0	2	1
TOTAL				15	1	8	20



SEMESTER III

SNo	Category	Course Code	Course Title	L	T	P	C
THEORY							
1	BS	MA23301	Transforms Techniques and Partial Differential Equations	3	1	0	4
2	PC	AE23301	Solid Mechanics	3	1	0	3
3	PC	AE23302	Fluid Mechanics and Machinery	3	0	0	3
4	PC	AE23303	Basics of Aeronautical Engineering	3	0	0	3
5	MC	MC23302	Human Values and Gender Equality	2	0	0	0
THEORY WITH LAB COMPONENT							
6	ES	AE23304	Aero Engineering Thermodynamics	3	0	2	4
PRACTICAL							
7	PC	AE23305	Strength of Materials Laboratory	0	0	3	2
8	PC	AE23306	Fluid Mechanics Laboratory	0	0	3	2
9	EE	EE23301	Professional Development I	0	0	0	1
TOTAL				20	2	8	22

SEMESTER IV

SNo	Category	Course Code	Course Title	L	T	P	C
THEORY							
1	BS	MA23404	Numerical Methods	3	1	0	4
2	PC	AE23401	Gas Turbine Propulsion	3	0	0	3
3	PC	AE23402	Low Speed Aerodynamics	3	0	0	3
4	PC	AE23403	Aircraft Systems and Instruments	3	0	0	3
5	MC	MC23401	Environmental Science and Sustainability	2	0	0	0
THEORY WITH LAB COMPONENT							
6	PC	AE23404	Aircraft Structural Mechanics	3	0	2	4
PRACTICAL							
7	PC	AE23405	Propulsion Laboratory	0	0	3	2
8	PC	AE23406	Aerodynamics Laboratory	0	0	3	2
9	EE	GE23401	Professional Development II	0	0	0	1
TOTAL				20	2	8	22



SEMESTER V

SNo	Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	AE23501	Flight Mechanics	3	0	0	3
2	PC	AE23502	Rocket Propulsion	3	0	0	3
3	PC	AE23503	High Speed Aerodynamics	3	0	0	3
4	PC	AE23504	Aircraft Structures	3	1	0	4
5	PC	AE23505	Artificial Intelligence and Machine Learning for Aerospace Applications	3	0	0	3
6	PE	AE23***	Professional Elective-1	3	0	0	3
PRACTICAL							
7	PC	AE23506	Aircraft Structures Laboratory	0	0	2	1
8	PC	AE23507	Aircraft Systems and Maintenance Laboratory	0	0	4	2
9	EE	AE23508	Industrial Training	0	0	2	1
10	EE	GE23501	Professional Development III	0	0	2	1
TOTAL				18	1	5	24

SEMESTER VI

SNo	Category	Course Code	Course Title	L	T	P	C
THEORY							
1	HS	BA23501	Entrepreneurship Development	3	0	0	3
2	PC	AE23601	Finite Element Methods	3	0	0	3
3	PC	AE23602	Unmanned Aerial Vehicle Systems	3	0	0	3
4	PC	AE23603	Composite Materials and Structures	3	0	0	3
5	PE	AE23***	Professional Elective-2	3	0	0	3
6	OE	AE2390*	Open Elective-I*	3	0	0	3
PRACTICAL							
7	PC	AE23605	Aeromodeling and computer aided drawing laboratory.	0	0	3	2
8	PC	AE23606	Unmanned Aerial Vehicle Systems Laboratory	0	0	3	2
9	EE	EE23601	Design Thinking	0	0	2	1
TOTAL				18	0	8	23



SEMESTER VII

SNo	Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	AE23701	Aircraft Design	3	0	0	3
2	PC	AE23702	Rockets and Missiles	3	0	0	3
3	PC	AE23703	Experimental stress analysis	3	0	0	3
4	PE	AE23***	Professional Elective-3	3	0	0	3
5	PE	AE23***	Professional Elective-4	3	0	0	3
6	OE	AE2390*	Open Elective –II*	3	0	0	3
PRACTICAL							
7	PC	AE23704	Aircraft Design Project	0	0	3	2
8	EE	AE23705	Project Phase-I	0	0	6	3
TOTAL				18	0	9	23

SEMESTER VIII

SNo	Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PE	AE23***	Professional Elective- 5	3	0	0	3
2	PE	AE23***	Professional Elective- 6	3	0	0	3
PRACTICAL							
4	EE	AE23801	Project Phase-II	0	0	12	6
TOTAL				6	0	12	12



Vertical I

AEROSPACE STRUCTURES & MATERIALS

SNo	Category	Course Code	Course Title	L	T	P	C
1	PE	AE23151	Aircraft Materials	3	0	0	3
2	PE	AE23152	Vibration and Aero elasticity	3	0	0	3
3	PE	AE23153	Fatigue and Fracture Mechanics	3	0	0	3
4	PE	AE23154	Smart Materials	3	0	0	3
5	PE	AE23155	Theory of Elasticity	3	0	0	3
6	PE	AE23156	Vibration Isolation and Control	3	0	0	3
7	PE	AE23157	Structural Health Monitoring in Aircraft	3	0	0	3

Vertical II

AERODYNAMICS

SNo	Category	Course Code	Course Title	L	T	P	C
1	PE	AE23251	Wind Tunnel Techniques	3	0	0	3
2	PE	AE23252	Boundary layer Theory	3	0	0	3
3	PE	AE23253	Computational Fluid Dynamics	3	0	0	3
4	PE	AE23254	Missile Aerodynamics	3	0	0	3
5	PE	AE23255	Industrial Aerodynamics	3	0	0	3
6	PE	AE23256	Experimental Aerodynamics	3	0	0	3
7	PE	AE23257	Hypersonic Aerodynamics	3	0	0	3

Vertical III

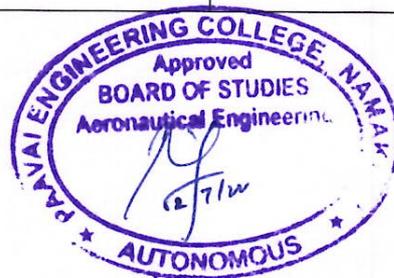
PROPULSION

SNo	Category	Course Code	Course Title	L	T	P	C
1	PE	AE23351	Combustion in Jet and Rocket Engines	3	0	0	3
2	PE	AE23352	Cryogenic Engineering	3	0	0	3
3	PE	AE23353	Computational Fluid Flow and Heat Transfer	3	0	0	3
4	PE	AE23354	Design of Gas Turbine Engine Components	3	0	0	3
5	PE	AE23355	Theory of Flames	3	0	0	3
6	PE	AE23356	Advanced Propulsion Systems	3	0	0	3
7	PE	AE23357	Electric Propulsion Systems	3	0	0	3



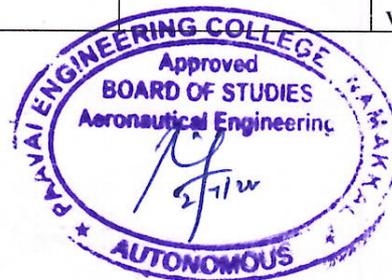
VALUE ADDED COURSES

Sl. No.	CourseCode	Course Title	Sem
1	VACAE01	Design and Drafting using Solid Works	III-VIII
2	VACAE02	Basics of robotics	III-VIII
3	VACAE03	CATIA with Industrial approach	III-VIII
4	VACAE04	Basics of Drone Technology	III-VIII
5	VACAE05	Technical Publications	III-VIII
6	VACAE06	Introduction to IIOT	III-VIII
7	VACAE07	Introduction in Networking	III-VIII
8	VACAE08	Hands on training on Medical Devices	III-VIII
9	VACAE09	Courses by Eduskills	III-VIII
10	VACAE10	Introduction to CNC by VMC	III-VIII



PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Aerospace Structures and Materials	Vertical II Aerodynamics	Vertical III Propulsion	Vertical IV Space Technology	Vertical V Aircraft Maintenance	Vertical VI Emerging Technology
Aircraft Materials	Wind Tunnel Techniques	Combustion in Jet and Rocket Engines	Spacecraft Attitude Dynamics	Aircraft General Engineering and Maintenance Practices	Lean Manufacturing
Vibration and Aero elasticity	Boundary layer Theory	Cryogenic Engineering	Orbital Mechanics	Aero Engine Maintenance and Repair	Additive Manufacturing
Fatigue and Fracture Mechanics	Computational Fluid Dynamics	Computational Fluid Flow and Heat Transfer	Avionics	Airframe Maintenance and Repair	Smart Manufacturing
Smart Materials	Missile Aerodynamics	Design of Gas Turbine Engine Components	Aerospace Guidance and Control System	Air Traffic Control and Airport Planning	Geometric Dimensioning and Tolerancing
Theory of Elasticity	Industrial Aerodynamics	Theory of Flames	Satellite Systems and Technology	Civil Aviation Regulations	Green Manufacturing
Vibration Isolation and Control	Experimental Aerodynamics	Advanced Propulsion System	Launch Vehicle Design Concepts	Avionics Systems Maintenance	Advanced Drone Technology
Structural Health Monitoring in Aircraft	Hypersonic Aerodynamics	Electric Propulsion Systems	Launch Vehicle Aerodynamics	Helicopter Maintenance	Design of fixed wing unmanned Aerial vehicles





200

MINOR DEGREE COURSE- AEROSPACE ENGINEERING

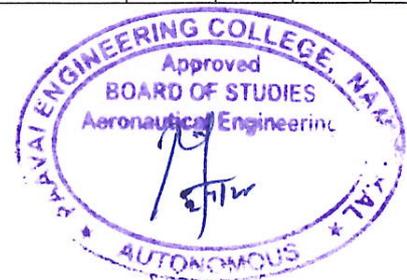
SNo	Category	Course Code	Course Title	L	T	P	C
1	MDC	AE23851	Introduction to Aeronautics	3	0	0	3
2	MDC	AE23852	Fundamentals of Propulsion	3	0	0	3
3	MDC	AE23853	Basics of Aerodynamics and Control	3	0	0	3
4	MDC	AE23854	Elements of Aircraft Structures and Materials	3	0	0	3
5	MDC	AE23855	Aircraft Regulations and Maintenance Fundamentals	3	0	0	3
6	MDC	AE23856	Intelligent Aerospace Systems	3	0	0	3

*MDC–Minor Degree Course



ONE CREDIT COURSES

S.No	Category	Course Code	Course Title	L	T	P	C
1	OCC	AE23951	NPTEL-Aircraft Stability and Control	0	0	2	1
2	OCC	AE23952	NPTEL-Introduction to Airplane performance	0	0	2	1
3	OCC	AE23953	NPTEL-Introduction to Air breathing Propulsion	0	0	2	1
4	OCC	AE23954	NPTEL-Introduction to Aerospace Engineering – Flight	0	0	2	1
5	OCC	AE23955	NPTEL-Introduction to Aircraft Design	0	0	2	1
6	OCC	AE23956	NPTEL-Design of fixed wing Unmanned Aerial Vehicles	0	0	2	1
7	OCC	AE23957	NPTEL-UAV Design-Part II	0	0	2	1
8	OCC	AE23958	NPTEL - Applied Computational Fluid Dynamics	0	0	2	1
9	OCC	AE23959	NPTEL - Space Flight Mechanics	0	0	2	1
10	OCC	AE23960	NPTEL - Drone Systems and Control	0	0	2	1
11	OCC	AE23961	NPTEL - Introduction to CFD	0	0	2	1
12	OCC	AE23962	Design Thinking	0	0	2	1
13	OCC	AE23963	General awareness, communication and Aero engines	0	0	2	1
14	OCC	AE23964	Mesh tools for industrial approach	0	0	2	1



AE23501	FLIGHT MECHANICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	familiarize students with the equation of motion.						
2.	describe the performance of flight under different maneuvering conditions.						
3.	familiarize with various Aircraft motions.						
4.	analyze the longitudinal stability modes of an aircraft.						
5.	familiarize with the concept of lateral and directional stability of Aircraft.						
UNIT I	AIRCRAFT EQUATION OF MOTION						9
Derivation of Rigid Body equation of motion - Orientation and position of the airplane - Gravitational and Thrust - Small Disturbance Theory -Aerodynamic force and moment representation: Forward speed, pitching velocity, Time rate of change of angle of attack.							
UNIT II	AIRCRAFT PERFORMANCE STEADY FLIGHT						9
Steady and level flight - Thrust required: Aerodynamic relation associated with Lift to drag ratio - Thrust available for various aircraft - Power required and available - Stalling velocity - High lift devices - Rate of Climb: maximum climb angle, maximum rate of climb. Gliding Flight - Range - Endurance.							
UNIT III	ACCELERATED FLIGHT						9
Level Turn: Minimum Turn Radius, Maximum turn rate - Pull-up and pull down maneuvers - V-n Diagram - Take of performance: Ground roll – Landing performance							
UNIT IV	LONGITUDINAL STABILITY AND CONTROL						9
Static stability - Dynamic Stability - Longitudinal static stability: Contribution of aircraft component, wing contribution, tail contribution, aft tail - Longitudinal control: Elevator effectiveness, elevator angle to trim - Stick forces - trim tabs - stick force gradients.							
UNIT V	LATERAL, DIRECTIONAL STABILITY AND CONTROL						9
Lateral control - Adverse yaw - Aileron Reversal, Coupling effect: Rolling moment with side slip angle - Dihedral effect. Weather cock stability - directional control - rudder requirements - Dorsal fin - One engine inoperative condition- Dutch roll -Spiral and directional divergence - Autorotation and Spin.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	predict the equation of motion and aerodynamic representations					Applying (K3)	
CO2	identify the thrust and power variation in different aircraft.					Analyzing (K4)	

CO3	compute the factors affecting landing, take off and maneuvering.	Analyzing (K4)												
CO4	describe the static longitudinal control.	Applying (K3)												
CO5	describe about the lateral and directional control.	Applying (K3)												
TEXT BOOKS														
1. Nelson, R.C., "Flight Stability and Automatics Control", Second Edition, Mc Graw Hill, 2007.														
2. John D. Anderson., "Aircraft Performance and Design", Tata Mc Graw - Hill, Delhi, 2017.														
REFERENCES														
1. Barnes W. Mc Cormick, "Aerodynamics, Aeronautics and Flight Mechanics", Second Edition, John Wiley, New York, 1994.														
2. E.L.Houghton, P.W.Carpenter, Steven H Collicott, and Daniel T Valentine, "Aerodynamic for Engineering Students", Sixth Edition, Butterworth-Heinemann, 2012.														
3. P.J.Swatton, "Principles of Flight for Pilots", A John Wiley and Sons, Ltd., Publication, 2011.														
4. Court land D.Perkins, Robert E.Hage, "Airplane Performance, Stability and Control", Wiley, 1 st edition, 1966.														
CO-PO MAPPING :														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	-	-	1	-	3	-	-	3	2	2
CO2	2	2	1	-	3	-	1	1	1	-	-	3	2	2
CO3	2	2	3	1	2	2	1	3	1	2	-	3	2	2
CO4	2	2	-	2	2	2	1	-	-	-	-	3	2	2
CO5	2	2	3	2	2	2	1	3	2	-	-	3	2	2



AE23502	ROCKET PROPULSION			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the working principles and performance of air-breathing engines such as ramjets and scramjets.						
2.	comprehend the classification, function, and performance of chemical and non-chemical rocket engines.						
3.	learn the design considerations and combustion processes in solid rocket propulsion systems						
4.	analyze the operations, feed mechanisms, and combustion behavior of liquid and hybrid propulsion systems.						
5.	explore emerging and advanced propulsion systems such as electro thermal, electrostatic and electromagnetic techniques.						
UNIT I	RAMJET AND SCRAMJET PROPULSION						9
Operating principle of ramjet engine and scramjet – various components; Combustion in ramjet engine; Introduction to hypersonic air breathing propulsion– performance measures; Need for scramjet propulsion for hypersonic vehicles; Salient features of scramjet engine and estimation of its performance.							
UNIT II	CHEMICAL ROCKET PROPULSION						9
Basic principle of propulsion– classification of propulsive devices; Comparison of Air-Breathing and Rocket Engines– Types of rocket engines; Chemical Rocket Engines; Nonchemical Rocket Engines; Applications of rocket engines; Thrust equation of rocket engines – Rocket performance parameters; Nozzles and its classifications.							
UNIT III	SOLID ROCKET PROPULSION						9
Solid Propellants; Classification; Propellant Characteristics; Propellant Ingredients– Basic Relations and Propellant Burning Rate; Propellant Grain and Grain Configuration– Ignition Process; Thrust termination; Combustion instability; Igniters–Types of igniters. Numerical problems.							
UNIT IV	LIQUID AND HYBRID ROCKET PROPULSION						9
Types of Propellants– propellant Feed Systems, gas Pressure Feed Systems, turbopump Feed Systems; Propellant Properties–liquid oxidizers, liquid fuels; Injectors; Combustion Process–combustion instability; Cooling systems; Introduction to Hybrid Propulsion; Combustion chamber– propellants for HPRE, grain configuration; Combustion of Hybrid Propellants.							
UNIT V	ELECTRICAL PROPULSION TECHNIQUES						9
Basic principles of electrical Rocket engine – Classifications of Electrical Rockets; Electro thermal thrusters– Resisto jets, Arc jets; Electrostatic thrusters; Electromagnetic thruster –Magneto plasma dynamic thrusters, Pulsed Plasma Thruster, Hall Effect Thruster.							
						TOTAL PERIODS	45



COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	illustrate the fundamental mechanisms behind ramjet and scramjet propulsion systems.	Understanding (K2)
CO2	explain the basic principles of chemical rocket propulsion systems.	Understanding (K2)
CO3	interpret the influence of grain geometry on burn rate and thrust output.	Applying (K3)
CO4	examine injector types and cooling methods used in combustion chambers and combustion processes of oxidizer-fuel interactions in hybrids.	Analysing (K4)
CO5	break down the functions and applications of advanced thruster technologies.	Analysing (K3)

TEXT BOOKS

- George P. Sutton & Oscar Biblarz, "Rocket Propulsion Elements, John Wiley & Sons Inc., NewYork, 9th Edition, 2016.
- D. P. Mishra, "Fundamentals of Rocket Propulsion" Taylor & Francis Group, 2017.

REFERENCES

- Hill, P.G. and Peterson, C.R. "Mechanics and Thermodynamics of Propulsion" 2nd Edition Pearson Education, 1999
- Martin Tajmar, "Advanced Space Propulsion Systems" Springer Verlag GmbH, 2003.
- Martin J. Chiaverini and Kenneth K. Kuo, "Fundamentals of Hybrid Rocket Combustion and Propulsion", Progress in Astronautics and Aeronautics, 2007
- David H. Heiser and David T. Pratt., "Hypersonic Air breathing Propulsion", AIAA Education Series, 1999.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	-	-	-	-	1	-	1	3	2
CO2	3	2	2	1	2	-	-	-	-	1	-	1	3	2
CO3	3	2	1	1	2	-	-	-	-	1	-	1	3	2
CO4	3	2	2	2	2	-	-	-	-	1	-	1	3	2
CO5	3	2	2	1	2	-	-	-	-	1	-	1	3	2



AE23503	HIGH SPEED AERODYNAMICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	inferring the concepts of compressibility,						
2.	correlating the theory behind the formation of shocks in Supersonic flows.						
3.	explaining the methodology of measurements in Supersonic flows.						
4.	extend the knowledge on high speed flow over air foils with use of differential equations.						
5.	gather the concepts of Transonic flow.						
UNIT I	REVIEW OF COMPRESSIBLE FLOW						9
Energy, Momentum, continuity equations; one-dimensional flow with area changes; Speed of sound and Mach number; Flow Parameters.							
UNIT II	NORMAL AND OBLIQUE SHOCKS						9
Normal shock equations - Rankine-Hugoniot relations; one-dimensional flow with Heat and Friction; Oblique shocks - Hodograph and pressure turning angle, shock polar, flow past wedges and concave corners; Strong/weak/detached shocks.							
UNIT III	EXPANSION WAVES AND METHOD OF CHARACTERISTICS						9
Prandtl-Meyer Expansion Waves; Shock-Expansion Theory; Area-Velocity Relation; Reflection and interaction of shocks and expansion waves; Rayleigh and Fanno Flows.							
UNIT IV	DIFFERENTIAL EQUATIONS OF MOTION						9
Small perturbation potential theory; Mach waves and angles; linearized Pressure Coefficient - Prandtl-Glauert rule, affine transformation relations for subsonic flows; linearized two-dimensional supersonic flow theory; supersonic profiles.							
UNIT V	TRANSONIC FLOW OVER WING						9
Lower and upper critical Mach numbers; Transonic flow past unswept Airfoils; Wave Drag Reduction by Design – Swept wing, Transonic area rule.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	relate the compressible flow through a duct of varying cross section.					Understanding (K2)	
CO2	estimate the properties across normal and oblique shock waves.					Analyzing (K4)	
CO3	administer fluid properties of expansion waves in Rayleigh and Fanno type flows.					Applying (K3)	

CO4	discuss the knowledge of various techniques and methods for solving compressible flows.	Understanding (K2)												
CO5	predict the properties of transonic flows.	Understanding (K2)												
TEXT BOOKS														
1. Anderson Jr., D., – “Modern compressible flows”, McGraw-Hill Book Co., New York, 5 th Edition, 2020														
2. L.J. Clancy, “Aerodynamics” Sterling Book House, 2006														
REFERENCES														
1. Rathakrishnan, E., “Gas Dynamics”, 6 th Edition, Prentice Hall of India, 2017.														
2. John J. Bertin and Russell M. Cummings, “Aerodynamics for Engineers”, 6 th Edition, Pearson, 2013.														
3. Shapiro, A.H., “Dynamics and Thermodynamics of Compressible Fluid Flow”, Ronald Press, 1982.														
4. Ethirajan Rathakrishnan, “Theoretical Aerodynamics”, 1 st Edition, Wiley Publications, 2013.														
CO-PO MAPPING :														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	3	3	3	3	-	-	-	-	-	-	-	3	-
CO2	2	3	3	3	3	-	-	-	-	-	-	-	3	-
CO3	2	3	3	3	3	-	-	-	-	-	-	-	3	-
CO4	2	3	3	3	3	-	-	-	-	-	-	-	3	-
CO5	2	2	2	2	2	-	-	-	-	-	-	-	3	2



AE23504	AIRCRAFT STRUCTURES			3	1	0	4
COURSE OBJECTIVES							
To enable the students to							
1.	understand the concept and advanced understanding of stress and strain in structural members, especially in unsymmetrical and thin-walled sections.						
2.	gain knowledge of shear flow in open and closed sections, emphasizing the design of aerospace structures.						
3.	learn the ability to analyze buckling behavior in structural panels and thin-walled members using analytical and numerical approaches.						
4.	locate the shear center and predict deformation, deflection, and instability in practical aircraft structural components.						
5.	analyze the structural response of aircraft components under various loading conditions using shear force, bending moment diagram, and basic tension field theories.						
UNIT I	UNSYMMETRICAL BENDING OF BEAMS						12
Bending of symmetric beams – Bending stresses in beams of unsymmetrical sections; sign conversions; resolution of bending; direct stress distribution due to bending; position of neutral axis; load intensity, shear force and bending moment relationships; deflection due to bending ; Introduction to torsional behavior of thin-walled sections - Concept of shear flow, Preliminary introduction to Bredt- Batho theory and its relevance to aircraft structures.							
UNIT II	SHEAR FLOW IN OPEN SECTIONS						12
Shear of Thin-Walled Open Section Beams – Shear Flow Distribution in Thin-Walled Open Sections with and Without Stiffening Elements – Determination of the Shear Centre Position – Torsion of Thin-Walled Open Sections – Thin-Webbed Tapered Beams.							
UNIT III	SHEAR FLOW IN CLOSED SECTIONS						12
Bending, Shear, and Torsion of Closed Sections – Shear Flow Analysis – Structural Idealization of Aircraft Wing and Fuselage Sections – Determination of the Shear Centre Position – Shear Flow in Multi-Cell Sections – Deflection Analysis – Wagner Beam Theory.							
UNIT IV	THIN PLATES						12
Thin Plates Under Combined Loading – Stress Resultants – Buckling of Thin Plates in Compression – Buckling Coefficient – Ultimate Strength of Stiffened Sheets – Effective Sheet Width – Needham Method – Buckling of Thin-Walled Columns – Crippling.							
UNIT V	AIRCRAFT STRESS ANALYSIS						12
Airworthiness Requirements – Construction of the V-n Diagram – Effect of Gust – Loads Acting on Aircraft Components – Balancing Tail Loads – Determination of Load Factor – Inertia Loads – Stress Analysis of Aircraft Wing & Fuselage Components.							
						TOTAL PERIODS	60



COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	analyze bending stresses in unsymmetrical beam sections, determine the neutral axis, and predict deflection under loading.	Analyzing (K4)
CO2	derive stress-strain-displacement relationships for open sections and calculate shear flow and shear center for unsymmetrical sections.	Applying (K3)
CO3	evaluate shear flow in closed thin-walled structures using bredt-batho theory and analyze warping and twist under loading.	Applying (K3)
CO4	estimate critical buckling loads for thin-walled plates and stiffened panels, and assess failure modes such as local instability and diagonal tension.	Analyzing (K4)
CO5	apply structural analysis techniques to assess real aircraft components.	Applying (K3)

TEXT BOOKS

1. Megson, T.H.G., "Aircraft Structures for Engineering Students", Fourth Edition (Rev.), Butterworth-Heinemann, 2021.
2. David J. Peery, "Aircraft Structures Dover Books on Aeronautical Engineering", Dover Publications, 2013.

