Department of Aeronautical Engineering

CURRICULUM AND SYLLABI
Regulation - 2023
Syllabus I to V semester

ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

Accredited by NBA and NAAC with "A+"and Recognized by UGC (2f&12B)

KOMARAPALAYAM – 637303

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B.E. AERONAUTICAL ENGINEERING
REGULATION – 2023
CHOICE BASED CREDIT SYSTEM
I TO VIII SEMESTERS CURRICULUM AND SYLLABI

I SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**ESE**	**Total**
Theory Courses									
23MA102	Matrices and Calculus	BS	3	1	0	4	40	60	100
23AE101	Fundamentals of Aeronautics	ES	3	0	0	3	40	60	100
23EE103	Basics of Electrical and Electronics Engineering	ES	3	0	0	3	40	60	100
23LET07	Heritage of Tamils (தமிழர்மரபு)	HSS	1	0	0	1	100	0	100
Theory with Practical Courses									
23LEXXX	Language Elective – I*	HSS	2	0	2	3	50	50	100
23CH102	Chemistry for Material Sciences	BS	3	0	2	4	50	50	100
23ME101	Engineering Graphics	ES	1	0	4	3	50	50	100
Mandatory Course									
23MC001	Induction Programme	MC	2 Weeks			0	100	0	100
TOTAL			**16**	**1**	**8**	**21**	**470**	**330**	**800**

*Language Electives – I									
Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**ESE**	**Total**
23LEE01	Communicative English	HSS	2	0	2	3	50	50	100
23LEE02	Advanced Communicative English	HSS	2	0	2	3	50	50	100

II SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**ESE**	**Total**
Theory Courses									
23MA202	Mathematical Foundations for Engineering	BS	3	1	0	4	40	60	100

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23ME201	Engineering Mechanics	ES	3	1	0	4	40	60	100
23LET08	Tamils & Technology (தமிழரும் தொழில்நுட்பமும்)	HSS	1	0	0	1	100	0	100
Theory with Practical Courses									
23LEXXX	Language Elective – II**	HSS	2	0	2	3	50	50	100
23PH202	Materials Physics	BS	3	0	2	4	50	50	100
23CS203	Problem Solving using Python Programming	ES	3	0	2	4	50	50	100
Practical Course									
23ME202	Mechanical Engineering Practices Laboratory	ES	0	0	2	1	60	40	100
Mandatory Course									
23MC002	Environmental Sciences	MC	2	0	0	0	100	0	100
Total			**17**	**2**	**8**	**21**	**490**	**310**	**800**

****Language Electives - II**

Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	ESE	Total
23LEE02	Advanced Communicative English	HSS	2	0	2	3	50	50	100
23LEH03	Hindi	HSS	2	0	2	3	50	50	100
23LEF04	French	HSS	2	0	2	3	50	50	100
23LEG05	German	HSS	2	0	2	3	50	50	100
23LEJ06	Japanese	HSS	2	0	2	3	50	50	100

III SEMESTER

Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	ESE	Total
Theory Courses									
23AE301	Aero Engineering Thermodynamics	PC	3	0	0	3	40	60	100
23AE302	Aircraft Materials	PC	3	0	0	3	40	60	100
23UH001	Universal Human Values	HSS	3	0	0	3	40	60	100
Theory with Practical Courses									
23MA301	Transforms and Boundary Value Problems	BS	3	0	2	4	50	50	100
23AE303	Solid Mechanics	ES	3	0	2	4	50	50	100
23AE304	Fluid Mechanics and Machinery	ES	3	0	2	4	50	50	100
Practical Course									

23AE305	Applied Thermodynamics Laboratory	ES	0	0	2	1	60	40	100
Mandatory Course									
23MC00X	Mandatory Course -III	MC	0	0	2	0	100	0	100
Knowledge Demonstration - I		KD	0	0	2	0	10% Total Semester Marks		
Total			**18**	**0**	**12**	**22**	**430**	**370**	**800**

IV SEMESTER

Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	ESE	Total
Theory Courses									
23AE401	Air Breathing Propulsion	PC	3	0	0	3	40	60	100
23AE402	Aircraft Structural Mechanics	PC	3	0	0	3	40	60	100
23AE403	Mechanics of Machinery	PC	3	0	0	3	40	60	100
23AE404	Manufacturing Technology	ES	3	0	0	3	40	60	100
Theory with Practical Courses									
23MA402	Statistical and Numerical Methods	BS	3	0	2	4	50	50	100
23AE405	Aerodynamics	PC	3	0	2	4	50	50	100
Practical Course									
23AE406	Propulsion Laboratory	PC	0	0	2	1	60	40	100
Mandatory Course									
23MC00X	Mandatory Course -IV	HSS	2	0	0	0	100	0	100
Knowledge Demonstration - II		KD	0	0	2	0	10% Total Semester Marks		
Total			**20**	**0**	**8**	**21**	**420**	**380**	**800**

V SEMESTER

Code No.	Course	Category	Periods / Week			Credits	Maximum Marks		
			L	T	P		CA	ESE	Total
Theory Courses									
23AE501	Flight Dynamics	PC	3	1	0	4	40	60	100
23AE502	Rocket and Space Propulsion	PC	3	0	0	3	40	60	100
23AE503	Compressible Flow Aerodynamics	PC	3	0	0	3	40	60	100

23AEEXX	Professional Elective-I	PE	3	0	0	3	40	60	100
23YYOXX	Open Elective - I	OE	3	0	0	3	40	60	100
Theory with Practical Courses									
23AE504	Aircraft Structural Analysis	PC	3	0	2	4	50	50	100
Practical Courses									
23AE505	Aero Engine & Airframe Laboratory	PC	0	0	2	1	60	40	100
23AE506	CAD Laboratory	PC	0	0	2	1	60	40	100
Mandatory Course									
23MC00X	Mandatory Course - V	HSS	0	0	2	0	100	0	100
Knowledge Demonstration - III		KD	0	0	2	0	10% Total Semester Marks		
Total			**18**	**1**	**10**	**22**	**470**	**430**	**900**

VI SEMESTER

Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**ESE**	**Total**
Theory Courses									
23AE601	Composite Materials and Structures	PC	3	0	0	3	40	60	100
23ME601	Entrepreneurship Development	EEC	3	0	0	3	40	60	100
23AEEXXX	Professional Elective – II	PE	3	0	0	3	40	60	100
23YYOXX	Open Elective-II	OE	3	0	0	3	40	60	100
Theory with Practical Courses									
23AE603	UAV Systems	PC	3	0	2	4	50	50	100
23AE604	Finite Element Methods and Analysis	PC	3	0	2	4	50	50	100
Practical Courses									
23AE605	Design Thinking and Mini Project	EEC	1	0	2	2	60	40	100
23AE606	Internship	EEC	2 Weeks			1	100	0	100
Mandatory Course									
23MC00X	Mandatory Course - VI	HSS	0	0	2	0	100	0	100
Knowledge Demonstration - IV		KD	0	0	2	0	10% Total Semester Marks		
Total			**19**	**0**	**10**	**23**	**520**	**380**	**900**

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VII SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**ESE**	**Total**
Theory Courses									
23AE701	Computational Fluid Dynamics	PC	3	0	0	3	40	60	100
23AE702	Aircraft Design	PC	3	0	0	3	40	60	100
23AE703	Aircraft Systems and Instruments	PC	3	0	0	3	40	60	100
23AEEXX	Professional Elective – III	PE	3	0	0	3	40	60	100
23AEEXX	Professional Elective – IV	PE	3	0	0	3	40	60	100
23YYOXX	Open Elective - III	OE	3	0	0	3	40	60	100
Practical Courses									
23AE704	Aircraft Systems Laboratory	PC	0	0	2	1	60	40	100
23AE705	Design Project	EEC	0	0	2	2	40	60	100
Knowledge Demonstration - V		KD	0	0	2	0	10% Total Semester Marks		
Total			**18**	**0**	**6**	**21**	**340**	**460**	**800**

VIII SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**ESE**	**Total**
Theory Courses									
23AEEXX	Professional Elective – V	PE	3	0	0	3	40	60	100
23AEEXX	Professional Elective – VI	PE	3	0	0	3	40	60	100
Practical Course									
23AE801	Major Project	EEC	0	0	16	8	50	50	100
Knowledge Demonstration - VI		KD	0	0	2	0	10% Total Semester Marks		
Total			**6**	**0**	**18**	**14**	**130**	**170**	**300**

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MANDATORY COURSES (MC)									
Code No.	**Course**	**Category**	**Periods / Week**			**Credits**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**ESE**	**Total**
23MC001	Induction Programme	MC	2 Weeks			0	100	-	100
23MC002	Environmental Sciences	MC	2	0	0	0	100	-	100
23MC003	Interpersonal Skills	MC	2	0	0	0	100	-	100
23MC004	Indian Constitution	MC	2	0	0	0	100	-	100
23MC005	Indian Knowledge systems	MC	2	0	0	0	100	-	100
23MC006	Soft Skills	MC	0	0	2	0	100	-	100

PROFESSIONAL ELECTIVE

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
STREAM – 1 AERODYNAMICS								
1	23AEE01	Low speed Aerodynamics	PE	3	3	0	0	3
2	23AEE02	High speed Aerodynamics	PE	3	3	0	0	3
3	23AEE03	Boundary Layer Theory	PE	3	3	0	0	3
4	23AEE04	Viscous Flow Theory	PE	3	3	0	0	3
5	23AEE05	Industrial Aerodynamics	PE	3	3	0	0	3
6	23AEE06	Aero Acoustics	PE	3	3	0	0	3
7	23AEE07	Experimental Aerodynamics	PE	3	3	0	0	3
8	23AEE08	Helicopter Aerodynamics	PE	3	3	0	0	3
9	23AEE09	Aviation weather and Metrology	PE	3	3	0	0	3
10	23AEE10	Avionics	PE	3	3	0	0	3
STREAM – 2 PROPULSION								
11	23AEE21	Space Mechanics	PE	3	3	0	0	3
12	23AEE22	Cryogenic Engineering	PE	3	3	0	0	3
13	23AEE23	Heat Transfer	PE	3	3	0	0	3
14	23AEE24	Aircraft Cooling Systems	PE	3	3	0	0	3
15	23AEE25	Combustion Modeling	PE	3	3	0	0	3
16	23AEE26	Micro Propulsion System	PE	3	3	0	0	3
17	23AEE27	Aero Engine Control System	PE	3	3	0	0	3
18	23AEE28	Rockets and Missiles	PE	3	3	0	0	3

19	23AEE29	High Temperature Gas Dynamics	PE	3	3	0	0	3
20	23AEE30	Wind Tunnel Techniques	PE	3	3	0	0	3
21	23AEE31	Missiles Guidance	PE	3	3	0	0	3
STREAM – 3 AIRCRAFT STRUCTURE AND DESIGN								
22	23AEE41	Fatigue and Fracture	PE	3	3	0	0	3
23	23AEE42	Failure Analysis	PE	3	3	0	0	3
24	23AEE43	Aircraft Structural Testing	PE	3	3	0	0	3
25	23AEE44	Experimental Technology for Aircraft Structures	PE	3	3	0	0	3
26	23AEE45	Vibration and Rotor Dynamics	PE	3	3	0	0	3
27	23AEE46	Experimental Stress Analysis	PE	3	3	0	0	3
28	23AEE47	Nano Composite Materials	PE	3	3	0	0	3
29	23AEE48	Theory of Elasticity	PE	3	3	0	0	3
30	23AEE49	Nondestructive Testing	PE	3	3	0	0	3
STREAM – 4 AIRCRAFT MAINTENANCE AND MANUFACTURING								
31	23AEE61	Air Traffic Control and Planning	PE	3	3	0	0	3
32	23AEE62	Aircraft Rules and Regulations	PE	3	3	0	0	3
33	23AEE63	Optimization and its Applications	PE	3	3	0	0	3
34	23AEE64	Helicopter Theory and Maintenance	PE	3	3	0	0	3
35	23AEE65	Airframe Maintenance and Repair	PE	3	3	0	0	3
36	23AEE66	Aero Engine Maintenance and Repair	PE	3	3	0	0	3
37	23AEE67	Total Quality Management	PE	3	3	0	0	3
38	23AEE68	Production Planning and Control	PE	3	3	0	0	3
39	23AEE69	Computer Integrated Manufacturing	PE	3	3	0	0	3
40	23AEE70	Additive Manufacturing	PE	3	3	0	0	3
41	23AEE71	Lean Manufacturing	PE	3	3	0	0	3
42	23AEE72	Professional Ethics in Engineering	PE	3	3	0	0	3
43	23AEE73	Principles of Managements	PE	3	3	0	0	3

OPEN ELECTIVES

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
OPEN ELECTIVE								
1	23AEO01	Drone Design and Development	OE	3	3	0	0	3
2	23AEO02	Nondestructive Testing	OE	3	3	0	0	3
3	23AEO03	Air Traffic Control	OE	3	3	0	0	3
4	23AEO04	Automobile Aerodynamics	OE	3	3	0	0	3
5	23AEO05	Space Engineering	OE	3	3	0	0	3
6	23AEO06	Aircraft Power Plant	OE	3	3	0	0	3
7	23AEO07	Basics of Aeronautical Science	OE	3	3	0	0	3
8	23AEO08	Airport Management	OE	3	3	0	0	3
9	23AEO09	Rocket and Space Science	OE	3	3	0	0	3
10	23AEO10	Aircraft Maintenances	OE	3	3	0	0	3
11	23AEO11	Industrial Aerodynamics	OE	3	3	0	0	3

ONE CREDIT COURSES

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	23AEA01	Wind Turbine Design and Testing	EEC	15	1	0	0	1
2	23AEA02	Real Time Industrial Applications in CFD	EEC	15	1	0	0	1
3	23AEA03	Failure Analysis of Advanced Composites	EEC	15	1	0	0	1
4	23AEA04	Technical Documentation for Aerospace Services	EEC	15	1	0	0	1
5	23AEA05	Introduction to Aerospace Navigation	EEC	15	1	0	0	1
6	23AEA06	Disruptive Innovation Based Startup Activities	EEC	15	1	0	0	1

Knowledge Demonstration

To evaluate the acquired knowledge in the courses learnt during each semester (from III semester to VII semester only) the students are made to demonstrate through Seminar, Project, Prototype, Design Ideas and Poster Presentation (any one mode). The skill demonstrated by the students will be evaluated by the external examiners for 10% of total semester marks. The marks obtained by the students out of the 10% of total semester marks will be distributed across the courses of that particular semester. The knowledge demonstration component will be evaluated from III semester to VII semester.

To accommodate the knowledge demonstration mark that need to be distributed, the maximum course marks (100) is converted for 90.

$$Course\ Marks = 90\%\ of\ the\ marks\ scored\ by\ the\ students\ including\ internal\ and\ External + \frac{10\%\ of\ the\ Total\ semester\ Marks}{Total\ No\ of\ Courses}$$

(Whereas Knowledge Demonstration Marks = 10% of the total Semester marks)

Final Viva - Voce Examination (100)		**Total**
Internal	External	100
20	80	

CREDITS DISTRIBUTION – SEMESTER WISE

Sl. No.	Category	Credits Per Semester								Total Credit (AICTE)	Credits in %
		I	II	III	IV	V	VI	VII	VIII		
1	**HSS**	4	4	3						**11 (10-14)**	**6.67 %**
2	**BS**	8	8	4	4					**24 (22-28)**	**14.55 %**
3	**ES**	9	9	9	3					**30 (24)**	**18.18 %**
4	**PC**			6	14	16	11	10		**57 (48)**	**34.54 %**
5	**PE**					3	3	6	6	**18 (18)**	**10.91 %**
6	**OE**					3	3	3		**9**	**5.45 %**
7	**EEC**						6	2	8	**16 (12-16)**	**9.70 %**
8	**MC**	0	0	0	0	0	0	0		**0**	**0**
Total		**21**	**21**	**22**	**21**	**22**	**23**	**21**	**14**	**165**	**100.00 %**

HSS - Humanities and Social Sciences
BS - Basic Sciences
ES - Engineering Sciences
PC - Professional Core
PE - Professional Electives
OE - Open Electives
EEC - Employability Enhancement Courses
MC - Mandatory Courses (Non-Credit Courses)
CA - Continuous Assessment
FE - Final Examination
L - Lecture
T - Tutorial
P - Practical's

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DEPARTMENT OF AERONAUTICAL ENGINEERING

REGULATION – 2023

VALUE ADDED COURSES

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	23AEV01	Future of Aviation Materials	EEC	30	2	0	0	2
2	23AEV02	Strategies for Product Development	EEC	30	2	0	0	2
3	23AEV03	Geometric Dimensioning and Tolerancing	EEC	30	2	0	0	2

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DEPARTMENT OF AERONAUTICAL ENGINEERING

REGULATION - 2023

NPTEL – COURSES

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	NPTEL	Drone Systems and Control	NPTEL	12 Weeks	-	-	-	3
2	NPTEL	Design of Fixed Wing Unmanned Aerial Vehicles	NPTEL	12 Weeks	-	-	-	3
3	NPTEL	Introduction to CFD	NPTEL	12 Weeks	-	-	-	3
4	NPTEL	Introduction to Aircraft Design	NPTEL	12 Weeks	-	-	-	3
5	NPTEL	Mechanics of Composite Materials and Structures	NPTEL	12 Weeks	-	-	-	3
6	NPTEL	Rocket Propulsion	NPTEL	12 Weeks	-	-	-	3
7	NPTEL	Space Flight Mechanics	NPTEL	12 Weeks	-	-	-	3
8	NPTEL	Introduction to Air breathing Propulsion	NPTEL	12 Weeks	-	-	-	3
9	NPTEL	Smart Structures	NPTEL	12 Weeks	-	-	-	3
10	NPTEL	Elements of Mechanical Vibration	NPTEL	12 Weeks	-	-	-	3
11	NPTEL	Product Design and Development	NPTEL	12 Weeks	-	-	-	3
12	NPTEL	Manufacturing guidelines for design and manufacturing	NPTEL	12 Weeks	-	-	-	3
13	NPTEL	Operation Management	NPTEL	12 Weeks	-	-	-	3
14	NPTEL	Additive Manufacturing	NPTEL	12 Weeks	-	-	-	3
15	NPTEL	Work System Design	NPTEL	12 Weeks	-	-	-	3

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23AE501	Flight Dynamics	L	T	P	C
		3	1	0	4
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Aeronautics				

Course Objectives

The course is intended to

1. Examine the performance of airplanes under various operating conditions.
2. Evaluate Aircraft Performance in Manoeuvring Flight.
3. Analyze Static Longitudinal Stability
4. Examine Lateral and Directional Stability Concepts
5. Emphasize the standard requirements of Lateral and Directional Stability.

Course Outcomes

On successful completion of the course the students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Learn about the forces and moments that are acting on an aircraft, the different types of drag, drag polar, ISA, variation of thrust, power, SFC with velocity and altitude.	Analyze
CO 2	Identify the performance in level flight, power required, climbing, gliding and turning flight, v-n diagram and load factor.	Analyze
CO 3	Know about degrees of stability, stick fixed and stick free stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing.	Apply
CO 4	Enhance the lateral control, rolling and yawing moments, static directional stability, rudder and aileron control requirements and rudder lock of an aircraft.	Analyze
CO 5	Examine the dynamic longitudinal stability, stability derivatives, modes and stability criterion, lateral and directional dynamic stability.	Apply

Course Contents

Module – I Cruising Flight Performance 9+3

Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag –estimation of parasite drag co-efficient by proper area method- Drag polar of vehicles from low speed to high speeds - Variation of thrust, power with velocity and altitudes for air breathing engines . Performance of airplane in level flight - Power available and power required curves. Maximum speed in level flight - Conditions for minimum drag and power required

Module – II Manoeuvering Flight Performance 9+3

Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) – Takeoff and landing - Turning performance (Turning rate turn radius). Bank angle and load factor – limitations on turn - V-n diagram and load factor.

Module – III Static Longitudinal Stability 9+3

Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Hinge moment coefficient - Stick free neutral points.

Module – IV Lateral and Directional Stability 9+3

Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - case study - Rudder lock

Module – V Dynamic Stability 9+3

Introduction to dynamic stability: - Modes of stability, Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin, develop a prototype model of direction stability of helicopter.

Total : 60 Periods

Text Books

1. Nelson, R.C. “Flight Stability and Automatic Control”, McGraw-Hill Book Co., 2014.
2. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son:,Inc, NY, 2010.
3. McCornick. W., “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, NY, 2012.

Reference Books

1. McCornick B. W, “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, NY, 2001.
2. Etkin, B., “Dynamics of Flight Stability and Control”, Edn. 2, John Wiley, NY, 2000.
3. Dommasch, D.O., Sherby, S.S., and Connolly, T.F., “Aeroplane Aero dynamics”, Third Edition, Issac Pitman, London, 2010.
4. Babister, A.W., “Aircraft Dynamic Stability and Response”, Pergamon Press, Oxford, 2003.

Additional References

1. https://nptel.ac.in/courses/101106041
2. https://nptel.ac.in/courses/101106043
3. http://digimat.in/nptel/courses/video/101104066/L06.html

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

COs	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 4	3	3	2	-	-	-	-	-	-	-	-	-	3	2	1
CO 5	3	3	3	2	3	-	-	-	-	-	-	-	3	3	1
	3- High				2- Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AE502	Rocket and Space Propulsion	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Air Breathing Propulsion				

Course Objectives

The course is intended to

1. Familiarize about the scramjet engines and hypersonic vehicles
2. Acquire the knowledge about chemical rocket propulsion
3. Learn about the principles of solid propellant rockets
4. Understand about liquid and hybrid rocket propulsion systems
5. Study the space propulsion and its applications

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Apply the concepts of scramjet engines and hypersonic air breathing propulsion systems	Apply
CO 2	Avail familiarity in chemical rocket propulsion systems	Apply
CO 3	Implement about solid propulsion systems	Apply
CO 4	Interpreting the applications and principles of liquid propulsion systems	Apply
CO 5	Obtain knowledge about the advanced propulsion techniques used for interplanetary space mission	Apply

Course Contents

Module – I Scramjet Propulsion 9

Introduction to hypersonic air breathing propulsion - need for supersonic combustion for hypersonic propulsion – scramjet engine operation and its applications for hypersonic vehicles –– Components of hypersonic vehicles – various types of scramjet combustors and its fuel injection schemes

Module – II Chemical Rocket Propulsion 9

Operating principle – specific impulse and internal ballistics – performance characteristics of rockets – simple rocket design problems – types of igniters- Rocket nozzle classification air augmented rockets – pulse rocket motors – static testing of rockets & instrumentation – safety considerations

Module – III Solid Rocket Propulsion 9

Salient features and selection criteria – estimation of solid propellant adiabatic flame temperature propellant grain design considerations – erosive burning – combustion instability – strand burner and T-burner – applications and advantages

Module – IV Liquid and Hybrid Rocket Propulsion 9

Salient features and selection criteria – applications and limitations - various feed systems - thrust control and cooling methods – combustion instability – operation of cryogenic engines hybrid rocket propulsion – standard and reverse hybrid systems

Module – V Space Propulsion 9

Electric rocket propulsion – Ion propulsion – Nuclear rocket – preliminary concepts in nozzle-less propulsion – Solar sail - comparison of performance of space propulsion systems with chemical rocket propulsion systems – current scenario of advanced propulsion projects worldwide

Total : 45 Periods

Text Books

1. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 2014.
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010.

Reference Books

1. Robert G. Jahn, "Physics of Electric Propulsion", Dover Publications, 2006
2. V.Ganesan, Gas Turbines, McGraw Hill, 2010.

Additional References

1. https://nptel.ac.in/courses/101/106/101106082/
2. https://www.grc.nasa.gov/www/k-12/rocket/rocket.html

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2	2	-	2	-	-	-	-	-	-	3	2	1
CO 2	3	2	3	2	-	2	-	-	-	-	-	-	3	2	1
CO 3	3	3	3	2	-	2	-	-	-	-	-	-	3	2	1
CO 4	3	3	2	2	-	2	-	-	-	-	-	-	3	2	1
CO 5	3	3	3	2	-	2	-	-	-	-	-	-	3	2	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examinations (FE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AE503	Compressible Flow Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Aerodynamics				

Course Objectives

The course is intended to

1. Introduce the concepts of compressibility and flow through convergent- divergent nozzle
2. Make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows
3. Make the student recognize the shock wave problems in supersonic flows
4. Understand the Linearized flow theory for streamlined bodies
5. Study the fundamental of compressible flow equations and transonic flow over wing

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Apply the concept of continuum, compressibility, and calculate the compressible flow through a duct of varying cross section	Apply
CO 2	Pertain about the formation of normal and oblique shocks	Apply
CO 3	Solve numerical problems related to shock wave in supersonic flow and design concept of supersonic nozzle	Apply
CO 4	Apply the Linearized flow theory for streamlined bodies	Apply
CO 5	Examine the concepts and performance of an aircraft during transonic and supersonic speeds as case studies	Apply

Course Contents

Module – I One Dimensional Compressible Flow 9

Continuity - Momentum - Energy and state equations - adiabatic steady state flow equations - velocity of sound - Flow through convergent and divergent passage - Performance under various back pressures

Module – II Normal and Oblique Shocks 9

Prandtl equation - Rankine and Hugonoit relation - Normal shock equations - Pitot static tube - Oblique shocks equations - Hodograph and pressure turning angle - shock polar - flow past wedges and concave corners - strong, weak and detached shocks

Module – III Expansion Waves and Method of Characteristics 9

Flow past convex corners - Expansion hodograph - Reflection and interaction of shocks and expansion, waves - Method of Characteristics - Two dimensional supersonic nozzle contours - Rayleigh and Fanno Flows

Module – IV Differential Equations of Motion for Steady Compressible Flows 9

Small perturbation potential theory - Prandtl-Glauert rule - affine transformation relations for subsonic flows - Linearized two dimensional supersonic flow theory - Lift, drag, pitching moment and center of pressure of supersonic profiles

Module – V High Speed Flow Over Wing 9

Lower and upper critical Mach numbers - Lift and drag divergence - Characteristics of swept wings - Effects of thickness - Camber and aspect ratio of wings - Transonic area rule - Introduction to Hypersonic Aerodynamics

Total : 45 Periods

(Use of Standard and approved Gas Tables are permitted)

Text Books

1. Anderson Jr., D., – "Modern compressible flows", McGraw-Hill Book Co., New York, 1999.
2. L.J. Clancy, "Aerodynamics" Sterling Book House, 2006
3. Rathakrishnan, E., "Gas Dynamics", 6th Edition, Prentice Hall of India, 2017.

Reference Books

1. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press,1982
2. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co. New York, 1989.
3. J. D. Anderson, "Fundamentals of Aerodynamics", Fifth Edition, McGraw Hill Education India Private Limited, 2010.

Additional References

1. http://nptel.ac.in/courses/112103021/
2. http://nptel.ac.in/courses/101106044/
3. https://nptel.ac.in/courses/101/105/101105059/

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	3	2	-	-	-	-	-	-	-	-	3	2	1
CO 2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	3	2	-	-	-	-	-	-	-	-	3	2	1
CO 4	3	3	3	2	-	-	-	-	-	-	-	-	3	2	1
CO 5	3	3	3	2	-	-	-	-	-	-	-	-	3	2	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

23AE504	Aircraft Structural Analysis	L	T	P	C
		3	0	2	4
Nature of Course	Professional Core				
Pre requisites	Solid Mechanics				

Course Objectives

The course is intended to

1. Enable students to understand and apply methods for analyzing bending stresses in beams with unsymmetrical cross-sections
2. Enable students to understand and apply methods for analyzing bending stresses in beams with unsymmetrical cross-sections
3. Develop competency in analyzing torsion and combined loading in closed thin-walled sections using classical and modern theories for aerospace applications.
4. Introduce the fundamental concepts of local buckling, crippling, and stiffening in thin-walled structures, enabling students to assess and prevent failure in aerospace components.
5. Equip students with the knowledge and tools for complete stress and shear flow analysis in aircraft wings and fuselage structures under realistic flight load conditions.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Investigate the normal stress variation on unsymmetrical sections, subjected to bending moments.	Apply
CO 2	Determine the shear flow variation in thin walled open sections with skin effective and ineffective in bending. Also to find out the shear centre of sections.	Apply
CO 3	Calculate the shear flow variation in single cell and multicell tubes subjected to shear and torque loads	Apply
CO 4	Investigate the behaviour of buckling of simply supported plates and also to know the effective width of sheet stringers combination.	Apply
CO 5	Apply the shear and bending moment variation of aircraft wing and fuselage and also to know the characteristics of thin webbed beams.	Apply

Course Contents

Module – I UNSYMMETRICAL BENDING OF BEAMS 9

Unsymmetrical bending of beams – different methods of analysis (neutral axis method, 'k' method, and the principal axis method)

Module – II SHEAR FLOW IN OPEN SECTIONS 9

Thin-walled beams – Concept of shear flow – The shear center and its determination – Shear flow distribution in symmetrical and unsymmetrical thin-Walled sections.

Module – III SHEAR FLOW IN CLOSED SECTIONS 9

Bredt - Batho theory – Single-cell and multi-cell tubes subject to torsion – Shear flow distribution in thin walled single & Multi-cell structures – With walls effective and ineffective in bending.

Module – IV BUCKLING OF PLATES 9

Rectangular sheets under compression – Local buckling stress of thin walled sections – Crippling stresses by Needham's and Gerard's methods

Module – V INDUCED STRESSES 9

Loads of aircraft wing, fuselage and tail unit. Use of V-n diagram for sizing the aircraft wing, fuselage and tail unit. Complete tension field beams – semi tension field beam theory.

Total : 45 Periods

Laboratory Components

S. No.	Exercises	CO Mapping	Blooms Level
1	Unsymmetrical bending of beams.	1	Apply
2	Flexibility matrix of a cantilever beam.	1	Apply
3	Shear center location for Open sections.	2	Apply
4	Shear center location for Angle section.	2	Apply
5	Shear center location for Closed sections.	3	Apply
6	Combined bending and Torsion of a Hollow Circular Tube.	3	Apply
7	Buckling of Column when both ends are fixed.	4	Apply
8	Buckling of Column when both ends are hinged.	4	Apply
9	Wagner beam - Tension field beam.	5	Apply
10	Stresses in circular disc using photo elastic model.	5	Apply

TOTAL: 30 PERIODS

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	QUANTITY	EXPERIMENT No
1	Unsymmetrical bending set up	1	1
2	Flexibility matrix	1	2
3	Set up of Open, Closed and Angle sections	1	3, 4, 5
4	Set up for combined bending and torsion	1	6
5	Column Test Apparatus	1	7, 8
6	Wagner beam	1	9
7	Photo elasticity set up	1	10
8	Weight, hangers and dial gauges	10	1, 2, 3, 4, 5, 6, 9

Text Books:

1. Bruhn. E.H., 'Analysis and Design of Flight Vehicles Structures', Tri-state off-setcompany, USA, 1985.
2. Megson T M G, 'Aircraft Structures for Engineering Students', Butterworth-Heinemann;5th edition, 2012.
3. Strength of materials by Dr.R.K.Bansal, Lakshmi Publications 6th Edition 2018.

Reference Books

1. 'Mechanics of Materials' by James M. Gere & Barry J Goodno, cengage Learning Custom Publishing; 8th edition, 2012.
2. Donaldson, B.K., 'Analysis of Aircraft Structures - An Introduction' Cambridge University Press publishers, 2 nd edition, 2008
3. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	1	2	1	-	-	-	-	2	-	-	3	2	1
CO 2	3	2	2	2	1	-	-	-	-	2	-	-	3	2	1
CO 3	3	2	2	2	2	-	-	-	-	2	-	-	3	2	1
CO 4	3	2	1	2	1	-	-	-	-	2	-	-	3	2	1
CO 5	3	2	2	2	2	-	-	-	-	2	-	-	3	3	1
	3- High				**2- Medium**				**1- Low**						

Summative Assessment						
	Continuous Assessment					**End Semester Examinations (ESE) (Theory) (50)**
Bloom's Category	**Theory**				**Practical**	
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**Attendance (5)**	**Rubric based CIA (20)**	
Remember	10	10	10			20
Understand	10	10	10			20
Apply	30	30	30		100	60
Analyse						
Evaluate						
Create						

23AE505	Aero Engine and Airframe Laboratory	L	T	P	C
		0	0	2	1
Nature of Course	Professional Core				
Pre requisites	Mechanical Engineering Practices Laboratory				

Course Objectives

The course is intended to

1. Examine the maintenance and repair procedures of aero engines
2. Enrich the skills for overhaul of aero engines.
3. Produce sheet metal components of aircraft structures through given design.
4. Practice the composite structure fabrication through E-glass and polymer matrix compositions.
5. Identify the repair procedure of aircraft structures.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Demonstrate the dismantling and reassembling of an aircraft piston engine.	Analyze
CO 2	Examine the overhaul procedure of an auxiliary systems, pumps, carburetor lubrication and cooling system.	Analyze
CO 3	Practice the aircraft repair process of a fabric, Riveted Patch repairs and tube bending	Create
CO 4	Create the sheet metal components of an aircraft structures (Wing, fuselage and stabilizers).	Create
CO 5	Prepare the glass/Epoxy based composite laminated structures.	Create

Laboratory Components

S. No.	Exercises	CO Mapping	Blooms Level
1.	Dismantling and reassembling of an aircraft piston engine.	1	Analyze
2.	Study and analysis of Camshaft operation and firing order	1, 2	Analyze
3.	Study and analysis of lubrication system	1, 2	Analyze
4.	Study and analysis of cooling system	1, 2	Analyze
5.	Study and analysis of auxiliary systems, pumps and carburetor	1, 2	Analyze
6.	Fabric patch repair	3	Create
7.	Riveted Patch repairs	3	Create
8.	Tube bending	3	Create
9.	Sheet metal forming (wing / Fuselage / Stabilizers)	4	Create
10.	Preparation of glass epoxy of composite laminates and specimens.	5	Create

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Name of the equipment	Quantity	Experiment No.
1.	Aircraft Piston engines.	1	1
2.	Set of basic tools for dismantling and assembly.	1 set	1,2,3,4,5
3.	Micrometers, depth gauges, vernier calipers.	1 sets	1,2,3,4,5
4.	Shear cutter pedestal type.	1	9
5.	Drilling machine.	1	7
6.	Bench vices.	3	6,7,8,9
7.	Pipe bending apparatus.	1	8
8.	Hand lay-up machine	1	10