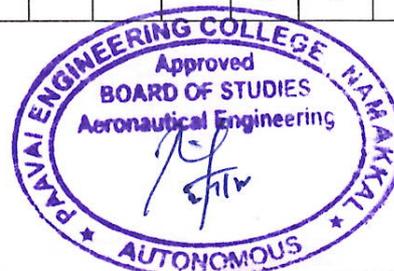
REFERENCES

1. James M. Gere & Barry J. Goodno, "Mechanics of Materials", Cengage Learning Custom Publishing; 9th Edition, 2019.
2. Howard D. Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-Mc Graw Hill, 1997.
3. Bruhn, E.H., "Analysis and Design of Flight Vehicles Structures", Tri-State Off set Company, USA, 2015.
4. Timoshenko, S. and Young, D.H., "Elements of Strength of Materials Vol. I and Vol. II", T. Van Nostrand Co, Inc., Princeton, N.J., 1990.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO2	3	3	2	3	3	-	-	-	-	-	-	1	3	3
CO3	3	3	2	3	3	-	-	-	-	-	-	1	3	3
CO4	3	3	2	3	2	-	-	-	-	-	-	2	3	2
CO5	3	2	3	2	2	-	-	-	-	-	-	2	3	3



AE23505	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR AEROSPACE APPLICATIONS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1.	introduce the fundamentals, types, and scope of Artificial Intelligence (AI) and intelligent agents.					
2.	develop understanding of problem-solving strategies and knowledge representation in AI.					
3.	explore foundational concepts of Machine Learning (ML), including types, models, and evaluation.					
4.	apply supervised learning algorithms in decision-making, prediction, and aerospace data analysis.					
5.	understand unsupervised learning techniques and their applications in aerospace systems and sensor data.					
UNIT I	INTRODUCTION TO ARTIFICIAL INTELLIGENCE				9	
Introduction: Definition of AI, Applications, History of AI; Types of AI; The state of the art - Risks and Benefits of AI; Intelligent agent: Types - Agent environment, Turing test; Examples of AI.						
UNIT II	INTRODUCTION TO MACHINE LEARNING				9	
Machine Learning: Definitions – Classification – Regression; approaches of machine learning models; Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance; Regression: Linear Regression - Logistic Regression.						
UNIT III	UNSUPERVISED LEARNING FOR AIRCRAFT SYSTEMS				9	
Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks; Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesian classification - Support Vector Machines (SVM); flight performance prediction and maintenance.						
UNIT IV	SUPERVISED LEARNING				9	
Unsupervised Learning – Principle Component Analysis; Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps; Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm; Aerospace Applications (Systems, Sensors).						
UNIT V	ARTIFICIAL INTELLIGENCE IN AVIATION				9	
Air Navigation and Flight Operations; Aircraft Operations and Crew; Customer, Contact, and Self-Service; In flight and Cabin Services; Digital Cabin and Sensory Applications; Emerging trends in AI for space travel.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	illustrate the role of intelligent agents and explain agent-environment interaction using real-world examples.				Understanding (K2)	

CO2	describe the types and approaches of machine learning models.	Understanding (K2)
CO3	implement supervised learning algorithms such as decision trees, neural networks, and SVMs for aerospace data.	Applying (K3)
CO4	apply unsupervised learning models to aerospace sensor systems and pattern detection.	Applying (K3)
CO5	analyze the use of AI in inflight and cabin services, focusing on personalization and automation.	Analyzing (K4)

TEXT BOOKS

1. Chandra, V., & Hareendran, A. (2014). Artificial intelligence and machine learning. PHI Learning.
2. John Valasek. (2013). Advances in Intelligent and Autonomous Aerospace Systems. American Society of Mechanical Engineering,

REFERENCES

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021.
2. Alpaydin. (2016). Introduction To Machine Learning. Phi Learning.
3. Machine Learning and Artificial Intelligence, Ameet V Joshi, Springer, Microsoft (USA), Redmond, ISBN 978-3-030-26621-9
4. Mueller, John Paul, Massaron, Luca, "Machine Learning for Dummies", Wiley, 2016.

CO-PO MAPPING:

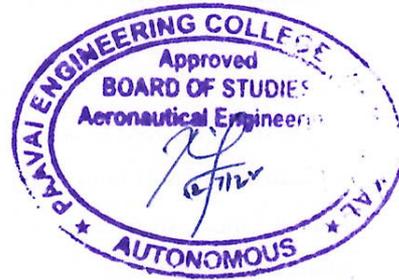
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	2	2	-	-	-	-	-	1	3	2
CO2	3	3	2	2	3	1	-	-	-	-	-	1	3	3
CO3	3	3	2	2	3	1	-	-	-	-	-	1	3	3
CO4	3	3	3	2	3	1	-	-	-	-	-	1	3	3
CO5	3	3	3	2	3	2	-	-	-	-	-	1	3	3



AE23506	AIRCRAFT STRUCTURES LABORATORY		0	0	2	1	
COURSE OBJECTIVES							
To enable the students to							
1.	analyze the principal stress directions and shear center in various structural sections such as unsymmetrical, angular, z-shaped, and open channel profiles.						
2.	apply experimental techniques to locate shear centres and interpret structural behaviour under different loading conditions.						
3.	gain practical exposure to photo-elastic methods using plane polari scope for fringe value calibration and stress visualization.						
4.	evaluate stress patterns and force distribution in components such as circular discs and beams under tension or compression using experimental tools.						
LIST OF EXPERIMENTS							
1. Analysis of Principal Stress Planes in Unsymmetrical Sections							
2. Shear Center Identification in Z-Shaped Structural Sections							
3. Evaluation of Shear Center in Open Channel Profiles							
4. Assessment of Shear Center in Angular Structural Members							
5. Fringe Value Calibration Using Plane Polariscope Techniques							
6. Stress Pattern Analysis in Circular Discs Under Compression							
7. Photo-Elastic Calibration Using Beams in Pure Tension							
8. Force Measurement in Hinged Bar Structures Using Tensioned Wires							
9. Experimental Analysis of Tension Fields in Wagner Beams Using Strain Gauges							
10. Experimental Vibration Analysis for Acceleration and Velocity Detection							
						TOTAL PERIODS	30
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	understand principal stresses and locate shear centers in various structural sections including unsymmetrical, angular, z-shaped, and open channel profiles.					Understand(K2)	
CO2	calibrate fringe values and interpret stress patterns using photo elastic techniques with plane polari scope.					Applying(K3)	
CO3	measure internal forces and stresses in structural elements using					Applying(K3)	

	strain gauges and tensioned wire methods.													
CO4	conduct experimental vibration analysis and determine system responses such as acceleration and velocity using suitable instrumentation.												Applying(K3)	
CO-PO MAPPING :														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-	-	-	-	-	-	-	1	-	3	2
CO2	3	3	2	2	1	-	-	-	-	-	2	-	3	3
CO3	3	3	3	3	2	-	-	-	-	-	2	-	3	3
CO4	3	2	1	-	-	-	-	-	-	-	1	-	3	2



AE23507	AIRCRAFT SYSTEMS AND MAINTENANCE LABORATORY			0	0	4	2
COURSE OBJECTIVES							
To enable the students to							
1.	familiarize students with fundamental aircraft maintenance procedures including jacking, leveling, control surface rigging, and brake system checks						
2.	perform inspection and testing techniques for critical aircraft systems such as landing gear, engines, and control surfaces.						
3.	provide hands-on experience in sheet metal and structural repairs, including riveting, welding, and tubing operations relevant to aviation standards.						
4.	develop skills in evaluating and executing fabrication techniques such as scarf joints, flaring, and MIG/ARC welding to ensure airworthiness and compliance.						
LIST OF EXPERIMENTS							
1. Aircraft Jacking Up and Leveling procedure.							
2. Control System Rigging check procedure.							
3. Brake Torque Load Test on wheel brake units.							
4. Landing gear retraction test.							
5. Engine (Piston Engine) - cleaning, visual inspection, NDT checks.							
6. Riveted patch repairs.							
7. Tube bending and flaring							
8. Welded single & double V- joints.							
9. MIG and ARC welding of aircraft components							
10. Aircraft wood gluing - Single scarf joint and Double scarf joint							
						TOTAL PERIODS	60
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	demonstrate understanding of key aircraft maintenance tasks such as jacking, rigging, and break load test procedures.					Understanding (K2)	
CO2	perform standard maintenance practices to perform landing gear retraction tests and conduct piston engine cleaning, visual inspections, and basic non-destructive testing.					Applying (K3)	
CO3	execute structural repair techniques such as riveted patch repairs, scarf joints, and tube flaring in accordance with aviation					Analyzing (K4)	

	maintenance standards.													
CO4	conduct MIG and ARC welding techniques for basic fabrication and repair of aircraft structural components in accordance with workshop safety and quality standards.												Applying (K3)	
CO-PO MAPPING :														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	-	-	-	1	1	-	1	3	2
CO2	3	2	2	1	2	-	-	-	1	1	-	1	3	2
CO3	3	2	2	1	2	-	-	-	1	1	-	1	3	2
CO4	3	2	2	1	2	-	-	-	1	1	-	1	3	2



AE23508		INDUSTRIAL TRAINING			
COURSE OBJECTIVES		0	0	2	1
To enable the students to					
1	give training in real-world engineering practices and professional work culture in the aeronautical industry.				
2	have a hands-on experience in key aeronautical domains such as aircraft design, propulsion, uavs, avionics, and maintenance.				
3	develop technical and problem-solving skills by involving them in ongoing industrial or research projects.				
4	gain the knowledge of professional communication and documentation abilities through training reports and presentations.				
DESCRIPTION					
<p>Industrial Training provides work experience relevant to their field of specialization, before graduation, and it is an essential component for the development of practical and professional skills required for an engineering graduate and supports for prospective employment.</p> <p>At the end of the industrial training, students should be able to improve their knowledge and skills relevant to their areas of specialization where they have been trained. The students should also be able to relate, apply, and adapt the relevant knowledge, concepts, and theories within an industrial organization, and also to practice the general workplace behavior and interpersonal skills.</p> <p>The student (either in group or single) should undergo industrial training for a minimum period of two weeks during the summer vacation after the completion of fourth semester as specified in the curriculum in any research organization/university/industry of State/National and International level industry relevant to their branch of specialization, after getting proper approval from the Head of the Institution.</p> <p>On the completion of the industrial training for the specified period, the student has to submit the industrial training report (at least 25-30 pages) containing the following details, along with the certificate obtained from the industry for the period of training undergone.</p> <ol style="list-style-type: none"> 1. Introduction of the industry. 2. Industry layout and its various operations with its infrastructure facilities. 3. Formulation of practical problems, data required to formulate the problems and its analysis. 4. Suggestions and recommendations for the above problems <p>During the period of training, the student has to abide the rules and regulations enforced by the organization and to ensure FULL attendance during the period of industrial training and uphold the discipline and decorum of the institution.</p> <p>On the completion of the industrial training, the End Semester Examinations shall be conducted by the Office of the Controller of Examinations at the end of the fifth semester. A three-member committee constituted by the</p>					

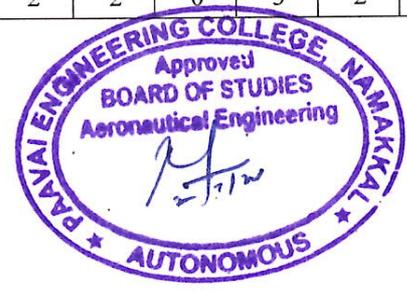
Head of the Institution, consisting of (1) a senior faculty member at the Professor level, (2) senior faculty member at the Associate Professor and (3) faculty member from outside the department, will evaluate the industrial training undergone by the student. The evaluation shall be made based on the report submitted along with the presentation and a Viva voce Examination.

		TOTAL PERIODS :30
COURSE OUTCOMES		BT MAPPED (Highest level)
At the end of the course, the students will be able to		
CO1	understand theoretical knowledge to practical problems in various aeronautical domains including aircraft systems, aerodynamics, and propulsion.	Understanding(K2)
CO2	demonstrate the ability to work professionally in teams and adapt to industry standards and safety protocols.	Applying(K3)
CO3	prepare and present a comprehensive technical report based on the training experience, demonstrating effective documentation skills.	Applying(K3)
CO4	exhibit improved understanding of industrial practices and current technological trends in the aeronautical sector.	Applying(K3)

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO2	-	-	-	-	-	-	-	1	3	2	1	2	1	2
CO3	2	-	-	-	1	-	-	-	2	3	2	2	1	2
CO4	2	2	-	1	2	1	-	-	2	2	0	3	2	2



GE23501	PROFESSIONAL DEVELOPMENT III	0	0	2	1
COURSE OBJECTIVES					
To enable students to					
1.	enhance their Resume writing skills and improving corporate vocabularies to survive in the corporate world.				
2.	evaluate their interview skills and improve their interview presentation.				
3.	solve the quantitative aptitude problems and improve their mental ability.				
4.	improve critical thinking and reasoning skills.				
UNIT I	RESUME WRITING SKILLS				6
Updated Resume Building III – Self Introduction III – Dressing Etiquette – JAM V – Corporate Vocabulary.					
UNIT II	INTERVIEW SKILLS				6
Interview skills – General guidelines - Work Ethics – Group Discussion III – JAM VI – Presentation Competence – Mock Interview.					
UNIT III	QUANTITATIVE APTITUDE				9
Cube Root and Square Root - Time and Work - Ages - Permutation and Combination - Probability – Calendar.					
UNIT IV	LOGICAL REASONING				9
Series Completion - Blood Relations - Coding and Decoding - Data Sufficiency - Statements and Assumptions.					
TOTAL PERIODS:					30
COURSE OUTCOMES					BT MAPPED
Upon completion of the course, the students will be able to					(Highest Level)
CO1	excel in drafting Resumes and speaking.				Applying (K3)
CO2	demonstrate the participative skills in group discussions and Interviews.				Applying (K3)
CO3	solve problems based on quantitative aptitude.				Applying (K3)
CO4	enhance their logical and verbal reasoning.				Analyzing (K4)
TEXTBOOKS					
1. Aggarwal, R. S. A Modern Approach to Verbal & Non-Verbal Reasoning. Revised ed., 2024–25, S. Chand & Company Ltd., 2024.					
2. Aggarwal, R. S. Objective General English: Fully Revised Video Edition. S. Chand & Company Ltd., 2022.					
REFERENCES					
1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.2015.					
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.					
3. Johnson, D.W. Reaching out — Interpersonal Effectiveness and self- actualisation. Boston: Allyn and Bacon.2019.					
4. Infosys Campus Connect Program — students' guide for soft skills.2015.					

CO/PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3



AE23151	AIRCRAFT MATERIALS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	learn different material properties, defects, and equipment, and the procedure to perform various destructive and non-destructive tests.						
2.	familiarize yourself with various strengthening and hardening mechanisms of materials.						
3.	understand materials used in aircraft construction – aluminium, magnesium, titanium, steel, copper alloys, and super alloys.						
4.	learn about composites, sandwich structures, and adhesives.						
5.	understand about material characterization.						
UNIT I	ELEMENTS OF AEROSPACE MATERIALS						9
Introduction to Materials; Atomic structure of materials - crystal structure, miller indices, density, packing factor; Space lattices; X-ray diffraction; Imperfection in crystals – physical metallurgy, general requirements of materials for aerospace applications.							
UNIT II	MECHANICAL BEHAVIOUR OF MATERIALS						9
Linear and non-linear elastic properties – Yielding, strain hardening, fracture, Bauchinger’s effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.							
UNIT III	CORROSION & HEAT TREATMENT OF METALS AND ALLOYS						9
Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles; Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys ; Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy.							
UNIT IV	CERAMICS AND COMPOSITES						9
Introduction – physical metallurgy, modern ceramic materials ; cermet - cutting tools ; glass ceramic –production of semi-fabricated forms ;Plastics and rubber ; Carbon/Carbon composites; Fabrication processes involved in metal matrix composites - shape memory alloys ; applications in aerospace vehicle design.							
UNIT V	HIGH TEMPERATURE MATERIALS CHARACTERIZATION						9
Classification- production and characteristics; Methods and testing – Determination of mechanical and thermal properties of materials at elevated temperatures; Application of these materials in Thermal protection systems of Aerospace vehicles; super alloys – High temperature material characterization.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	gain knowledge of atomic and crystal structures, miller indices, and					Understanding (K2)	

	imperfections in crystals.	
CO2	develop the ability to evaluate linear and non-linear elastic properties, yielding, fracture, and strain hardening behavior.	Applying (K3)
CO3	understand various types of corrosion and their effects on mechanical properties.	Analysing (K4)
CO4	familiarize with the properties and applications of modern ceramics, cermets, and composites.	Applying (K3)
CO5	gain insights into the classification, production, and testing of high-temperature materials.	Analysing (K4)

TEXT BOOKS

1. Adrian P. Mouritz, "Introduction to Aerospace Materials", Wood head Publishing, 2012.
2. Biliyar N. Bhat, "Aerospace Materials and Applications", American Institute of Aeronautics & Astronautics, 2018.

REFERENCES

1. V. Raghavan, "Material Science & Engineering: A First Course", Sixth Edition, 2015.
2. Lalith Gupta, "Advanced Composite Materials", Himalaya Book House, Delhi, 2006.
3. Biliyar N. Bhat, "Introduction to Aerospace Structures and Materials", American Institute of Aeronautics & Astronautics, 2018.
4. N. Eswara Prasad, R. J. H. Wanhill (Eds.), "Aerospace Materials and Material Technologies", Springer Singapore, 2017.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3



AE23152	VIBRATION AND AERO ELASTICITY			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	study the effect of time dependent forces on mechanical systems						
2.	learn the Eigen value and vector problems						
3.	understand about the natural characteristics of continuous system.						
4.	familiarize with the Approximate Methods						
5.	study the Aero elastic effects of aircraft wing						
UNIT I	SINGLE DEGREE OF FREEDOM SYSTEMS						9
Introduction to simple harmonic motion, D'Alembert's principle, free vibrations – damped vibrations– forced vibrations, with and without damping–support excitation–transmissibility-vibration measuring instruments.							
UNIT II	MULTI DEGREE OF FREEDOM SYSTEMS						9
Two degrees of freedom systems - static and dynamic couplings - vibration absorber- Multi degree of freedom systems - principal co-ordinates - principal modes and orthogonal conditions - Eigen value problems - Hamilton's principle - Lagrangean equations and application.							
UNIT III	CONTINUOUS SYSTEMS						9
Vibration of elastic bodies-Vibration of strings–longitudinal, lateral and torsional vibrations.							
UNIT IV	APPROXIMATE METHODS						9
Approximate methods-Rayleigh's method-Dunkerley's method–Rayleigh-Ritz method-Holzer method-Matrix iteration method.							
UNIT V	ELEMENTS OF AEROELASTICITY						9
Concepts –coupling- aeroelastic instabilities and their preventions problems - Collars triangle - wing divergence - aileron control reversal – Flutter and its preventions							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	understand the fundamental concepts of single degree of freedom systems and analyze free, damped, and forced vibrations including support excitation and transmissibility.					Understanding (K2)	
CO2	analyze multi-degree of freedom systems using principal coordinates and solve vibration problems using lagrange's equations and hamilton's principle.					Analysing (K4)	

CO3	interpret the vibration behavior of continuous systems such as strings and rods under longitudinal, lateral, and torsional modes.	Understanding (K2)
CO4	apply approximate methods like rayleigh's, dunkerley's, rayleigh-ritz, holzer, and matrix iteration methods to solve complex vibration problems.	Applying (K3)
CO5	understand the basic concepts of aeroelasticity, identify different types of aeroelastic instabilities such as wing divergence, control reversal, and flutter, and suggest methods for their prevention.	Understanding (K2)

TEXT BOOKS

1. Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003
2. S.S. Rao, "Mechanical Vibrations" – SI Edition Pearson, Sixth Edition.

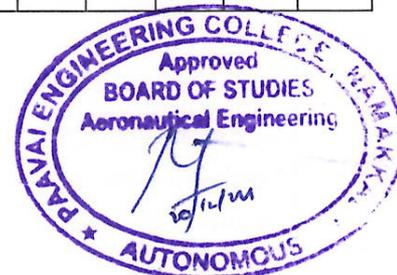
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1. Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Addison Wesley Publication, New york, 1983.
2. Den Hartog, "Mechanical Vibrations", Crastre Press, 2008.
3. Leonard Meirovitch, "Elements of Vibration Analysis", Mc Graw Hill International Edition, 2007.
4. Y.C Fung, "Theory of Elasticity", Dover Publications, Inc. (For the 3rd edition), 2013.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO2	3	3	2	3	3	-	-	-	-	-	-	1	3	3
CO3	3	3	2	3	3	-	-	-	-	-	-	1	3	3
CO4	3	3	2	3	2	-	-	-	-	-	-	2	3	2
CO5	3	2	3	2	2	-	-	-	-	-	-	2	3	3



AE23153	FATIGUE AND FRACTURE MECHANICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	provide the basic knowledge on the mechanics of elastic and plastic deformation.						
2.	understand creep, fracture, and fatigue failure, as applied to metals, composites, and ceramics.						
3.	provide a thorough introduction to the principles of fracture mechanics.						
4.	provide practical examples of the application of fracture mechanics to design and life prediction.						
5.	apply stress analysis to calculate the crack driving force in linear and non linear materials, and formulate appropriate fracture criteria for stationary and growing cracks.						
UNIT I	FATIGUE OF STRUCTURES						9
Definition of fatigue - S-N curve , Endurance limit ; Effect of mean stress on fatigue - Goodman diagram ; Gerber and Soderberg relations - Notches and Stress concentrations ; Neuber's stress concentrations ; Plastic stress concentration - Notched S-N curve.							
UNIT II	STATISTICAL STUDY OF FATIGUE BEHAVIOUR						9
Low cycle and high cycle fatigue - Coffin - Manson's relation , Transition life ; cyclic strain hardening and softening - Analysis of load histories ; Cycle counting techniques –Cumulative damage ; Miner's theory - Other theories.							
UNIT III	PHYSICAL ASPECTS OF FATIGUE						9
Phase in fatigue life - Crack initiation , Crack growth , Final Fracture , Dislocations ; fatigue fracture surfaces.							
UNIT IV	FRACTURE MECHANICS						9
Strength of cracked bodies - Potential energy and surface energy ; Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials ; stress analysis of cracked bodies - Effect of thickness on fracture toughness; stress intensity factors for typical geometries.							
UNIT V	FATIGUE DESIGN AND TESTING						9
Safe life and Fail-safe design philosophies; Importance of Fracture Mechanics in aerospace structures ;Application to composite materials and structures.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the need and importance of fatigue analysis.					Understanding (K2)	
CO2	analyze the fatigue life of a component based on its s-n data.					Analysing (K4)	

CO3	define the physical phases in the fatigue life of a component.	Remembering (K1)
CO4	recognize the mechanics of the propagation of cracks during fracture in a material.	Understanding (K2)
CO5	distinguish the fatigue-based design philosophies and classify materials based on their fatigue life.	Analysing (K4)

TEXT BOOKS

1. T. L. Anderson, "Fracture Mechanics: Fundamentals and Applications", IV Edition, 2017.
2. Prasanth Kumar, "Elements of Fracture Mechanics", Wheeler Publication, 2009.

REFERENCES

1. Barrois W., Ripley E. L., "Fatigue of Aircraft Structure", Pergamon Press, Oxford, 2006.
2. Knott J. F., "Fundamentals of Fracture Mechanics", Butterworth & Co. Ltd., London, 1983.
3. Subra Suresh, "Fatigue of Materials", II Edition, 1998.
4. Sin C. G., "Mechanics of Fracture", Vol. I, Sijth off and Noordh off International

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	3	-	-	-	-	-	-	1	2	3	2
CO2	2	3	2	3	-	-	-	-	-	2	2	-	2	3
CO3	-	2	3	2	2	-	-	-	-	-	-	2	-	2
CO4	3	2	3	2	2	-	-	-	-	-	-	-	1	-
CO5	2	1	3	3	-	-	-	-	-	2	-	3	-	-



AE23154	SMART MATERIALS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	familiarize with the fundamentals of structural health monitoring.				
2.	impart knowledge in the areas of Vibration based techniques in structural health monitoring, fibre optics and Piezo electric sensors.				
3.	familiarize with the fundamentals of fabrication, modelling, analysis, and design of smart materials and structures.				
4.	enable the student to get exposed to the state of the art of smart materials and systems, spanning piezo electrics, shape memory, alloys, electro active polymers.				
5.	familiarize with artificial neural networks and image processing.				
UNIT I	OVERVIEW AND INTRODUCTION				9
Piezoelectric Material Crystal Structure – Fundamentals of Piezoelectricity ; Shape Memory Alloys – Fundamentals of Shape Memory Alloy (SMA) Behaviour , Phase Transformation , Lattice Structure and Deformation Mechanism ;Electrostrictive Material Systems – ER and MR Fluids , Current Application ,Aerospace Field ; Machine Tools – Automotive Systems , Medical Systems , Electronics Equipment , Robots , Energy Harvesting Using Smart Materials.					
UNIT II	PIEZOELECTRIC THEORY				9
Electromechanical Constitutive Equations – Piezo ceramic Actuator & Sensor Equations , Piezoelectric Coupling Coefficients ; Actuator Performance and Load Line Analysis – Hysteresis and Nonlinearities in Piezoelectric Materials , Piezo ceramic Actuators ,Behavior under Static & Dynamic Excitation Fields ;DepolingBehavior and Dielectric Breakdown , Curie Temperature , Power Consumption , Equivalent Circuits to Model Piezo ceramic Actuators ; The Bimorph Sensor.					
UNIT III	BEAM MODELLING WITH PIEZOELECTRIC MATERIAL				9
Basic Definitions of Stress, Strains and Displacements in Beams – Transverse Deflection of Uniform Isotropic Beams ; Simple Blocked Force Beam Model (Pin Force Model) – Single Actuator Characteristics , Dual Actuators ; Symmetric & Asymmetric Actuation with Differential Voltages – Uniform Strain Model , Euler-Bernoulli Beam Model , Dissimilar Actuators , Embedded Actuators ; Testing of a Beam with Surface Mounted Piezoactuators.					
UNIT IV	UNDERSTANDING SHAPE MEMORY ALLOYS (SMA)				9
Low Temperature Stress-Strain Curve – Origin of the One-Way Shape Memory Effect , Stress Induced Martensite and Pseudoelasticity , Two-Way Shape Memory Effect , All-Round Shape Memory Effect ; R-Phase Transformation - Porous SMA , Constrained Behavior of SMA , Free Recovery , Constrained Recovery ; Effective Load-Lines of an SMA Wire Actuator – Sample Preparation , Transformation Temperatures under Zero Stress.					
UNIT V	CONSTITUTIVE MODELLING AND SMA BEHAVIOUR				9
Tanaka Model – Liang and Rogers Model , Brinson Model ; Testing of SMA Wires –Variation of Transformation Temperatures with Stress , Stress Strain Behavior at Constant Temperature , Stress-Temperature Behavior at Constant Strain ; Heat Absorbed by the SMA Wire ;Thermo mechanical					

Energy Equilibrium Power Requirements for SMA Activation ; Resistance Behavior of SMA Wires – Heat Dissipation , SMA Wire Damping Capacity.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

**BT Mapped
(Highest Level)**

CO1	classify the various forms of functional materials.	Understanding (K2)
CO2	investigate the piezoelectric material behaviour.	Applying(K3)
CO3	investigate the behaviour of sma material.	Analyzing(K4)
CO4	model a beam with piezoelectric patch.	Applying(K3)
CO5	impart knowledge on modelling of sma material.	Analyzing(K4)

TEXT BOOKS

1. Inderjit Chopra and JayantSirohi, “Smart Structures Theory”, Cambridge University Press, 2014.
2. Michael F. Ashley, “Material Selection in Mechanical Design”, 5th edition, Butter worth Heiner, 2016.

REFERENCES

1. Martin, J.W., Engineering Materials, Their properties and Applications, Wyk edham Publications (London) Ltd., 1987.
2. Prasad, N. Eswara, Wanhill, R. J. H, “Aerospace Materials and Material Technologies – Indian Institute of Metals Series”, 2017.
3. Sam Zhang, “Aerospace Materials Handbook (Advances in Materials Science and Engineering) 1st Edition, 2016.
4. Van Vlack.L.H., Elements of Materials Science and Engineering Prentice Hall; Publishers, Sixth edition, 1989.