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	3	1	2	-	-	3	2	-	-	3	3	1
CO2	3	3	3	3	1	-	-	-	3	2	-	-	3	3	1
CO3	3	3	3	3	1	-	-	-	3	2	-	-	3	3	1
CO4	3	3	3	3	1	-	-	-	3	2	-	-	3	3	1
CO5	3	3	3	3	1	2	-	-	3	2	-	-	3	3	1
	3	High				2	Medium				1	Low			

Assessment based on Continuous and Final Examination			
Bloom's Level	Continuous Assessment (60 marks) (Attendance – 5 marks)		End Semester Examinations (ESE) [40 marks]
	Rubric basedContinuous Assessment [30 marks]	Model Examination [25 marks]	
Remember			
Understand			
Apply			
Analyze	40	40	40
Evaluate			
Create	60	60	60

23AE506	Computer Aided Design Laboratory	L	T	P	C
		0	0	2	1
Nature of Course	Professional Core				
Pre requisites	Engineering Graphics				

Course Objectives

The course is intended to

1. Understand and interpret drawings of machine components.
2. Prepare part drawings using standard CAD packages.
3. Create assembly of basic aeronautical components.
4. Create assembly of standard machine components.
5. Understand the concepts of geometric dimensioning and tolerancing.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Prepare 2D drawings using computer aided design and drafting software.	Apply
CO 2	Prepare part drawings using standard CAD packages.	Apply
CO 3	Design and model basic aeronautical components.	Apply
CO 4	Design and assemble standard machine components.	Apply
CO 5	Utilize the symbols of geometric dimensioning and tolerancing.	Understand

Laboratory Components

S. No.	Exercises	CO Mapping	Blooms Level
1.	Study of modeling software and basics of design.	CO1	Apply
2.	Basic 2D Drafting.	CO1	Apply
3.	Design and modeling of rectangular plate with hole.	CO2	Apply
4.	Design and modeling of simple mechanical component.	CO2	Apply
5.	Design and modeling of riveted joints.	CO3	Apply
6.	Design and modeling of welded joints.	CO3	Apply
7.	Design and assembly of muff coupling.	CO4	Apply
8.	Design and assembly of screw jack.	CO4	Apply
9.	Introduction to geometric dimensioning and tolerancing.	CO5	Understand

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Name of the equipment	Quantity	Experiment No.
1.	Computer	30	All
2.	Modelling Package	30 Licenses	All
3.	Printer	1	All
4.	UPS	1	All

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1	1	3	-	-	-	2	2	-	-	2	1	3
CO2	3	3	1	1	3	-	-	-	2	2	-	-	2	1	3
CO3	3	3	2	2	3	-	-	-	2	2	-	-	2	1	3
CO4	3	3	1	2	3	-	-	-	2	2	-	-	2	1	3
CO5	3	3	2	2	3	-	-	-	2	2	-	-	2	1	3
	3	High				2	Medium				1	Low			

Assessment based on Continuous and Final Examination			
Bloom's Level	Continuous Assessment (60 marks) (Attendance – 5 marks)		End Semester Examinations (ESE) [40 marks]
	Rubric based Continuous Assessment [30 marks]	Model Examination [25 marks]	
Remember			
Understand	20	20	20
Apply			
Analyze	60	60	60
Evaluate	20	20	20
Create			

Professional Elective

STREAM – 1 AERODYNAMICS

23AEE01	Low Speed Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fluid mechanics and machinery				

Course Objectives

The course is intended to

1. Introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
2. Provide the mathematical understanding of basic flows and their combinations.
3. Understand the Theory of Aero foil And Wing Sections.
4. Understand the vortex filament and lifting line theory.
5. Introduce the conceptual boundary layer thickness.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Apply governing equation to various fluid flow models	Apply
CO 2	Use the basic flows to the various bodies in the atmosphere for the generation of lift	Apply
CO 3	Solve the aerodynamic problems associated with the airfoils and the transformation.	Apply
CO 4	Simulate wings with help of aerodynamic tools for various ambient conditions.	Apply
CO 5	Model the incompressible flow and viscous flow.	Apply

Course Contents

Module – I **Basic Aerodynamics** **6**

Continuity, momentum and energy equations-Differential and Integral forms

Module – II **Two Dimensional Flows and Generation of Lift** **12**

Basic flows – Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations, Pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows Kutta Joukowski's theorem, Kutta condition.

Module – III **Conformal Transformation and Airfoil Theory** **11**

Cauchy-Riemann relations, complex potential, methodology of conformal transformation, Kutta Joukowski transformation and its applications. Thin airfoil theory and its applications.

Module – IV **Subsonic Wing Theory** **8**

Vortex filament, Biot and Savart law, bound vortex and trailing vortex, horse shoe vortex, lifting line theory and its limitations.

Module – V **Introduction to Boundary Layer** **8**

Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasius solution.

Total : 45 Periods

Text books:

1. Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 2012.
2. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw Hill Book Co., 6th edition, 2016.

Reference books:

1. John J Bertin., "Aerodynamics for Engineers", Pearson Education Inc, 2002
2. Clancey, L J.," Aerodynamics", Pitman, 1986
3. Milne Thomson, L.H., "Theoretical aerodynamics", Macmillan, 2007

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	2	-	-	-	-	-	-	-	3	3	2	1
CO2	3	3	2	2	-	-	-	-	-	-	-	3	3	2	1
CO3	3	3	3	2	-	-	-	-	-	-	-	3	3	2	1
CO4	3	3	2	2	-	-	-	-	-	-	-	2	3	2	1
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	2	1
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End semester Examinations (ESE) (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

23AEE02	High Speed Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fluid mechanics and machinery				

Course Objectives

The course is intended to

1. Introduce the concepts of compressibility and flow through convergent- divergent nozzle,
2. Make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows.
3. Make the student recognize the shock wave problems in supersonic flows.
4. Understand the Linearized flow theory for streamlined bodies.
5. Study the fundamental of compressible flow equations and transonic flow over wing.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Apply the concept of continuum, compressibility, and calculate the compressible flow through a duct of varying cross section.	Apply
CO 2	Understand about the formation of normal and oblique shocks	Understand
CO 3	Solve numerical problems related to shock wave in supersonic flow and design concept of supersonic nozzle.	Apply
CO 4	Apply the Linearized flow theory for streamlined bodies	Apply
CO 5	Apply the concepts to increase the performance of an aircraft during transonic and supersonic speeds	Apply

Course Contents

Module – I **One Dimensional Compressible Flow** **10**

Continuity, Momentum, Energy and state equations, adiabatic steady state flow equations, velocity of sound, Flow through convergent- divergent passage, Performance under various back pressures

Module – II **Normal and Oblique Shocks** **12**

Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube,corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations,Hodograph and pressure turning angle, shock polar, flow past wedges and concave corners,strong, weak and detached shocks.

Module – III **Expansion Waves and Method of Characteristics** **8**

Flow past convex corners, Expansion hodograph, Reflection and interaction of shocks andexpansion, waves. Method of Characteristics Two dimensional supersonic nozzle contours.Rayleigh and Fanno Flows.

Module – IV **Differential Equations of Motion for Steady Compressible Flows** **7**

Small perturbation potential theory, Prandtl-Glauert rule - affine transformation relations for subsonic flows, Linearized two dimensional supersonic flow theory - Lift, drag, pitching moment and center of pressure of supersonic profiles.

Module – V **High Speed Flow Over Wing** **8**

Lower and upper critical Mach numbers, Lift and drag, divergence, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, transonic area rule. Introduction to Hypersonic Aerodynamics.

Total : 45 Periods

(Use of Standard and approved Gas Tablesare permitted)

Text books:

1. Anderson Jr., D., – "Modern compressible flows", McGraw-Hill Book Co., New York, 1999.
2. L.J. Clancy, "Aerodynamics" Sterling Book House, 2006
3. Rathakrishnan, E., "Gas Dynamics", 6th Edition, Prentice Hall of India, 2017.

References:

1. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press,1982
2. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co. New York, 1989.
3. J. D. Anderson, "Fundamentals of Aerodynamics", Fifth Edition, McGraw Hill Education IndiaPrivate Limited, 2010.

Additional references:

1. http://nptel.ac.in/courses/112103021/
2. http://nptel.ac.in/courses/101106044/
3. https://nptel.ac.in/courses/101/105/101105059/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	2	-	-	-	-	-	-	-		3	2	1
CO2	3	3	2	2	-	-	-	-	-	-	-		3	2	1
CO3	3	3	3	2	-	-	-	-	-	-	-		3	2	1
CO4	3	3	2	2	-	-	-	-	-	-	-		3	2	1
CO5	3	3	2	2	-	-	-	-	-	-	-		3	2	1
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE) (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

23AEE03	Boundary Layer Theory	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics				

Course Objectives

The course is intended to

1. Learn the fundamentals of Boundary Layer Theory
2. Study the fluid flows and flow separation.
3. Study about wind tunnel techniques.
4. Identify the turbulent boundary layers
5. Express the thermal boundary layer

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand viscous flow concepts and boundary layer theory and their role in fluid dynamics.	Understand
CO 2	Solve approximate boundary layer solutions, including Blasius and Von Karman's solutions	Apply
CO 3	Analyze the transition from laminar to turbulent flow, critical Reynolds number, and flow stability theory.	Analyze
CO 4	Understand turbulent boundary layers, including Reynolds stresses, velocity profiles, and Prandtl's mixing length theory.	Understand
CO 5	Apply boundary layer control techniques and analyze thermal boundary layer growth and heat transfer under varying conditions.	Apply

Course Contents

Module – I **Basic Concepts of Viscous Flows** **9**

Introduction to hydrodynamic and thermal boundary layer theory- flow over the flat plate at zero incidences - Boundary layer thickness - momentum thickness- energy thickness.

Module – II **Solutions to Boundary Layer Flows** **9**

Method of exact solution-Blassius solution to boundary layer problems - approximate solutions – Von Karman solution to boundary layer flows over the flat plate - flow with pressure gradient - flow over a cylinder - plane Counter flow.

Module – III **Transition** **9**

Pipe flow and flow over a flat plate, critical Reynolds number, turbulent, principles of theory of stability of Laminar flows, Summerfield equation, factors effecting transition, Laminar aerofoils

Module – IV **Turbulent Boundary Layers** **9**

Fundamentals of turbulent flow- Mean motion fluctuations- Reynolds Equations- Reynolds stresses- wind tunnel turbulence - Prandtl's mixing length theory- velocity distribution laws.

Module – V **Boundary Layer Control and Thermal Boundary Layer** **9**

Causes of boundary layer separation- Heat transfer from cold surface- thermal boundary layer growth over the hot and cold surface - flow over the flat plate with different flow

conditions with heat transfer - Reynolds analogy- non-dimensional numbers governing Boundary layer flows - case study.

Total : 45 Periods

Text Books

1. H Schlichting - Boundary-Layer Theory Published May 20th 2003 by Springer – available in Indian Edition
2. J.O. Hinze -Turbulence: An Introduction to Its Mechanism and Theory 1959

Reference Books

1. Guy Metivier - Small Viscosity and Boundary Layer Methods: Theory, Stability Analysis, and Applications (Modelling and Simulation in Science, Engineering and Technology) 1st ed. 2004 Edition, Kindle Edition**.**

Additional References

1. https://www.springer.com/in/book/9783662529171
2. https://www.elsevier.com/books/boundary-layer-and-flow-control/lachmann/978-1-4832-1323-1

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	-	2	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	-	2	-	-	-	-	-	-	-	-	3	1	1
CO 3	2	3	3	1	-	-	-	-	-	-	-	-	3	1	1
CO 4	3	3	2	2	-	-	-	-	-	-	-	-	3	1	1
CO 5	3	2	3	1	-	-	-	-	-	-	-	-	3	1	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEE04	Viscous Flow Theory	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics				

Course Objectives

The course is intended to

1. Introduce the fundamentals of viscous fluid flow and derive governing equations for Newtonian and Non-Newtonian fluids.
2. Provide analytical solutions for classical incompressible laminar viscous flows.
3. Analyze compressible laminar flows, boundary layers, and shock interactions.
4. Explain transition mechanisms from laminar to turbulent flow using theory, computation, and experiments.
5. Apply turbulence models and Reynolds-averaged equations for analyzing turbulent flows in engineering applications.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand governing equations for compressible Newtonian and Non-Newtonian fluid flows using tensor notation	Understand
CO 2	Apply exact solutions and boundary layer theory to solve laminar incompressible viscous flow problems.	Apply
CO 3	Analyze laminar compressible viscous flows, shock interactions, and hypersonic flow effects.	Analyze
CO 4	Interpret transition mechanisms from laminar to turbulent flow using theoretical, numerical, and experimental approaches.	Apply
CO 5	Apply turbulence models and Reynolds-averaged equations to analyze turbulent boundary layers and free shear flows.	Apply

Course Contents

Module – I Introduction **9**

Boundary layer on an airfoil, Boundary layer separation, Derivation of the Equations of Motion: Review of Cartesian tensor notation – Derivation of the full compressible viscous Newtonian equations – Conservation of mass, momentum, energy – Vortices and entropy equations – Kelvin's theorem – Introduction to Non-Newtonian fluids.

Module – II Laminar Incompressible Viscous Flow **9**

Exact solutions: stagnation point flow, Jeffrey-Hamel flow, Stokes problems – Low Reynolds number flow – Introduction to perturbation theory – Boundary layer theory – Unsteady boundary layer flows – Boundary layer integral equations – Similarity solutions in boundary layer analysis (Blasius, Falkner-Skan solutions).

Module – III Laminar Compressible Viscous Flow **9**

Exact solutions: Rayleigh and Fanno flow analysis, flow through a shock wave – Compressible boundary layers – Introduction to shock-boundary layer interaction and hypersonic effects: High-enthalpy flow modeling and real gas effects.

Module – IV **Transition to Turbulence** **9**

Linear transition theory – Introduction to nonlinear theory and numerical methods – Introduction to experimental results in bounded and free shear flows, both incompressible and compressible – Effects of roughness, turbulence, vibration, noise, curvature, etc – Transition separation interactions in boundary layers.

Module – V **Turbulent Flow** **9**

Introduction to Turbulent Flow: Reynolds averaged equations of motion – Law of the wall in the turbulent boundary layer – Introduction to experimental results for various fundamental turbulent flows – Bluff bodies, internal flows, free shear flows.

Total : 45 Periods

Text Books

1. Frank M. White, 'Viscous Fluid Flow', Third Edition, Tata McGraw Hill Pvt Ltd., New Delhi, 2011.
2. H.Schlichting and K.Gersten, 'Boundary Layer Theory', Ningth Edition, Springer, 2017.

Reference Books

1. Carl M. Bender and Steven A. Orszag, 'Advanced Mathematical Methods for Scientists and Engineers I: Asymptotic Methods and Perturbation Theory', Springer Verlag, New York, 2013
2. Rutherford Aris, 'Vectors, Tensors and the Basic Equations of Fluid Mechanics', Dover Publications, 2012

Additional References

1. https://ocw.mit.edu/courses/mechanical-engineering/2-25-advanced-fluid-mechanicsfall-2013/equations-of-viscous-flow/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-13-aerodynamics-ofviscousfluids-fall-2003/
3. https://nptel.ac.in/courses/Webcourse-contents/Iit-Kanpur/FluidMechanics/Ui/Course_Home-8.Htm

	Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)														
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2	2									3	2	1
CO 2	3	3	3	2									3	2	1
CO 3	3	3	3	3									3	2	1
CO 4	3	3	3	3									3	2	1
CO 5	3	3	3	3									3	2	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEE05	Industrial Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics				

Course Objectives

The course is intended to

1. Build up necessary background for understand the aerodynamic aspects of wind generators, automobiles, buildings etc.
2. Introduce the basics of wind energy collectors**.**
3. Learn the aerodynamics important in recent vehicle industries.
4. Understand the application of various aerodynamic aspects in vehicles and buildings.
5. Realize the effect of vibrations and Reynolds numbers.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Classify the basic wind characteristics.	Understand
CO 2	Realize the historical development of wind turbine, its components and classifications.	Apply
CO 3	Apply the aerodynamic effects in road vehicle and analyse the various method of drag reduction.	Apply
CO 4	Identify the aerodynamics of low rise buildings and high rise building for good ventilation	Apply
CO 5	Compare and apply the effect of Reynolds number on wake formation of bluff shapes	Apply

Course Contents

Module – I Atmosphere **9**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows

Module – II Wind Energy Collectors **9**

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory, advanced model wind.

Module – III Vehicle Aerodynamics **9**

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft

Module – IV Building Aerodynamic **9**

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

Module – V Flow Induced Vibrations **9**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, galloping and stall flutter, basic analysis software (CFD).

Total : 45 Periods

Text Books

1. M.Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and Road vehicles”, Plenum press, New York, 1978.
2. Sachs. P., “Winds forces in Engineering”, Pergamon Press, 1978.

Reference Books

1. Blevins. R.D., “Flow Induced Vibrations”, Van Nostrand, 1990
2. Calvent. N.G., “Wind Power Principles”, Charles Griffin & Co., London, 1979.

	Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)														
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	3	2	-	2	-	-		-	-		3	2	1
CO 2	3	3	3	2	-	2	-	-		-	-		3	2	1
CO 3	3	3	3	2	-	2	-	-		-	-		3	2	1
CO 4	3	3	3	2	-	2	-	-		-	-		3	2	1
CO 5	3	3	3	2	-	2	-	-		-	-		3	2	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**End Semester Examinations(ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	18	10	10	20
Understand	32	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE06	Aero Acoustics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Impart the knowledge on fundamentals of sound.
2. Understand the knowledge on sound reflection, refraction,diffraction and diffusion.
3. Learn the knowledge on sound absorption & absorption testing.
4. Enable students to understand the behaviour of sound in different environments.
5. Familiarize students with practical methods for quantifying and measuring acoustic properties.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the fundamental concepts of sound levels and explain how measurements such as decibels, sound pressure, intensity, and acoustic power are defined.	Understand
CO 2	Illustrate the behaviour of sound in free-field environments and demonstrate how it reflects from various surface geometries like concave and convex forms.	Understand
CO 3	Interpret the propagation of wave fronts and summarize the influence of diffraction and refraction across different media and obstacles.	Understand
CO 4	Apply concepts of sound diffusion and reverberation to enclosed spaces and architectural environments.	Apply
CO 5	Implement techniques to evaluate sound absorption and use appropriate methods to quantify absorption in various materials.	Apply

Course Contents

Module – I Fundamentals of Sound And Sound Levels 9

Sine wave and Complex wave. Octave and Decibels. Acoustic Power, Sound intensity and Sound Pressure Level measurement.

Module – II Sound In Free Filed and Reflection 9

Sound Divergence, Sound intensity in free field, Sound field in an enclosed space, specular reflection, Reflection from concave, convex and parabolic surfaces. Standing waves. Corner reflection.

Module – III Diffraction and Refraction 9

Wave front propagation and diffraction of sound by obstacles, Apertures, Slit and Various diffusion objects- Reflection of sound in solid, atmosphere, enclosed space and Ocean.

Module – IV Reverberation 9

The perfectly diffused sound field, Evaluation of diffusion in a room, concave surface and convex surface. Decay of sound in room, Reverberation time calculation and measurement.

Module – V Absorption 9

Dissipation of sound energy, Absorption coefficient of Insulation materials, effect of thickness and density of Absorbents.

Total : 45 Periods

Text Books

1. Alton F. Everest “The Master Handbook of Acoustics” McGraw-Hill Companies, 2002.
2. Glen M. Ballou “Handbook for Sound Engineers” Elsevier, Focal Press, 2008.
3. Jerry H. Ginsberg “Acoustics – A Textbook for Engineers and Physicists”, Volume I: Fundamentals, ASA Press, Springer, 2018.

Reference Books

1. Jerry H. Ginsberg, “Acoustics – A Textbook for Engineers and Physicists, Volume II”: Applications, ASA Press, Springer, 2018.
2. Carl Q. Howard & Benjamin S. Cazzolato, “Acoustic Analyses Using MATLAB and ANSYS”, CRC Press, Taylor & Francis, 2014.
3. Leo L. Beranek & Tim Mellow, “Acoustics: Sound Fields and Transducers”, Academic Press, 2012.

Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)															
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2										3	2	1
CO 2	3	2		2									3	2	1
CO 3	3	2											3	2	1
CO 4	3	3	2										3	2	1
CO 5	3	2	2										3	2	1
	3- High				**2- Medium**				**1-Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	20	10	10
Understand	40	30	20	58
Apply			20	32
Analyse				
Evaluate				
Create				

23AEE07	Experimental Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aerodynamics				

Course Objectives

The course is intended to

1. Fundamental principles of experimental methods in fluid mechanics and highlight the importance of accurate measurement and data analysis.
2. Instruments and techniques used for measuring fluid properties such as pressure, velocity, and temperature in different flow conditions.
3. Impart knowledge on wind tunnel testing and calibration procedures, including the analysis of low-speed, transonic, and supersonic wind tunnels.
4. Enabling qualitative and quantitative interpretation of fluid flow phenomena.
5. Evaluate the accuracy and reliability of experimental data.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the functions of instruments used for determining fluid properties such as pressure, velocity, and temperature.	Understand
CO 2	Conduct wind tunnel tests and interpret performance characteristics under various flow regimes.	Apply
CO 3	Use flow visualization techniques such as Schlieren, smoke tunnels, and interferometry to analyze fluid flow behaviour.	Apply
CO 4	Utilize measurement devices like Pitot tubes, hot-wire anemometers, and pressure transducers for velocity and pressure data.	Apply
CO 5	Solve the data acquisition and apply uncertainty analysis to evaluate the reliability of experimental fluid mechanics results.	Apply

Course Contents

Module – I Basic Measurements in Fluid Mechanics 9

Objective of experimental studies – 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.

Module – 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.

Module – III Flow Visualization and Analogue Methods 9

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph.

Module – IV Pressure, Velocity and Temperature Measurements 9

Pitot - static tube characteristics - Velocity measurements Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques --Pressure transducers – Temperature measurements.

Module – V Data Acquisition Systems and Uncertainty Analysis 9

Data acquisition and processing – Signal conditioning – Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation Uses of uncertainty analysis.

Total : 45 Periods

Text Books

1. Rathakrishnan, E. “Instrumentation, Measurements, and Experiments in Fluids” CRC Press, 2nd Edition, 2016.
2. Robert B. Northrop, “Introduction to Instrumentation and Measurements”, CRC Press, 3rd Edition, 2014.
3. Cengel, Y.A. & Cimbala, J.M., “Fluid Mechanics: Fundamentals and Applications”, McGraw-Hill Education, 4th Edition, 2020.

Reference Books

1. Benedict, R. P. “Fundamentals of Temperature, Pressure and Flow Measurements” Wiley, 1984.
2. Holman, J.P. “Experimental Methods for Engineers” McGraw-Hill Education, 8th Edition, 2011.
3. Doebelin, E.O. & Manik, D.N. “Measurement Systems: Application and Design” McGraw-Hill, 5th Edition, 2007.

Additional Reference

NPTEL: https://nptel.ac.in/courses/105101208

Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)															
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2											3	2	1
CO 2	3	3	2										3	2	1
CO 3	3	2	2										3	2	1
CO 4	3	3	2										3	2	1
CO 5	3	3	3	2									3	2	1
	3- High				**2- Medium**				**1-Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	10
Understand	40	10	10	40
Apply		30	30	50
Analyse				
Evaluate				
Create				

23AEE08	Helicopter Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fluid Mechanics and Machinery, Aerodynamics				

Course Objectives

The course is intended to

1. Understand the historical development and basic configurations of helicopters.
2. Explore the aerodynamic principles of helicopters.
3. Apply rotor theory to evaluate hovering performance.
4. Understand how altitude influences helicopter performance and stability.
5. Gain foundational knowledge of Ground Effect Machines.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Classify the historical development and various configurations of helicopters and rotor systems.	Understand
CO 2	Describe the aerodynamic principles involved in helicopter flight, including control mechanisms.	Understand
CO 3	Utilize the rotor theory to analyze hovering performance and calculate figure of merit.	Apply
CO 4	Estimate power requirements in forward flight and evaluate the effects of altitude and drag.	Apply
CO 5	Apply the principles of ground effect machines to analyze their types, working mechanisms, and perform basic performance and power calculations.	Apply

Course Contents

Module – I Introduction **9**

Historical development if helicopters - helicopter configurations based on torque reaction – control requirements - Types of Rotor Systems - VTOL and STOL.

Module – II Elements of Helicopter Aerodynamics **9**

Configurations based on torque reaction - Jet rotors and compound helicopters - Methods of control - collective and cyclic pitches changes - Lead - lag and flapping hinges.

Module – III Ideal Rotor Theory **9**

Hovering performance - Momentum and simple blade element theories - Figure of merit - Profile and induced power estimation - Constant chord and ideal twist rotors.

Module – IV Power Estimates **9**

Induced, profile and parasite power requirements in forward flight - performance curves with effects of altitude - Preliminary ideas on helicopter stability.

Module – V Ground Effect Machines **9**

Types - Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machines - Drag of hovercraft on land and water. Applications of hovercraft.

Total : 45 Periods

Text Books

1. Wayne Johnson, "Helicopter Theory", Dover Publications, New York, 2010.
2. J. Gordon Leishman, "Principles of Helicopter Aerodynamics", Cambridge University Press, United Kingdom, 2006.
3. Alfred Gessow and Garry C. Myers, "Aerodynamics of the Helicopter", Frederick Ungar Publishing Co., New York, 1985.

Reference Books

1. B.W. McCormick, "Aerodynamics of V/STOL Flight", Academic Press, New York, 1978.
2. A.R.S. Bramwell, "Helicopter Dynamics", Edward Arnold Publishers, London, 1976.
3. John Fay, "The Helicopter: History, Piloting and How it Flies", Naval Institute Press, Maryland, 1987.

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2										3	2	1
CO 2	3	3	2										3	2	1
CO 3	3	3	2	2									3	2	1
CO 4	3	3	2	2									3	2	1
CO 5	3	3	2	2									3	2	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	10
Understand	40	10	10	42
Apply		30	30	48
Analyse				
Evaluate				
Create				

23AEE09	Aviation weather and Metrology	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Materials Physics				

Course Objectives

The course is intended to

1. Introduce the composition, structure and behavior of the Earth's atmosphere relevant to aviation.
2. Learn the dynamics of wind formation and movement and its impact on flight performance and safety.
3. Impart knowledge on cloud formation, classification and precipitation and their implications on aircraft operations.
4. Understand large -scale weather systems and hazardous weather conditions affecting aviation.
5. Familiarize students with aviation weather reporting, forecasting and meteorological support services for flight planning.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the structure and composition of the atmosphere and its variation with altitude.	Understand
CO 2	Understand the dynamics of wind systems, jet streams, and turbulence and their effect on aviation.	Understand
CO 3	Identify and describe cloud types and precipitation, and explain their effects on flight operations.	Understand
CO 4	Learn weather systems, including fronts and thunderstorms, and their implications on flight safety.	Understand
CO 5	Interpret standard aviation weather reports and forecasts for flight planning.	Understand

Course Contents

Module – I Fundamentals of the Atmosphere **9**

Composition and vertical structure of the atmosphere - Atmospheric pressure, temperature, and density variations with altitude - International Standard Atmosphere (ISA) and deviations - Lapse rates, atmospheric stability, and thermal layers - Heat transfer in the atmosphere: radiation, conduction, convection - Measurement techniques for temperature, pressure, and humidity

Module – II Wind and Atmospheric Motion **9**

Forces affecting wind: Pressure Gradient Force, Coriolis effect, friction - Geostrophic and gradient winds - Local winds: sea breeze, land breeze, katabatic and anabatic winds - Upper-level winds and jet streams - Wind shear and turbulence: causes and classification - Impact of wind on aircraft performance, takeoff, and landing

Module – III Clouds and Precipitation **9**

Water vapor processes, saturation, dew point - Cloud formation mechanisms - Cloud types: high, middle, low, cumuliform and stratiform - Fog: radiation, advection, upslope, and frontal fog - Types of precipitation: rain, snow, hail, sleet - Aircraft icing conditions and effects

Module – IV Weather Systems and Hazards 9

Air masses and fronts: characteristics and movement - Cyclones and anticyclones: formation and impact - Thunderstorms: development stages, hazards (hail, lightning, microbursts) - Clear air turbulence and mountain waves - Tropical weather systems: hurricanes, typhoons, depressions - Weather-related aviation hazards and mitigation techniques

Module – V Aviation Weather Services and Forecasting 9

ICAO and WMO role in aviation meteorology - Aviation weather reports and formats: METAR, TAF, SIGMET, AIRMET - Use of weather radar and satellite images -Numerical Weather Prediction (NWP): basic overview - Weather briefings and decision-making aids for pilots - Flight planning based on weather data

Total : 45 Periods

Text Books

1. Meteorology for Scientists and Engineers – Roland B. Stull
2. Aviation Weather – FAA Advisory Circular AC 00-6B
3. Aviation Meteorology – I.C. Joshi, Himalayan Books

Reference Books

1. Meteorology Today – C. Donald Ahrens
2. Pilot's Handbook of Aeronautical Knowledge – FAA
3. ICAO Annex 3 – Meteorological Service for International Air Navigation

Additional References

1. India Meteorological Department (IMD) Website: https://mausam.imd.gov.in
2. ICAO – Meteorological Services f or Aviation Website: https://www.icao.int/airnavigation/MET
3. NPTEL Course – "Atmospheric Science" Link: https://nptel.ac.in/courses/119/104/119104050

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2		2									3	1	
CO 2	3	3	2	2									3	1	
CO 3	3	2	2										3	1	
CO 4	3	3		2									3	1	
CO 5	3	2	2										3	2	
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	20	20	40
Understand	30	30	30	60
Apply				
Analyse				
Evaluate				
Create				

23AEE10	Avionics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Introduce the basic of avionics and its need for civil and military aircrafts
2. Impart knowledge about the avionic architecture and various avionics data buses
3. Gain more knowledge on various avionics subsystems
4. Understand the concepts of navigation systems.
5. Interpret the knowledge on auto pilot system

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Classify the Digital avionics integrated systems for aircraft	Understand
CO 2	Integrate architecture and know about data buses	Apply
CO 3	Design the navigation system to avoid collision between aircrafts	Apply
CO 4	Apply the performance of various cockpit display technologies	Apply
CO 5	Design the autopilot for small aircrafts using MATLAB	Apply

Course Contents

Module – I Introduction to Avionics **9**

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories

Module – II Digital Avionics Architecture **9**

Avionics system architecture – data buses – MIL-STD-1553B – ARINC 429 – ARINC 629

Module – III Flight Decks and Cockpit **9**

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS

Module – IV Navigation Systems **9**

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Satellite navigation systems – GPS

Module – V Air Data Systems and Autopilot **9**

Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot

Total : 45 Periods

Text Books

1. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
2. Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 2010.

Reference Books

1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
4. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000

Additional References

1. https://www.coursera.org/learn/avionics-aircraft-systems-fundamentals
2. https://ocw.mit.edu/courses/16-682-prototyping-avionics-spring-2006/

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and ProgrammeSpecific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	-	2	-	-	-	-	-	-	-	2	2	1
CO 2	3	2	1	-	1	-	-	-	-	1	-	-	2	1	1
CO 3	3	2	2	1	1	-	-	-	-	1	-	-	2	2	1
CO 4	3	2	2	-	2	-	-	-	-	-	-	-	2	1	1
CO 5	3	2	1	1	1	-	-	-	-	1	-	-	2	1	1
	3-High				**2-Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	10	20
Understand	30	10	10	20
Apply		30	30	60
Analyse				
Evaluate				
Create				

STREAM – 2

PROPULSION

23AEE21	Space Mechanics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	NIL				

Course Objectives

The course is intended to

1. Understand the basic concepts related to celestial mechanics, coordinate systems, and time systems used in space dynamics.
2. Analyze the general N-body and two-body problems, including the implications of relative motion and satellite orbits.
3. Evaluate satellite injection strategies and investigate orbital perturbations using analytical and numerical methods.
4. Apply trajectory planning techniques for interplanetary missions considering two- and three-dimensional space flight paths.
5. Examine ballistic missile trajectory phases and assess the influence of space environmental conditions on spacecraft materials**.**

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Describe the solar system, coordinate systems, and time measurement concepts relevant to space flight.	Understand
CO 2	Utilize the N-body problem and apply it to two-body and restricted three-body cases including libration points.	Apply
CO 3	Understand satellite orbit transfers and evaluate deviations due to injection errors and perturbations.	Understand
CO 4	Design interplanetary trajectories and compute trajectories around target planets.	Apply
CO 5	Illustrate missile trajectory phases and evaluate environmental effects on spacecraft material selection.	Understand

Course Contents

Module – I Basic Concepts **9**

The solar system - references frames and coordinate systems - the celestial sphere - the ecliptic – motion of vernal equinox - sidereal time - solar time - standard time.

Module – II The General N-Body Problem **9**

The many body Problem - Lagrange - Jacobian Identity -The Circular Restricted Three Body Problem -Libration Points- Relative Motion in the N-body Problem -Two Body Problem - Satellite Orbits -Relations Between Position and Time.

Module – III Satellite Injection and Satellite Orbit Perturbations **9**

General aspects of satellite injections - satellite orbit transfer -various cases - orbit deviations due to injection errors - special and general perturbations - Cowells method - Encke- method – General perturbations approach.

Module – IV Interplanetary Trajectories 9

Two dimensional interplanetary trajectories -fast interplanetary trajectories - three dimensional interplanetary trajectories - launch if interplanetary spacecraft -trajectory about the target planet.

Module – V Ballistic Missile Trajectories and Materials 9

The boost phase - the ballistic phase -trajectory geometry- optimal flights - time of flight - re-entry phase- the position of the impact point - influence coefficients. Space environment - peculiarities - effect of space environment on the selection of spacecraft material.

Total: 45 Periods

Textbooks

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamic", W.H. Freeman & Co., 2012.
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 2019.
3. Howard D. Curtis., Orbital Mechanics for Engineering Students, Elsevier / Butterworth-Heinemann,2005

Reference Books

1. Howard D. Curtis., "Orbital Mechanics for Engineering Students", Elsevier, 2015.
2. Francis J Hale., "Introduction to Space Flight", Prentice Hall, 2013.