CO-PO MAPPING :

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific

Outcomes PSO’s

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	Programme Outcomes PO’s												PSO’s	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	3	-	-	-	-	-	-	1	2	3	2
CO2	2	3	2	3	-	-	-	-	-	2	2	-	2	3
CO3	2	2	3	2	2	-	-	-	-	-	-	2	-	2
CO4	3	2	3	2	2	-	-	-	-	-	-	-	1	-
CO5	2	1	3	3	-	-	-	-	-	2	-	-	-	-



AE23155	THEORY OF ELASTICITY			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand and apply fundamental principles of elasticity, including stress-strain relationships, equilibrium, and compatibility equations to solve real-world problems.						
2.	develop an understanding of plane stress and plane strain conditions, and apply Airy's stress function to solve two-dimensional elasticity problems						
3.	apply polar coordinate methods to solve axisymmetric problems in elasticity, including rotating discs and thick-walled pressure vessels.						
4.	understand and apply torsion theories to solve problems in shafts with various cross-sectional geometries, and use membrane analogy to determine stress distribution.						
5.	learn classical plate theory and solution methods (Navier's and Levy's methods) to solve bending problems of rectangular plates under various boundary conditions.						
UNIT I	BASIC EQUATIONS OF ELASTICITY						9
Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants							
UNIT II	PLANE STRESS AND PLANE STRAIN PROBLEMS						9
Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.							
UNIT III	POLAR COORDINATES						9
Equations of equilibrium, Strain-displacement relations, Stress-strain relations, Airy's stress function, Axi-symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lamé's, Kirsch, Michell's and Boussinesque problems-Rotating discs.							
UNIT IV	TORSION						9
Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi-inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.							
UNIT V	INTRODUCTION TO THEORY OF PLATES AND SHELLS						9
Classical plate theory - Assumptions - Governing equations - Boundary conditions - Navier's method of solution for simply supported rectangular plates-Levy's method of solution for rectangular plates under different boundary conditions.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	apply basic equations of elasticity (stress-strain relationships,					Applying (K3)	

	equilibrium, compatibility) to solve real-world engineering problems involving complex loading and boundary conditions.	
CO2	analyze two-dimensional plane stress and plane strain problems using Airy's stress function and bi-harmonic equations.	Analysing (K4)
CO3	solve problems in polar coordinates, such as axi symmetric problems (e.g., rotating discs, thick-walled pressure vessels, curved beams).	Applying (K3)
CO4	understand and apply various theories of torsion (Navier, St. Venant, Prandtl) to solve torsion problems in shafts of different cross-sectional shapes.	Understanding (K2)
CO5	apply classical plate theory and solution methods (Navier's and Levy's methods) to solve bending problems of rectangular plates with different boundary conditions.	Applying (K3)

TEXT BOOKS

1. Ansel C U gural and Saul K Fenster, "Advanced Strength and Applied Elasticity", 4th Edition,
2. Bhaskar K and Varadan, T.K., "Theory of Isotropic/Orthotropic Elasticity", CRC Press USA, 2009.

REFERENCES

1. Barber, J. R., Elasticity (Solid Mechanics and Its Applications), Springer publishers, 3rd edition, 2010.
2. Sokolnik off, I.S., Mathematical Theory of Elasticity, Mc Graw-Hill, New York, 1978.
3. Wang, C.T., Applied Elasticity, Mc Graw-Hill Co., New York, 1993.
4. Volterra & J.H. Caines, Advanced Strength of Materials, Prantice Hall , New Jersey ,1991.

CO-PO MAPPING :

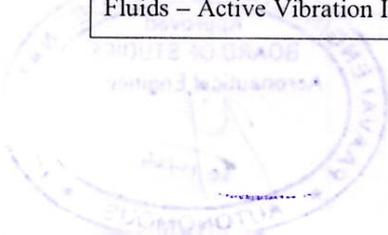
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	3	-	-	-	-	-	-	1	2	3	2
CO2	2	3	2	3	-	-	-	-	-	2	2	-	2	3
CO3	2	2	3	2	2	-	-	-	-	-	-	2	-	2
CO4	3	2	3	2	2	-	-	-	-	-	-	-	1	-
CO5	2	1	3	3	-	-	-	-	-	2	-	3	-	-



AE23156	VIBRATION ISOLATION AND CONTROL	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	introduce the fundamental concepts of vibration theory and to understand the behavior of mechanical systems undergoing free and forced vibrations.				
2.	explore different types of vibration isolators and their effectiveness in reducing the impact of vibration on structures and systems.				
3.	analyze the role of absorbers in continuous systems and examine the process of field balancing of rotors.				
4.	learn how to select appropriate materials based on damping-stress relationships and criteria for linear hysteretic materials				
5.	understand how shape memory actuators and tuned vibration absorbers work for vibration control in real-world applications.				
UNIT I	BASIC VIBRATION THEORY				9
Free Vibration Theory – Determination of Natural Frequency of a Single Degree Of Freedom – System– Response of a Damped Single Degree of Freedom System – Role of Damping – Forced Vibrations of Discrete Systems – Continuous Systems – Vibrations of Beams and Shafts –Idealization of a Real System Into a Discrete Model – Resonance – An Overview of the Different Methods of Vibration Control.					
UNIT II	VIBRATION ISOLATION				9
Transmissibility – Numerical Examples – Necessity of Vibration Isolation – Vibration Reduction at Source – System Redesign – Different Types of Isolators & Their Effectiveness – Pneumatic Suspension – Excitation Reduction at Source and Factors Affecting Vibration Level – Source Classification – Control of Flow Induced & Self-Excited Systems.					
UNIT III	DYNAMIC VIBRATION ABSORBER				9
Dynamic Vibration Neutralizers – Self-tuned Pendulum Neutralizer - Optimum Design of Damped Absorbers – Absorber with ideal spring and viscous dashpot – Gyroscopic vibration absorbers –Impact Absorbers – Absorbers attached to continuous systems – Field Balancing of Rotors –Resonance: Detuning and Decoupling – Remedial Measures.					
UNIT IV	SELECTION OF MATERIALS				9
Dynamic Properties of Visco elastic Material – Selection of Materials – Damping-Stress Relationship – Selection Criteria for Linear Hysteretic Material – Design for enhanced material damping – Linear Viscoelastic Model – Constrained Layer Damping – Relaxation – Frequency and Temperature Dependence of the Complex Modulus – Overview and Role of Smart Materials.					
UNIT V	PRINCIPLES OF ACTIVE VIBRATION CONTROL				9
Conceptual Understanding – Shape Memory Actuators for Vibration Control – Shape Memory Materials – Tuned Vibration Absorbers using SMA – Basics of Electro-and Magneto-Rheological Fluids – Active Vibration Isolation using ERF and MRF – Methods of Active Vibration Control Using					



Piezoelectric Materials – Derivation of Governing Equations – Response of the Structure.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

**BT Mapped
(Highest Level)**

CO1	explain the basic concepts of vibration, natural frequency, damping, resonance, and system modeling.	Understanding (K2)
CO2	analyze the vibration response of single and multi-degree of freedom systems under free and forced conditions.	Analyzing (K4)
CO3	apply the principles of vibration isolation to reduce vibrations in mechanical systems.	Applying (K3)
CO4	select suitable materials and damping treatments based on their dynamic properties for vibration control.	Applying (K3)
CO5	interpret and simulate the response of structures under active vibration control using smart materials and feedback systems.	Analyzing (K4)

TEXT BOOKS

1. S.S.Rao, "Mechanical Vibrations", (Addison-Wesley series in mechanical engineering), Pearson Education 2nd edition, 1990.
2. Ira H. Shames, "Fundamentals of Vibration", Prentice Hall 2nd Edition, 1995.

REFERENCES

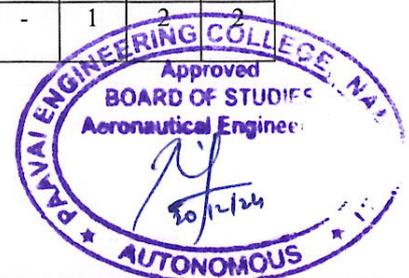
1. Mead, D J, "Passive Vibration Control", Wiley, 1st edition, 1999.
2. Preumont, "A Vibration Control of Active Structures", Springer Netherlands, 3rd edition, 2011.
3. B. R. Gupta, "Vibration and Damping of Mechanical Systems", Oxford & IBH Publishing Co. 1st Edition, 2007
4. Alfred C. Ziemian, "Vibration and Shock Handbook", CRC press 1st Edition, 2008.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	-	-	2	2	-	-	-	-	1	2	1
CO2	3	3	2	-	-	2	2	-	-	-	-	1	3	2
CO3	3	3	2	-	-	2	1	-	-	-	-	1	3	2
CO4	3	2	2	-	-	1	1	-	-	-	-	1	2	1
CO5	3	3	2	-	-	2	1	-	-	-	-	1	2	2



AE23157	STRCUTURAL HEALTH MONITORING IN AIRCRAFT	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	provide an understanding of NDT techniques, their applications, and their role in detecting structural issues like corrosion, fatigue, and cracks in aerospace components.				
2.	introduce the fundamentals of optical and electron microscopy, including SEM and TEM, and their applications in material inspection.				
3.	explore the principles and applications of acoustic emission and ultrasonic testing methods for defect detection and characterization in metals and composites.				
4.	cover the various NDT methods used in aircraft inspections, including their application in jet engines, fuselage, and critical locations for maintaining airworthiness.				
5.	examine the role of SHM, smart materials, and their applications in monitoring the health of aerospace structures, with an emphasis on current and future trends.				
UNIT I	INTRODUCTION				9
Need for non-destructive evaluation (NDT) – Applications – Structural inspection; Structural deterioration due to corrosion and fatigue – Crack growth , Fabrication defects, Overloading ; Detailed visual inspection – Aircraft wing and fuselage inspection using various NDT techniques ; Overview and relative comparison of NDT methods – Jet engine inspection , Critical locations.					
UNIT II	ELECTRON MICROSCOPY				9
Fundamentals of optics – Optical microscope and its instrumental details , Variants in the optical microscopes and image formation , Polarization light effect , Sample preparation and applications of optical microscopes ; Introduction to Scanning electron microscopy (SEM) – Instrumental details and image formation of SEM ; Introduction to transmission electron microscopy (TEM) – Imaging techniques and spectroscopy ; Sample preparation for SEM and TEM.					
UNIT III	ACOUSTIC EMISSION AND ULTRASONICS				9
Sources of acoustic emission – Physical principals involving acoustic emission and ultrasonics, Configuration of ultrasonic sensors , Phased array ultrasonics; Instrument parts and features for acoustic emission and ultrasonics ; Defect characterization – Inspection of cracks and other flaws in metals and composites , Interpretation of data , Image processing , Concepts and application.					
UNIT IV	AIRCRAFT INSPECTION				9
Inspection Levels ; General Visual Inspection – During pre, or post flight ; Detailed Visual Inspection (DET) – Periodic inspection ; Special Detailed Inspection (SDET) – Uses of NDT Methods ; Jet Engine Inspection – Engine overhaul , Fluorescent penetrate inspection ; Airframe Loading – Fuselage Inspection , Critical Locations ; Comparison of different methods of NDT – Visual , Radiography , Eddy Current Testing , Liquid Penetrant Testing , Remote Testing ; Landing Gear Inspection.					
UNIT V	STRUCTURAL HEALTH MONITORING				9
An Overview of Structural Health Monitoring – Structural Health Monitoring and Role of Smart Materials; Structural Health Monitoring versus Non-Destructive Evaluation – A Broad Overview of Smart Materials Applications ; Notable Applications of SHM in Aerospace Engineering ; Structural health monitoring of					

composites ; Repair investigation using SHM – Current limits and future trends.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the need, applications, and methods of non-destructive testing (ndt) in structural inspection and damage assessment in aerospace.	Understanding (K2)
CO2	gain knowledge on the principles and applications of optical microscopy, sem, and tem for detailed material analysis.	Applying (K3)
CO3	understand the principles of acoustic emission and ultrasonics for detecting and characterizing defects in materials and structures.	Analysing (K4)
CO4	learn the various ndt methods and inspection levels used in aircraft structural and engine inspections, ensuring safety and reliability.	Applying (K3)
CO5	explore the role of structural health monitoring (shm) and smart materials in aerospace, with an emphasis on future trends and applications.	Analysing (K4)

TEXT BOOKS

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Guemes, “Structural Health Monitoring”, Wiley ISTE, 2006.
2. Douglas E Adams, “Health Monitoring of Structural Materials and Components-Methods with Applications”, John Wiley and Sons, 2007.

REFERENCES

1. Douglas B. Murphy, “Fundamentals of light microscopy and electronic imaging”, Wiley- Liss, Inc. USA, 2012.
2. Richard Brundle. C, Charles A. Evans, Jr., Shaun Wilson, “Encyclopedia of Materials Characterization, Surfaces, Interfaces, Thin Films”, Butterworth-Heinemann, Boston, USA, 2021.
3. Williams, D B & Barry Carter,C, “Transmission electron microscopy, vol. 4”, Springer, USA, 2009.
4. "Non-Destructive Testing Handbook", ASNT, 3rd Edition, 2021.

CO-PO MAPPING:

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CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3



AE23251	WIND TUNNEL TECHNIQUES			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	learn the types of low speed wind tunnels and non-dimensional numbers with its applications.						
2.	learn the types of high speed wind tunnels and with its calibration methods.						
3.	understand the special wind tunnels and with its calibration methods with its design methods.						
4.	describe flow visualization techniques and data acquisition methods.						
5.	understand the functions of various instruments associated with wind tunnel						
UNIT I	LOW SPEED WIND TUNNELS						9
Classification –non-dimensional numbers-types of similarities - Layout of open circuit and closed circuit subsonic wind tunnels – design parameters-energy ratio - HP calculations - Calibration methods.							
UNIT II	HIGH SPEED WIND TUNNELS						9
Blow down, in draft and induction tunnel layouts and their design features -Transonic, and supersonic tunnels- peculiar features of these tunnels and operational difficulties - sample design calculations and calibration methods.							
UNIT III	SPECIAL WIND TUNNEL TECHNIQUES						9
Types of Special Wind Tunnels – Hypersonic, Gun and Shock Tunnels – Design features and calibration methods- Intake tests – store carriage and separation tests - wind tunnel model design for these tests							
UNIT IV	WIND TUNNEL INSTRUMENTATION						9
Instrumentation and sensors required for both steady and unsteady measurements – Force measurements using three component and six component balances – calibration of measuring instruments – error estimation and uncertainty analysis.							
UNIT V	FLOW VISUALIZATION and NON-INTRUSIVE FLOW DIAGNOSTICS						9
Smoke and Tuft grid techniques – Dye injection special techniques – Oil flow visualization and PSP techniques - Optical methods of flow visualization – PIV and Laser Doppler techniques – Image processing and data deduction.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the classification, layout, and design parameters of low-speed and high-speed wind tunnels.					Understanding (K2)	

CO2	apply design principles to calculate energy ratios and horsepower requirements for various types of wind tunnels.	Applying (K3)
CO3	analyze the operational features and challenges of special wind tunnels such as hypersonic, gun, and shock tunnels.	Analysing (K4)
CO4	identify the types of sensors and instrumentation used for steady and unsteady flow measurements in wind tunnels.	Applying (K3)
CO5	describe various flow visualization techniques such as smoke, tuft grid, dye injection, and oil flow methods.	Analysing (K4)

TEXT BOOKS

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984
2. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.

REFERENCES

1. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore
2. Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press – Taylor & Francis, 2007.
3. Short term course on Flow visualization techniques, NAL , 2009
4. P. Bradshaw, "Experimental Fluid Mechanics", Pergamon Press, 1964.

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	1	3	-	-	3	-	-	-	-	-	-	-	3	1
CO3	1	3	1	1	1	-	-	-	-	-	-	-	3	1
CO4	1	2	-	2	3	-	-	-	-	-	-	-	2	-
CO5	1	1	1	-	-	-	-	-	-	-	-	-	1	1



AE23252	BOUNDARY LAYER THEORY			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the basic equations that govern viscous fluid flow, including the Navier–Stokes equations.						
2.	learn exact solutions for incompressible viscous flows such as Couette and Poiseuille flows.						
3.	study how laminar boundary layers develop and how to analyze them using classical methods.						
4.	understand the nature of turbulent boundary layers and how to analyze their velocity profiles.						
5.	explore different methods used to control boundary layers in practical applications.						
UNIT I	VISCOUS FLOW						9
Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum - Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekman drift, shear layer growth in jet flows							
UNIT II	INCOMPRESSIBLE VISCOUS FLOW						9
Solutions of viscous flow equations, Hagen-Poiseuille flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.							
UNIT III	LAMINAR BOUNDARY LAYER						9
Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation - boundary layer over a curved body-Flow separation - similarity solutions, Blasius solution for flat-plate flow, Falkner-Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold’s analogy – Pohlhausen method.							
UNIT IV	TURBULENT BOUNDARY LAYER						9
Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate							
UNIT V	BOUNDARY LAYER CONTROL						9
Boundary layer control in laminar flow-Methods of Boundary layer control: Acceleration of the boundary layer-Suction- Injection of a different gas-Prevention of transition - Cooling of the wall-Boundary layer suction- Practical examples of Boundary Layer Control.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	describe the fundamental equations governing viscous fluid flows including conservation laws and navier-stokes equations.					Understanding (K2)	

CO2	apply the navier-stokes equations to analyze simple viscous flows such as couette and poiseuille flows and creeping motions	Apply (K3)
CO3	analyze incompressible viscous flow phenomena including flow between rotating cylinders and boundary layer development using classical solutions like stokes and hagen–poiseuille.	Analyze (K4)
CO4	define turbulence and explain its physical and mathematical characteristics in boundary layer flows.	Remembering (K1)
CO5	interpret turbulent boundary layer equations and velocity profiles using concepts like the law of the wall and turbulent flow in ducts and plates.	Understanding (K2)

TEXT BOOKS

1. H. Schlichting, “Boundary Layer Theory”, 9th Edition, Mc Graw-Hill, New York, 2017.
2. Frank White, “Viscous Fluid flow”, 4th Edition, Mc Graw Hill, 2022.

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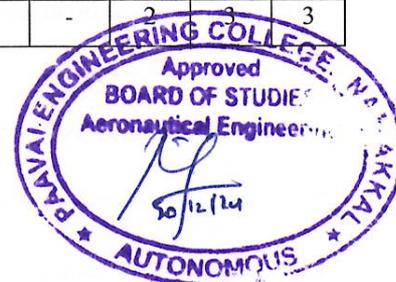
1. A. J. Reynolds, “Turbulent flows in Engineering”, John Wiley & Sons, 1974
2. Ronald L., Panton, “Incompressible fluid flow”, John Wiley & Sons, 2006
3. Tuncer Cebeci and Peter Bradshaw, “Momentum transfer in boundary layers”, Hemisphere Publishing Corporation, 1977.
4. Rolland B.Stull, “An Introduction to Boundary Layer Meteorology”, 2nd edition, Kluwer Academy Publisher, 2019.

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	Programme Outcomes PO’s												PSO’s	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3



AE23253	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1.	understand the basics of computational fluid dynamics and the governing equations of fluid dynamics.					
2.	learn the techniques of grid generation and mesh adaptation.					
3.	apply various cfd techniques to solve fluid dynamics problems.					
4.	solve numerical problems related to quasi-one-dimensional nozzle flows and two-dimensional supersonic flows.					
5.	explore modern cfd methods and their applications.					
UNIT I	FUNDAMENTALS OF COMPUTATIONAL FLUID DYNAMICS	9				
Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations						
UNIT II	GRID GENERATION AND MESH ADAPTATION	9				
Structured grids. Types and transformations. Generation of structured grids. Unstructured grids – Mesh refinement – Adaptive mesh.						
UNIT III	CFD TECHNIQUES	9				
The Lax-Wendroff Technique- MacCormack's Technique- The Relaxation Technique- The Alternating-Direction-Implicit (ADI) Technique-The Pressure Correction Technique-Variou Computer Graphic Techniques.						
UNIT IV	NUMERICAL SOLUTIONS OF QUASI-ONE-DIMENSIONAL NOZZLE FLOWS AND TWO-DIMENSIONAL SUPERSONIC FLOW	9				
CFD Solution of Subsonic-Supersonic Isentropic Nozzle Flow- Purely Subsonic Isentropic Nozzle Flow- Governing Equations in Conservation Form- The Numerical Solution of a Prandtl-Meyer Expansion Wave Flow Field- Explicit Finite-Difference Solution of the Two-Dimensional Complete Navier-Stokes Equations						
UNIT V	MODERN CFD	9				
The Conservation Form of the Governing Flow Equations-Additional Considerations for Implicit Methods- Upwind Schemes-High-Resolution Schemes: TVD and Flux Limiters-The Future of CFD-Industrial Applications						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the basics of computational fluid dynamics and the governing equations				Understanding (K2)	

	of fluid dynamics.	
CO2	generate structured and unstructured grids and adapt meshes for CFD simulations.	Applying (K3)
CO3	implement various cfd techniques such as lax-wendroff, maccormack's, and adi techniques.	Applying (K3)
CO4	solve numerical problems involving quasi-one-dimensional nozzle flows and two-dimensional supersonic flows.	Analysing (K4)
CO5	utilize modern CFD methods, including upwind schemes and high-resolution schemes, for advanced simulations.	Applying (K3)

TEXT BOOKS

1. John D. Anderson Jr., "Computational Fluid Dynamics: The Basics with Applications", International Edition, Mc Graw-Hill Education, 2000.
2. Clovis R. Maliska, "Fundamentals of Computational Fluid Dynamics: The Finite Volume Method", 1st Edition, Springer, 2023.

REFERENCES

1. H. Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson, 2007.
2. Joel H. Ferziger, Milovan Perić, and Robert L. Street, "Computational Methods for Fluid Dynamics," 4th Edition, Springer, 2020.
3. Randall J. LeVeque, "Finite Volume Methods for Hyperbolic Problems", Cambridge University Press, 2002.
4. Jiri Blazek, "Computational Fluid Dynamics Principles and Applications", Third Edition, Elsevier Ltd, 2015.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3



AE23254	MISSILE AERODYNAMICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	describe classification and basics of aerodynamics						
2.	understand about missile configuration and its drag						
3.	learn about the aerodynamics effects on slender body						
4.	provide details of launching aerodynamics.						
5.	comprehend the stability and performance of missile.						
UNIT I	BASICS OF MISSILE AERODYNAMICS						9
Classification of missiles-Aerodynamics characteristics and requirements of air to air missiles, air to surface missiles and surface to air missiles-Missile trajectories							
UNIT II	MISSILE CONFIGURATIONS AND ITS DRAG						9
Various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation – Various types of drag and their origin – methods of minimize the drag types.							
UNIT III	AERODYNAMICS EFFECTS OF SLENDER AND BLUNT BODIES						9
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles							
UNIT IV	LAUNCHING AERODYNAMICS						9
Forces and moments acting on missiles-Lateral, rolling and longitudinal moments-missile dispersion - stability aspects of missile configuration -Aerodynamic control methods-Jet control methods-Stability derivatives.							
UNIT V	STABILITY AND CONTROL OF MISSILES						9
Forces and moments acting on missiles-Lateral, rolling and longitudinal moments-missile dispersion-stability aspects of missile configuration-Aerodynamic control methods-Jet control methods-Stability derivatives							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	identify missile classification					Understanding (K2)	
CO2	compute the drag reduction method in missile					Applying (K3)	
CO3	analyze the slender and blended wing body aerodynamic effects.					Analysing (K4)	
CO4	compute aerodynamic control methods in missile.					Analysing (K4)	
CO5	compute the stability and control of missile					Analysing (K4)	

TEXT BOOKS

1. Mark Pinney, "Aerodynamics of Missiles and Rockets", Mc Graw Gill, 2014
2. Jack N. Nielsen, "Missile Aerodynamics," American Institute of Aeronautics and Astronautics, Nielsen Engineering & Research, Inc, 1988 .

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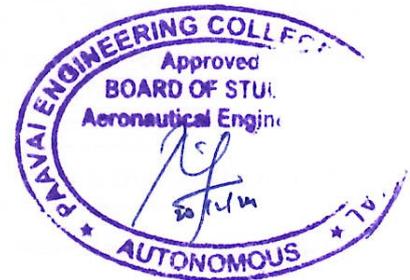
1. Joseph Z. Ben-Assher and Isaac Yaseh, "Advances in Missile Guidance Theory" Israel Military Industries, Inc, 1998
2. Joseph Caleone, "Tactical Missile Warhead", Aerojet General Corporation, 1993.
3. Michael R. Mendenhall, "Tactical Missile Aerodynamics: Prediction Methodology", Nielsen Engineering & Research, 1992.
4. Michael J. Hensch, "Tactical Missile Aerodynamics: General Topics", Lock head Engineering and Science Company, 1992

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	1	3	-	-	3	-	-	-	-	-	-	-	3	1
CO3	1	3	1	1	1	-	-	-	-	-	-	-	3	1
CO4	1	2	-	2	3	-	-	-	-	-	-	-	2	-
CO5	1	1	1	-	-	-	-	-	-	-	-	-	3	1



AE23255	INDUSTRIAL AERODYNAMICS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	apply the principles of aerodynamics to the study of atmospheric effects.				
2.	analyze the aerodynamic properties of ground vehicles.				
3.	investigate the role of aerodynamics in sports, focusing on fluid-structure interactions.				
4.	study the aerodynamic effects on buildings and urban environments.				
5.	apply wind turbine aerodynamics, on design principles, momentum theory, and the efficiency of renewable energy systems.				
UNIT I	ATMOSPHERE AERODYNAMICS				9
Aviation Aerodynamics vs Non-Aviation Aerodynamics, Industrial Aerodynamics and its need, Branches of Industrial Aerodynamics, Atmospheric layers, Atmospheric circulations, Local winds, Terrain types, Atmospheric Boundary Layer (ABL), Aerodynamic Roughness length, Mean velocity profiles, Power-law and Logarithmic law, Variation of wind velocity with height in ABL for different terrain types, Turbulence Intensity and its variation in ABL, Need for ABL simulation, Boundary layer tunnels.					
UNIT II	AUTOMOTIVE AERODYNAMICS				9
Rolling resistance Vs Air resistance, Need for automotive aerodynamics, History of Automotive Aerodynamics, Classification of cars, Pressure distribution over cars, Aerodynamic forces on Automobiles, Lift, Drag and Moments, Sources of vortices in automobiles, Flow separation and wake dynamics, Aerodynamic Improvements, Aerodynamics of motor bikes, Aerodynamics of roofless vehicles, Aerodynamics of Trucks and Buses, Aerodynamics of Trains, Ahmed body – Generic automobile shape, Hovercraft Aerodynamics.					
UNIT III	SPORTS AERODYNAMICS AND FLUID-STRUCTURE INTERACTIONS				9
Aerodynamics of race cars, Ground effects, Down force generation, Frontal and rear wings, Aerodynamic braking - Spoilers, Aerodynamics of wheels, Introduction to sports aerodynamics, Aerodynamics of Cricket ball, Swing and Spin, Effect of dimples on golf ball, Vortex shedding, Strouhal number, Flow induced vibrations, Fluid-structure interactions, Effect of Reynolds number on wake, Aerodynamic flutter, Wake galloping, Vortex shedding control methods					
UNIT IV	BUILDING AERODYNAMICS				9
Need for Building aerodynamics, Environmental winds in city blocks, Low-rise buildings (LRB), Roof suction effects, High-rise buildings (HRB), Dynamic loads, Aerodynamic load mitigation techniques, Flow over a simplified building, Pressure distribution, Wind loads – Time-Varying Load (TVL) Formula, Funneling effect, Heating, Ventilation, and Air Conditioning (HVAC), Architectural Aerodynamics, Wind catchers, Building codes, loads on launch vehicles subjected to winds.					
UNIT V	WIND TURBINE AERODYNAMICS				9
Need for renewable energy sources, Wind energy and its importance, Wind turbine and its parts, Classification of wind turbines, Horizontal axis wind turbine (HAWT), Advantages and disadvantages of HAWT, Vertical axis					

wind turbine (VAWT), Advantages and disadvantages of VAWT, Wind power, Power coefficient, Tip speed ratio, Solidity ratio, 1-D Momentum theory, Betz limit, Power losses, Methods for power control, Blade sections - Airfoil, Wind turbine siting.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	apply the principles of atmospheric boundary layers and analyze wind profiles.	Applying (K3)
CO2	analyze the aerodynamic characteristics of automobiles and other ground vehicles.	Analysing (K4)
CO3	investigate the aerodynamic effects on race cars, cricket balls, and golf balls.	Analysing (K4)
CO4	analyze the aerodynamic forces acting on buildings, focusing on the impact of wind on low-rise and high-rise structures.	Analysing (K4)
CO5	apply principles of wind turbine aerodynamics.	Applying (K3)