Additional References

1. https://www.nptelprep.in/courses/101105029/materials
2. https://onlinecourses.nptel.ac.in/noc24_ae20/preview

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

COs	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	3	2	2	2	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	3	3	3	2	-	-	-	-	-	-	3	2	1
CO 4	3	3	3	3	3	-	-	-	-	-	-	-	3	2	3
CO 5	3	2	2	2	2	3	-	-	-	-	-	-	3	2	3
	3-High				2-Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	20	20	20
Understand	30	20	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE22	Cryogenic Engineering	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	NIL				

Course Objectives

The course is intended to

1. Provide the concepts on cryogenic engineering
2. Implement the properties of cryogenics
3. Acquire the knowledge about the solid cryogenic system
4. Gain the knowledge on storage and instrumentation of cryogenics
5. Learn the procedure of usage of cryogenic equipment

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Learn about the cryogenic engineering basics	Understand
CO 2	Apply the properties of cryogenics systems.	Apply
CO 3	Interpret the insulation process of cryogenic system	Apply
CO 4	Insisting the properties of storage and instrumentation of cryogenics	Apply
CO 5	Examine the concepts of cryogenic equipments	Apply

Course Contents

Module – I Introduction to Cryogenic Engineering 9

Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison.

Module – II Cryogenic Properties and Safety 9

Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative - Linde -- Hampson, Claude Regenerative - Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator - Liquefaction of natural gas – Safety in Cryogenic fluid handling – Hypothermia and Asphyxiation – Safety against cryogenic hazards.

Module – III Cryogenic Insulation 9

Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

Module – IV Storage and Instrumentation of Cryogenic Liquids 9

Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems

Module – V Cryogenic Equipment 9

Cryogenic heat exchangers - recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization and Magneto-caloric refrigerator

Total : 45 Periods

Text Books

1. T.M. Flynn, Marcel Dekker., Cryogenic Engineering, Springer Science, 1989.
2. Randall F. Barron., Cryogenic Systems, Oxford University Press, 1985.

Reference Books

1. Bose and P. Sengupta, "Cryogenics: Applications and Progress", Tata McGraw Hill, 1985.
2. J.G. Weisend II, Taylor and Francis, "Handbook of Cryogenic Engineering", CRC Press, 1998.

Additional References

1.https://nptel.ac.in/downloads/112101004/
2.https://nptel.ac.in/Clarify_doubts.php?subjectId=112101004

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and ProgrammeSpecific Outcomes (PSO's)															
CO No.	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO 2	3	2	3	2	3	-	-	-	-	-	-	-	3	2	2
CO 3	3	2	3	2	3	-	-	-	-	-	-	-	2	3	3
CO 4	3	1	2	2	3	-	-	-	-	-	-	-	3	3	3
CO 5	3	2	3	1-	3	-	-	-	-	-	-	-	2	2	3
	3-High				**2-Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	10	20
Understand	30	20	30	40
Apply		20	10	40
Analyse				
Evaluate				
Create				

23AEE23	Heat Transfer	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisite	Aero Engineering Thermodynamics				

Course Objectives

The course is intended to

1. Introduce the fundamental principles of heat transfer, including conduction, convection, and radiation, and develop analytical methods for solving related engineering problems.
2. Enable students to analyze steady and unsteady state heat conduction in different geometries and composite systems relevant to aircraft structures.
3. Familiarize students with the concepts and calculations of convective heat transfer for both internal and external flows, using empirical and theoretical approaches.
4. Develop an understanding of heat exchanger types, performance parameters, and design methodologies used in aerospace thermal systems.
5. Impart knowledge on radiative heat transfer, including black and grey body concepts, and apply them to aerospace components and enclosures.

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Define and compare the different modes of heat transfer and calculation of thermal resistance and heat transfer through plane and composite wall and cylinder	Apply
CO 2	Learn about the various types of fins and their significance in steady state conduction heat transfer calculations. It will also help them to understand the concept of unsteady state heat transfer.	Apply
CO 3	Select and apply Appropriate empirical correlations to estimate forced and free convections heat transfer for internal and external flows.	Apply
CO 4	Evaluate heat transfer rate by radiation from ideal and actual surfaces and enclosures of different geometries.	Apply
CO 5	Evaluate heat exchanger performance for the given geometry and boundary conditions to deliver a desired heat transfer rate.	Apply

Course Contents

Module – I Introduction to heat transfer **9**

Basic modes of heat transfer, Laws of heat transfer, General Differential equation of Heat Conduction – Cartesian(derivation) and cylindrical coordinates (Only expression)

One Dimensional Steady State Heat Conduction — Plane, cylinder and Composite Systems

Module – II Conduction **9**

Unsteady state heat transfer- Lumped heat analysis, Heisler's chart, Biot Number , Fourier Number Extended surface – Types of fins, temperature distribution and their heat transfer rate, Fin efficiency and effectiveness.

Module – III Convection **9**

Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

Module – IV Heat Exchangers **9**

Heat Exchanger - Types - Overall Heat Transfer Coefficient – Fouling Factors -- Analysis – LMTD Method NTU method.

Module – V Radiation **9**

Basic definitions – Concept of Black body - Laws of black body Radiation, Radiation between Black Surfaces – Radiation Heat exchange between grey surfaces.

Total: 45 Periods

(Use of standard HMT data book permitted)

Text Books

1. Heat Transfer, J.P. Holman, Mcgraw Hill Book Company, New York, 10th edition, 2010.
2. Fundamentals of Heat and Mass Tranfer, Incropera, F.P.,Devitt, D.P., John Wiley & Sons, 6th Edition.
3. Fundamentals of Engg. Heat and Mass Transfer, RC.Sachdeva, 3/e, New Age International, 2009.

Reference Books

1. Heat Transfer – A Practical Approach, Yunus A. Cengel, Tata Mcgraw Hill Publishing Company Ltd., New Delhi.
2. Heat & Mass transfer, R.K.Rajput, Laxmi Publication, 5th Edition.
3. Fundamentals of Heat and Mass Transfer, Kondandaraman, C.P., 3/e, New Age Publ, 2006.

Data Book:

1. Heat and Mass transfer, C.P. Kothandaraman and S. Subramaniyan, New Age International publishers, 2022

Additional References (e-Resources and Digital Material)

1. http://web.mit.edu/lienhard/www/ahtt.html
2. https://archive.nptel.ac.in/courses/112/108/112108149/
3. https://nptel.ac.in/courses/112106315

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

COs	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
CO 2	3	2	1	-	-	-	-	-	-	-	-	-	3	3	1
CO 3	3	3	2	1	1	-	-	-	-	-	-	-	3	3	1
CO 4	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 5	3	3	3	2	2	-	-	-	-	-	-	-	3	3	2
	3- High				2- Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	08	08	08	20
Apply	32	32	32	60
Analyse				
Evaluate				
Create				

23AEE24	Aircraft Cooling systems	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Nil				

Course Objectives

The course is intended to

1. Impart fundamental knowledge of refrigeration principles, air cycles, and vapor cycle systems used in various industrial and aircraft applications.
2. Enable students to understand and analyze vapor compression and absorption refrigeration systems along with modifications for performance enhancement.
3. Introduce alternative and advanced refrigeration technologies such as steam-jet, thermoelectric, pulse tube, and thermoacoustic refrigeration systems.
4. Familiarize students with different refrigerants, their properties, environmental impact, and selection criteria - ensuring sustainable and eco-friendly practices.
5. Develop competence in psychrometry and air-conditioning load calculations, preparing students to design and evaluate efficient HVAC systems for diverse applications.

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Illustrate the principles, nomenclature and applications of refrigeration systems.	Understand
CO 2	Investigate vapor compression refrigeration system and identify methods for performance improvement	Apply
CO 3	Apply the working principles of air, vapor absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems	Apply
CO 4	Estimate the performance of air-conditioning systems using the principles of psychometry. Compute and Interpret cooling and heating loads in an air-conditioning system	Apply
CO 5	Identify suitable refrigerants for various refrigerating systems	Apply

Course Contents

Module – I Introduction to Cooling Systems and Refrigeration 9

Basic Definitions, Basic Air Cycle systems – Vapour Cycle Systems, Boot-strap air cycle system – Evaporative vapour cycle systems – Evaporation air cycle systems. Heat pump and Refrigerating Machine, Best Refrigeration Cycle: The Carnot Principle, Gas as a Refrigerant in Reversed Carnot Cycle, Limitations of Reversed Carnot Cycle, Reversed Brayton or Bell Coleman Cycle, Application to Aircraft Refrigeration, Simple Numerical problems.

Module – II Vapor Compression Refrigeration System (VCRS) 9

Modifications in Reversed Carnot Cycle with Vapor as a refrigerant, Vapor Compression Cycle, Ewing's Construction, Actual Vapor Compression Cycle, Effect of Operating Conditions. Simple Numerical problems. Multistage or Compound Compression, Multi-evaporator systems, Cascade Systems, – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

Module – III Vapor Absorption Refrigeration Systems 9

Simple Vapor – Absorption System, Maximum Coefficient of Performance of a Heat Operated Refrigerating Machine, Absorbent – Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Modifications to Simple Vapor-Absorption, Electrolux Refrigerator. Steam-Jet refrigeration system, Thermoelectric refrigeration, pulse tube refrigeration, and thermo acoustic refrigeration systems

Module – IV Refrigerants 9

Primary and Secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants, Selection of a Refrigerant, Ozone Depletion Potential and Global Warming Potential of CFC Refrigerants. Thermodynamic requirements, Comparison between different refrigerants, Substitutes for CFC refrigerants, Secondary Refrigerants. Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Module – V Air-Conditioning, Loading Calculation and Applied Psychometrics 9

Basic Processes in Conditioning of Air, Psychrometric Processes in Air-Conditioning Equipment, Simple Air-Conditioning /system and State and Mass Rate of Supply Air, Summer Air Conditioning, Winter Air Conditioning. Preliminary Considerations, Internal Hear Gains, System Heat Gains, Break-up of Ventilation Load and Effective Sensible Heat Factor, Cooling Load Estimate. Psychrometric Calculations for Cooling, Selection of Air-Conditioning Apparatus for Cooling and Dehumidification, Building Requirements and Energy Conservation in Air-Conditioned Buildings.

Total: 45 Periods

Text Books:

1. Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw –Hill, New Delhi, 2ndEdition, 2001.
2. Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw - Hill, New Delhi 2nd edition, 2004.

Reference Books:

1. Dossat, Principles of Refrigeration Pearson-2006.
2. Mc Quistion, Heating, Ventilation and Air Conditioning, Wiley Students edition, 5th edition 2000.
3. Refrigeration and Air-Conditioning' by Manohar prasad.
4. S C Arora& S Domkundwar, Refrigeration and Air-Conditioning Dhanpat Rai Publication

Additional References:

1. http://nptel.ac.in/courses/112105128/#

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	1
CO 3	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 4	3	2	1	3	2	-	-	-	-	-	-	-	2	3	1
CO 5	2	1	1	2	2	-	-	-	-	-	-	-	2	2	1
	3- High				**2- Medium**				**1- Low**						

Passed in Board of Studies CHAIRMAN-BOARD OF STUDIES *Approved in Academic Council*

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	20	20	20
Understand	30	20	20	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE25	Combustion Modeling	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Nil				

Course Objectives

The course is intended to

1. Familiarize in Diffusion Flames and Droplet Burning
2. Provide the knowledge in combustion of solid propellants
3. Create skills on ignition, extinction and flammability limits.
4. Understand the Conservation of acoustic energy
5. Learn the knowledge in spray combustion

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Understand the concept diffusion and droplet burning	Understand
CO 2	Apply the concepts of solid propellants	Apply
CO 3	Utilize the methods of Ignition, Extinction, and Flammability Limits	Apply
CO 4	Interpret the experimental methods in combustion instabilities	Apply
CO 5	Investigate the conversion equation in spray combustion	Apply

Course Contents

Module – I Diffusion Flames and Droplet Burning 9

The flame at the mouth of a tube in a duct- Definition, Assumptions, species conservation equation The flame shape and the flame height, formulation and the analysis-- The oxidation of carbon at the walls of a duct- Definition, nature of carbon combustion, Analysis- The burning of a fuel particle in an oxidizing atmosphere- definition, Assumptions, Analysis predicting the burning rate, simple problems --Structure of the flame Monopropellant droplet burning

Module – II Combustion of Solid Propellants 9

Description of steady deflagration of a homogeneous solid- Applications of transition-state theory Approach to interfacial equilibrium -Deflagration controlled by condensed-phase reaction rates - Deflagration controlled by gas-phase reaction rates -Dispersion phenomena and other influences - Combustion of heterogeneous propellants Erosive burning

Module – III Ignition, Extinction, and Flammability Limits 9

Minimum ignition energies and quenching distances- Premixed flames with heat losses-- Methods of analysis, the existence of two flame speeds, Concentration limits of flammability, Pressure limits of flammability, Estimates of heat loss Activation-energy asymptotic in ignition theory.

Module – IV Combustion Instabilities **9**

Acoustic instabilities in solid-propellant rocket motors -- Oscillation modes, Conservation of acoustic energy, the acoustic admittance, Damping mechanisms, Amplification mechanisms, Nonlinear effects- Inherent oscillations of burning solids-Oscillatory burning in liquid-propellant rocket motors-. System instabilities in combustion equipment-Hydrodynamic and diffusive instabilities in premixed flames.

Module – V Spray Combustion **9**

Spray statistics-Simplified model of combustion in a liquid-propellant rocket motor- The conservation equations for dilute sprays- Simplified conservation equations- Extended model of combustion in a liquid-propellant rocket motor-Deflagrations in sprays Spray penetration and cloud combustion.

Total: 45 Periods

Text Books:

1. Glassman, R.A. Yetter, and N. Glumac., "Combustion", Academic Press, 2014.
2. F.A Williams, “Combustion theory”, Benjamin cummins,1985.

Reference Books:

1. N.Peters, “Turbulent Combustion”, Cambridge University Press, 2005.
2. R.S cant & E.Mastorakos “An introduction to turbulent reacting flows”, Imperial college press, 2008.

Additional References:

1. https://nptel.ac.in/courses/112/104/112104272/

Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)															
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	2	1	2	-	-	-	-	-	-	-	-	2	2	1
CO 4	3	2	1	2	-	-	-	-	-	-	-	-	2	3	1
CO 5	3	2	2	2	-	-	-	-	-	-	-	-	3	3	2
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	20	20	40
Understand	30	20	30	40
Apply		10		20
Analyse				
Evaluate				
Create				

23AEE26	Micro Propulsion System	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Nil				

Course Objectives

The course is intended to

1. Learn about the types of micro propulsion system
2. Understand the emerging technologies of micro propulsion system
3. Gain knowledge of MEMS systems
4. Gather the information about system considerations of micro propulsion system
5. Learn more ways of experimenting in micro propulsion system

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Classify the types of micro propulsion	Understand
CO 2	Examine the emerging technologies of micro propulsion	Apply
CO 3	Implement the Propulsion Concepts of MEMS	Apply
CO 4	Demonstrate the system requirements for micro propulsion system	Apply
CO 5	Interpret the experiments on micro propulsion system	Apply

Course Contents

Module – I Introduction of Micro propulsion **9**

Introduction Chemical Micro Propulsion – Electromagnetic Micro Propulsion – Electrostatic Micro Propulsion – Electro dynamic Tether – Electric Power Processing

Module – II Emerging Technologies **9**

Recent trends – System integration requirements – minimum pulse bit and thrust requirements – Bipropellant engines – Monopropellant engines – Monopropellant thrusters – Cold Gas thrusters – sold and hybrid rocket motors.

Module – III MEMS **9**

Propulsion Concepts - Case study for MEMS - Brief History of MEMS – Challenges on MEMS-Propulsion - Micro-Ion Engine Concepts - MEMS-Based Micro resistojet Concepts – Subliming Solid Micro thruster Concept - Cold Gas Thruster Concept Bipropellant Thruster Concept

Module – IV System Considerations **9**

Micro spacecraft – Micro propulsion – Micro propulsion Scaling Issues – Micro nozzle Expansions Ion
Formation at Small-Scale Lengths - Micron-Scale Combustion and Mixing Micro-Heat Transfer

Module – V Experiments **9**

Nomenclature – Propellant testing – Electron Temperature experiment – Doppler shift experiment – Thrust measurement

Total: 45 Periods

Passed in Board of Studies CHAIRMAN-BOARD OF STUDIES *Approved in Academic Council*

Text Books

1. Michael M. Micci, Andrew D. Ketsdever., "Micropropulsion for small Spacecraft", American
2. Mohamed Gad-el-Hak., 'MEMS: Introduction and Fundamentals", CRC Press, 2005

Reference Books

1. Martin Tajmar, "Advanced Space propulsion system", Springer, 2003
2. George P. Sutton & Oscar Biblarz., "Rocket Propulsion Elements", Wiley, 2023

Additional References

1. https://youtu.be/zP72l08yD3Q

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	2	3	-	-	-	-	-	-	-	3	3	2
CO 4	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2
CO 5	2	2	-	3	3	-	-	-	-	-	-	-	3	3	2
	3-High				**2-Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	10	20
Understand	30	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE27	Aero engine control system	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Nil				

Course Objectives

The course is intended to

1. Summarize about the engine controls and historical development
2. Understand the concepts of engine monitoring and simulation
3. Learn the design aspects on set-point controllers and design
4. Implement on control mode and engine accessories
5. Compare the engine and its health management through various designs

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Classify the about the engine control system history	Understand
CO 2	Implement the principles of engine modelling and simulation	Apply
CO 3	Interpret the design of set - point controllers	Apply
CO 4	Examine the control system integration on aircraft engines	Apply
CO 5	Demonstrate the methods of monitoring and health management systems.	Apply

Course Contents

Module – I Overview of Engine Control Systems 9

Basic Concept of Control System - Terminology for Control Systems - Basic Engine Control Concept - Environment within a Gas Turbine Engine Control Systems – Historical Development of Engine Control Systems.

Module – II Engine Modelling and Simulation 9

Steady-State Engine Models - Control Law Design Procedure - Dynamic Engine Models - Modelling of Complete Engine Dynamics - Modelling of Actuator and Sensor Dynamics - High-Fidelity Engine Simulations -- Derivation of Linear Engine Models- Engine Simulation Software Packages.

Module – III Design of Set-Point Controllers 9

Controller Design for One-Spool Engines - Controller Design for Two-Spool Engines - Control Design for Turboshaft Engines Some Practical Considerations for Set-Point Controls, Design of Intelligent Controller for Aero-engine.

Module – IV Control System Integration 9

Power Setting - Transient Schedules - Control Modes - Engine Accessories -- Integrated Flight Propulsion Control - Controller Synthesis Examples.

Module – V Engine Monitoring and Health Management 9

Basic Concepts - Monitoring System Design - Engine health management - Monitoring Algorithm Design - Trend Monitoring from Periodically Recorded Data - Integration Architecture, Capabilities and Requirements -- Life-Extending Control Safety Assurance Control.

Total: 45 Periods

Text Books

1. Link C. Jaw, Jack D. Mattingly, "Aircraft Engine controls design, system analysis and health monitoring" AIAA Education series, 2023.
2. Philip P. Walsh and Paul Fletcher., "Gas Turbine Performance (2nd Edition)", Blackwell Science, 2008

Reference Books

1. K. Padmanabhan, "Control Systems" Dream tech press, 2020.

Additional References

1. NASA TMs are available for free download at: http://gltrs.grc.nasa.gov/
2. NPTEL - https://onlinecourses.nptel.ac.in/noc24_ae05/preview
3. The following engine simulation software packages, developed in Matlab/Simulink and useful for propulsion controls and diagnostics research, are available from NASA GRC software repository • MAPSS – Modular Aero-Propulsion System Simulation • Simulation of a modern fighter aircraft prototype engine with a basic research control law: http://sr.grc.nasa.gov/public/project/49/

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	-	-	-	-	2	-	-	-	-	-	-	3	1	1
CO 2	3	2	3	3	3	-	-	-	-	-	-	-	3	2	3
CO 3	3	2	3	2	3	-	-	-	-	-	-	-	3	2	3
CO 4	3	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO 5	3	3	2	2	3	2	2	-	-	-	-	-	3	3	3
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	10	20
Understand	30	20	20	40
Apply		20	20	40
Analyse				
Evaluate				
Create				

23AEE28	Rockets and Missiles	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Aerodynamics				

Course Objectives

The course is intended to

1. Classify the rockets and missiles with respect to Indian & international scenario.
2. Import the knowledge in the area of missile and rocket flight.
3. Understand methods of space and gravity systems.
4. Learn concepts of staging of rockets.
5. Examine the characteristics of materials for rockets.

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Extract the varieties of rockets and missiles.	Understand
CO 2	Investigate the aerodynamics of rocket and missiles.	Apply
CO 3	Apply the motion of rockets.	Apply
CO 4	Interpret the various types of stages and control of rockets and missiles.	Apply
CO 5	Demonstrate a range of control methods of rockets and launch vehicles.	Apply

Course Contents

Module – I Classification of Rockets and Missiles 9

Various methods of classification of missiles and rockets – Basic aerodynamic characteristics of surface to surface, surface to air, air to surface and air to air missiles – Examples of various Indian space launch vehicles and missiles.

Module – II Aerodynamics of Rockets and Missiles 9

Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics – method of describing forces and moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinal moment – drag estimation – up wash and downwash in missile bodies – rocket dispersion.

Module – III Rocket Motion in Free Space and Gravitational Field 9

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to determine burn out velocity and altitude – estimation of culmination time and altitude.

Module – IV Staging of Rockets and Missiles 9

Design philosophy behind multistage of launch vehicles– multistage vehicle optimization– stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics

Module – V Control of Rockets and Launch Vehicles 9

Introduction to aerodynamic control and jet control methods- thrust control methods – various types of thrust vector control methods including secondary injection thrust vector control for launch vehicles.

Total: 45 Periods

Text Books

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co.,Ltd, London, 2008.
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons; 8th Edition 2010.

Reference Books

1. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition 2014.
2. Parket, E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 2009.

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1
CO 2	3	2	1	2	1	-	-	-	-	-	-	-	3	2	1
CO 3	3	1	2	3	2	-	-	-	-	-	-	-	2	3	1
CO 4	3	2	1	2	1	-	-	-	-	-	-	-	2	3	1
CO 5	3	2	1	2	1	-	-	-	-	-	-	-	2	3	2
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	40	10	10	20
Apply		30	30	60
Analyse				
Evaluate				
Create				

23AEE29	High Temperature Gas Dynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Aerodynamics				

Course Objectives

The course is intended to

1. Understand the fundamentals of high-temperature gas behavior and chemically reacting flows in aerospace applications.
2. Learn the principles of statistical thermodynamics for predicting thermodynamic properties at high temperatures.
3. Intended the concepts of equilibrium and non-equilibrium inviscid flow fields relevant to high- enthalpy applications.
4. Describe transport phenomena and radiative heat transfer processes in high-temperature gas mixtures.
5. Slove the governing equations and modeling approaches for chemically reacting viscous boundary layers and stagnation-point heat transfer.

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Understand the concepts of thermodynamics, and chemical effects on temperature gas flows	Understand
CO 2	Apply statistical thermodynamics to compute equilibrium and non-equilibrium properties of gas mixtures.	Apply
CO 3	Analyze inviscid high-temperature flow problems including shocks, nozzles, and blunt-body flows.	Analyze
CO 4	Determine transport properties and radiative heat transfer characteristics of high-temperature gases.	Apply
CO 5	Solve viscous chemically reacting flow and boundary layer problems using appropriate numerical or analytical methods.	Apply

Course Contents

Module – I Introduction **9**

Importance of High-Temperature Flows, Nature of High-Temperature Flows, Chemical Effects in Air: The Velocity-Altitude Map, Thermodynamics of Chemically Reacting Gases, Kinetic theory of gases, Definition of Real Gases and Perfect Gases, Various Forms of the Perfect-Gas Equation of State, Collision Frequency and Mean Free Path, Velocity and Speed Distribution Functions, Classification of Gases.

Module – II Statistical Thermodynamics **9**

Introduction, Boltzmann Distribution, Evaluation of Thermodynamic Properties in Terms of the Partition Function, Chemical Equilibrium in High-Temperature Gas Mixtures (merged from related topics), Thermodynamic Properties of an Equilibrium Chemically Reacting Gas Equilibrium Properties of High-Temperature Air, Non-Equilibrium Thermodynamics in High-Temperature Flows

Module – III Inviscid High Temperature Equilibrium and Non-Equilibrium Flows 9

Introduction, Governing Equations for Inviscid High-Temperature Equilibrium Flow, Equilibrium Normal and Oblique Shock-Wave Flows, Equilibrium Quasi-One-Dimensional Nozzle Flows, Frozen and Equilibrium Flows: The Distinction, Equilibrium and Frozen Specific Heats, Equilibrium Speed of Sound, Equilibrium Conical Flow, Equilibrium Blunt-Body Flows. Governing Equations for Inviscid, non-equilibrium flows, Non-equilibrium Normal and Oblique Shock-Wave Flows.

Module – IV Transport Properties in High Temperature Gases 9

Introduction, Definition of Transport Phenomena, Transport Coefficients, Mechanism of Diffusion, Energy Transport by Thermal Conduction and Diffusion: Total Thermal Conductivity, Transport Properties for High-Temperature Air, Radiative Heat Transfer in High-Temperature Gases.

Module – V Viscous High Temperature Flows 9

Governing Equations for Chemically Reacting Viscous Flow, Alternate Forms of the Energy Equation, Boundary-Layer Equations for a Chemically Reacting Gas, Boundary Conditions: Catalytic Walls, Boundary-Layer Solutions: Stagnation-Point Heat Transfer for a Dissociating Gas, Parabolized Navier-Stokes Solutions to Chemically Reacting Flows.

Total: 45 Periods

Text Books

1. John D. Anderson Jr., “Hypersonic and High-Temperature Gas Dynamics”, 2nd Edition, AIAA Education Series, 2006.
2. Tarit K. Bose, “High Temperature Gas Dynamics”, 2nd Edition, Springer, 2014

Reference Books

1. H.W. Liepmann and A Roshko, “Elements of Gas Dynamics”, Dover Publications, 2001
2. John D. Anderson, “Modern Compressible Flow: with Historical Perspective”, McGraw Hill Education, Indian Edition, 2017

Additional References

1. https://onlinecourses.nptel.ac.in/noc21_ae03/preview?utm_source=chatgpt.com
2. https://onlinecourses.nptel.ac.in/noc24_ae12/preview?utm_source=chatgpt.com

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

COs	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	1	1	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	2	1	-	-	-	-	-	-	-	3	2	1
CO 4	2	1	2	1	1	-	-	-	-	-	-	-	3	1	1
CO 5	2	3	3	3	2	-	-	-	-	-	-	-	3	2	1
	3- High				2- Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	40	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE30	Wind Tunnel Techniques	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Aerodynamics				

Course Objectives

The course is intended to

1. Build up necessary background for understand the different types of wind tunnels.
2. Interpret the basic concepts of measuring setup of forces and moments on models during the wind tunnel testing.
3. Learn the application of various types of wind tunnels.
4. Involve the basic measurement procedure involving wind tunnel testing.
5. Familiarize students with flow visualization methods used in wind tunnels.

Course Outcomes

On successful completion of the course the students will be able to

CO No.	Course Outcome	Bloom's Level
CO 1	Understand the dimension of physical quantities in wind tunnel.	Understand
CO 2	Design and analyse different types of wind tunnel with respect to speed regions.	Apply
CO 3	Apply the calibration procedure in wind tunnel based on speed, flow angularity and turbulence	Apply
CO 4	Compare the wind tunnel measurement techniques and their applications and limitations.	Apply
CO 5	Check the flow around aerodynamic models using flow visualizations techniques.	Apply

Course Contents

Module – I Introduction **9**

General features -Types of wind tunnel, Low speed wind tunnel - High speed wind tunnel - Diffuser - diffuser-test section - driving unit special purpose tunnels.

Module – II Low Speed Wind Tunnels **9**

Components of low speed wind tunnel - convergent section - test section - divergent section – power plant- power losses - energy ratio - losses in cylindrical section -losses in convergent cone - honeycombs guide vanes-losses due to open jet test section.

Module – III High Speed Wind Tunnel **9**

Blow down type wind tunnels - Induction type tunnels - continuous supersonic wind tunnels -- losses in supersonic wind tunnel - supersonic wind tunnel diffusers effect of second throat.

Module – IV Wind Tunnel Measuring Setup **9**

Pressure and velocity measurements - force measurements -- three component and six component balances- internal balances.

Module – V Flow Visualization **9**

Smoke and tuft grid techniques - Water flow visualization method dye injection special techniques, make demo of smoke flow visualization (prototype model).

Total : 45 Periods

Text Books

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 2006.
2. Sachs. P., "Winds forces in Engineering", Pergamon Press, 2010.

Reference Books

1. Blevins. R.D., "Flow Induced Vibrations", Van Nostrand, 2012
2. Calvent. N.G., "Wind Power Principles", Charles Griffin & Co., London, 2010

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
CO NO.	**PO's**													**PSO's**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	3	2	2
CO 2	3	3	3	2	2	-	-	-	-	-	-	-	3	2	2
CO 3	3	2	2	3	-	-	-	-	-	-	-	-	3	2	2
CO 4	3	2	-	3	1	-	-	-	-	-	-	-	3	2	1
CO 5	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	40	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE31	Missiles Guidance	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Prerequisites	Nil				

Course Objectives

The course is intended to

1. Fundamental concepts and classifications of missile guidance systems.
2. Learn the various missile guidance techniques.
3. Provide knowledge of homing guidance methods.
4. Familiarize students with modern guidance laws and optimal control techniques.
5. Implementation aspects of missile guidance systems.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Discuss the fundamentals and classification of missile guidance systems.	Understand
CO 2	Apply the missile guidance techniques of command, homing, and beam-rider guidance.	Apply
CO 3	Describe the principles of homing guidance methods.	Understand
CO 4	Summarize modern guidance laws and optimal control strategies.	Understand
CO 5	Implement the aspects of missile guidance systems.	Apply

Course Contents

Module – I Introduction to Missile Guidance **9**

Fundamentals of missile systems and their classification - Guidance vs. control vs. navigation - Types of guidance: Command, homing, and beam-rider - Overview of guidance loop architecture - Basic kinematics of missile-target engagement - Coordinate systems used in guidance.

Module – II Homing Guidance Techniques **9**

Pursuit guidance - Proportional Navigation (PN) guidance: True, pure, and biased PN - Advantages and limitations of PN - Augmented PN and hybrid methods - LOS (Line-of-Sight) rate estimation - Introduction to terminal guidance.

Module – III Command and Beam-Rider Guidance **9**

Command guidance: types, advantages, limitations - Ground-based and airborne command systems - Beam-rider guidance: principle and applications - Midcourse guidance concepts - Range and angle tracking systems - Noise and error sources in command/beam-rider guidance.

Module – IV Modern Guidance Laws and Optimal Control **9**

Optimal guidance problem formulation - Linear Quadratic Regulator (LQR) for guidance - Advanced guidance laws: Sliding Mode Control, Guidance with constraints, Predictive and fuzzy logic-based guidance - Guidance of interceptors and high-speed missiles.

Module – V Guidance System Implementation and Simulation **9**

Sensor technologies in missile guidance (IMU, seekers) - Real-time implementation issues - Digital vs. analog guidance systems - Introduction to guidance system simulation - Flight testing of guided missiles - Case studies of modern missile systems.

Total : 45 Periods

Text Books

1. George M. Siouris, "Missile Guidance and Control Systems", Springer, New York, 2004.
2. P.V. Rao, "Modern Missile Guidance", McGraw Hill Education, New Delhi, 2011.
3. N. Harris McClamroch, "Modern Control in Guidance and Control of Aerospace Vehicles", Academic Press, New York, 1988.

Reference Books

1. B.W. McCormick, "Aerodynamics of V/STOL Flight", Academic Press, New York, 2000.
2. Ashish Tewari, "Atmospheric and Space Flight Dynamics: Modeling and Simulation with MATLAB® and Simulink®", Birkhäuser, Boston, 2007.
3. R.G. Brown and P.Y.C. Hwang, "Introduction to Random Signals and Applied Kalman Filtering", Wiley, New York, 1997.

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	–	2	–	–	–	–	–	–	–	–	3	1	1
CO 2	3	2	2	2	–	–	–	–	–	–	–	–	3	1	1
CO 3	3	3	2	3	–	–	–	–	–	–	–	–	3	2	1
CO 4	3	1	3	3	2	–	–	–	–	–	–	–	3	3	1
CO 5	3	1	1	3	2	–	–	–	–	–	–	-	2	3	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	10
Understand	40	10	10	42
Apply		30	30	48
Analyse				
Evaluate				
Create				

Stream – 3 AIRCRAFT STRUCTURE AND DESIGN

23AEE41	Fatigue and fracture	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft Structural Mechanics				

Course objectives:

The course is intended to

1. Understand the basic concepts involved in fatigue analysis.
2. Study the importance of fracture mechanics in aerospace applications.
3. Identify the crack propagation of materials.
4. Learn the fracture mechanics concepts.
5. Interpret the design philosophies.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Solve and estimate fatigue life for simple problems	Apply
CO 2	Understand and solve the concepts of cumulative damage and load histories.	Understand
CO 3	Estimate fatigue crack propagation life for simple problems	Apply
CO 4	Apply the concept fracture mechanics to aircraft structure problems	Apply
CO 5	Expose to the concept of various design philosophies, fatigue resistance of fiber-metal laminates	Apply

Course Contents

Module - I Fatigue of Structures **7**

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber‟s stress concentration factors Plastic stress concentration factors Notched S.N. curves – Fatigue of composite materials.

Module - II Statistical Aspects of Fatigue Behaviour **10**

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.

Module - III Physical Aspects of Fatigue **10**

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations fatigue fracture surfaces.

Module - IV Fracture Mechanics **10**

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.

Module - V Fatigue Design and Testing **8**

Safe life and Fail-safe design philosophies - Types of Fatigue Tests -Importance of Fracture Mechanics in aerospace structures Application to composite materials and structures.

Total: 45 Periods

Text books:

1. Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 2009.
2. Barrois W, Ripely, E.L., “Fatigue of aircraft structure," Pergamon press. Oxford, 1983.