TEXT BOOKS

1. J. F. Manwell and J. G. McGowan, "Wind Energy Explained Theory, Design and Application" Second Edition, John Wiley & Sons Ltd, 2009.
2. John D. Holmes, "Wind Loading of Structures", Third Edition, Taylor & Francis Group, LLC, 2015

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1. Wolf-Heinrich Hucho, "Aerodynamics of Road Vehicles from Fluid Mechanics to Vehicle Engineering", Butterworth-Heinemann Ltd, 1990.
2. Tom Lawson, Building aerodynamics. Imperial College Press, 2001.
3. Joseph Katz, Automotive Aerodynamics, John Wiley & Sons, 2016.
4. Martin OL Hansen, Aerodynamics of wind turbines. Routledge, 2015

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	2	3	-	2	-	-	-	-	-	3	2
CO2	3	3	2	3	2	-	2	-	-	-	-	3	2	3
CO3	2	2	3	2	3	-	-	-	-	-	-	-	3	3
CO4	3	-	-	-	2	2	3	-	-	-	-	-	3	3
CO5	3	2	3	2	3	-	3	-	-	-	-	3	2	2



AE23256	EXPERIMENTAL AERODYNAMICS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1.	describe flow visualization techniques and to highlight in depth discussion of analog methods					
2.	understand about calibration and instrumentation of various wind tunnels and force measurements					
3.	learn about the flow visualization.					
4.	provide details, operating principles and limitations of pressure, velocity.					
5.	comprehend the temperature, mass and volume flow measurements.					
UNIT I	MEASUREMENTS IN FLUIDS	9				
Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization – Components of measuring systems – Importance of model studies						
UNIT II	WIND TUNNEL MEASUREMENTS	9				
Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence- Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type – Pyramid type – Strain gauge balance – Balance calibration.						
UNIT III	FLOW VISUALIZATION AND ANALOGUE METHODS	9				
Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe- Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank						
UNIT IV	PRESSURE MEASUREMENTS	9				
Pressure measurement techniques: Introduction-Barometers – Manometers – Dial type pressure gauge – Pressure transducers –Pitot, static and Pitot-Static tube - factors and characteristics –Pitot, static and Pitot-Static probes – Yaw effect-static pressure measurement in compressible Flows-Determination of flow direction –Low pressure measurements – Preston and Stanton Tubes - Sound measurements – Dynamic pressure gauges.						
UNIT V	VELOCITY AND TEMPERATURE MEASUREMENTS	9				
Velocity measurement: Velocity and Mach number from pressure measurements– Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Hot-wire anemometry –Constant current and Constant temperature Hot-Wire anemometer – Hot-wire probes – Hot-wire bridge for classroom demonstration – effect of compressibility and limitations Temperature measurements Techniques: Temperature scales – Temperature measurements – by thermal expansion and electrical effects – Practical Thermocouple measurements – The Resistance temperature detector – Pyrometer – Temperature measuring problems in fluid flow – Dynamic response of temperature sensors.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the basic properties of fluids and various fluid measurement methods				Understanding (K2)	

	including direct, analogue, and visualization techniques.	
CO2	analyze the characteristics, performance, and instrumentation involved in various types of wind tunnels.	Understanding (K2)
CO3	apply flow visualization and analogue techniques such as smoke tunnels, heleshaw apparatus, and schlieren systems to study fluid motion.	Applying(K3)
CO4	compare and analyze the performance and accuracy of pitot, static, and pitot-static tubes in compressible and incompressible flows.	Analysing (K4)
CO5	measure and interpret fluid velocity and temperature using advanced instruments such as ldv, piv, and thermocouples with an understanding of their limitations and dynamic responses.	Applying (K3)

TEXT BOOKS

1. Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press – Taylor & Francis, 2020.
2. R. Goldstein, "Fluid Mechanics Measurements", Second Edition, New York Publication, 2017

REFERENCES

1. Stavros Tavoularis, Jovan Nedic, "Measurement in Fluid Mechanics", Second Edition, Cambridge University Press, 2024
2. Bruno Canet, Patrick Gillieron, "Experimental Aerodynamics", Springer, 2021
3. Stefano Discetti, Andrea Ianiro, "Experimental Aerodynamics", CRC Press, 2020.
4. J.D. Anderson, "Introduction to Aerodynamics", 10th edition, Tata McGraw Gill, 2022.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	3	-	2	-	-	-	-	-	3	2
CO2	3	2	2	2	2	-	2	-	-	-	-	3	2	2
CO3	3	2	2	2	-	-	-	-	-	-	-	-	3	2
CO4	3	-	-	-	2	2	3	-	-	-	-	-	3	3
CO5	3	2	2	3	-	-	3	-	-	-	-	3	2	2



AE23257	HYPERSONIC AERODYNAMICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	learn basics of hypersonic flow, shock wave, boundary layer interaction and aerodynamic heating.						
2.	extend the surface inclination methods for hypersonic inviscid flows.						
3.	explain the approximate methods for inviscid hypersonic flows.						
4.	familiarize them with the aerodynamical aspects of hypersonic vehicles and the general hypersonic flow theory						
5.	understand the viscous interactions in hypersonic viscous flow.						
UNIT I							
BASICS OF HYPERSONIC AERODYNAMICS							9
Thin shock layers – entropy layers – low density and high-density flows – hypersonic flight paths – hypersonic flight similarity parameters – shock wave and expansion wave relations of in viscid hypersonic flows.							
UNIT II							
SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS							9
Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties.							
UNIT III							
APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS							9
Approximate methods – hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory – entropy effects – rotational method of characteristics – hypersonic shock wave, shapes and correlations							
UNIT IV							
VISCOUS HYPERSONIC FLOW THEORY							9
Navier-Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non-similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.							
UNIT V							
VISCOUS INTERACTIONS IN HYPERSONIC FLOWS							9
Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain shock wave and expansion wave relations of inviscid hypersonic flows					Understanding (K2)	
CO2	execute the solution methods for hypersonic inviscid flows					Understanding (K2)	
CO3	analyze the hypersonic boundary layers					Applying(K3)	
CO4	express the viscous interaction in hypersonic flows					Analysing (K4)	
CO5	predict chemical and temperature effects in hypersonic flow.					Applying (K3)	

TEXT BOOKS

1. Anderson J. D., "Hypersonic and High Temperature Gas Dynamics", AIAA Education Series, 2nd Ed., 2006.
2. Anderson J. D., "Modern Compressible Flow with Historical Perspective", TMH, 3rd Ed., 2012.

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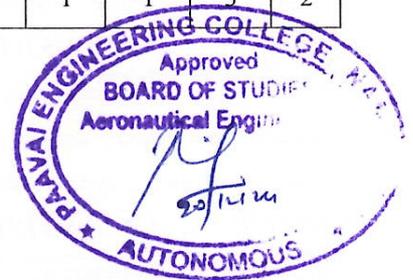
1. Heiser, W. H. and Pratt, D. T., "Hypersonic Air Breathing Propulsion", AIAA, 1994.
2. John T. Bertin, "Hypersonic Aerothermodynamics", AIAA Inc., Washington DC, 1994
3. Rathakrishnan E, "Applied Gas Dynamics", John Wiley & Sons (Asia) Pvt Ltd, 2010.
4. Bradsaw, "Experimental Fluid Mechanics", Elsevier, 2nd edition, 1970.

CO-PO MAPPING:

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	1	-	-	-	-	1	1	1	3	2
CO2	3	2	1	1	2	-	-	-	-	1	1	1	3	2
CO3	3	3	2	-	2	-	-	-	-	1	1	2	3	1
CO4	3	2	1	1	2	-	-	-	-	1	1	1	3	1
CO5	3	2	1	1	2	-	-	-	-	1	1	1	3	2



AE23351	COMBUSTION IN JET AND ROCKET ENGINES	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	learn the basic principles of combustion, types of flames and also familiarizes the combustion process in gas turbine, ramjet, scram jet and rocket engines.					
2	understand the concept of thermochemistry, enthalpy, adiabatic flame temperature, combustion products and their application to combustion related problems					
3	present the concept of chemical rates of reaction, collision theory and Arrhenius equation for analysing the different types of reactions					
4	compare the properties and characteristics of different type of flames and apply the same to combustion phenomenon in rocket motors and its exhaust.					
5	gain knowledge to interpret the various combustion processes that take place in chemical rockets..					
UNIT I	THERMODYNAMICS OF COMBUSTION				9	
Stoichiometry – absolute enthalpy- enthalpy of formation- enthalpy of combustion- laws of thermochemistry- pressure and temperature effect on enthalpy of formation, adiabatic flame temperature, chemical and equilibrium products of combustion						
UNIT II	PHYSICS AND CHEMISTRY OF COMBUSTION				9	
Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow. Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.						
UNIT III	PREMIXED AND DIFFUSED FLAMES				9	
One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame. Gaseous and diffusion flame - Examples -. Differences between premixed flame and diffusion.						
UNIT IV	COMBUSTION IN GAS TURBINE, RAMJET AND SCRAMJET				9	
Combustion in gas turbine chambers, recirculation, combustion efficiency, flame holders, subsonic combustion in ramjet, supersonic combustion in scramjet. Subsonic and supersonic combustion controlled by diffusion mixing and heat convection – peculiarities of supersonic combustion.						
UNIT V	COMBUSTION IN CHEMICAL ROCKET				9	
Combustion in liquid propellant rockets; Combustion of solid propellants- application of laminar flame theory to the burning of homogeneous propellants, Combustion in hybrid rockets; combustion instability in rockets.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the basic thermodynamic and chemical principles involved				Understanding (K2)	

	in combustion.	
CO2	apply reaction kinetics and transport phenomena to describe flame propagation in premixed and diffusion flames.	Applying (K3)
CO3	use appropriate models to evaluate combustion characteristics in gas turbines, ramjets, and scramjets.	Applying (K3)
CO4	analyze the effects of chemical composition and flow conditions on flame stability, ignition, and combustion efficiency	Analysing (K4)
CO5	examine combustion behavior and identify instability issues in liquid, solid, and hybrid rocket propulsion systems.	Analysing (K4)

TEXT BOOKS

1. Kuo, KK, "Principles of Combustion", John Wiley and Sons, 2005
2. Mishra, DP, "Fundamentals of Combustion", Prentice Hall of India, New Delhi, 2008.

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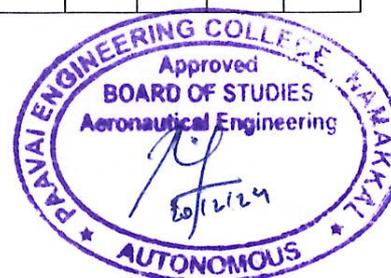
1. Mukunda, HS, "Understanding Combustion", 2nd edition, Orient Blackswan, 2009. .
2. Warren C. Strahle, "An Introduction to Combustion", Taylor & Francis, 1993.
3. Arthur H. Lefebvre and Dilip R. Ballal, "Gas Turbine Combustion: Alternative Fuels and Emissions", CRC Press, 2010.
4. Gary L. Borman and Kenneth W. Ragland, "Combustion Engineering", Mc Graw-Hill Education, 2008

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	-	2	1
CO2	3	2	2	3	1	-	-	-	-	-	-	-	2	1
CO3	3	2	2	2	1	-	-	-	-	-	-	-	2	1
CO4	3	2	2	2	2	-	-	-	-	-	-	-	2	1
CO5	2	1	2	3	3	-	-	-	-	-	-	-	2	1



AE23352	CRYOGENIC ENGINEERING			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the behaviour of materials at low temperatures						
2.	learn about various liquefaction systems for refrigeration.						
3.	familiarize the students for different cryogenic applications.						
4.	develop skills for designing cryogenic systems including refrigeration, storage and transfer of cryogenics, and instrumentation						
5.	know the safety considerations for different types of fuels						
UNIT I	BASIC PRINCIPLES OF CRYOGENIC						9
Historical Background - Introduction to cryogenic propellants and their properties, Liquid hydrogen, Liquid helium, Liquid nitrogen and liquid oxygen; Theory behind the production of low temperature- Joule Thompson Effect.							
UNIT II	REFRIGERATION AND GAS-LIQUEFACTION SYSTEMS						9
Basic principles of low temperature heat transfer; Refrigeration system and its types; Cryogenic liquefaction process; Production of Low Temperatures; Liquefaction systems-Variou liquefaction cycles, Ideal, Linde Hampson.							
UNIT III	CRYO INSULATION AND DEVICES						9
Storage vessel - Thermal shields and insulation, Effect of size and shape of storage vessel on heat inleak, Vapor shielding, Vacuum insulation, Evacuated porous insulation, Solid foams, Multilayer insulation; Composite insulation heat exchangers for cryogenic applications; Cryogenic Instrumentation-strain, Displacement and position, Pressure, Flow, Liquid level, Density for cryogenic applications							
UNIT IV	CRYOGENIC ROCKET SYSTEMS						9
Design concepts of cryogenic rockets - Selection of propellants and its challenges, Boil-off rate, Thrust and velocity gain; Specific impulse - Propellant feed system ; Tank pressurization and vent system - Two phase flow and heat transfer in reduced gravity ;Effect of cryogenic liquids on properties of aerospace materials							
UNIT V	SUPERCONDUCTIVITY AND SAFETY						9
Matter at low temperatures - Electrical and Magnetic properties of Superconductors, Specific heat, thermal conductivity, Electrical conductivity and basic properties of Superconductors; Introduction Physiological hazards - Explosions and flammability ;Safety considerations for liquid hydrogen and liquid oxygen - General safety principles.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	get introductory knowledge of cryogenic Engineering.					Understanding (K2)	

CO2	determination of liquid yield, work per unit mass of gas compressed different liquefaction systems.	Understanding (K2)
CO3	understand the knowledge of insulations.	Applying (K3)
CO4	interest to embark on a research career in Cryogenic Engineering.	Analysing (K4)
CO5	explain key performance parameters and apply basic principles of safety in cryogenic applications.	Applying (K3)

TEXT BOOKS

1. Haseldom, G., "Cryogenic Fundamentals", Academic Press, 1971.
2. Barron, R. F., "Cryogenic Systems", Oxford University, 1985

REFERENCES

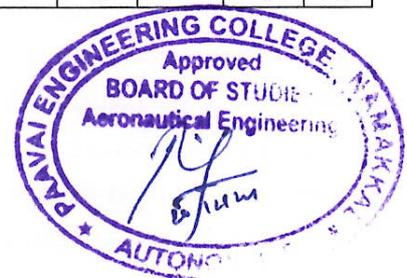
1. Mamata Mukhopadhyay, "Fundamentals of Cryogenic Engineering", PHI Learning , 2013.
2. Thomas M. Flynn, "Cryogenic Engineering", Second Edition.
3. George P. Sutton & Oscar Biblarz, "Rocket Propulsion Elements", John Wiley & Sons 9th Edition 2016
4. G.M Walker. "Cryocooler Part – 2", Plenum Press, New York and London, 2005.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	3	2	3	2	-	-	-	-	-	3	-	3	3
CO2	3	2	2	3	2	-	-	-	-	-	2	-	3	2
CO3	2	3	3	2	2	-	-	-	-	3	-	-	3	3
CO4	2	3	2	3	1	-	-	-	-	-	2	-	2	2
CO5	3	2	2	2	2	-	-	-	-	-	2	-	3	2



AE23353	COMPUTATIONAL FLUID FLOW AND HEAT TRANSFER			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the basic aspects of various discretization methods.						
2.	apply numerical methods to solve different types of partial differential equations.						
3.	understand the governing equations of fluid mechanics and heat transfer.						
4.	apply computational methods to solve inviscid flow and boundary-layer-type equations.						
5.	develop numerical solutions for navier–stokes equations.						
UNIT I	INTRODUCTION						9
Partial Differential Equations- Physical Classification- Mathematical Classification-Well-Posed Problem - Systems of Partial Differential Equations- Basics of Discretization Methods-Finite Differences-Difference Representation of Partial Differential Equations- Finite-Volume Method- Finite Element Method (FEM)- Stability Considerations.							
UNIT II	APPLICATIONs OF NUMERICAL METHODS						9
Wave Equation- Heat Equation- Laplace’s Equation- Burgers’ Equation							
UNIT III	EQUATIONS OF FLUID MECHANICS AND HEAT TRANSFER						9
Governing Equations of Fluid Mechanics and Heat Transfer- Fundamental Equations- Averaged Equations for Turbulent Flows- Boundary-Layer Equations- Introduction to Turbulence Modeling- Euler Equations- Multi-Phase and Multi-Fluid Flows- Finite-Volume Formulation.							
UNIT IV	INVISCID FLOW EQUATIONS AND BOUNDARY-LAYER-TYPE EQUATIONS						9
Method of Characteristics- Classical Shock-Capturing Methods- Flux Splitting Schemes- Flux Difference Splitting Schemes- Finite-Difference Methods for Two-Dimensional or Axisymmetric Steady External Flows- Inverse Methods, Separated Flows, and Viscous–Inviscid Interaction- Three-Dimensional Boundary Layers.							
UNIT V	NAVIER–STOKES EQUATIONS						9
Compressible Navier–Stokes Equations-Incompressible Navier–Stokes Equations-Free-Surface Flow.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the basics of discretization methods and their applications in solving PDEs.					Understanding (K2)	
CO2	solve wave, heat, LaPlace’s, and burgers’ equations using numerical methods.					Applying (K3)	
CO3	analyze the fundamental and averaged equations for turbulent flows and					Analysing (K4)	

	boundary-layer equations.	
CO4	implement methods of characteristics, shock-capturing methods, and flux splitting schemes for solving inviscid flow problems.	Applying (K3)
CO5	create numerical codes to solve compressible and incompressible navier–stokes equations and free-surface flow problems.	Analysing (K4)

TEXT BOOKS

1. Dale A. Anderson, John C. Tannehill, Richard H. Pletcher, Ramakanth Munipalli, and Vijaya Shankar, "Computational Fluid Mechanics and Heat Transfer," 4th Edition, Taylor & Francis Group, 2020.
2. Mukesh Kumar Awasthi, Ashwani Kumar, Nitesh Dutt, and Satyvir Singh, "Computational Fluid Flow and Heat Transfer: Advances, Design, Control, and Applications," 1st Edition, CRC Press, 2024.

REFERENCES

1. Pradip Majumdar, "Computational Fluid Dynamics and Heat Transfer," 3rd Edition, CRC Press, 2020.
2. Mark A. Pinsky, "Partial Differential Equations and Boundary-Value Problems with Applications" Third Edition, Waveland Press, 2003.
3. Jiyuan Tu, Guan Heng Yeoh, and Chaoqun Liu, "Computational Fluid Dynamics: A Practical Approach," 3rd Edition, Butterworth-Heinemann, 2018.
4. John F. Wendt, "Computational Fluid Dynamics an Introduction" Third Edition, Springer-Verlag Berlin Heidelberg, 2000

CO-PO MAPPING:

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	-	-	2	-	-	-	-	-	-	2	3
CO2	2	3	3	2	2	3	-	-	-	-	-	-	2	3
CO3	3	3	3	3	3	3	-	-	-	-	-	-	2	3
CO4	3	3	3	3	3	3	-	-	-	-	-	-	2	3
CO5	2	3	3	3	3	3	-	-	-	-	-	-	2	3



AE23354	DESIGN OF GAS TURBINE ENGINE COMPONENTS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	introduce basic design concepts of jet engine and estimation of required thrust to students.				
2.	make students familiarize with the design parameter and off design calculations				
3.	give the students adequate exposure to design procedure to the rotating components of engine such as compressor and turbine along with staging.				
4.	understand the aspects of combustion processes, flame stabilization issue, igniters design and controls.				
5.	make students familiarize with the concept of design inlet and nozzle for various on - off design conditions.				
UNIT I	GAS TURBINE ENGINE DESIGN FUNDAMENTALS				9
Design Process- compressible flow relationship; Constraint Analysis - Concept-Design tools preliminary estimates; Mission analysis - Aircraft weight and fuel consumption data-Example problems on Constrain analysis, Mission analysis.					
UNIT II	ON DESIGN AND OFF-DESING PARAMETRIC ANALYSIS				9
Total and static properties-corrected mass flow rate-Engine Cycle Design- One-Dimensional Through flow Area-Flow path force on components- aircraft constraint analysis, aircraft mission analysis, engine parametric (design point) analysis, engine performance (off-design) analysis, engine installation drag and sizing.					
UNIT III	DESIGN OF ROTATING COMPONENTS				9
Fan and Compressor Aerodynamics-Diffusion factor-Aerofoil geometry-Flow path dimension Radial variation-Turbine Aerodynamics- Constant axial velocity-adiabatic-selected Mach number-Mean line stage Design-stage pressure ratio-Airfoil geometry-radial variation-turbine cooling-range of turbine parameters- Engine life-Design Example -for fan-compressor-turbine.					
UNIT IV	COMBUSTION CHAMBER DESIGN				9
Design: Combustion system components- Combustion- Chemical reactor theory. Combustor Stability map-Stirring and mixing-Total pressure loss-Fuels-Ignition-Combustion Systems of Main Burner Design: Air partitioning- Main burner component Design: Diffuser-types of burner inner and outer casing design-Fuel nozzle-Dome and liner-Primary zone- swirler-Secondary holes-Dilution holes-Transition duct-Design of Afterburners-Design parameters-Diffuser-Fuel injection-Ignition-Flame stabilization – Flame spread and after burner length – Examples design calculation.					
UNIT V	INLET AND NOZZLE DESIGN				9
Inlets and Exhaust Nozzles Design: Elements of a Successful Inlet-Engine Integration Program-Definition of Subsonic Inlet-Engine Operational Requirements- Definition of Supersonic Inlet-Engine Operational Requirements- Engine Impact on Inlet Design- Inlet Impact on Engine Design-Validation of Inlet-Engine System-Exhaust nozzle design-Nozzle types and their design -Jet control methods for reduction of infrared signature					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	do preliminary weight and fuel estimation for an aircraft mission.	Understanding (K2)
CO2	identify variation in parametric analysis of on and off design calculations.	Applying (K3)
CO3	explain the principle design of compressor and turbine and selection of suitable materials.	Analysing (K4)
CO4	estimate the total pressure losses and able to predict ignition delay.	Applying (K3)
CO5	determine the basic design factors affects on and off design operation of inlets and nozzle on engine performance.	Analysing (K4)

TEXT BOOKS

1. Mattingly J.D., Heiser, W.H. and Pratt D.T, "Aircraft Engine Design", 2nd Edition, AIAA Education Series, AIAA, 2002.
2. Oates G.C., "Aircraft Propulsion Systems Technology and Design", 1989, AIAA Education Series.

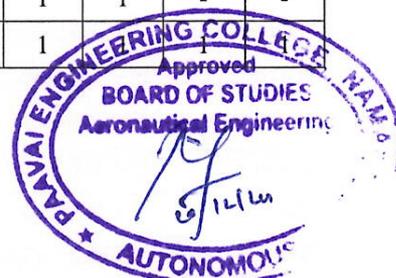
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1. Cumpsty N., "Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamics Design and Performance of Jet Engines", Cambridge University Press; 2nd edition, 2003
2. Murthy S.N. and Curran E.T., "High-Speed Flight Propulsion Systems", Volume 137, Progress in Astronautics and Aeronautics, AIAA, 1991.
3. Rathakrishnan E, "Applied Gas Dynamics", John Wiley & Sons (Asia) Pvt Ltd, 2010.
4. Treage I.E, "Aircraft Gas Turbine Engine Technology", 3rd edition, Glencoe McGraw-Hill, Inc. 1995

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	2	1	-	-	-	1	1	1	1	-	-
CO2	3	3	3	2	2	-	-	-	1	1	1	1	-	-
CO3	3	3	3	2	2	-	-	-	1-	1	1	1	-	-
CO4	3	3	3	2	2	1	2	1	1	1	1	1	-	-
CO5	3	3	3	-	2	2	2	1	1	1	1	1	-	-



AE23355	THEORY OF FLAMES			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1	understand the basic principles and processes involved in combustion.						
2	comprehend the structure and behavior of laminar and turbulent flames						
3	learn about combustion processes in internal combustion and jet engines						
4	gain knowledge of various techniques for measuring temperature, pressure, and flame properties						
5	explore practical applications and recent advancements in combustion technology.						
UNIT I	INTRODUCTION TO COMBUSTION						9
Basic Concepts of Combustion-Definition and types of combustion, Chemical and physical processes involved; Types of Combustion- Premixed and Diffusion Flames, Characteristics and differences ,Applications and examples; Chemical Kinetics of Combustion-Reaction mechanisms, Rate laws and Arrhenius equation; Ignition and Extinction							
UNIT II	FLAME STRUCTURE AND PROPAGATION						9
Laminar and Turbulent Flames-Definitions and characteristics, Differences and applications; Flame Front Structure- Structure and properties of flame fronts, Visualization techniques; Flame Propagation Mechanisms-Mechanisms of flame spread, Factors affecting propagation; Flame Stability-Stability criteria and factors, Methods to enhance stability							
UNIT III	COMBUSTION IN ENGINES						9
Combustion in Jet Engines-Combustion processes in jet engines, Challenges and solutions; Emissions and Environmental Impact-Types of emissions, Environmental regulations and control methods; Advanced Combustion Techniques.							
UNIT IV	MEASUREMENT TECHNIQUES						9
Temperature and Pressure Measurement in Flames-Techniques and instruments, Calibration and accuracy; Optical Diagnostics: Laser-Induced Fluorescence (LIF)-Principles and applications, Experimental setup and data interpretation; Spectroscopy and Chemiluminescence- Spectroscopic techniques for flame analysis, Applications and limitations; Data Analysis and Interpretation-Methods for analyzing combustion data, Case studies and examples							
UNIT V	APPLICATIONS AND CASE STUDIES						9
Combustion in Aerospace Applications; Case Studies of Real-World Combustion Systems; Innovations in Combustion Technology; Future Trends in Combustion Engineering							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	define and describe key concepts and types of combustion.					Understanding (K2)	
CO2	explain the mechanisms and factors affecting flame propagation					Understanding (K2)	

	and stability.	
	identify and evaluate the principles, challenges, and environmental impacts of engine combustion	Analysing (K4)
CO4	apply appropriate measurement and diagnostic techniques to analyze combustion data.	Applying (K3)
CO5	analyze real-world combustion systems and discuss future trends in combustion engineering	Analysing (K4)

TEXT BOOKS

1. An Introduction to "Combustion: Concepts and Applications", by Stephen R. Turns.2020
2. Mishra, DP, "Fundamentals of Combustion", Prentice Hall of India, New Delhi, 2008

REFERENCES

1. Mukunda, HS, "Understanding Combustion", 2nd edition, Orient Blackswan 2009. .
2. Warren C. Strahle, "An Introduction to Combustion", Taylor & Francis, 1993.
3. Arthur H. Lefebvre and Dilip R. Ballal, "Gas Turbine Combustion: Alternative Fuels and Emissions", CRC Press, 2010
4. D.Anderson, "Hypersonic and High Temperature Gas Dynamics", Third Edition, 2019.