References:

1. Sih C.G., “Mechanics of fracture.” Vol - I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.
2. Knott, J.F., “Fundamentals of Fracture Mechanics,” - Buterworth & Co., Ltd., London, 1983.
3. Robert o Ritchie ,"Introduction to Fracture Mechanics", elseiver,2021

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	1	2	-	-	-	-	-	-	-	3	2	1
CO2	3	3	1	1	2	-	-	-	-	-	-	-	3	2	1
CO3	3	3	1	1	2	-	-	-	-	-	-	-	3	2	1
CO4	3	3	1	1	2	-	-	-	-	-	-	-	3	2	1
CO5	3	3	1	1	2	-	-	-	-	-	-	-	3	2	1
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE) (60)**
	IAE- I (5)	**IAE - II (10)**	**IAE - III (10)**	
Remember	10	10	10	20
Understand	30	30	30	50
Apply	10	10	10	30
Analyze				
Evaluate				
Create				

23AEE42	Failure Analysis	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft Materials				

Course Objectives

The course is intended to

1. Introduce the fundamental classifications, causes, and mechanisms of material failures.
2. Familiarize students with environment-induced failures and contemporary corrosion mechanisms with prevention methods.
3. Explain different wear failure types, creep phenomena, and modern surface engineering techniques for wear resistance.
4. Describe failure data analysis methods, life predictions, and failure mode effect analysis (FMEA).
5. Acquaint students with advanced tools and techniques for failure analysis, including modern microscopy, NDT methods, and CT scanning.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Identify and classify different material failure mechanisms and their fundamental causes	Understand
CO 2	Analyze environment-induced failures and propose appropriate preventive strategies	Analyze
CO 3	Describe various wear failures, creep mechanisms, and advanced surface engineering solutions.	Understand
CO 4	Perform failure data analysis using life prediction models and FMEA techniques.	Apply
CO 5	Apply advanced microscopy, non-destructive testing, and modern failure analysis tools for defect evaluation.	Apply

Course Contents

Module – I Introduction **9**

Definition of failures, Classification of failures, Instantaneous failures, Cumulative failures, Fundamental causes of failures-Deficiencies in design, Deficiencies in selection of materials. Principles and Approaches of Failure analysis, objectives, scope, planning, preparation, Advanced Fractography and Microstructural Analysis using SEM/TEM.

Module – II Environment Induced Failures **9**

Corrosion damage, Forms of corrosion-Uniform attack, Two metal corrosion or galvanic corrosion, Crevice corrosion, Pitting corrosion, Inter-granular corrosion, Selective leaching, Erosion corrosion, Corrosion cracking- Stress Corrosion Cracking, Corrosion fatigue, Hydrogen cracking, Hydrogen degradation, Liquid metal embrittlement, High temperature corrosion, corrosion failure mechanisms and Preventive techniques.

Module – III Wear Failures **9**

Definition of wear, Types of wear-adhesive wear, Abrasive wear, Corrosive wear, Erosive wear, fretting wear, Fatigue wear, Wear failure mechanisms and Preventive techniques Surface Engineering Techniques for Wear Resistance, Creep failures, Stages of creep, Creep curve, Stress rupture.

Module – IV Failure Data Analysis **9**

MTTF, MTBF, Bath tub Curve, Mean Life, Life Testing, Problems, Introduction to Failure Mode and Effect Analysis.

Module – V Tools for failure analysis **9**

Microscopic examination-Metallurgical Microscope, Electron Microscope, Fatigue test, NonDestructive Testing techniques-Magnetic particle inspection, Radiography, Computed Tomography (CT) Scanning for Internal Defect Analysis, Ultrasonic testing, Acoustic Emission Testing, Thermograph, Chemical analysis- Spectroscopy.

Total : 45 Periods

Text Books

1. Failure Analysis & Prevention American Society of Metal Handbook V 10.11 and 17.
2. H.M. Tawancy, A. Ul-Hamid and N.M. Abbas, Marcel Dekker “Practical engineering failure analysis” New York, 2004.
3. Failure analysis and prevention, Volume 11, ASM Handbook, The Materials Information Society, 2002.
4. V. amachandran, A.C. Raghuram, R.V. Krishnan and S.K. Bhaumik “Failure analysis of engineering structures” Methodology and case histories, ASM International, 2005

Reference Books

1. V. Ramachandran, A.C. Raghuram, R.V. Krishnan, and S.K. Bhaumik, “Failure analysis of engineering structures: Methodology and case histories” ASM International, 2005
2. A.J. McEvily, J. Kasivitamnuay, “Metal Failures: Mechanisms, Analysis, Prevention, Wiley”Interscience, 2013
3. C. R. Brooks and A. Choudhury, “Failure analysis of engineering materials” McGraw-Hill.2002

Additional References

1. https://www.asminternational.org/web/failure-analysis
2. https://nptel.ac.in/courses/113106032
3. https://nptel.ac.in/courses/113106070

	Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)														
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2	2	1								3	2	1
CO 2	3	2	2	3	2		1						3	3	1
CO 3	3	2	3	3	2		1						3	3	1
CO 4	3	2	2	3	3		1						3	3	1
CO 5	3	3	3	3	3		2						3	3	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEE43	Aircraft Structural Testing	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft Structural Mechanics				

Course Objectives

The course is intended to

1. Introduce various structural testing methods used in aircraft applications.
2. Explain the theoretical basis of structural testing procedures.
3. Discuss the industrial applications of structural testing in aerospace.
4. Illustrate different types of non-destructive testing (NDT).
5. Provide insights into liquid penetrant and magnetic particle inspection methods.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the role, applications, and procedures of aircraft structural testing.	Understand
CO 2	Identify the appropriate test method for different load conditions on aircraft.	Apply
CO 3	Develop the industrial applications of structural testing techniques.	Apply
CO 4	Interpret the various methods of non - destructive testing.	Understand
CO 5	Understand the principles of liquid penetrant and magnetic particle inspections.	Understand

Course Contents

Module – I Introduction to Structural Testing 9

Certification for testing Civil & Military Aircraft - FAR and MIL Standards - Threats to Structural Integrity - Role and Scope of Structural Testing and Analysis - Experimental Characterization of Composite Materials used in Aerospace

Module – II Data Generation in Testing 9

Data Generation and Development Tests for Structural Joints and Features - Crashworthiness Testing - Impact Testing Procedures

Module – III Aircraft Structural Testing Methods 9

Strain Gauging Techniques - Measurement of Structural Loads on Aircraft and Components - Full-scale Static and Fatigue Testing - Aircraft Structural Dynamics and Associated Test Requirements

Module – IV Vibration Testing and Instrumentation 9

Scope and Methodology of Aircraft Vibration Testing - Structural Testing Facilities for Civil Aircraft Instrumentation in Structural Testing - Data Acquisition Systems and Test Control Methods

Module – V Non-Destructive Testing Techniques 9

Liquid Penetrant Testing - Principles, Types, Properties, Developers Advantages, Limitations, Procedure, Result Interpretation Magnetic Particle Testing: - Theory of Magnetism, Materials Used, Magnetization Methods, Test Indications, Evaluation, Demagnetization Techniques, Residual Magnetism and Safety Considerations

Total : 45 Periods

Text Books

1. John E. McCarty , *Full-Scale Structural Testing*, ASM International, Vol. 21, 2001.
2. Robert T. Reese, Wendell A. Kawahara , *Handbook on Structural Testing*, Fairmont Press, 1999.

Reference Books

1. MIL-STD-1540D – Military Standard for Test Requirements for Space Vehicles.
2. FAA Advisory Circular 23 -19A – Aircraft Certification and Testing Guidance.
3. *Introduction to Nondestructive Testing: A Training Guide*, John Wiley & Sons.

Additional References

1. NPTEL - https://youtu.be/FTtoPcsOeU8

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	1									1	3	2	
CO 2	3	2	2	1								2	3	2	
CO 3	3	2	2	2								2	3	3	
CO 4	2	1	1									2	3	2	
CO 5	2	2	1									2	2	1	
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	20	20	40
Understand	30	30	30	60
Apply				
Analyse				
Evaluate				
Create				

23AEE44	Experimental Technology for Aircraft Structures	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft Structural Mechanics				

Course Objectives

The course is intended to

1. Understand the behavior of stress, strain, and displacement fields through analytical and experimental approaches.
2. Explore holographic and speckle - based interferometry techniques for stress visualization.
3. Study the principles and applications of photoelastic coatings in experimental stress analysis.
4. Compare the use of strain gauges, bridge circuits, and rosettes for strain measurement.
5. Learn strain gauge installation techniques and the impact of transverse sensitivity effects in measurements.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Classify the behavior of stress, strain, and displacement fields in aircraft structural components.	Understand
CO 2	Select and apply appropriate experimental methods based on loading conditions in aircraft structures.	Apply
CO 3	Apply the principles of photoelastic coatings for analyzing stress distribution.	Apply
CO 4	Understand and compare various experimental methods used for stress analysis in aircraft structures.	Understand
CO 5	Describe strain gauge installation procedures and correct for transverse sensitivity effects.	Understand

Course Contents

Module – I Stress, Strain and Displacement Fields 9

Stress, Strain and Displacement fields for various problems -Beam under pure bending,-Analytical solution -Fringe contours from various experimental methods -Disc under diametric compression - Analytical solution - Fringe contours from various experimental techniques -Clamped circular plate under a central load -Analytical solution, Fringe contours from various experimental techniques

Module – II Hologram Interferometry, Speckle Methods 9

Hologram interferometry -Steps in a double exposure hologram interferometry -Speckle methods Objective speckles, Subjective speckles

Module – III Introduction to Photoelastic Coatings 9

Photoelastic coatings -Historical development, -Optical arrangements-Photoelastic strain gauges, Strainoptic relation for coating, -Evaluation of coating and specimen stresses

Module – IV **Strain Sensitivity of a Strain Gauge, Bridge Sensitivity, Rosettes** **9**

Strain sensitivity of a strain gauge, -Transverse sensitivity factor, -Gauge factor,-Experimental determination of gauge factor, -Wheatstone bridge,-Strain measurement options,-Bridge sensitivity,-Bridge factor, Accuracy achievable in Foil strain gauges, Linearity, -Hysteresis and Zero shift, -Determination of strain at a point, -Three element rectangular rosette

Module – V **Soldering, Accounting for Transverse Sensitivity Effect** **9**

Masking, Tinning,Soldering,Application of protective coating, Testing the installation, Transverse sensitivity, Actual and apparent strains, Corrections for transverse strain effects for the case of known ratio of the transverse strain to the axial strain.

Total : 45 Periods

Text Books

1. K. Ramesh, e-Book on Experimental Stress Analysis, IIT Madras, 2009
2. J.W. Dally and W.F. Riley,Experimental Stress Analysis, McGraw-Hill, 1991.

Reference Books

1. L.S.Srinath, M.R. Raghavan,K. Lingaiah, G. Gargesa,B.Pant, and K.Ramachandra, Experimental Stress Analysis, Tata McGraw Hill, 1984..
2. 2. K. Ramesh, Digital Photoelasticity – Advanced Techniques and Applications, Springer, 2000.

Web References

1. http://apm.iitm.ac.in/smlab/kramesh/book_5.htm

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

COs	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2		2									3	2	1
CO 2	3	3	2										3	2	1
CO 3	3	2	2	2									3	2	1
CO 4	3	2		1									3	2	1
CO 5	3	2	2	1									3	2	1
	3- High				2- Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	20	30
Understand	30	10	30	40
Apply		30		30
Analyse				
Evaluate				
Create				

23AEE45	Vibration and Rotor Dynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Mechanics of Machinery				

Course Objectives

The course is intended to

1. Understand the fundamental concepts of vibration in single degree of freedom systems including free, damped, and forced vibrations.
2. Analyze multi degree of freedom systems and understand their mode shapes, natural frequencies, and coupling effects.
3. Study vibrations in continuous systems such as strings and shafts in different modes.
4. Apply approximate methods for solving complex vibration problems where exact solutions are difficult.
5. Understand rotor dynamics including rotor -bearing interactions, critical speeds, gyroscopic and aerodynamic effects.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Explain and analyze free, damped, and forced vibrations of single degree of freedom systems and measure vibration parameters.	Understand
CO 2	Analyze two-degree of freedom systems, determine natural frequencies, mode shapes, and understand vibration absorbers and principal modes.	Analyze
CO 3	Describe the vibrations of continuous systems including elastic bodies, strings, and shafts in various modes.	Understand
CO 4	Apply approximate solution techniques such as Rayleigh's, Dunkerley's, Rayleigh-Ritz, and matrix iteration methods to solve vibration problems.	Apply
CO 5	Analyze rotor dynamics phenomena including rotor-bearing interaction, critical speeds, gyroscopic effects, and aerodynamic influences.	Analyze

Course Contents

Module – 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

Module – II Multi Degrees of Freedom Systems 9

Two degrees of freedom systems - static and dynamic couplings-- vibration absorber-principal coordinates - principal modes and orthogonal conditions - eigen value problems - hamilton‟s principle.

Module – III Continuous Systems 9

Vibration of elastic bodies vibration of strings – longitudinal, lateral and torsional vibrations.

Module – IV **Approximate Methods** **9**

Approximate methods – rayleigh's method – dunkerlay's method – rayleigh-ritz method, matrix iteration method

Module – V **Rotor Dynamics** **9**

Rotor-bearing interaction. Flexural vibration, critical speeds of shafts, Effects of anisotropic bearings, unbalanced response of an asymmetric shaft. Gyroscopic effects. Aerodynamic effects.

Total : 45 Periods

Text Books

1. Leonard Meirovitch, "Elements of Vibration Analysis". McGraw Hill International Edition,2017.
2. J. S. Rao, Rotor Dynamics, New Age, New Delhi, Third ed.,2010.

Reference Books

1. Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003
2. Thomson W T, "Theory of Vibration with Application" - CBS Publishers, 1990.
3. Childs, Dara,, Turbomachinery Rotor Dynamics: Phenomena, Modeling and Analysis, John Wiley and sons , 1993.
4. William Weaver, Stephen P. Timoshenko, Donovan H. Yound, Donovan H. Young. "Vibration Problems in Engineering" – John Wiley and Sons, New York, 2001.

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)														
COs	**PO's**												**PSO's**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO 1	3	3	2	2	2							2	3	
CO 2	3	3	3	2	3							2	3	
CO 3	2	3	2	3	2							2	3	
CO 4	3	3	3	2	3							2	2	
CO 5	3	3	3	3	3							2	3	
	3- High				**2- Medium**				**1- Low**					

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEE46	Experimental stress analysis	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Aircraft Structural Mechanics				

Course Objectives

The course is intended to

1. Understand the fundamental principles of stress analysis and measurement techniques .
2. Gain proficiency in using strain gauges and extensometers for stress measurement.
3. Explore optical methods like photoelastici ty for stress visualization.
4. Familiarize with advanced experimental techniques and their integration with computational methods.
5. Comprehend various NDT methods and their applications in industry .

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Classify the fundamental concepts of stress analysis and measurement.	Understand
CO 2	Demonstrate the use of strain gauges and extensometers in experimental setups.	Apply
CO 3	Identify the tress patterns using photoelasticity and interpret fringe patterns.	Apply
CO 4	Develop advanced experimental techniques and integrate them with computational tools.	Apply
CO 5	Apply appropriate NDT methods for evaluating material and structural integrity.	Apply

Course Contents:

Module - I Fundamentals of Stress Analysis and Measurement **9**

Principles of measurements, accuracy, sensitivity and range of measurements - Analytical, numerical, and experimental approaches to stress analysis - Introduction to digital data acquisition systems- Overview of strain measurement techniques.

Module - II Strain Gauges and Extensometers **9**

Types of strain gauges: electrical resistance, semiconductor, and foil gauges - Gauge factor, temperature compensation, and calibration techniques- Strain gauge rosettes and data interpretation- Mechanical, optical, and digital extensometers- Integration with data acquisition systems and software.

Module - III Transmission Photo elasticity **9**

Introduction to Transmission Photoelasticity - Ordinary and Extraordinary Rays - Stress-optic Law Plane and circular polariscope - Fringe pattern analysis and order determination - Digital photoelasticity and image processing techniques- Applications in complex stress analysis

Module - IV Advanced Experimental Techniques **9**

Moiré methods for displacement and strain analysis - Digital Image Correlation (DIC) for full-field strain measurement- Holographic interferometry and speckle pattern interferometry- Thermoelastic stress analysis (TSA)

Module - V Non Destructive Testing **9**

Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing - Case studies on NDT applications in aerospace and mechanical industries.

Total: 45 Periods

Text Books:

1. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York 2012.
2. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2010.

Reference Books:

3. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984
4. Ramesh, K., Digital Photoelasticity, Springer, New York, 2000.
5. U C Jindal, "Experimental Stress Analysis", 1st edition, Pearson, 2012..
6. W.N. Sharpe (Ed.), "Springer Handbook of Experimental Solid Mechanics", Springer, 2008.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	1	2	2								3	2	1
CO 2	3	3	2	2	3								3	3	1
CO 3	3	2	2	2	3								3	3	1
CO 4	2	3	3	3	3								3	3	1
CO 5	2	2	2	2	3								3	3	1
	3	**High**				**2**	**Medium**					**1**	**Low**		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE) (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	40	20	20	40
Apply		10	20	20
Analyze		10		20
Evaluate				
Create				

20AEE47	Nano Composite Materials	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft materials				

Course Objectives

The course is intended to

1. Familiarize about the various types of nanomaterials and its dispersibility
2. Acquire the knowledge about the synthesis methods for the manufacturing of nanocomposite.
3. Acquaint with the various characterizing techniques
4. Learn the theory and modelling of nanocomposite materials.
5. Introduce the application of nanocomposite materials in different fields.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Classify the various types of nanomaterials and its dispersibility	Understand
CO 2	Apply the knowledge about the synthesis methods for the manufacturing of nanocomposite.	Apply
CO 3	Understand the various characterizing techniques.	Understand
CO 4	Identify the theory and modelling of nanocomposite materials.	Apply
CO 5	Interpret the application of nanocomposite materials in different fields.	Understand

Course Contents

Module – I Introduction to Nano Composite Materials 9

Nanomaterials – Physics of Nanomaterials - classification of Nanomaterials, carbon and – non carbon based nanomaterials properties of materials, different polymers such as thermoplastic, thermoset and elastomer characterization of nanocomposite materials and their dispersibility.