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CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	2	-	-	-	-	1	-	-	2	2	2
CO2	3	2	1	2	-	-	-	-	1	-	-	2	2	2
CO3	3	2	1	2	-	-	-	-	1	-	-	2	2	2
CO4	3	2	2	2	-	-	-	-	1	-	-	2	2	2
CO5	3	2	2	2	-	-	-	-	1	-	-	2	2	2



AE23356	ADVANCED PROPULSION SYSTEMS	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1	understand the evolution and principles of chemical, electric, and hybrid propulsion systems.					
2	analyze plasma behavior and electromagnetic effects in advanced propulsion contexts.					
3	describe the design and working of nuclear and radioisotope propulsion systems.					
4	analyze performance and efficiency of electric propulsion systems for space missions.					
5	apply propulsion concepts to design mission-specific systems under practical constraints.					
UNIT I	INTRODUCTION TO SPACE PROPULSION SYSTEMS				9	
Historical outline, Scramjet Propulsion-Scramjet Inlets; Scramjet Performance, Chemical rocket Propulsion-Tripropellants; Metalized Propellants; Free Radical Propulsion, Electric Propulsion, Micro propulsion - Micro Propulsion Requirements, MEMS and MEMS- Hybrid Propulsion Systems.						
UNIT II	BASIC CONCEPTS OF IONIZED GASES				9	
Electromagnetic theory: electric charges and fields, currents, and magnetic fields, and applications to ionized gases. Atomic structure of gases - Ionization processes - Particle collisions in an ionized gas – Electrical conductivity of an ionized gas - Kinetic Theory, Introduction to plasma physics- Electrode phenomena.						
UNIT III	NUCLEAR ROCKET PROPULSION				9	
Nuclear Rocket Engine Design and Performance; Component Design-Nuclear Rocket Reactors, General Design Considerations, Reactor Core Materials, Thermal Design, Mechanical Design, Nuclear Design, Shielding; Nuclear Rocket Nozzles; General Design Considerations; Heat-Transfer Analysis; Over- all Problem-Hot-Gas Boundary, Cold-Gas Boundary.						
UNIT IV	RADIO ISOTOPE PROPULSION				9	
Alternative Approaches-Direct Recoil Method, Thermal Heating Method; Basic Thruster Configurations- Propulsion System and Upper Stage; Relative Mission Capabilities-Primary Propulsion, Auxiliary Propulsion, Thruster Technology; Design Criteria- Performance, Safety, Heat Source Development, Radioisotope Fuel; Capsule Technology						
UNIT V	ADVANCED SPACE PROPULSION CONCEPTS				9	
General Consideration for Propulsion in Space-Power Supply, Propellant Storage and Handling Facilities; Advanced Electric Propulsion Systems for Space Vehicles; Sputtering-A Thrust Generation Mechanism, Sputtering Phenomena, Possible Performance of Sputtering Thrusters; Energy Efficiency of the Sputtering Process; Analyses of an Elementary Mission with Different Electric Thrusters; General Consideration, Performance Formula for Electric Thrusters; Optimization with Electric Thrusters.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	explain the evolution, performance, and applications of space				Understanding (K2)	

	propulsion technologies.	
CO2	illustrate the role of ionized gases in plasma-based propulsion systems.	Applying (K3)
CO3	analyze design and safety aspects of nuclear and radioisotope propulsion systems.	Analysing (K4)
CO4	evaluate electric propulsion systems based on energy efficiency and mission needs.	Analysing (K4)
CO5	design integrated propulsion systems for specific space missions.	Analysing (K4)

TEXT BOOKS

1. Czysz, Paul A., Bruno, Claudio, Chudoba, Bernd, "Future Spacecraft Propulsion Systems and Integration", Springer, Praxis Publishing Ltd, 2018
2. Electric Propulsion: Applications and Advances, George P. Sutton, Oscar Biblarz, Wiley, 2023

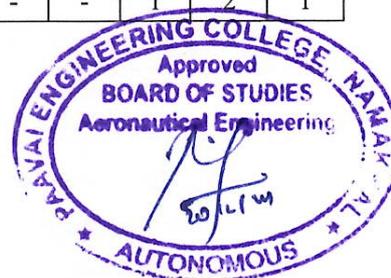
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1. George P. Sutton & Oscar Biblarz, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 9th Edition, 2017
2. Martin Tajmar, "Advanced Space Propulsion Systems", Springer Verlag GmbH, 2003.
3. Robert G. Jahn, "Physics of Electric Propulsion", McGraw-Hill Series, New York, 2006
4. William J. Emrich, "Principles of Nuclear Rocket Propulsion", Elsevier Science, 2016

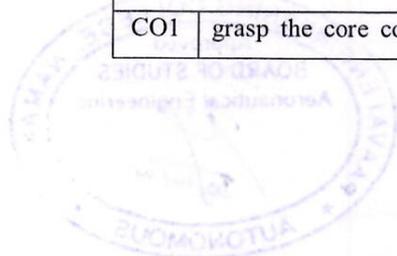
CO-PO MAPPING :

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CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	1	-	-	-	1	-	1	2	1
CO2	3	2	1	1	2	1	-	-	-	1	-	1	2	1
CO3	3	2	1	1	2	1	-	-	-	1	-	1	2	1
CO4	3	2	1	1	2	1	-	-	-	1	-	1	2	1
CO5	2	1	1	-	1	1	-	-	-	-	-	1	2	1



AE23357	ELECTRIC PROPULSION SYSTEMS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	grasp the core concepts of electric propulsion and distinguish it from conventional chemical systems.						
2.	examine plasma dynamics, electromagnetic forces, and non-equilibrium flow behavior in propulsion contexts.						
3.	summarize the operating principles, key elements, and capabilities of electrostatic, electromagnetic, and electrothermal thrusters.						
4.	utilize foundational knowledge to assess the performance and mission suitability of electric propulsion systems.						
5.	critically assess the strengths, constraints, and emerging trends of electric propulsion in aerospace engineering.						
UNIT I	INTRODUCTION TO ELECTRIC PROPULSION						9
Introduction – Fundamentals And Definitions – Mission Analysis – Basic Orbital Mechanics And Astrodynamics – Introduction To Rocket Propulsion And Rocket Performance – Comparison of Chemical And Electrical Rockets.							
UNIT II	BASIC PHYSICS						9
Basic electrodynamics, kinetic theory, non – equilibrium flows, and plasma physics – overview of physics in plasma sheath.							
UNIT III	TYPES OF ELECTRIC PROPULSION						9
Electrostatic Propulsion (Hall thrusters and ion thrusters) – Electromagnetic Propulsion (MPD thrusters and PPT thrusters) – Electro thermal Propulsion (arc jets and resisto jets)							
UNIT IV	ELECTROMAGNETIC PROPULSION						9
Introduction – Thruster Principle – Particle Energies and velocities – hollow cathode – hall thrusters – ion thrusters.							
UNIT V	ELECTRO THERMAL AND ELECTROMAGNETIC PROPULSION						9
Resisto jet – arc jet - Physics of MPD thrusters – Magnetogas dynamics and Plasma Accelerators.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	grasp the core concepts of electric propulsion and distinguish it					Understanding (K2)	



	from conventional chemical systems.	
CO2	examine plasma dynamics, electromagnetic forces, and non-equilibrium flow behavior in propulsion contexts.	Applying (K3)
CO3	summarize the operating principles, key elements, and capabilities of electrostatic, electromagnetic, and electro thermal thrusters.	Analysing (K4)
CO4	utilize foundational knowledge to assess the performance and mission suitability of electric propulsion systems.	Applying (K3)
CO5	critically assess the strengths, constraints, and emerging trends of electric propulsion in aerospace engineering.	Analysing (K4)

TEXT BOOKS

1. Fundamentals of Electric Propulsion: Ion and Hall Thrusters, Dan M. Goebel and Ira Katz, JPL – 2023
2. Electric Propulsion and Its Applications to Space Missions, Robert C. Finke, American Institute of Aeronautics and Astronautics, 2021

REFERENCES

1. “Physics of Electric Propulsion”, Robert G. John, 2006.
2. “Introduction to Plasma Physics and Controlled Fusion” (3rd Edition), Francis F. Chen, Springer, 2016
3. “Spacecraft Electric Propulsion”, Alexander V. Polinovsky, Cambridge University Press, 2019
4. “Electric Propulsion: Applications and Advances”, George P. Sutton, Oscar Biblarz, Wiley, 2023

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CO’s	Programme Outcomes PO’s												PSO’s	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	1	-	-	-	1	-	1	2	1
CO2	3	2	1	1	2	1	-	-	-	1	-	1	2	1
CO3	3	2	1	1	2	1	-	-	-	-	-	1	2	1
CO4	3	2	1	1	2	1	-	-	-	1	-	1	2	1
CO5	2	1	1	1	1	1	-	-	-	-	-	1		



AE23451	SPACECRAFT ATTITUDE DYNAMICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the principles and technologies used for spacecraft attitude sensing and measurement.						
2.	identify different types of spacecraft attitude control actuators.						
3.	derive equations of motion for spacecraft attitude in orbital conditions..						
4.	design and evaluate attitude stabilization and automatic control systems.						
5.	explore the basics of guidance and control and controller theory.						
UNIT I	ATTITUDE SENSORS						9
Attitude sensors – Gyroscopes; Horizon sensor; Orbital Gyrocompass; Earth sensors; sun sensors – types; star sensor; Magnetometer.							
UNIT II	CONTROL ACTUATORS						9
Classification; Thrusters; Momentum Wheel; Control Moment Gyros; Reaction wheel; Magnetic Torquers; Reaction Control system and solar sails.							
UNIT III	ATTITUDE DYNAMICS AND ORBITAL DISTURBANCES						9
Rigid Body Dynamics; Flexible body Dynamics; Disturbances due to Drag; Solar radiation Pressure; Magnetic and Gravity							
UNIT IV	ATTITUDE STABILIZATION						9
Spin, Dual spin, Gravity gradient, and three axis stabilization; Orbit Maintenance- introduction, techniques, Station Keeping.							
UNIT V	BASICS OF GUIDANCE AND CONTROL						9
Operating principles and design of guidance laws- various guidance laws; Examples; Controllers theory; Introduction to linear and nonlinear; Case study.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	describe the working principles of Earth, Sun, and Star sensor					Understanding (K2)	
CO2	explain the operational principles of propulsion-based and momentum-based actuators.					Applying (K3)	
CO3	model internal torques and environmental disturbances acting on a satellite					Analyzing (K4)	

CO4	demonstrate the working of momentum and reaction wheel-based control.	Applying (K3)
CO5	describe the basic laws and theories spacecraft guidance and control	Understanding (K2)

TEXT BOOKS

1. James R Wertz, Spacecraft Attitude Determination and control, Springer, 2012.
2. Marcel J. Sidi, Spacecraft Dynamics and control, A Practical Engineering Approach, Cambridge University Press.2000

REFERENCES

1. Marshall H. Kaplan, Modern Spacecraft Dynamics and Control, Dover Publications, 2019.
2. John H. Blakelock, Automatic Control of Aircraft and Missiles, 2nd Edition, Wiley, 2011.
3. Meyer Rudolph X, Elements of Space Technology for Aerospace Engineers, Academic Press, 1999.
4. Vladimir A. Chobotov, Spacecraft Attitude Dynamics and Control (Orbit), Krieger Publishing Company, 1991.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	-	2	1
CO2	3	2	2	3	1	-	-	-	-	-	-	-	2	1
CO3	3	2	2	2	1	-	-	-	-	-	-	-	2	1
CO4	3	2	2	2	2	-	-	-	-	-	-	-	2	1
CO5	2	1	2	3	3	-	-	-	-	-	-	-	2	1



AE23452	ORBITAL MECHANICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	introduce the solar system, relevant reference frames, coordinate systems, and celestial sphere terminology.						
2.	learn about orbital elements and methods of orbit determination.						
3.	get acquainted on the methodologies for computation of satellite orbit perturbations .						
4.	elucidate the concepts of computing various orbit maneuvers.						
5.	explore mission planning involving gravitational assists and transfers.						
UNIT I	SPACE ENVIRONMENT						9
Peculiarities of space environment and its description; Radiation and magnetic fields; Space mission Types- effect of space environment on materials of spacecraft structure and astronauts; manned space missions; Effect on satellite life time; The solar system – reference frames and coordinate systems, terminology related to the celestial sphere and its associated concepts.							
UNIT II	CHARACTERISTICS OF VARIOUS ORBITS						9
Newton’s universal law of gravitation ; Two Body Motion-equations of motion; Kepler laws; Solution to two-body problem – conics and relations, vis-viva equation; Kepler equation; Orbital elements – orbit determination; -The many body problem; Lagrange-Jacobi identity; The circular restricted three body problem – libration points; The general N-body problem.							
UNIT III	SATELLITE INJECTION AND PERTURBATIONS						9
General aspects of satellite injection – satellite orbit transfer, various cases; Orbit deviations due to injection errors; General and Special Perturbations; Earth a spherical potential; Oblateness – third body effects, atmospheric drag effects; Application of perturbations.							
UNIT IV	ORBIT MANEUVERS						9
Orbital Maneuvers in earth satellite and deep space missions; Hohmann transfer – inclination change maneuvers, combined maneuvers, bi-elliptic maneuvers; Case studies on the Illustration of practical examples of three body problem and restricted three body problems.							
UNIT V	INTERPLANETARY TRAJECTORIES						9
Concept of Patched Conics; Two-dimensional interplanetary trajectories; Sphere of influence; Methods of trajectory design.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	differentiate between various types of space missions and their environmental requirements.					Understanding (K2)	

CO2	apply Newton's law of gravitation and two-body motion equations to calculate orbital parameters.	Applying (K3)
CO3	evaluate combined orbital maneuvers for complex mission requirements.	Analysing (K4)
CO4	explain fundamental orbital maneuvers used in space missions.	Understanding (K2)
CO5	apply methods of trajectory design for interplanetary missions.	Applying (K3)

TEXT BOOKS

1. Curtis, H. D. Orbital Mechanics for Engineering Students, 4th Edition, Elsevier, 2021
2. Chobotov, V. A., Orbital Mechanics, 3rd Edition., AIAA Edu. Series (2002).

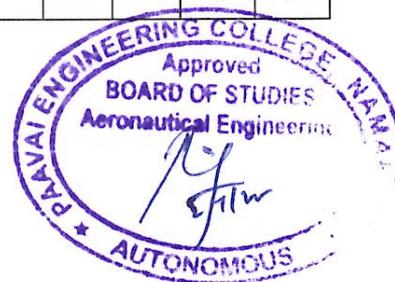
REFERENCES

1. Wiesel, W. E. Space flight Dynamics, 3rd Edition, McGraw-Hill, 1997.
2. Brown, C. D., Spacecraft Mission Design, 2nd Edition., AIAA Edu. Series (1998).
3. Escobal, P. R., Methods of Orbit Determination , 2nd Edition., Krieger Pub. Co. (1976).
4. Tewari, A., Atmospheric and Space Flight Dynamics: Modeling and Simulation with MATLAB and Simulink , Birkhuser (2007).

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
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CO1	3	2	2	1	2	-	-	-	-	-	-	-	3	2
CO2	3	2	2	1	2	-	-	-	-	-	-	-	3	2
CO3	3	2	1	1	2	-	-	-	-	-	-	-	3	2
CO4	3	2	2	2	2	-	-	-	-	-	-	-	3	2
CO5	3	2	2	1	2	-	-	-	-	-	-	-	3	2



AE23453	AVIONICS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	understand the role, evolution, and classification of avionics systems in civil and military aircraft, and their integration into aerospace platforms.				
2.	gain insight into avionics computing architecture, including microprocessors, FPGAs, data buses (MIL-STD-1553B, ARINC), and real-time operating systems.				
3.	learn about modern cockpit technologies and display systems, such as HUDs, MFDs, HMDs, and virtual cockpits, with emphasis on pilot interface and situational awareness.				
4.	comprehend the principles of navigation, autopilot, and sensor systems, including INS, GPS, and AHRS, with a focus on aircraft and UAV applications.				
5.	become familiar with avionics system integration, EMI/EMC requirements, fault tolerance, and software/hardware certification standards such as DO-178C and ARP 4754.				
UNIT I	INTRODUCTION TO DIGITAL AVIONICS				9
Role and evolution of avionics in aerospace systems-Classification: Civil vs Military avionics-Key avionics subsystems and their integration-System-level requirements and design principles (reliability, modularity, maintainability)- Overview of digital electronics and computing for avionics applications.					
UNIT II	AVIONIC COMPUTING & DATA BUSES				9
Digital computing systems in aircraft: Microprocessors, DSPs, and FPGAs-Real-time operating systems (RTOS) for avionics-Data buses and protocols: MIL-STD-1553B, ARINC-429, ARINC-629, CAN bus, AFDX-Interfacing sensors and actuators with flight computers-Avionics communication and redundancy management.					
UNIT III	DISPLAY SYSTEMS & COCKPIT TECHNOLOGIES				9
Display technologies: CRT, LED, LCD, OLED, HMD, HUD-Human-Machine Interface (HMI): HOTAS, MFDs, DVI, voice and gesture input; Smart Cockpits: Virtual cockpits, panoramic displays, synthetic and enhanced vision systems; Civil vs Military cockpit design philosophies; Pilot situational awareness and workload reduction through avionics.					
UNIT IV	NAVIGATION, SENSING & AUTOPILOT SYSTEMS				9
Navigation systems: INS, GPS, GNSS, ILS, MLS, DME, VOR; Data fusion and Kalman filtering for navigation accuracy; Autopilot systems: Longitudinal, lateral, and vertical control; Sensors: Air data, inertial, radar altimeters, attitude and heading reference systems (AHRS); Avionics in UAVs and modern navigation challenges.					
UNIT V	SYSTEM INTEGRATION, VALIDATION & EMI/EMC				9
Integrated Modular Avionics (IMA) and architecture trends; EMI/EMC: Fundamentals, shielding, grounding, and filtering techniques; Built-In-Test (BIT) and Condition-Based Monitoring (CBM); Safety-critical software certification: DO-178C, DO-254, ARP 4754; Avionics system validation, fault					

tolerance, redundancy, and failure mode analysis.

	TOTAL PERIODS	45
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COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the architecture and purpose of avionics systems in aircraft and UAVs.	Understanding (K2)
CO2	explain avionics computing, digital communication protocols, and data buses.	Applying (K3)
CO3	evaluate cockpit interface technologies and pilot-centered display systems.	Analysing (K4)
CO4	apply principles of navigation, autopilot, and sensor fusion systems.	Analysing (K4)
CO5	analyze integration issues, EMI/EMC, and certification requirements in avionics.	Applying (K3)

TEXT BOOKS

1. Cary R. Spitzer, "Digital Avionics Systems", CRC Press, 2nd Edition, 2006.
2. Ian Moir and Allan Seabridge, "Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration", Wiley, 3rd Edition, 2011.

REFERENCES

1. Thomas F. Budinger and Miriam D. Budinger, "Avionics: Development and Implementation", Wiley, 1998.
2. Albert Helfrick, "Principles of Avionics", Avionics Communications Inc., 8th Edition, 2010.
3. Archambeault, Ramahi, Bunch, "EMI/EMC Computational Modeling Handbook", Springer, 2001.
4. R.P.G. Collinson, "Introduction to Avionics Systems", Springer, 3rd Edition, 2011.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
 (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	-
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	-
CO3	2	3	3	3	3	-	-	-	-	-	-	2	3	-
CO4	2	3	3	3	3	-	-	-	-	-	-	2	3	-
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	-



AE23454	AEROSPACE GUIDANCE AND CONTROL SYSTEM			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	explore different types of space navigation systems						
2.	apply guidance law concepts to determine trajectory corrections for a missile.						
3.	describe the concept of coordinate transformations in inertial navigation						
4.	analyze various types of hybrid navigation systems.						
5.	explore the Attitude stabilization of satellites.						
UNIT I	NAVIGATION CONCEPTS						9
Fundamentals of spacecraft navigation systems and Position Fixing –Geometric concepts of Navigation –Elements -Earth in inertial space -Earth's Rotation -Revolution of Earth –Different Coordinate Systems –Coordinates Transformation -Euler angle formulations -Direction cosine formulation - Quaternion formulation.							
UNIT II	INTRODUCTION TO GUIDANCE						9
Missile Guidance laws; Classification of guidance laws; Classical guidance laws; Modern guidance laws, Autopilots; Longitudinal, Lateral & Missile							
UNIT III	INERTIAL NAVIGATION SYSTEMS						9
Accelerometers –Pendulous type, Force Balance type, MEMs Accelerometers; Basic Principles of Inertial Navigation –Types -Platform and Strap down; Mechanization INS system; Rate Corrections; Block diagram; Acceleration errors; Coriolis effect; Schuler Tuning; Cross coupling; Gimbal lock; Alignment.							
UNIT IV	GPS & HYBRID NAVIGATION SYSTEMS						9
DC-GPS overview –Concept, GPS Signal, Signal Structure, GPS data; Signal Processing; GPS Clock; GPS for position and velocity determination; GPS Concepts -LAAS & WAAS Technology, Hybrid Navigation; Introduction to Kalman filtering.							
UNIT V	ATTITUDE STABILIZATION SCHEMES AND ORBIT MANEUVERS						9
Spin, Dual spin, Gravity gradient, Zero momentum system; Momentum Biased system; Reaction control system; Single and Multiple Impulse orbit Adjustment; Station Keeping and fuel Budgeting.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	discuss the different types of navigation and position estimation.					Understanding (K2)	

CO2	classify different types of missile guidance laws and summarize the functional role of autopilot systems in longitudinal and lateral control.	Understanding (K2)
CO3	illustrate the working of inertial navigation systems using inertial sensors and perform basic coordinate transformations between reference frames	Applying (K3)
CO4	explore the concept of Hybrid navigation systems and Global position navigation system.	Applying (K3)
CO5	design and develop the concept of stabilization and control.	Analysing (K4)

TEXT BOOKS

1. Anil K. Maini, Varsha Agrawal, Satellite Technology: Principles and Applications, 3rd Edition, Wiley.
2. Blake Lock, J.H, "Automatic control of Aircraft and missiles", John Wiley Sons, Second Edition, 1991.

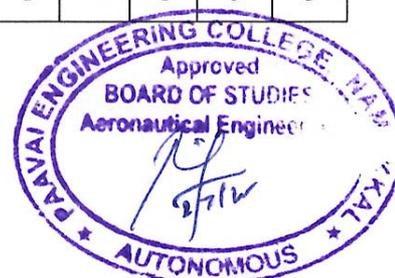
REFERENCES

1. N.S. Nagaraja, "Elements of Electronic Navigation", 2nd Edition, McGraw-Hill Education, 2017.
2. Myron Kayton & Walter R. Fried, "Avionics Navigation Systems", 2nd Edition, Wiley-Interscience, 1997.
3. Paul Zarchan, "Tactical and Strategic Missile Guidance", 7th Edition, AIAA, 2019
4. Norman S. Nise, "Control Systems Engineering", 8th Edition, Wiley, 2019.

CO-PO MAPPING :

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	1	-	1	3	2
CO2	3	3	2	2	2	-	-	-	-	1	-	1	3	3
CO3	3	2	2	2	2	-	-	-	-	1	-	1	3	2
CO4	3	3	3	2	2	-	-	-	-	1	-	1	3	3
CO5	3	3	3	2	2	-	-	-	-	1	-	1	3	3



AE23455	SATELLITE SYSTEMS AND TECHNOLOGY			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand how different missions need different types of satellites, based on space conditions and mission goals.						
2.	learn how to design a system that gives the right amount of power to different parts of the satellite.						
3.	explain how satellites keep their direction and position in space using sensors and control systems.						
4.	explore how satellites move in space using different types of propulsion systems.						
5.	assess how ground stations interact with satellites through command and communication systems						
UNIT I	SATELLITE MISSION AND CONFIGURATION						9
Mission Overview; Requirements for different missions – Space Environment, Spacecraft configuration; Spacecraft Bus; Payload; Requirements and constraints; Initial configuration decisions and Trade-offs; Spacecraft configuration process; Subsystem layout; Types of Satellites; Types of Orbits- Applications.							
UNIT II	POWER SYSTEM						9
Power sources; Energy storage; Solar panels–Deployable solar panels; Spacecraft Power management –Power distribution, Power regulation and control; Deep Space Probes.							
UNIT III	ATTITUDE AND ORBIT CONTROL SYSTEM						9
Coordinate system; AOCS requirements; Environment effects; Attitude stabilization; Attitude sensors; Actuators; Orbit Control-Design of control algorithms.							
UNIT IV	PROPULSION SYSTEMS, STRUCTURES AND THERMAL CONTROL						9
Propulsion systems; Thermodynamic- Electro dynamic propellant systems; Design of Spacecraft structure; Structural elements; Material selection–Environmental Loads, guiding factors; Structural fabrication; Thermal control techniques– Active and Passive thermal control techniques, Heat balance equation.							
UNIT V	TELEMETRY SYSTEMS						9
Base Band Telemetry system; Modulation; TT system; Tele command system; Ground Control Systems.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain how different space missions affect the design of satellites					Understanding (K2)	
CO2	examine the working of power systems in long-duration missions like deep space probes					Analysing (K4)	
CO3	use sensor and actuator information to explain how satellite					Applying (K3)	

	position is controlled.	
CO4	demonstrate the effect of structural design and material choice under launch and space conditions	Applying (K3)
CO5	examine how ground control systems handle satellite data and commands.	Analysing (K4)

TEXT BOOKS

1. Marcel J. Sidi, "Spacecraft Dynamics and Control", Cambridge University press, 1997.
2. James R. Wertz and Wiley J. Larson, "Space Mission Analysis and Design", 4th Edition, Microcosm Press & Springer, 2011.

REFERENCES

1. James R.Wertz "Spacecraft Attitude Determination and Control", Kluwer Academic Publisher, 1988.
2. Lecture notes on "Satellite Architecture", ISRO Satellite Centre Bangalore – 560 017
3. Peter Fortescue, Graham Swinerd, and John Stark, "Spacecraft Systems Engineering", 4th Edition, Wiley, 2011.
4. Hanspeter Schaub and John L. Junkins, "Analytical Mechanics of Space Systems", 4th Edition, AIAA Education Series, 2018.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	2
CO4	3	2	3	3	3	-	-	-	-	-	-	2	3	2
CO5	2	2	2	3	2	-	-	-	-	-	-	2	3	2



AE23456	LAUNCH VEHICLE DESIGN CONCEPTS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	familiarize students with the different classes and configurations of launch vehicles and their operational platforms				
2.	develop an understanding of aerodynamic considerations in airframe design for launch vehicles.				
3.	estimate the thrust requirements and appropriately size propulsion components based on mission needs.				
4.	compare different types of aerodynamic controls like canard, wing, and tail-based methods..				
5.	assess the advantages and limitations of single-nozzle jet control methods.				
UNIT I	LAUNCH VEHICLE CONFIGURATIONS AND MISSIONS	9			
Classes of launch vehicles – air launched, sea launched, submarine launched and land based rocket vehicles; Civil and military rocket vehicles; Requirements of launch site and launch platforms; Peculiarities of air launched and submarine launched missiles with respect to launching requirements; A brief introduction to launch vehicle airframe components and their functions.					
UNIT II	AERODYNAMIC DESIGN ASPECTS OF AIRFRAME	9			
Aerodynamic design considerations of airframe components; Different forebody configurations and their applications to different classes of launch vehicles; Planforms and cross sections of wings and fins; Minimization of overall drag of the airframe of the launch vehicle – Interference effects of flow over different airframe components and its effect on normal force distribution.					
UNIT III	DESIGN ASPECTS OF PROPULSION SYSTEM COMPONENTS	9			
Basic design considerations of propulsion system components such as igniter and nozzle; Injector and combustion chamber design for liquid propulsion systems; Determination of thrust requirements and sizing of propulsion system – performance loss estimation of solid and liquid propulsion systems, matching the propulsion system design to mission requirements.					
UNIT IV	AERODYNAMIC CONTROL METHODS	9			
Advantages and limitations of aerodynamic control methods; Basic principle involved in aerodynamic control – Aerodynamic characteristics of wing control, canard control, tail control, tail-less control and other control methods using surface projections; Mission areas of applications; Influence of centre of gravity travel; Comparison of aerodynamic control methods; Use of required hardware and electronics.					
UNIT V	JET CONTROL METHODS	9			
Principle behind the jet control methods for thrust vectoring; Different types of jet control methods and their advantages & limitations; Principle involved in fluidic thrust vector control methods and types – shifting nozzle throat method, counter flow method and secondary injection through diverging wall of the nozzle; A brief introduction to multiple nozzle based jet control methods.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	identify and classify different launch vehicle types based on launch platforms.	Understanding (K2)
CO2	interpret the effects of wing and fin plan forms on launch vehicle performance.	Applying (K3)
CO3	analyze injector and chamber design requirements for liquid propulsion systems.	Analysing (K4)
CO4	distinguish between control types such as wing, canard, tail, and tailless systems.	Analysing (K4)
CO5	describe the working principles behind jet/thrust vector control methods	Understanding (K2)

TEXT BOOKS

1. George P. Sutton & Oscar Biblarz, "Rocket Propulsion Elements, John Wiley & Sons Inc., NewYork, 9th Edition, 2016.
2. Nielson, Jack N, Stever, Gutford, "Missile Aerodynamics", Mc Graw Hill, New York, 1960.

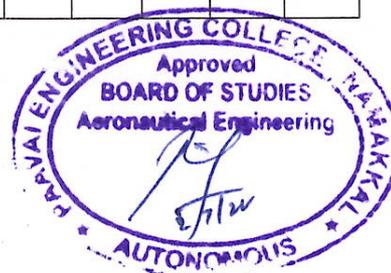
REFERENCES

1. Chin S S, "Missile Configuration Design", Mc Graw Hill, New York, 1961.
2. S. R. Mohan, "Fundamentals of Guided Missiles", Cataloguing-in-Publication, 2016
3. George M. Siouris, "Missile Guidance and Control Systems", Springer- Verlag New York, 2004
4. Ronald Humble, Henry and Larson, "Space Propulsion Analysis and Design", Mc Graw-Hill. 1995

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CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	-	-	-	-	-	-	-	3	2
CO2	3	2	2	1	2	-	-	-	-	-	-	-	3	2
CO3	3	2	1	1	2	-	-	-	-	-	-	-	3	2
CO4	3	2	2	2	2	-	-	-	-	-	-	-	3	2
CO5	3	2	2	1	2	-	-	-	-	-	-	-	3	2



AE23457	LAUNCH VEHICLE AERODYNAMICS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	explain the purpose of launch vehicles and the differences between various types used in space missions				
2.	describe how air flows around launch vehicles and how it affects their movement during launch.				
3.	analyze how launch vehicle stability is affected by forces, side loads, and steering methods like thrust vectoring				
4.	examine thermal protection methods like insulation, coatings, and fairings to keep the vehicle and payload safe				
5.	discuss the effects of the boundary layer and shock waves at high speeds on the design of launch vehicles.				
UNIT I INTRODUCTION TO LAUNCH VEHICLES					
9					
Introduction to Launch vehicles - Anatomy of a Launch Vehicle - need for Launch Vehicles - Launch Vehicle types and terminologies- Review on the development of Launch Vehicle- Inhabited and reusable launch vehicles- Current and future Launch Vehicles in India and across the world					
UNIT II AERODYNAMICS OF LAUNCH VEHICLES					
9					
Aerodynamic Flow Characteristics of launch vehicles- Overall Vehicle Aerodynamic Features- Aerodynamic Force and Moment for a Launch Vehicle- Aerodynamic Characteristics and Loads- launch and ascent phases & event definitions- load factors- Expendable and Reusable launch vehicle design characteristics					
UNIT III STABILITY OF LAUNCH VEHICLES DURING LAUNCH PHASE					
9					
Pressure change during launch- Aerodynamic stability- center of pressure vs. Centre of Gravity- Aerodynamic side loads and Trimmed flight & lateral acceleration moments- Attitude sensing, angular position and rate/velocity- stability analysis- Steering: thrust vectoring, aerodynamic controls, jet vanes, jet injection					
UNIT IV THERMAL ENVIRONMENT OF LAUNCH VEHICLES					
9					
Pre-launch thermal environment- Heat transfer process - Basic parameters in aerodynamic heating - Aerodynamic heating on conical surfaces - Exhaust plumes, gas recirculation, & base heating- Thermal control, including seals, coatings, insulation- Payload thermal protection via payload fairing- Aerodynamic Heating Problems of New-Generation Multi-Stage Launch Vehicles					
UNIT V SPECIAL TOPICS					
9					
Atmospheric Boundary Layer effects on launch Vehicles and influences of boundary layer transition at hypersonic speeds- Shock Wave boundary layer interactions of Launch vehicles-Aerodynamic problems and Technical Challenge of Launch Vehicles design- Launch Vehicle Failure case studies.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	summarize the history and recent advances in launch vehicle technology worldwide and in india	Understanding (K2)
CO2	differentiate aerodynamic features of reusable versus expendable launch vehicles	Analysing (K4)
CO3	investigate aerodynamic side forces and their impact on stability during launch.	Analysing (K4)
CO4	identify thermal protection techniques used on vehicles and payloads.	Understanding (K2)
CO5	interpret launch failure case studies to identify aerodynamic and structural causes.	Applying (K3)

TEXT BOOKS

1. Anderson, J D, "Fundamentals of Aerodynamics", McGraw-Hill Book Co, 2010.
2. Chin SS, "Missile Configuration Design", Mc Graw Hill, 1961.

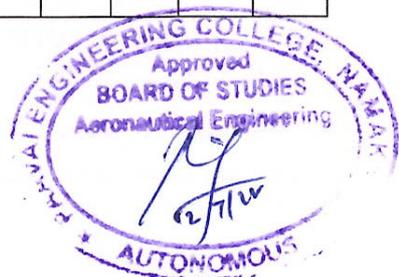
REFERENCES

1. Hermann Schlichting, "Boundary Layer Theory", Springer, 8th edition, 2000 .
2. Michael Mendenhall, "Tactical Missile Aerodynamics: Prediction Methodology, Progress in Astronautics and Aeronautics", 1992.
3. Nielson, Jack N, Stever, Gutford, "Missile Aerodynamics", McGraw Hill, 1960.
4. Toshiyuki Fujii, "Aerodynamics of Launch Vehicles", AIAA Education Series, 2014.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	2
CO4	3	2	3	3	3	-	-	-	-	-	-	2	3	2
CO5	2	2	2	3	2	-	-	-	-	-	-	2	3	2

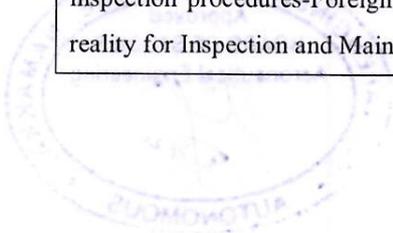


AE23551	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	identify ground handling tools and equipment's to perform ground handling operation of aircraft.						
2.	maintain the aircraft ground servicing units.						
3.	summarize the safety aspects and improve human relations in working environment.						
4.	gain knowledge of inspection types, intervals, documentation, and airworthiness compliance.						
5.	identify correct aircraft hardware, materials, and quality control procedures.						
UNIT I	AIRCRAFT GROUND HANDLING						9
Mooring, jacking, levelling and towing operations – Preparation – Equipment – precautions - Engine starting procedures – Piston engine, turboprops and turbojets - Engine fire extinguishing. - Ground Power Units							
UNIT II	MAINTENANCE AND HANDLING OF GROUND EQUIPMENT'S						9
Air Starter Unit - Portable Hydraulic Test Stand - Electric power supply equipment - Air-conditioning Unit - Oil Pressure Unit - Jacks, Cranes, Ladders, Platforms, Trestles & Chocks.							
UNIT III	MAINTENANCE OF SAFETY AND AIRCRAFT SYSTEM PROCESSES						9
Shop safety – Environmental cleanliness – Precautions- Hand tools – Precision instruments – Special tools and equipment's in an airplane maintenance shop – Identification terminology							
UNIT IV	INSPECTION						9
Inspection Process, Purpose, Types - Inspection intervals – Techniques – Checklist - Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives. - Type certificate Data Sheets – ATA specifications							
UNIT V	AIRCRAFT HARDWARE AND MATERIALS						9
Hand tools – Precision instruments – Special tools and equipment in an airplane maintenance shop - Identification terminology – Specification and correct use of various aircraft hardware - American and British systems of specifications – Threads, gears, bearings – Drills, tapes & reamers.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the operation of various ground handling equipment's and its procedures					Applying (K3)	
CO2	restate the utility of aircraft ground servicing units and their maintenance ground servicing units.					Applying (K3)	

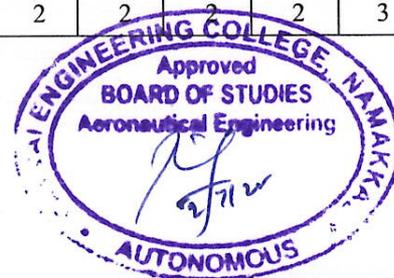
CO3	apply safety practices and correctly use maintenance tools in aircraft workshops.	Applying (K3)												
CO4	discuss different maintenance operational procedures	Understanding (K2)												
CO5	explain the various precision instruments and special tools	Understanding (K2)												
TEXT BOOKS														
1. Airframe and Power plant Mechanics, General Hand Book, Federal Aviation Administration, and AC65 - 9A.														
2. Michael J. Kroes, William A. Watkins, and Frank Delp, Aircraft Maintenance and Repair, 7 th Edition, Tata Mc Graw-Hill, New Delhi.														
REFERENCES														
1. Airframe and Power plant Mechanics, Airframe Hand Book, Federal Aviation Administration, and AC65-15A.														
2. CAP 715 – An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66, Civil Aviation Authority, UK.														
3. Dale Crane, Aviation Maintenance Technician: Power plants, 2nd edition, Aviation Supplies and Academics Inc, 2018.														
4. General Hand Books of Airframe and Powerplant Mechanics. U. S. Dept. of Transportation, Federal Aviation Administration, the English Book Store, New Delhi 2020.														
CO-PO MAPPING :														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	Programme Outcomes PO's												PSO's	
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CO1	3	2	1	1	1	-	-	-	-	-	-	-	2	2
CO2	2	2	1	1	3	-	-	-	-	-	-	-	2	2
CO3	2	2	3	1	2	-	-	-	-	-	-	-	2	2
CO4	2	2	1	2	2	-	-	-	-	-	-	-	2	2
CO5	2	2	3	2	2	-	-	-	-	-	-	-	2	2



AE23552	AERO ENGINE MAINTENANCE AND REPAIR	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	understand the fundamental principles of operation, components, and materials used in various types of piston engines.				
2.	gain knowledge of the inspection, maintenance, and troubleshooting procedures for piston engines.				
3.	familiarize with the inspection methods and tools used for jet engines, including non-destructive testing techniques.				
4.	comprehend the classification, principles of operation, components, and materials used in different types of jet engines				
5.	learn about engine overhaul procedures, troubleshooting, and condition monitoring techniques for both piston and jet engines.				
UNIT I					
BASIC OF PISTON ENGINE INSPECTION AND MAINTENANCE					9
Classification of piston engines - Principles of operation - Function of components - Materials used - Details of starting the engines - carburetion and Fuel injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes – Engine power measurements – Classification of engine lubricants and fuels-Induction, Exhaust and cooling system - Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting - Inspection of all engine components - Daily and routine checks-Overhaul procedures					
UNIT II					
PROPELLER INSPECTION AND REPAIR					9
Propeller theory- Operation, construction assembly and installation -Pitch change mechanism- Propeller axially system-Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions – Damage and repair criteria.					
UNIT III					
ENGINE INSPECTION, TESTING AND REPAIR					9
Symptoms of failure - Fault diagnostics - Case studies of different engine systems - Rectification during testing equipment for overhaul: Tools and equipment requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and visual inspection - Methods and instruments for non-destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance. Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and supercharger - Checks and inspection procedures.					
UNIT IV					
JET ENGINE INSPECTION AND MAINTENANCE					9
Types of jet engines – Fundamental principles – Bearings and seals - Inlets – compressors turbines-exhaust section – classification and types of lubrication and fuels- Materials used - Details of control, starting around running and operating procedures – Inspection and Maintenance-permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage Inspection robots and drones -Augmented and mixed reality for Inspection and Maintenance					



UNIT V		JET ENGINE OVERHAUL AND TROUBLESHOOTING											9		
Engine Overhaul - Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for troubleshooting - Condition monitoring of the engine on the ground and at altitude - engine health monitoring and corrective methods. Use of Big Data Analytics in MRO															
													TOTAL PERIODS		45
COURSE OUTCOMES															
At the end of this course, students will be able to													BT Mapped (Highest Level)		
CO1	understand and apply the maintenance and troubleshooting procedures on various aircraft engine systems											Understanding (K2)			
CO2	perform maintenance, inspection, and troubleshooting procedures on piston engines.											Applying (K3)			
CO3	apply inspection methods and fault diagnostics for jet engines using appropriate tools.											Applying (K3)			
CO4	carry out overhaul procedures and testing schedules for jet engines.											Analysing (K4)			
CO5	demonstrate understanding of engine health monitoring, storage, and preservation techniques.											Analysing (K4)			
TEXT BOOKS															
1. Kroes & Wild, "Aircraft Power plants ", 7 th Edition - McGraw Hill, New York, 1994.															
2. Jeppesen Sanderson "A & P Technician Power plant Textbook" 2 nd edition,2004															
REFERENCES															
1. Shevantha Weerasekera, Introduction to Maintenance, Repair and Overhaul of Aircraft, Engines and Components, SAE International, 2020.															
2. Michael J. Kroes, James R. Rardon, Aircraft Maintenance & Repair, McGraw-Hill Education, 8 th Edition, 2020.															
3. Dale Crane, Aviation Maintenance Technician: Powerplants, 2 nd Edition, Aviation Supplies and Academics Inc., 2023.															
4. Ian Moir, Allan Seabridge, Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration, Wiley, 2008.															
CO-PO MAPPING:															
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's) (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak															
CO's	Programme Outcomes PO's												PSO's		
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CO1	3	2	2	1	2	-	-	2	2	2	1	1	3	2	
CO2	2	3	3	3	3	1	-	2	2	2	2	1	3	3	
CO3	2	3	3	3	3	-	-	2	1	2	2	1	3	3	
CO4	2	2	3	2	3	-	-	2	1	2	2	2	3	3	
CO5	2	2	2	2	2	2	3	2	2	2	2	2	2	3	



AE23553	AIRFRAME MAINTENANCE AND REPAIR	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	learn rules and regulatory requirements governing civil aviation and aircraft maintenance practices in india.				
2.	provide knowledge and practical understanding of sheet metal repair, welding techniques, and structural integrity in aircraft.				
3.	impart skills in the maintenance and repair of plastics and composite materials including frp and honey comb structures.				
4.	train students in aircraft jacking, center of gravity (cg) assessment, rigging procedures, and rotor tracking and balancing.				
5.	understand the inspection, servicing, and troubleshooting of hydraulic, pneumatic, and aircraft auxiliary systems.				
UNIT I	WELDING IN AIRCRAFT STRUCTURAL COMPONENTS				9
Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing. Sheet Metal Repair and Maintenance: Selection of materials; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight - change on the surrounding structure. Sheet metal inspection - N.D.T. Testing. Riveted repair design - Damage investigation - Reverse engineering- Use of Additive Manufacturing in Airframe Repair					
UNIT II	PLASTICS AND COMPOSITES IN AIRCRAFT				9
Plastics in Aircraft: Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., and various repairs schemes - Scopes. Advanced Composites in Aircraft: Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test - Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Vacuum-bag process. Use of self-healing composites					
UNIT III	AIRCRAFT JACKING, ASSEMBLY AND RIGGING				9
Airplane jacking, weighing, C.G. Location; Balancing of control surfaces inspection maintenance; Helicopter flight controls- Tracking and balancing of main rotor.					
UNIT IV	REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM				9
Trouble shooting and maintenance practices - Service and inspection, Inspection and maintenance of landing gear systems, Aircraft Fuel System, Aircraft Wheels, Aircraft Brakes System; Inspection and maintenance of air-conditioning and pressurization system, water and waste system; Installation and maintenance of Instruments – handling, Testing, Inspection; Inspection and maintenance of auxiliary Power Units (APUs).					
UNIT V	SAFETY PRACTICES				9
Hazardous materials storage and handling; Aircraft furnishing practices – Equipment, Trouble shooting, Theory and practices, Maintenance Schedule, inspection of Cessna 172.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the principles of function and safe operation to aircraft as per FAA	Understanding (K2)
CO2	identify welding, soldering, brazing, and sheet metal repair techniques used in aircraft structural maintenance.	Applying (K3)
CO3	demonstrate the repair and maintenance procedures for plastic and composite components in aircraft.	Applying (K3)
CO4	perform aircraft jacking, control surface balancing, and helicopter rotor tracking and balancing.	Applying (K3)
CO5	apply safety practices for hazardous material handling and general aircraft maintenance operations.	Applying (K3)

TEXT BOOKS

1. Kroes, Michael, William Watkins, and Frank Delp. "Aircraft Maintenance and Repair", Seventh Edition, Mc Graw-Hill Education, 2017.
2. Federal Aviation Administration, "Aviation Maintenance Technician Handbook: General", Federal Aviation Administration, Year: 2023.

REFERENCES

1. Michael J. Kroes and James R.Rardon, "Aircraft Maintenance and Repair", Glencoe Mc Graw-Hill, 2019.
2. Brendan Phibbs, "Aircraft Composite Materials", Lightning Source Inc., 2015.
3. Dale Crane, "Aircraft Inspection and Repair", Aviation Supplies & Academics (ASA), FAA-H-8083-31, 2023.
4. Federal Aviation Administration (FAA), "Aviation Maintenance Technician Handbook-General", FAA-H-8083-30A, 2021.

CO-PO MAPPING:

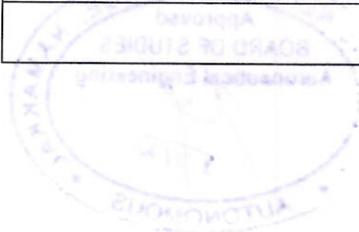
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

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CO's	Programme Outcomes PO's												PSO's	
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CO1	3	2	2	1	1	1	-	1	2	2	2	1	3	2
CO2	2	2	2	1	1	-	-	1	1	2	1	1	3	2
CO3	2	2	3	2	3	-	-	2	2	2	2	1	3	3
CO4	2	3	3	3	2	-	-	2	2	1	2	1	3	3
CO5	2	2	2	2	2	2	2	2	2	2	2	2	2	2



AE23554	AIR TRAFFIC CONTROL AND AIRPORT PLANNING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	understand the fundamental structure, objectives, and classification of air traffic services (ats).				
2.	learn the operational aspects of atc services, including vfr/ifr operations and separation methods.				
3.	gain knowledge of radar systems, emergency procedures, and international rules of the air.				
4.	understand key airport planning elements, including runway design and obstacle limitation criteria.				
5.	familiarize with visual aids and emergency services available at airports.				
UNIT I					
FUNDAMENTALS OF AIR TRAFFIC SERVICES (ATS)					9
Objectives and components of ATS - Scope and provision of Air Traffic Control (ATC) services; VFR and IFR operations- Principles and applicability, Classification of ATS airspaces (A to G); Types of separation- Vertical, lateral, longitudinal, time/distance; Altimeter setting procedures, ATS unit identification and designation; Division of control responsibility between ATS units.					
UNIT II					
ATC SERVICES AND FLIGHT PLANNING					9
Area control service and assignment of cruising levels- Minimum flight altitudes and ATS routes, Significant points and reporting points; RNAV and RNP concepts and applications; ATC clearances - Structure and terminology, Flight plans - ICAO flight plan format, filing and amendments; Position reporting and coordination among ATC units.					
UNIT III					
RADAR SERVICES, EMERGENCY PROCEDURES, AND RULES OF THE AIR					9
Secondary Surveillance Radar (SSR) - Principles and performance checks, Use of radar in area and approach control, Radar vs non-radar coordination; Flight information and advisory services; Alerting services- Structure and protocols; Emergency procedures and ATC response - ICAO "Rules of the Air", general operating and flight rules.					
UNIT IV					
AIRPORT PLANNING: PHYSICAL CHARACTERISTICS AND OBSTACLE LIMITATION					9
Basic airport data and ICAO aerodrome reference code - Aerodrome reference point, elevation, and temperature; Runway configurations - Primary/secondary, length, width; Parallel runways and minimum distance requirements; Obstacle limitation surfaces (OLS) and restriction criteria; Design differences - Domestic vs international airports					
UNIT V					
VISUAL AIDS AND EMERGENCY SERVICES					9
Visual navigation aids - Wind and landing direction indicators, signal area; Runway and taxiway markings - Design and specifications; Airfield lighting systems - Aerodrome beacon, identification beacon, approach lights; VASI, PAPI, and other visual guidance systems; Obstacle marking and lighting standards; Emergency services – Fire fighting, rescue, medical support at airports;					
TOTAL PERIODS					45



COURSE OUTCOMES		BT Mapped (Highest Level)
At the end of this course, students will be able to		
CO1	explain the principles and components of air traffic services (ats) and classification of airspaces.	Understanding (K2)
CO2	interpret flight planning procedures, atc clearances, and coordination among ats units.	Applying (K3)
CO3	analyze the use of radar services and emergency procedures in air traffic operations.	Analysing (K4)
CO4	evaluate airport planning standards including runway configuration and obstacle limitation surfaces.	Analysing (K4)
CO5	apply knowledge of visual aids and emergency services used in airport operations.	Applying (K3)

TEXT BOOKS

1. Michael S. Nolan, "Fundamentals of Air Traffic Control", Cengage Learning, 6th Edition, 2019.
2. Ann R. Rittgers, "Air Traffic Control Career Prep: A Comprehensive Guide to One of the Best-Paying Federal Government Careers", ASA, 3rd Edition, 2018.

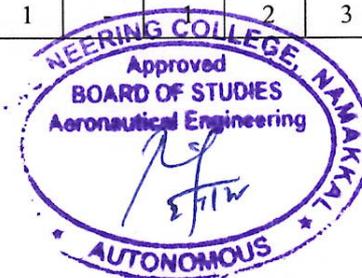
REFERENCES

1. Federal Aviation Administration (FAA), Pilot's Handbook of Aeronautical Knowledge, FAA-8083-25 B, U.S. Department of Transportation, 2020.
2. Peter J. Swatton, Aircraft Performance: Theory and Practice for Pilots, Wiley-Blackwell, 2nd Edition, 2022.
3. Aviation Supplies & Academics (ASA), Aeronautical Chart User's Guide, 14th Edition, 2020.
4. Alexander T. Wells & Seth B. Young, "Airport Planning & Management", Mc Graw-Hill Professional, 6th Edition, 2017.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
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CO1	3	2	-	-	2	1	1	-	-	-	-	1	2	2
CO2	3	3	2	2	3	1	1	-	-	-	-	1	3	3
CO3	3	3	3	3	3	1	-	1	-	-	-	1	3	3
CO4	3	3	3	3	3	1	-	-	-	1	-	1	2	3
CO5	3	3	3	3	3	1	1	1	-	1	-	1	2	3



AE23555	CIVIL AVIATION REGULATIONS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the framework of civil aviation requirements (car) and the regulatory responsibilities related to airworthiness.						
2.	learn procedures for defect recording, analysis, reporting, and scheduled maintenance of aircraft.						
3.	understand certification processes, airworthiness requirements, and organizational approvals.						
4.	gain knowledge on licensing, mandatory modifications, and safety inspections.						
5.	familiarize with flight testing, aircraft documentation, and miscellaneous aviation regulations.						
UNIT I							
CAR SERIES 'A'							9
Introduction- Module I CAR series 'A' - Procedure for civil air worthiness requirements and responsibility operators - Air worthiness directorate							
UNIT II							
CAR SERIES 'C'							9
CAR Series 'C'- Defect recording, monitoring, reporting, investigation, rectification; Flight report evaluation- In-flight readings and analysis; CAR Series 'D'- Aircraft Maintenance Programme and approval, Reliability Programme (engines), TBO revisions, On-condition maintenance - Fuel/oil uplift and consumption records; Routine maintenance scheduling							
UNIT III							
CAR SERIES 'E' and 'F' - APPROVAL OF ORGANISATIONS							9
Approval of organizations in categories A, B, C, D, E, F, & G; requirements of infrastructure at stations other than parent base. CAR SERIES 'F' - Air worthiness and continued air worthiness Procedure relating to registration of aircraft; procedure for issue / revalidation of type certificate of aircraft and its engines / propeller issue / revalidation of certificate of airworthiness; requirements for renewal of certificate of airworthiness.							
UNIT IV							
CAR SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEE LICENSING							9
Issue of AME license, its classification and experience requirements, complete Series 'L'. C.A.R. SERIES 'M' mandatory modifications and inspections: mandatory modifications /inspections. Procedure for issue of type approval of aircraft components and equipment including instruments.							
UNIT V							
CAR SERIES 'T' - FLIGHT TESTING OF AIRCRAFT							9
Flight testing of (series) aircraft for issue of C of A; fight testing of aircraft for which C or A had been previously issued. CAR SERIES 'X' Miscellaneous Requirements: Registration Markings of aircraft; weight and balance control of an aircraft; provision of first aid kits & physician's kit in an aircraft; use furnishing materials in an aircraft; concessions. Aircraft log books; document to be carried on board on Indian registered aircraft; procedure for issue of taxi permit.							
						TOTAL PERIODS	45

COURSE OUTCOMES		BT Mapped (Highest Level)
At the end of this course, students will be able to		
CO1	explain the maintenance requirement for airworthiness of aircraft and systems.	Understanding (K2)
CO2	summarize the procedure followed for airworthiness certificate.	Applying (K3)
CO3	illustrate the airworthiness procedures based on regulation authorities.	Analysing (K4)
CO4	explain the issuance, renewal and experience requirements of ames.	Understanding (K2)
CO5	compare the flight testing of aircraft.	Analysing (K4)

TEXT BOOKS

1. Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness), Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.
2. Aircraft Manual (India), Volume - Latest Edition, The English Book Store, 171, Connaught Circus, New Delhi.”

REFERENCES

1. Kern, R., Flight Safety and Aircraft Maintenance, McGraw-Hill Education, 2015.
2. ICAO Doc 9760, Airworthiness Manual, International Civil Aviation Organization.
3. R.K. Sharma, Air Safety and Aviation Management, Kanishka Publishers, 2018.
4. David Wyatt, Mike Tooley, Aircraft Maintenance and Repair, Routledge, 2014.

CO-PO MAPPING:

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CO's	Programme Outcomes PO's												PSO's	
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CO2	3	3	2	2	3	-	2	2	-	-	-	1	2	3
CO3	3	3	2	3	2	-	2	3	-	-	-	2	3	3
CO4	2	2	2	1	1	-	2	2	-	-	-	2	2	2
CO5	2	3	2	3	2	-	3	2	-	-	-	2	2	3



AE23556	AVIONICS SYSTEMS MAINTENANCE			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	introduce the fundamentals of avionics systems maintenance in modern aircraft.						
2.	train students in handling, testing, and troubleshooting of key avionics components.						
3.	develop competency in interpreting test equipment results and maintaining system integrity.						
4.	create awareness of post-event inspections and airworthiness practices.						
5.	emphasize safety, certification, and documentation in avionics maintenance procedures.						
UNIT I	AVIONICS INSTALLATION AND SAFETY PROCEDURES						9
Standard practices in avionics hardware installation; Mounting of avionics units (panel-mounted and remote units); Use of trays, racks, shock mounts, and anti-vibration devices; Connector handling and ESD (Electrostatic Discharge) precautions; Power sources and battery management in emergency systems; Safety procedures and ground handling precautions.							
UNIT II	WIRING, CABLING, AND WAVEGUIDE MAINTENANCE						9
Types of cables (coaxial, fiber optic, shielded cables); Cable integrity checks using cable testers and TDRs; Crimping, soldering, and connector replacements; Waveguide inspection, sealing, and fitment practices; Static dischargers and lightning protection checks; Use of insulation resistance tester (Megger).							
UNIT III	BITE SYSTEMS AND DIAGNOSTIC TOOLS						9
Introduction to Built-In Test Equipment (BITE); Functional checks using cockpit interfaces; Use of portable testers: ramp testers, signal simulators; Reading and interpreting BITE fault codes; Limitations of BITE systems; Integration with aircraft health monitoring systems (AHMS)							
UNIT IV	POST-ABNORMAL EVENT INSPECTION						9
Procedures after lightning strike or turbulence; Inspection after magnetic storms, heavy landings; Fault isolation techniques post-event; Recording and documentation of event-driven maintenance; Regulatory requirements and return-to-service criteria.							
UNIT V	ENVIRONMENTAL CONSIDERATIONS AND COOLING SYSTEMS						9
Avionics cooling methods (forced air, conduction, liquid cooling); Heat generation in avionics – sources and impacts; Blowers, heat exchangers, and airflow management; Cooling failure effects and monitoring; Environmental sealing of equipment (humidity, vibration, pressure).							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	understand the installation procedures and safety practices for avionics systems.					Understanding (K2)	

CO2	apply maintenance techniques for aircraft wiring, cables, and waveguides.	Applying (K3)
CO3	analyze faults using bite systems and diagnostic test tools.	Analyzing (K4)
CO4	apply inspection procedures after abnormal flight events like lightning or turbulence.	Applying (K3)
CO5	analyze avionics cooling systems and propose suitable maintenance solutions.	Analysing (K4)

TEXT BOOKS

1. R.P.G. Collinson, Introduction to Avionics Systems, Springer, 4th Edition, 2023.
2. Ian Moir & Allan Sea bridge, Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration, Wiley, 3rd Edition, 2011.

REFERENCES

1. Jeppesen, Avionics Fundamentals, Jeppesen Sanderson Training Products, 2005.
2. ARINC Standards and RTCA DO-160/DO-178C Documentation, for instructor and advanced reference, various editions: RTCA DO-160G – Environmental Conditions and Test Procedures for Airborne Equipment, 2010.
3. RTCA DO-178C, Software Considerations in Airborne Systems and Equipment Certification, 2011.
4. Cary R. Spitzer, Digital Avionics Handbook, CRC Press, 3rd Edition, 2014.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3



AE23557	HELICOPTER MAINTENANCE			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the fundamental configurations and operational principles of helicopters.						
2.	familiarize with main rotor systems, controls, and maintenance techniques.						
3.	comprehend rotor transmission mechanisms and associated subsystems.						
4.	explore helicopter power plants and tail rotor dynamics.						
5.	gain knowledge of helicopter airframes and specialized equipment for operational support and safety.						
UNIT I	INTRODUCTION TO HELICOPTER SYSTEMS						9
Helicopter as an aircraft – basic features and configurations; Evolution and classification of rotorcraft (single, tandem, coaxial, etc.);Rotor arrangements: conventional tail rotor, NOTAR, compound helicopters; Basic aerodynamic directions: pitch, roll, yaw; Ground handling procedures – landing gears (skid /wheel-based);Bearings and gear systems in helicopter mechanics; Introduction to helicopter-specific components like jet rotors.							
UNIT II	MAIN ROTOR SYSTEM AND CONTROLS						9
Rotor blade maintenance – alignment, balancing (static and dynamic);Vibration monitoring, blade tracking, span wise balancing; Blade sweeping and electronic balancing systems; Dampener maintenance and counterweight adjustments;Mast assembly and stabilizer systems; Swash plate flight control: collective/cyclic inputs; Push-pull tubes, torque tubes, bell cranks, mixer box; Control rigging procedures – maintenance and inspection.							
UNIT III	ROTOR TRANSMISSION SYSTEM						9
Engine-transmission coupling systems; Drive shaft and clutch maintenance; Freewheeling units, spray clutch, roller units; Torque meter operation and maintenance; Rotor brake inspection and fault diagnosis; Mounting systems and vibration analysis; Transmission system maintenance procedures.							
UNIT IV	POWER PLANTS AND TAIL ROTOR SYSTEM						9
Types of helicopter power plants – piston, turbine, ramjet concepts; Power plant installation and maintenance procedures; Horsepower requirements and engine performance considerations; Tail rotor system: structure, servicing, and track adjustments; Tail rotor rigging, alignment, and system checks; Safety standards during power plant and tail rotor inspections.							
UNIT V	AIRFRAMES AND SPECIAL SYSTEMS						9
Helicopter fuselage structure: tubular, sheet metal, bonded types; Examples: Bell 206, Hughes 500, Eurocopter BO-105;Stress and load analysis on airframe; Maintenance of visibility systems, landing gear (wheel/skid types);Special purpose equipment: hoists, floats, emergency systems; Airframe materials, structural inspection techniques; Airframe vibration analysis and dampening systems.							
						TOTAL PERIODS	45

COURSE OUTCOMES		BT Mapped (Highest Level)
At the end of this course, students will be able to		
CO1	describe helicopter configurations, aerodynamic directions, and rotor arrangements.	Understanding (K2)
CO2	explain main rotor system mechanics, swash plate control, and rotor blade maintenance.	Applying (K3)
CO3	analyze rotor transmission components and maintenance practices.	Analysing (K4)
CO4	demonstrate understanding of helicopter powerplant operations and tail rotor control systems.	Applying (K3)
CO5	evaluate airframe structures, materials, and vibration analysis techniques used in helicopters.	Analysing (K4)

TEXT BOOKS

1. FAA-H-8083-21B, "Helicopter Flying Handbook", U.S. Department of Transportation, FAA, 2021.
2. W.J. Wagtendonk, "Principles of Helicopter Flight", 2nd Edition, Aviation Supplies & Academics, Inc., 2006.

REFERENCES

1. Shawn Coyle, "Cyclic and Collective: Fundamentals of Helicopter Flight", Aviation Supplies & Academics, Inc., 2003.
2. R.W. Prouty, "Helicopter Performance, Stability, and Control", Krieger Publishing Company, 2009.
3. Gordon J. Leishman, "Principles of Helicopter Aerodynamics", 2nd Edition, Cambridge University Press, 2006.
4. Joseph Schafer, "Helicopter Maintenance", 3rd Edition, Avotek Information Resources, 2019.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	1	-	-	-	-	-	-	-	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	-	3	3
CO3	3	3	2	3	2	-	-	-	-	-	-	-	3	3
CO4	2	2	2	2	2	-	-	-	-	-	-	-	2	3
CO5	2	3	2	3	3	-	-	-	-	-	-	-	3	3



AE23651	LEAN MANUFACTURING			3	0	0	3	
COURSE OBJECTIVES								
To enable the students to								
1.	understand the historical development, philosophy, and necessity of lean manufacturing.							
2.	study the foundational elements that provide stability in lean systems like 5S, TPM, and standardized work.							
3.	comprehend and apply Just-In-Time principles such as Kanban, pull systems, and value stream mapping.							
4.	analyze the concept of Jidoka and mistake-proofing techniques for autonomous quality control.							
5.	promote worker involvement and systematic planning methodologies like Hoshin Kanri to support lean culture.							
UNIT I INTRODUCTION								
9								
The mass production system– Origin of lean production system ,Other developments, Lean production system- New economics ;system and systems thinking – Basic image of lean production – Customer focus – Muda (waste).								
UNIT II STABILITY OF LEAN SYSTEM								
9								
Standards in the lean system – 5S system – Total Productive Maintenance – standardized work –Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency - standardized work and Kaizen – Common layouts.								
UNIT III JUST IN TIME								
9								
Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production Levelling – Pull systems – Value stream mapping								
UNIT IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH)								
9								
Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka.								
UNIT V WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY								
9								
Involvement – Activities to support involvement – Quality circle activity – Kaizen training – Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning –Lean culture.								
						TOTAL PERIODS		45
COURSE OUTCOMES								
At the end of this course, students will be able to						BT Mapped (Highest Level)		
CO1	explain the origin, need, and basic principles of lean manufacturing and					Understanding (K2)		

	systems thinking	
CO2	apply lean tools such as 5S, TPM, and standardized work to stabilize production systems.	Applying (K3)
CO3	develop and implement Just-In-Time systems using Kanban and value stream mapping.	Applying (K3)
CO4	analyze the concept of Jidoka and implement Poka-Yoke techniques for quality control.	Applying (K3)
CO5	illustrate the step-by-step process of Hoshin Planning and its alignment with strategic organizational goals.	Applying (K3)

TEXT BOOKS

1. Rother M. and Shook J, 1999 Learning to See: Value Stream Mapping to Add Value and Eliminate Muda , Lean Enterprise Institute, Brookline, MA.
2. Design and Analysis of Lean Production Systems, Ronald G. Askin & Jeffrey B. Goldberg, John Wiley & Sons, 2003

REFERENCES

1. Mikell P. Groover (2002), "Automation, Production Systems and CIM".
2. Liker, J. K., & Meier, D. (2006). The Toyota Way Field book: A Practical Guide for Implementing Toyota's 4 Ps. McGraw-Hill.
3. Nicholas, J. M. (2018). Lean Production for Competitive Advantage: A Comprehensive Guide to Lean Methodologies and Management Practices (3rd Edition). CRC Press.
4. Marchwinski, C., & Shook, J. (2007). Lean Lexicon: A Graphical Glossary for Lean Thinkers (5th Edition). Lean Enterprise Institute.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
 (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	1	1	-	-	-	-	-	3	1	3
CO2	2	3	3	2	1	2	-	-	-	-	-	3	2	3
CO3	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO4	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO5	2	3	2	2	1	2	-	-	-	-	-	2	2	3



AE23652	ADDITIVE MANUFACTURING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	introduce the fundamentals of Additive Manufacturing and its impact on modern product development.				
2.	understand the unique capabilities of AM and learn key concepts in design, data processing, and file preparation for quality part production.				
3.	interpret the principles, materials, processes, advantages, and applications of SLA, DLP, LOM, and UAM additive manufacturing techniques.				
4.	comprehend the principles, processes, materials, and applications of FDM, SLS, SLM, and EBM additive manufacturing technologies.				
5.	explore the principles, processes, materials, and applications of Binder Jetting, Material Jetting, and LENS additive manufacturing techniques.				
UNIT I INTRODUCTION					
9					
Introduction to Additive Manufacturing - Impact of AM on Product Development - Historical development, benefits of AM, commonly used terms, process chain, 3D modelling, Data Conversion and transmission, Checking and preparing, Building, Post processing- Classification of AMT process- Applications to various fields.					
UNIT II DESIGN FOR ADDITIVE MANUFACTURING					
9					
Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing; CAD Model Preparation - AM File formats; STL-Problems with STL- AMF Design for Part Quality Improvement; Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.					
UNIT III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES					
9					
Stereolithography Apparatus (SLA); Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications. Laminated Object Manufacturing (LOM); Working Principles - Process - Materials, Advantages, Limitations and Applications-Ultrasonic Additive Manufacturing (UAM) - Process - Parameters and Applications.					
UNIT IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES					
9					
Fused deposition Modelling (FDM); Working Principles - Process - Materials and Applications. Selective Laser Sintering (SLS); Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Selective Laser Melting (SLM) and Electron Beam Melting (EBM); Principles – Processes – Materials – Advantages - Limitations and Applications.					
UNIT V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES					
9					
Binder Jetting; Three dimensional Printing (3DP); Principles – Process - Physics of 3DP – Types of printing; Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications. Material Jetting; Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.					

Laser Engineered Net Shaping (LENS); Processes- Materials- Advantages - Limitations and Applications.														
												TOTAL PERIODS		45
COURSE OUTCOMES														
At the end of this course, students will be able to												BT Mapped (Highest Level)		
CO1	explain the AM process chain, classify AM technologies, and identify their applications across various industries.											Understanding (K2)		
CO2	apply design principles such as part orientation, support structures, and slicing to improve part quality in extrusion-based AM.											Applying (K3)		
CO3	describe the working principles, material usage, and benefits of SLA, DLP, LOM, and UAM processes and identify their industrial applications.											Understanding (K2)		
CO4	discuss the working principles, material selection, and industrial relevance of FDM, SLS, SLM, and EBM processes.											Applying (K3)		
CO5	differentiate between 3DP, MJM, and LENS processes based on their working principles, material compatibility, and application suitability.											Analysing (K4)		
TEXT BOOKS														
1. Chua C.K, Leong K.F and Lim C.S, Rapid Prototyping: Principles and Applications, second edition, World Scientific, 2005.														
2. Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer - New York, USA, 2 nd Edition, 2015														
REFERENCES														
1. Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing:3D Printing for Prototyping and Manufacturing", Hanser publications Munchen, Germany, 2016.														
2. Ben Redwood, Brian Garret, Filemon Schöffner, and Tony Fadel, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs B.V., Netherland, 2017.														
3. Bandyopadhyay, A & Bose.S. Additive Manufacturing, second edition, CRC Press, 2019														
4. Milan Brandt. "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Wood head Publishing, UK, 2016.														
CO-PO MAPPING:														
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's														
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes PO's												PSO's	
CO's	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	1	1	1	1	1	1	1	-	2	3	1	1
CO2	3	2	2	1	2	1	3	1	1	-	1	3	2	1
CO3	3	1	1	1	1	1	2	1	1	-	1	3	2	1
CO4	3	1	1	1	1	1	2	1	1	-	1	3	2	1
CO5	3	3	2	1	1	1	2	3	1	-	1	3	2	1



AE23653	SMART MANUFACTURING			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	introduce students to fundamentals of Manufacturing						
2.	familiarize with selection of sensors for various application						
3.	earn the basics of agent-based manufacturing						
4.	understand Cyber physical systems						
5.	provide brief understanding about industry 4.0 concepts in Manufacturing systems						
UNIT I	SENSORS SMART MANUFACTURING						9
Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. Automatic identification techniques for shop floor control – optical character and machine vision sensors – smart / intelligent sensors – integrated sensors, Robot sensors, Micro sensors, Nano sensors							
UNIT II	DATA ANALYTICS						9
Introduction to Data and Analytics in a Digital Context (Internet of Things), Product Data Management for Design and Manufacturing (PLM Tools), Typical data challenges (data quality, enrichment, integration of ERP & PLM data), Preparing data for analytics (techniques to improve data quality, integration - ETL) Advances in data visualization & related tools-Statistical Techniques for Analytics, Descriptive Statistics Inferential statistics, Regression and ANOVA							
UNIT III	CYBER PHYSICAL SYSTEMS						9
Concept of Cyber Physical Systems (CPS) and Cyber Physical Production System (CPPS), System Architecture for implementation of CPPS, Components for CPPS, Communication for CPPS.							
UNIT IV	E- MANUFACTURING						9
Introduction of Agent based manufacturing- agent based Manufacturing, Cloud Based Manufacturing Information technology-based Supply chain, Concept of agile manufacturing and E-manufacturing.							
UNIT V	INDUSTRY 4.0						9
Evaluation of industries, Introduction to Industry 4.0, Challenges in industry 4.0, Impact of Industry 4.0, Case studies on industry 4.0, Introduction to Internet of Things (IoT) and its applications, Smart supply chain and Case studies							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the role and operating principles of various industrial sensors used in					Understanding (K2)	

	smart manufacturing systems	
CO2	analyze and select appropriate sensors and monitoring techniques for condition monitoring in manufacturing environments.	Analysing (k4)
CO3	apply data analytics and visualization techniques to solve problems in design and manufacturing.	Applying (Level 3)
CO4	compare agent-based, cloud-based, and agile manufacturing approaches in the context of e-manufacturing.	Analysing (K4)
CO5	demonstrate understanding of Industry 4.0 concepts, its challenges, and impact through real-world case studies.	Understanding (K2)

TEXT BOOKS

1. Bahga and V. Madiseti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515.
2. M. P. Grover “Automation, Production Systems and Computer-Integrated Manufacturing” Pearson Education, 4th edition, 2016, ISBN: 978-0133499612.

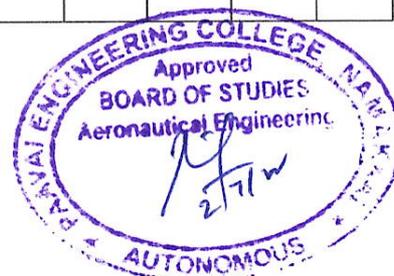
REFERENCES

1. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas and G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2017 ISBN: 978-1259006210
2. M. Skilton and F. Hovsepian, The 4th Industrial Revolution: Responding to the Impact of Artificial Intelligence on Business, Springer Nature, 2017, ISBN: 978-3-319-62479-2
3. Gilchirst, Industry 4.0: The Industrial Internet of Things, a press (Springer), 1st Edition, 2016, ISBN: 978-1-4842-2046-7
4. N. Viswanandham, Y. Narhari “Performance Modeling of Automated Manufacturing Systems” Prentice-Hall, 1st Edition, 1994, ISBN: 978-8120308701

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	1	1	-	-	-	-	-	3	1	3
CO2	2	3	3	2	1	2	-	-	-	-	-	3	2	3
CO3	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO4	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO5	2	3	2	2	1	2	-	-	-	-	-	2	2	3



AE23654	GEOMETRIC DIMENSIONING AND TOLERANCING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	introduce the fundamental principles of Geometric Dimensioning and Tolerancing (GD&T) based on international standards including geometric symbols, datum systems, and tolerance zones.				
2.	enable students to understand and apply material condition modifiers such as Maximum Material Condition (MMC), Least Material Condition (LMC), and Regardless of Feature Size (RFS), along with the correct interpretation of Feature Control Frames.				
3.	develop the ability to analyze and design datum reference frames and geometric tolerances for complex shapes, including curved and irregular surfaces, and understand their impact on manufacturing and inspection processes				
4.	explain the importance of size and form control through principles such as Taylor's principle and gauging methods, along with interpretation of tolerancing rules for untoleranced dimensions.				
5.	equip students with skills to create and evaluate dimensioning and tolerancing schemes, and to develop effective dimensional inspection plans using functional and paper gauging methods.				
UNIT I					
FUNDAMENTALS OF GEOMETRIC DIMENSIONING AND TOLERANCING					9
Introduction: Geometric product definition principles; verification of position with open setup; geometric characteristic symbols Geometric Dimensioning and Tolerancing: an explanation of tolerance zone conversion; surfaces, features, features of size, datum features, datum features of size, and datum's; tolerances; components common to geometrically dimensioned & tolerance drawing; fits & allowances, advantages of GD&T.					
UNIT II					
MATERIAL CONDITION SYMBOLS					9
MMC, LMC & RFS: Maximum Material Condition (meaning & use); Least Material Condition (meaning & use); Regardless of Feature Size How to read a Feature Control Frame.					
UNIT III					
FUNCTIONAL BOUNDARIES AND COMPLEX DATUM FEATURE INTERPRETATION					9
Datum features; oddly configured & curved surfaces as datum features; equalizing datum's; datum feature symbols; flexible parts; direct vs indirect tolerancing. MMC and its ramifications. Relations between individual features. Virtual Condition and Resultant condition Boundaries: Virtual condition (MMC concept & a functional boundary).					
UNIT IV					
FORM AND SIZE CONTROL					9
Size Control Form: The Taylors principle; Gauging size limits. Rules, concepts, Characteristics, and Un toleranced Dimensions: individual or related Datum's, Material Conditions; Un toleranced dimension.					
UNIT V					
STRATEGIC TOLERANCING AND DIMENSIONAL INSPECTION PLANNING					9
A Logical Approach to part tolerance Dimensioning and tolerance Schemes Steps for the Development of a Dimensional Inspection Plan Paper Gauging and Functional Gauging.					
TOTAL PERIODS					45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the fundamentals and terminology of GD&T, including geometric characteristics and datums.	Understanding (K2)
CO2	apply material condition symbols (MMC, LMC, RFS) and interpret Feature Control Frames effectively.	Applying (K3)
CO3	analyze complex datum features, functional boundaries, and relationships between geometric controls.	Analysing (K4)
CO4	interpret size control and form tolerances using principles like Taylor's Principle and understand gauging.	Applying (K3)
CO5	develop logical tolerancing schemes and inspection plans using paper and functional gauging techniques.	Applying (K3)

TEXT BOOKS

1. James D Meadows, "Geometric Dimensioning and Tolerancing", Marcel Dekker, Inc
2. James D Meadows, "Measurement of Geometric Tolerances in Manufacturing" Marcel Dekker, Inc

REFERENCES

1. P S Gill, "Geometric Dimensioning and Tolerancing", S K Kataria & sons, 2005-6
2. Cogorno, G. R. (2020). Geometric Dimensioning and Tolerancing for Mechanical Design (3rd ed.). McGraw-Hill Education. ISBN 978-1-260-45378-2.
3. Krulikowski, A. (2018). Fundamentals of Geometric Dimensioning and Tolerancing (ASME Y14.5-2018 Edition). SAE International.
4. ASME Y14.5-2018. (2018). Dimensioning and Tolerancing. The American Society of Mechanical Engineers.

CO-PO MAPPING:

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	1	1	-	-	-	-	-	3	1	3
CO2	2	3	3	2	1	2	-	-	-	-	-	3	2	3
CO3	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO4	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO5	2	3	2	2	1	2	-	-	-	-	-	2	2	3



AE23655	GREEN MANUFACTURING	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1.	expose the students to the basics of environmental sustainability and impact assessment objectives					
2.	explore metrics for sustainability and green supply chains in manufacturing.					
3.	promote the concept of Zero-Waste manufacturing and explore practical methods and systems for implementation.					
4.	introduce clean energy technologies and their role in green manufacturing.					
5.	explore enabling technologies (like sensors and process monitoring systems) for green manufacturing.					
UNIT I	ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT	9				
Introduction to Green Manufacturing-Motivations and Barriers to Green Manufacturing,, Environmental Impact of Manufacturing, Toxic Chemical Releases; Waste Generation; Energy Consumption; Carbon Emissions, Strategies for Green Manufacturing. The Social Environment—Present Atmosphere and Challenges for Green Manufacturing.						
UNIT II	METRICS FOR GREEN MANUFACTURING AND GREEN SUPPLY CHAIN	9				
Overview of Currently Used Metrics, Overview of LCA Methodologies-Overview of Three Types of LCA; Impact Assessment; Risk Assessment, Metrics Development Methodologies-Ecological/Cost Metric Choice Mode; Decision Tree Model for Equipment Investment, Issues in Green Supply Chains (GSC).						
UNIT III	CONCEPTS, METHODS, AND STRATEGIES FOR ZERO-WASTE IN MANUFACTURING	9				
Concepts of Zero Waste in Manufacturing, Waste Assessment Process and Systems Approach- Establish the Team and Define the Project, Common Strategies for Zero Waste-Recyclable Product Identification; Paper Product Reduction Strategies; Collection Station , Food Management, Alternative Uses for Products, Green Purchases and Green Partners, HR/PR Measures, Case Study.						
UNIT IV	GREEN MANUFACTURING THROUGH CLEAN ENERGY SUPPLY	9				
Introduction, Clean Energy Technologies- Solar Photovoltaic; Wind Energy; Fuel Cells, Application Potential of Clean Energy Supply in Green Manufacturing-Technological Performance of Clean Energy Supply; Cost Benefit of Environmental Emission Mitigation Through Clean Energy Supply; Cost Benefit of Environmental Emission Mitigation Through Clean Energy Supply						
UNIT V	ENABLING TECHNOLOGIES FOR ASSURING GREEN MANUFACTURING	9				
Process Monitoring System-Electrical Flows; Fluid Flows; Cutting Fluid; Compressed Air; Water, Applying Sensor Flows in Decision Making: Automated Monitoring-Approach; Data Standards: MT Connect; Reasoning: Event Stream Processing, Case Study.						
					TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the concept of green manufacturing and its significance in promoting environmental sustainability.	Understanding (K2)
CO2	analyze and use sustainability metrics for manufacturing processes, including Life Cycle Assessment (LCA).	Analysing (K4)
CO3	implement green manufacturing strategies for waste reduction, resource efficiency, and emission minimization.	Applying (K3)
CO4	develop green supply chains and assess sustainability risks associated with them.	Applying (K3)
CO5	apply process monitoring systems and create automated decision-making strategies to optimize sustainability	Applying (K3)

TEXT BOOKS

1. Dorn field David, Green Manufacturing, Springer, 2013
2. Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013

REFERENCES

1. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
2. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
3. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015
4. Larry W. Canter, “Environmental Impact Assessment” 2nd Edition (1995) ,McGraw-Hill Higher Education

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	1	1	-	-	-	-	-	3	1	3
CO2	2	3	3	2	1	2	-	-	-	-	-	3	2	3
CO3	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO4	3	3	3	2	1	2	-	-	-	-	-	2	2	3
CO5	2	3	2	2	1	2	-	-	-	-	-	2	2	3



AE23656	ADVANCED DRONE TECHNOLOGY	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1.	understand the fundamental design principles, airframe configurations, and international regulatory aspects of drones.				
2.	connect the principles of static stability and control, focusing on longitudinal stability and the contribution of various aircraft components.				
3.	gain knowledge about the categorization of Unmanned Aerial Vehicles and various drone technologies including propulsion, sensors, and flight control.				
4.	explore diverse applications of drones across various industries, including industrial and military sectors.				
5.	examine the integration of Artificial Intelligence in drone navigation and its various applications and associated challenges.				
UNIT I	THE DESIGN STANDARDS AND CONFIGURATION				9
Introduction to Design and Selection of the System; Aerodynamics and Airframe Configurations; Characteristics of Drone Types; Design Standards and Regulatory Aspects of Drones (UK, USA, Europe); Design for Stealth.					
UNIT II	STATIC STABILITY AND CONTROL				9
Introduction - Static Stability, Dynamic stability; Longitudinal static stability, Contribution of Aircraft Components; Wing Contribution, Tail Contribution, Aft Tail – Canard forward Tail Surface - Fuselage Contribution; Longitudinal Control - Elevator Effectiveness, Elevator Angle to Trim, Flight Measurement of XNP, Elevator Hinge Moment.					
UNIT III	AVIATION STRATEGIES				9
Categorization of Unmanned Aerial Vehicle - Based on Size, Range, Endurance and Altitude, Weight, Engine type, Configuration and Mechanical Design; Drone Technology - Monitoring Equipment, Countermeasure Equipment, Collision Avoidance and Obstacle Detection Technology, Flight Controllers, Gyroscope Stabilization, Drone Propulsion Technology, Real-Time Telemetry Flight Parameters, No Fly Zone Drone Technology					
UNIT IV	APPLICATIONS OF DRONE				9
Drone Hardware; Components of UAV; Applications - Drones in Aerial Systems, Oil and Gas Industries, Military, Mines – Geotechnical Characterization, Rock Size Distribution Analysis, Underground Coal Mine Gas Detection.					
UNIT V	AI APPLICATIONS OF DRONES				9
Introduction; Review of Literature; AI in Drone Navigation; Companies that Use the AI Drone to Solve Big Problems; Drone Applications Using AI; Issues in the Integration of AI with Drones					
					TOTAL PERIODS 45

COURSE OUTCOMES		BT Mapped (Highest Level)
At the end of this course, students will be able to		
CO1	express the design standards and configurations relevant to drone aerodynamics and global regulatory frameworks.	Understanding (K2)
CO2	analyze drone static stability and understand the contribution of various aircraft components to longitudinal control.	Analyzing (K4)
CO3	illustrate UAVs based on their characteristics and describe various drone technologies.	Applying (K3)
CO4	discuss the drone technology in various real-world scenarios across different industrial and military applications.	Applying (K3)
CO5	discuss the role of Artificial Intelligence in drone navigation and its applications, while identifying associated integration issues.	Applying (K3)

TEXT BOOKS

1. Sachi Nandan Mohanty, J. V. R. Ravindra, G. Surya Narayana, Chinmaya Ranjan Pattnaik, Y. Mohamed Sirajudeen "Drone Technology: Future Trends and Practical Applications" Wiley, 2023.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

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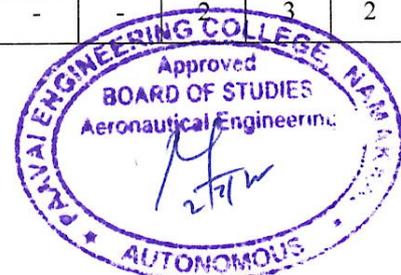
1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
2. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
3. D. Saxby, Drone Aerial Photography and Video: Techniques and Stories from the Field, Cengage Learning, 2018.
4. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your Own Drone, A press, 2019.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	2
CO4	3	2	3	3	3	2	2	-	-	-	-	2	3	2
CO5	2	2	2	3	2	2	2	-	-	-	-	2	3	2



AE23657	DESIGN OF FIXED WING UNMANNED AERIAL VEHICLES	3	0	0	3	
COURSE OBJECTIVES						
To enable the students to						
1.	describe the stages and taxonomy of fixed-wing UAVs design, from concept to decommissioning.					
2.	categorize the structure and components of fixed-wing UAVs, including wings, fuselage, propulsion, and avionics systems.					
3.	produce the knowledge of airworthiness and critical design considerations for fixed-wing UAVs.					
4.	illustrate the manufacturing processes for UAVs, including 3D printing, cutting, along with the assembly and transport mechanisms.					
5.	understand the regulatory requirements for UAVs operations, including the documentation needed for flight planning and safety case development.					
UNIT I	INTRODUCING FIXED-WING UAVs				9	
Stages of Design - Concept Design, Preliminary Design, Detail Design; Manufacturing Design and In-service Design and Decommissioning; Taxonomy of UAVs; Morphology of a UAVs.						
UNIT II	STRUCTURE OF FIXED WING AIRCRAFT				9	
Wings; Fuselages and Tails; Propulsion; Airframe Avionics and Systems; Undercarriages						
UNIT III	DESIGNING UAVs				9	
Airworthiness; Failure Modes; Systems Engineering - Work-breakdown Structure, Interface Definitions; Requirements Flowdown - Cost and Weight Management; Design "Checklist".						
UNIT IV	MANUFACTURE AND FLIGHT				9	
Externally Sourced Components; Three-Dimensional Printing; Hot-wire Foam Cutting, Laser Cutting, Wiring Looms; Assembly Mechanisms; Storage and Transport Cases.						
UNIT V	REGULATORY APPROVAL AND DOCUMENTATION				9	
Aviation Authority Requirements; System Description; Operations Manual; Safety Case; Flight Planning Manual.						
					TOTAL PERIODS	45
COURSE OUTCOMES						
At the end of this course, students will be able to					BT Mapped (Highest Level)	
CO1	interpret the various stages involved in designing fixed-wing UAVs and their classification in terms of morphology and taxonomy.				Understanding (K2)	
CO2	analyze the components that make up the structure of fixed-wing UAVs,				Analyzing (K4)	

	including propulsion, avionics, and undercarriages.	
CO3	administer the principles of airworthiness in UAVs design and for UAV systems.	Applying (K3)
CO4	articulate various manufacturing techniques, assembly and transport of UAVs.	Applying (K3)
CO5	interpret the documentation required for UAVs operations, including safety, planning and the operations manual.	Understanding (K2)

TEXT BOOKS

1. Andrew J. Keane, Andras Sobester and James P. Scanlan, Small Unmanned Fixed-Wing Aircraft Design. Wiley, 2017
2. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.

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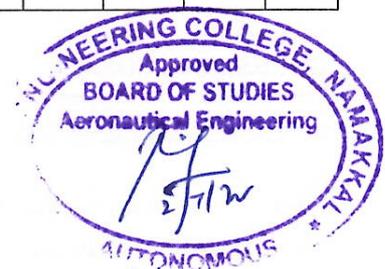
1. Paul G. Fahlstrom, Thomas J. Gleason, "Introduction to UAV Systems", UAV Systems, Inc., 1998.
2. Andrew M. D., David G. L., "Introduction to Flight", McGraw-Hill, 2016.
3. Douglas M. Marshall, "UAVs: Unmanned Aerial Vehicles – The Development of the UAV", Pearson Education, 2010.
4. Prof. Saderla Subrahmanyam, "Design Of Fixed Wing Unmanned Aerial Vehicles", Aerospace Engineering, IIT Kanpur. NPTEL course book.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	3	1	2	-	-	-	-	2	3	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	1	1	-	-	-	-	2	3	3
CO4	3	2	3	3	3	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	2	-	-	-	-	-	2	3	3



AE23851	INTRODUCTION TO AERONAUTICS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the historical development and evolution of flight and aeronautical engineering.						
2.	identify different types of aircraft and their structural components.						
3.	comprehend the fundamental aerodynamic principles and performance parameters of flight.						
4.	analyze the concepts of aircraft stability, control, and various flight phases.						
5.	gain basic knowledge of flight simulation technologies and their applications in training and testing.						
UNIT I FUNDAMENTALS OF AERONAUTICS 9							
Introduction to aeronautical engineering; Evolution and history of flight; Types of aircraft: fixed-wing, rotary-wing, UAVs; Basic flight principles: lift, drag, thrust, and weight.							
UNIT II AIRCRAFT COMPONENTS AND INSTRUMENTS 9							
Fuselage, wings, tail section, landing gear; Control surfaces: ailerons, elevators, rudders; Flight instruments: altimeter, airspeed indicator, vertical speed indicator, heading indicator; Engine monitoring instruments: RPM indicators, temperature sensors, fuel flow meters; Electronic Flight Instrument System (EFIS).							
UNIT III AIRPLANE PERFORMANCE 9							
Lift, drag, thrust, and weight relations; Performance parameters: range, endurance, speed; Lift-to-drag ratio optimization; Effects of altitude and environment on performance.							
UNIT IV FLIGHT MECHANICS 9							
Newton's laws of motion applied to flight; Aircraft stability and control; Phases of flight: takeoff, climb, cruise, descent, landing; Flight envelope and limitations.							
UNIT V INTRODUCTION TO FLIGHT SIMULATION 9							
Types of flight simulators: fixed-base, motion-based; Role of simulators in pilot training; Flight dynamics and aircraft control simulation; Flight simulation software and hardware.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the evolution of flight and classify different types of aircraft.					Understanding (K2)	
CO2	identify and describe aircraft components, control surfaces, and onboard instruments.					Applying(K3)	
CO3	analyze flight performance based on aerodynamic forces and environmental conditions.					Analyzing (K4)	

CO4	apply flight mechanics concepts to describe aircraft stability and phases of flight.	Applying (K3)
CO5	analyze the role and functionality of flight simulators in aviation training and system testing.	Analyzing (K4)

TEXT BOOKS

1. J.D. Anderson, "Introduction to Flight", 9th Edition, Mc Graw-Hill Education, 2021.
2. A.C. Kermode, "Mechanics of Flight", 11th Edition, Pearson Education, 2020.

REFERENCES

1. R.C. Nelson, "Flight Stability and Automatic Control", 2nd Edition, Mc Graw-Hill, 2007.
2. W.D. McCormick, "Aerodynamics, Aeronautics, and Flight Mechanics", 2nd Edition, John Wiley & Sons, 1994.
3. E.L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 6th Edition, Butterworth-Heinemann, 2012.
4. K.E. Graham, P.E. Spinks, "Introduction to Aircraft Flight Mechanics", 2nd Edition, Elsevier, 2018.

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	2	-
CO5	2	2	2	2	3	-	-	-	-	-	-	-	2	2



AE23852	FUNDAMENTALS OF PROPULSION			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the principles of aircraft propulsion systems.						
2.	learn the thermodynamics and fluid dynamics involved in propulsion.						
3.	analyze the performance of different engine types.						
4.	explore the fundamentals of engine design and efficiency.						
5.	investigate future trends in propulsion systems.						
UNIT I INTRODUCTION TO PROPULSION 9							
Overview of propulsion systems; Principles of jet propulsion; Types of propulsion systems: turbojets, turbofans, turboprops, ramjets; Fluid dynamics and thermodynamics in propulsion; Performance measures for propulsion systems.							
UNIT II ENGINE COMPONENTS AND THERMODYNAMICS 9							
Basic components of jet engines: compressor, turbine, combustion chamber, nozzle; Thermodynamic cycles: Brayton cycle, ideal vs real cycles; Efficiency and specific fuel consumption; Energy conversion in propulsion systems; Thermodynamic analysis of jet engines.							
UNIT III JET ENGINES AND TURBOJET PERFORMANCE 9							
Working principles of turbojet engines; Characteristics and performance of turbojets; Thrust generation and fuel efficiency; Impact of altitude on engine performance; Performance calculations for turbojet engines.							
UNIT IV TURBOFAN AND TURBOPROP ENGINES 9							
Working principles of turbofan and turboprop engines; Efficiency of turbofan engines in commercial aviation; Design characteristics of turboprop engines; Thrust-to-power ratios; Applications of turbofan and turboprop engines in aviation.							
UNIT V ENGINE DESIGN AND FUTURE TRENDS 9							
Current trends in engine design: lightweight materials, hybrid technologies; Electric propulsion in aircraft; Environmental impact: emissions, noise reduction; Future advancements in propulsion systems; Alternative propulsion technologies: hydrogen and biofuels.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the basic principles and types of propulsion systems used in aircraft.					Understanding (K2)	
CO2	identify the components of jet engines and analyze their thermodynamic					Analysing (K4)	

	processes.	
CO3	analyze the performance parameters of turbojet engines under various flight conditions.	Analysing (K4)
CO4	compare the working and performance characteristics of turbofan and turboprop engines.	Applying (K3)
CO5	identify recent advancements in engine design and the environmental impacts of alternative propulsion technologies.	Analysing (K4)

TEXT BOOKS

1. N.D. Ratliff, "Aircraft Propulsion", 3rd Edition, Wiley, 2019.
2. J.D. Anderson, "Aircraft Performance and Design", Mc Graw-Hill Education, 2017.

REFERENCES

1. P.G. Hill, C.R. Peterson, "Mechanics and Thermodynamics of Propulsion", 2nd Edition, Pearson Education, 1999.
2. C.L. Mattingly, "Elements of Propulsion: Gas Turbines and Rockets", 2nd Edition, AIAA, 2006.
3. S. White, "Fluid Mechanics and Thermodynamics of Turbomachinery", 6th Edition, Butterworth-Heinemann, 2011.
4. E.R. Garrison, "Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamics of Jets and Rockets", Dover Publications, 2017.

CO-PO MAPPING:

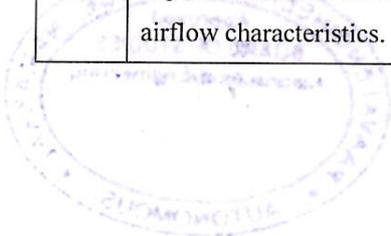
Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO2	3	3	1	2	-	-	-	-	-	-	-	-	3	1
CO3	3	3	2	2	-	-	-	-	-	-	-	-	3	1
CO4	3	2	2	1	-	-	-	-	-	-	-	-	2	1
CO5	2	2	1	1	-	3	3	2	-	-	-	-	2	2



AE23853	BASICS OF AERODYNAMICS AND CONTROL			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the basic principles of aerodynamics and airflow.						
2.	analyze the effects of aerodynamics on aircraft performance.						
3.	study the behavior of airflow around aircraft structures.						
4.	familiarize with aircraft control mechanisms and stability.						
5.	learn the effects of high-speed aerodynamics on aircraft design.						
UNIT I	INTRODUCTION TO AERODYNAMICS						9
Basic aerodynamic principles; Airflow over bodies: laminar and turbulent flow; Types of drag: parasite, induced, wave drag; Bernoulli's theorem and its application in flight; Reynolds number and its significance.							
UNIT II	PRINCIPLES OF LIFT AND AIRFOIL DESIGN						9
Generation of lift: Bernoulli's principle, circulation theory; Airfoil theory and design; Lift coefficient and drag coefficient; Variation of lift with angle of attack; Airfoil design for optimal lift-to-drag ratio.							
UNIT III	FLUID DYNAMICS AND FLOW BEHAVIOR						9
Navier-Stokes equations and their application to aerodynamics; Boundary layers and flow separation phenomena; Stall and control of flow separation; Supersonic and hypersonic aerodynamics; Shock waves and their effects on aircraft design.							
UNIT IV	STABILITY AND CONTROL OF AIRCRAFT						9
Longitudinal stability and control surfaces; Lateral and directional stability; Adverse yaw and aileron reversal; Control surface effectiveness: ailerons, rudders, elevators.							
UNIT V	HIGH-SPEED AERODYNAMICS						9
Aerodynamic principles at transonic, supersonic, and hypersonic speeds; Design challenges in high-speed flight: shock waves, expansion fans; Supersonic airframe design and performance; Aerodynamic heating effects; Applications of high-speed aerodynamics in aerospace engineering.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the basic aerodynamic principles and classify types of drag and airflow characteristics.					Understanding (K2)	



CO2	apply airfoil theory to analyze lift generation and optimize lift-to-drag ratios for flight.	Applying (K3)
CO3	analyze fluid dynamics principles such as boundary layer behavior, stall, and compressibility effects.	Analysing (K4)
CO4	analyze aircraft stability in terms of longitudinal, lateral, and directional control using aerodynamic derivatives.	Analysing (K4)
CO5	analyze aerodynamic challenges and design principles for transonic, supersonic, and hypersonic flight.	Analysing (K4)

TEXT BOOKS

1. J.D. Anderson, "Fundamentals of Aerodynamics", 6th Edition, McGraw-Hill Education, 2017.
2. E.L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 6th Edition, Butterworth-Heinemann, 2012.

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1. B. Etkin, L.D. Reid, "Dynamics of Flight: Stability and Control", 3rd Edition, Wiley, 2012.
2. W.J. McLean, "The Aerodynamics of Aircraft", Wiley, 2007.
3. Kermode, A.C., "Mechanics of Flight", 10th Edition, Pearson Education, 2013.
4. P.G. Hill, C.R. Peterson, "Mechanics and Thermodynamics of Propulsion", 2nd Edition, Pearson Education, 1999.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	-	-	2	-	-	-	-	-	2	2
CO2	3	2	2	1	-	-	2	-	-	-	-	-	3	2
CO3	3	3	2	2	-	-	2	-	-	-	-	-	3	2
CO4	3	3	2	2	-	-	2	-	-	-	-	-	2	2
CO5	3	3	2	2	-	-	2	-	-	-	-	-	3	2



AE23854	ELEMENTS OF AIRCRAFT STRUCTURES AND MATERIALS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the principles of aircraft structural design.						
2.	learn about the materials used in aircraft construction.						
3.	analyze the strength, stiffness, and fatigue resistance of aircraft structures.						
4.	familiarize with the manufacturing and assembly of aircraft components.						
5.	study the impact of materials on aircraft performance and safety.						
UNIT I	INTRODUCTION TO AIRCRAFT STRUCTURES						9
Overview of aircraft structural components: wings, fuselage, tail, landing gear; Structural loads: bending, torsion, shear, and compression; Load paths and distribution in aircraft; Material selection for aircraft structures; Strength and safety considerations in structural design.							
UNIT II	STRESS AND STRAIN IN AIRCRAFT STRUCTURES						9
Stress-strain relationships and deformation in structural materials; Types of stresses: tension, compression, shear, bending, torsion; Yield strength, ultimate tensile strength, and failure modes; Buckling and instability in structural elements; Fatigue life and crack propagation in aircraft structures.							
UNIT III	AIRCRAFT MATERIALS AND THEIR PROPERTIES						9
Common materials used in aircraft construction: metals, composites, polymers; Material properties: strength, stiffness, fatigue resistance; Advanced composite materials in modern aircraft; Material testing and evaluation methods; Effects of environmental factors on material performance.							
UNIT IV	AIRCRAFT STRUCTURAL ANALYSIS						9
Static and dynamic analysis of structural components; Beam bending and torsion analysis; Stress concentration and mitigation; Vibration analysis and damping in structural components.							
UNIT V	AIRCRAFT ASSEMBLY AND MANUFACTURING						9
Aircraft assembly processes: riveting, bolting, welding, bonding; Composite material manufacturing techniques; Non-destructive inspection (NDI) for structural integrity; Quality control in manufacturing; Certification standards for aircraft structures.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the major aircraft structural components, loading conditions, and material selection criteria.					Understanding (K2)	

CO2	analyze stress-strain relationships and failure mechanisms in aircraft structural elements.	Analysing (K4)
CO3	apply knowledge of mechanical properties and environmental behavior to select suitable traditional and composite materials for aircraft structures.	Applying (K3)
CO4	apply structural analysis techniques, including beam theory and finite element methods, to aircraft components.	Applying (K3)
CO5	understand aircraft manufacturing techniques, quality assurance, and certification standards for structural integrity.	Understanding (K2)

TEXT BOOKS

1. J. P. Den Hartog, "Mechanical Vibrations", 4th Edition, Dover Publications, 2017.
2. Megson, T.H.G., "Aircraft Structures for Engineering Students", 6th Edition, Butterworth-Heinemann, 2019.

REFERENCES

1. R.C. Hibbeler, "Mechanics of Materials", 10th Edition, Pearson Education, 2017.
2. A.C. Kermode, "Mechanics of Flight", 10th Edition, Pearson Education, 2013.
3. B.W. Beardsley, "Introduction to Aircraft Structural Analysis", 2nd Edition, McGraw-Hill, 2006.
4. J.D. Anderson, "Introduction to Flight", 9th Edition, McGraw-Hill Education, 2021.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	2	2	-	-	-	-	-	-	2	-
CO2	3	3	2	2	2	2	-	-	-	-	-	-	3	-
CO3	3	2	1	1	2	2	2	-	-	-	-	-	3	2
CO4	3	3	3	3	2	1	-	-	-	-	-	-	3	3
CO5	2	1	2	1	1	2	-	2	-	-	-	-	2	2



AE23855	AIRCRAFT REGULATIONS AND MAINTENANCE FUNDAMENTALS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand aviation regulations and compliance standards.						
2.	study the maintenance philosophy and systems for aircraft.						
3.	learn about aircraft safety and emergency systems.						
4.	familiarize with maintenance scheduling and logbooks.						
5.	understand the future trends in aircraft maintenance.						
UNIT I	INTRODUCTION TO AVIATION REGULATIONS						9
Overview of aviation regulatory bodies (ICAO, FAA, EASA); Airworthiness standards and certification processes; Flight safety regulations and operational standards; International and national aviation laws; Role of regulatory bodies in ensuring aviation safety.							
UNIT II	AIRCRAFT MAINTENANCE SYSTEMS						9
Maintenance philosophy: preventive vs. corrective maintenance; Aircraft maintenance schedules and inspections; Components of maintenance: airframe, engine, avionics; Maintenance documentation: logbooks, records, and reports; Fault diagnosis and troubleshooting.							
UNIT III	MAINTENANCE AND REPAIR OPERATIONS						9
Aircraft component repair procedures: airframe, engine, avionics; Maintenance of power, hydraulic, and pneumatic systems; Inspection and maintenance of control systems; Landing gear maintenance; Performance testing and troubleshooting.							
UNIT IV	SAFETY AND QUALITY ASSURANCE IN MAINTENANCE						9
Safety management systems in aircraft maintenance; Risk management and hazard analysis; Quality control procedures in maintenance; Regulatory compliance and audit processes; Training and certification for maintenance personnel.							
UNIT V	FUTURE TRENDS IN AIRCRAFT MAINTENANCE						9
Automation and robotics in maintenance operations; Predictive maintenance technologies; Use of drones in aircraft inspection; Additive manufacturing (3D printing) for spare parts; Environmental sustainability in aircraft maintenance.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the roles of global and national aviation regulatory bodies and their contributions to airworthiness and safety.					Understanding (K2)	
CO2	apply aircraft maintenance philosophies and interpret standard maintenance schedules and documentation.					Applying (K3)	
CO3	perform basic maintenance and troubleshooting procedures on airframe,					Applying (K3)	

	engine, and support systems.	
CO4	analyze safety and quality assurance systems in aircraft maintenance operations.	Analyzing (K4)
CO5	discuss emerging technologies and sustainable practices in aircraft maintenance operations.	Understanding (K2)

TEXT BOOKS

1. L.H. Abbott, "Aircraft Maintenance and Repair", 7th Edition, McGraw-Hill Education, 2018.
2. B. F. Duckworth, "Aircraft Maintenance and Repair", 3rd Edition, CRC Press, 2012.

REFERENCES

1. M.D. Borenstein, "Principles of Aircraft Maintenance and Inspection", Wiley, 2009.
2. G. M. Ashford, "Aviation Maintenance Management", 2nd Edition, McGraw-Hill, 2013.
3. P.J. Sweeney, "Aviation Safety and Maintenance Regulations", Routledge, 2018.
4. A. R. Gokce, "Aircraft Systems: Maintenance and Operations", Wiley-Blackwell, 2016.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	1	2	2	-	-	-	-	1	2	1
CO2	3	2	2	1	1	1	1	-	-	-	-	1	3	1
CO3	3	2	3	2	2	1	1	-	-	-	-	1	3	2
CO4	3	3	2	2	1	3	2	2	-	-	-	1	2	2
CO5	2	1	1	1	3	2	3	-	-	-	-	2	2	3



AE23856	INTELLIGENT AEROSPACE SYSTEMS			3	0	0	3
COURSE OBJECTIVES							
To enable the students to							
1.	understand the role of intelligent systems in aerospace applications.						
2.	explore the integration of artificial intelligence (ai) and machine learning (ml) in aerospace systems.						
3.	study autonomous systems and their applications in aerospace.						
4.	familiarize with the principles of intelligent navigation, flight control, and monitoring systems.						
5.	learn about future trends and innovations in intelligent aerospace systems.						
UNIT I	INTRODUCTION TO INTELLIGENT AEROSPACE SYSTEMS						9
Overview of intelligent systems in aerospace; Role of AI and machine learning in aerospace applications; Autonomous flight systems and UAVs; Smart sensors and systems integration; Importance of intelligent systems in modern aviation and space exploration.							
UNIT II	SENSORS AND INSTRUMENTATION IN AEROSPACE						9
Types of sensors used in aerospace: inertial sensors, GPS, radar, LIDAR; Sensor fusion and data integration techniques; Flight data management and monitoring systems; Real-time data processing in aerospace systems; Applications of sensors in navigation, control, and monitoring.							
UNIT III	AUTONOMOUS AIRCRAFT AND UNMANNED AERIAL SYSTEMS (UAS)						9
Principles of autonomous flight systems; UAV design, control, and communication systems; Autonomous navigation and collision avoidance systems; Integration of autonomous systems in commercial and military aviation; Regulatory and safety considerations for UAS.							
UNIT IV	INTELLIGENT FLIGHT CONTROL AND NAVIGATION SYSTEMS						9
AI-based flight control systems; Machine learning in flight path optimization and trajectory prediction; Intelligent navigation systems: adaptive control, real-time decision-making; Autonomous decision-making in critical flight situations; Flight path planning and control for autonomous aircraft.							
UNIT V	ADVANCED AEROSPACE APPLICATIONS AND FUTURE TRENDS						9
Emerging technologies in intelligent aerospace systems; AI and machine learning in space exploration and satellite systems; Smart aircraft systems for improved fuel efficiency and safety; Cyber security in aerospace systems; Future of autonomous flight and space missions using intelligent systems.							
						TOTAL PERIODS	45
COURSE OUTCOMES							
At the end of this course, students will be able to						BT Mapped (Highest Level)	
CO1	explain the role and significance of ai and intelligent systems in aerospace applications.					Understanding (K2)	
CO2	apply knowledge of sensors, instrumentation, and data fusion techniques in aerospace systems.					Applying (K3)	

CO3	demonstrate the principles of autonomous flight systems and describe design considerations for uavs and uas.	Applying (K3)
CO4	analyze the use of ai and machine learning in intelligent flight control and real-time decision-making.	Analysing (K4)
CO5	discuss advanced aerospace applications of intelligent systems and future trends in autonomy, security, and exploration.	Understanding (K2)

TEXT BOOKS

1. R.K. Gupta, "Intelligent Systems in Aerospace Engineering", Wiley, 2018.
2. M. L. Shand, "Autonomous Aerospace Systems: Modeling, Control, and Applications", 2nd Edition, Springer, 2020.

REFERENCES

1. B. M. Langley, "Intelligent Flight Systems: Navigation, Control, and Safety Systems", Elsevier, 2016.
2. P. T. McCullough, "Artificial Intelligence for Aerospace Applications", Springer, 2015.
3. H. L. Schwartz, "Autonomous Systems: Engineering and Applications in Aerospace", Wiley-Blackwell, 2017.
4. J. B. Bell, "Intelligent Systems for Aerospace Applications", CRC Press, 2019.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	1	1	1	-	-	-	-	-	-	2	1
CO2	3	2	2	2	3	1	-	-	-	-	-	-	3	2
CO3	3	2	2	2	2	2	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	1	-	-	-	-	-	-	3	3
CO5	2	1	1	1	2	2	3	-	-	-	-	2	2	3