Module – II Synthesis of Nanocomposites 9

Top Down Approach Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Preparation technologies - mechanical alloying, Colloidal Nanoparticles production, Sol Gel Methods, Gas phase Production Methods: physical/Chemical Vapour Depositions- Cryochemical synthesis.

Module – III Characterization of Nanocomposites 9

Morphological Studies – Scanning Electron Microscopy (SEM) / Transmission Electron Microscopy (TEM) / Atomic Force Microscopy (AFM) –– Structural and Thermal studies – Melt Flow Index (MFI) – Fourier transform Infra-red (FTIR) – X Ray Diffraction (XRD).

Magnetic measurements: Vibrating sample magnetometer (VSM)

Module – IV Multi Scale Modelling In Nanocomposites 9

Nanocomposite materials modelling: current issues. Multiscale modelling. Multi-physics modelling, Basics of MD simulations, modelling of nanocomposites and its constituents.

Module – V Applications to Nanocomposites **9**

Nanocomposites for fiber reinforced polymer matrix composites, Thermoplastic elastomer nanocomposites for propulsion systems, Thermoset nanocomposites for rocket ablative materials, nano modified carbon-carbon composites, Sensors for aerospace and defense applications

Total : 45 Periods

Text Books

1. Ajayan P.M., Schadler L.S., Braun P.V. "Nanocomposites Science and Technology", Wiley-VCH, 2013.
2. Joseph H. Koo, “Polymer Nanocomposites”: Processing, Characterization and applications, McGraw-Hill Nanoscience and Technology series(McGraw-Hill professional, 2023

Reference Books

1. Riichiro Saito, Gene Dresslhaus, and Dresselhaus M.S., "Physical Properties of Carbon Nanotubes", Imperial College Press, 2020
2. 2. K KChattopadhyayAnd A N Banerjee, Introduction To Nanoscience And Nanotechnology, PHI Learning, ISBN-978-81-203-3608-7, 2019.
3. 3. Shaker A. Meguid, Advances in Nanocomposites: Modeling, Characterization and Applications, Springer International Publishing, ISBN:978-3-319-31660-4, 2016.

Additional References

1. http s://ieeexplore.ieee.org/document/6827
2. NPTEL - https://www.youtube.com/watch?v=5Zlx6FCbues
3. MOOC Courses - https://www.learntoupgrade.com/courses/Nano-Materials-and-Nano-Composites-Certification-Course-666ad5b9d241e27c14941ad5

Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)															
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	-	-	2	1	-	-	-	-	-	-	3	1	-
CO 2	3	2	3	-	3	1	-	-	-	-	-	-	3	2	-
CO 3	3	3	3	-	-	2	-	-	-	-	-	-	3	2	-
CO 4	3	3	3	-	-	3	-	-	-	-	-	-	3	1	-
CO 5	3	2	-	3	3	3	-	-	-	-	-	-	3	1	-
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEE48	Theory of Elasticity	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Solid Mechanics				

Course Objectives

The course is intended to

1. Understand the basic concepts of stress, strain, equilibrium, and compatibility in elastic materials.
2. Solve plane stress and plane strain problems using Airy's stress function.
3. Analyze axisymmetric problems in polar coordinates, including curved beams and rotating discs.
4. Study torsion of bars using classical and advanced methods, including membrane analogy.
5. Learn the fundamentals of plate theory and solve problems using analytical methods.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand and apply stress-strain relationships, equilibrium, compatibility, and boundary conditions in elastic solids.	Understand
CO 2	Solve 2D elasticity problems in Cartesian coordinates using Airy's stress function and polynomial solutions.	Apply
CO 3	Analyze axisymmetric problems in polar coordinates, including rotating discs and curved beams.	Analyze
CO 4	Evaluate torsion in various cross-sections using classical, Prandtl's, and membrane analogy methods.	Evaluate
CO 5	Apply classical plate theory to analyze rectangular plates using Navier's and Levy's methods under different boundary conditions.	Apply

Course Contents

Module – 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

Module – 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.

Module – 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, Lame's, Kirsch, Michell's and Boussinesque problems – Rotating discs.

Module – 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.

Module – 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: 45 Periods

Text Books

1. Ansel C Ugural and Saul K Fenster, "Advanced Strength and Applied Elasticity", 4th Edition, Prentice Hall, New Jersey, 2003.
2. Bhaskar, K., and Varadan, T. K., "Theory of Isotropic/Orthotropic Elasticity", CRC Press USA, 2009.
3. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw – Hill Ltd., Tokyo, 1990.98

Reference Books

1. Barber, J. R., "Elasticity", Kluwer Academic Publishers, 2004
2. Sokolnikoff, I. S., "Mathematical Theory of Elasticity", McGraw – Hill, New York, 1978.
3. Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991
4. Wang, C. T., "Applied Elasticity", McGraw – Hill Co., New York, 1993.

Additional References

1. https://nptel.ac.in/courses/105/105/105105177/
2. https://nptel.ac.in/courses/101/104/101104005/

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2	2	1								3	2	-
CO 2	3	3	2	2	2								3	2	-
CO 3	3	3	3	2	2								3	2	-
CO 4	3	3	3	2	2								3	2	-
CO 5	3	3	3	2	3								3	2	-
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEE49	Non- destructive Testing	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft materials				

Course Objectives

The course is intended to

1. Impart knowledge on fundamental concepts of NDT.
2. Provide knowledge on different methods of NDE.
3. Impart knowledge on the concept of Thermography and Eddy current testing.
4. Acquire knowledge on the concept of Ultrasonic Testing and Acoustic Emission.
5. Provide knowledge on the concept of Radiography.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO1	Apply the various NDT principle and concept for Testing	Apply
CO2	Relate the application of Surface NDT methods.	Apply
CO3	Explore the concept of Thermography and Eddy current testing	Apply
CO4	Exhibit the concept of Ultrasonic Testing and Acoustic Emission	Apply
CO5	Illustrate the concept of Radiography	Understand

Course Contents

Module – I Overview of NDT **9**

Introduction of Non Destructive Testing vs Mechanical testing, Overview of the NDT Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.

Module – II Surface NDT Methods **9**

Liquid Penetrant Testing Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure. Magnetic Particle Testing-Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Module – III Thermography and Eddy Current Testing (ET) **9**

Thermography- Principles - Contact and non-contact inspection methods - Advantages and limitation Instrumentations and methods, applications - Eddy Current Testing --Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements- Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Module – IV Ultrasonic Testing (UT) and Acoustic Emission (AE) **9**

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Acoustic Emission Technique –Principle, AE parameters, Applications.

Module – V Radiography (RT) 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films. Fluoroscopy-XeroRadiography, Computed Radiography, Computed Tomography.

Total : 45 Periods

Text Books

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

Reference Books

1. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
2. ASM Metals Handbook,"Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
3. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol.1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

Additional References

1. **NPTEL** -https://archive.nptel.ac.in/courses/113/106/113106070/

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

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	14	14	14	20
Understand	20	36	36	64
Apply	16			16
Analyse				
Evaluate				
Create				

STREAM – 4 AIRCRAFT MAINTENANCE AND MANUFACTURING

23AEE61	Air Traffic Control and Planning	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Learn the basic concepts of air traffic control
2. Analyze real time problems in air traffic communication systems
3. Familiarize the flight information system and its applications
4. Improve the knowledge about importance of aerodrome data
5. Provide the foundation for navigation and other air traffic data

Course Outcomes

On successful completion of the course the students will be able to

CO.No	Course Outcome	Bloom's Level
CO 1	Illustrate the scope, provision and services of air traffic control	Understand
CO 2	Develop an air bound communication systems for reliable traffic control	Apply
CO 3	Relate the flight information systems with other systems for proper way of understanding the concepts of air traffic control	Understand
CO 4	Solve the aerodrome data whenever necessary for emergency conditions on aircraft	Apply
CO 5	Identify the data required for navigation purpose and other aspects	Apply

Course Contents

Module – I Basic Concepts **9**

Objectives of air traffic control systems Parts of ATC services – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Various kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control

Module – II Air Traffic Communication Systems **9**

Area control service, assignment of cruising levels - minimum flight altitude ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance –ACARS – Satellite communication – GNSS – Importance of Communication Systems

Module – III Flight Information Systems **9**

Radar service, Basic radar terminology – Identification procedures using primary / secondary radar – performance checks – use of radar in area and approach control services – assurance control and co- ordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air

Module – IV **Aerodrome Data** **9**

Aerodrome data Basic terminology – Aerodrome reference code – Aerodrome reference point – Aerodrome elevation — Aerodrome reference temperature — Instrument runway, physical Characteristics; length of primary / secondary runway — Width of runways — Minimum distance between parallel runways etc. – obstacles restriction

Module – V **Navigation and Other Services** **9**

Visual aids for navigation Wind direction indicator — Landing direction indicator — Location and characteristics of signal area — Markings, general requirements — Various markings — Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services

Total : 45 Periods

Text Books

1. Avionics Navigation Systems , 2nd Edition, Myron Kayton and Walter R. Freid, John Wiley and Sons, Inc, 2017, ISBN 0-471-54795.

2. AIP (India) Vol. I & II, “The English Book Store”, 17-1, Connaught Place, New Delhi.

Reference Books

1. “Aircraft Manual (India) Volume I”, latest Edition – The English Book Store, 17-1, Connaught Place, New Delhi.
2. “PANS – RAC – ICAO DOC 4444”, Latest Edition, The English Book Store, 17-1, Connaught Place, New Delhi.

Additional References

1. https://nptel.ac.in/courses/105/101/105101008/

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

COs	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	3	2	3	-	-	-	-	-	-	-	-	3	2	1
CO 2	2	2	2	3	-	-	-	-	-	-	-	-	3	2	1
CO 3	2	2	2	3	-	-	-	-	-	-	-	-	3	2	1
CO 4	2	2	2	3	-	-	-	-	-	-	-	-	3	2	1
CO 5	2	2	2	3	-	-	-	-	-	-	-	-	3	2	1
	3-High				2-Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	40	10	10	20
Apply		30	30	60
Analyse				
Evaluate				
Create				

23AEE62	Aircraft Rules and Regulations	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Introduce the civil aviation regulations under DGCA, focusing on airworthiness responsibilities.
2. Provide knowledge on defect recording, maintenance programs, and reliability systems.
3. Familiarize with procedures for organizational approvals and continued airworthiness.
4. Explain aircraft maintenance engineer licensing and mandatory modifications.
5. Describe the regulatory requirements related to flight testing, documentation, and aircraft equipment.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the regulatory responsibilities and procedures under CAR Series ‘A’.	Understand
CO 2	Apply procedures for defect recording, reliability maintenance, and rectification as per CAR Series ‘C’ & ‘D’.	Apply
CO 3	Explain certification and approval processes for organizations and aircraft under CAR Series ‘E’ & ‘F’.	Understand
CO 4	Identify the licensing requirements and mandatory inspections as outlined in CAR Series ‘L’ & ‘M’.	Apply
CO 5	Utilize regulations related to flight testing,documentation, and onboard aircraft requirements.	Apply

Course Contents

Module – I **C.A.R SERIES 'A' - PROCEDURE FOR CIVIL AIR WORTHINESS REQUIRMENTS AND RESPONSIBILITY OPERATORSHIP -A- VIS AIR WORTHINESS DIRECTORATE** **9**

To introduce the civil aviation regulations followed by directorate general of civil aviation. Module I C.A.R series 'a' - procedure for civil air worthiness requirements and responsibility operators vis-à-vis air worthiness directorate.

Module – II **C.A.R. SERIES 'C' - DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING** **9**

Defect recording, reporting, investigation, rectification and analysis; flight report; reporting and rectification of defects observed on aircraft; analytical study of in-fight readings & recordings; maintenance control by reliability method. C.A.R. SERIES 'D' - AND AIRCRAFT MAINTENANCE PROGRAMMES: reliability programme (engines); aircraft maintenance programme & their approval; on condition maintenance of reciprocating engines; TBO - revision programme; maintenance of fuel and oil uplift and consumption records - light aircraft engines; fixing routine maintenance Total Hours and component TBOs initial & revisions.

Module – III **C.A.R. SERIES 'E' - 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. C.A.R. 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.

Module – IV **C.A.R. SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEER 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.

Module – V **C.A.R. 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. C.A.R. SERIES 'X' MISCELLANEOUS REQUIREMENTS: Registration Markings of aircraft; weight and balance control of an aircraft; provision of first aid kits & hysician'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 taxy permit.

Total : 45 Periods

Text Books

1. "Aircraft Manual (India)", Volume - Latest Edition, The English Book Store, 171, Connaught Circus, New Delhi, 2008.
2. Aircraft Manual (India) Vol I - II The Aircraft Act along with the Aircraft Rules, including the Indian Aircraft Rules,2000.

Reference 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. "Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA. Advisory Circulars", form DGCA.

Additional References

1. http://164.100.60.133/dgca/dgca-ind.htm
2. https://www.gcaa.gov.ae/en/epublication/pages/cars.aspx

	Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)														
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	2									3	2	1
CO 2	3	2	3	2									3	3	1
CO 3	3	2	3	2									3	2	1
CO 4	3	2	3	2									3	3	1
CO 5	3	2	3	2									3	3	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	10	20
Understand	30	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE63	Optimization and its Applications	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	NIL				

Course objectives:

The course is intended to

1. Introduce the historical evolution, fundamental concepts, and classifications of optimization problems across engineering domains
2. Familiarize students with classical optimization techniques for solving large -scale problems.
3. Enable students apply nonlinear programming techniques including Lagrangian methods, Kuhn-Tucker conditions, and advanced approaches like SQP.
4. Develop the ability to apply optimization methods to static structural and mechanical design problems, incorporating advanced tools like topology optimization.
5. Explore dynamic system optimization and introduce students to modern multi - objective optimization techniques using evolutionary algorithms for real-time engineering applications

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Apply basic theoretical principles in optimization and formulate the optimization models	Understand
CO 2	Solve linear optimization problems using classical methods	Apply
CO 3	Analyze nonlinear optimization problems using Lagrangian methods, Kuhn-Tucker conditions, and advanced techniques like Sequential Quadratic Programming (SQP).	Analyze
CO 4	Apply optimization methods to structural design problems involving trusses, shafts, and springs.	Apply
CO 5	Optimize dynamic systems and mechanisms using single- and multi-objective evolutionary algorithms.	Apply

Course Contents

Module - I Evolution of Optimization **9**

Optimization — Historical Development — Engineering applications of optimization — Statement of an Optimization problem – classification of optimization problems. Genetic algorithms – Simulated annealing – Neural Network, Fuzzy systems and Particle swam optimization

Module - II Classic Optimization Techniques **9**

Linear programming Graphical method — simplex method — dual simplex method — revised simplex method — duality in LP — Parametric Linear programming — Goal Programming. Interior-Point Methods for large-scale linear programming problems

Module - III Non-Linear Programming **9**

Introduction — Lagrangeon Method — Kuhn-Tucker conditions — Quadratic programming — Separable programming – Stochastic programming – Geometric programming - Sequential Quadratic Programming (SQP) for constrained nonlinear optimization

Module - IV Static Applications **9**

Structural applications – Design of simple truss members Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members — Design of springs- Topology Optimization in structural design for material efficiency

Module - V Dynamic Applications **9**

Dynamic Applications — Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Multi-objective Optimization in Dynamic Systems using evolutionary algorithms

Total: 45 Periods

Text Book

1. Sukanta Nayak "Fundamentals of Optimization Techniques with Algorithms", Elsevier Science , 2020
2. Rao S. S. – 'Engineering Optimization, Theory and Practice' – New Age International Publishers — 2012 — 4th Edition

Reference books:

1. R. Panneerselvam, "Operations Research", Prentice Hall of India Private Limited, New Delhi L, 2005
2. P.K. Guptha and Man-Mohan, "Problems in Operations Research" — Sultan Chand & Sons, 2011
3. Ravindran, Philips and Solberg, "Operations Research Principles and Practice", John Wiley & Sons, Singapore, 2002

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2									3	2	
CO2	3	3	2	2									3	2	
CO3	3	3	2	2									3	2	
CO4	3	2	3	2									3	2	
CO5	3	3	3	2									3	3	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE) (60)**
	IAE- I (5)	**IAE - II (10)**	**IAE - III (10)**	
Remember	10	10	10	20
Understand	30	20	20	50
Apply	10	10	20	20
Analyze		10		10
Evaluate				
Create				

20AEE64	Helicopter Theory and Maintenance	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Fundamentals of Aeronautics				

Course Objectives

The course is intended to

1. Introduce fundamental aspects on helicopter rotor aerodynamics, generation of lift and rotor control & efficiency to students
2. Make students familiarize with the concepts like hovering and vortex ring state and calculation of induced power
3. Make students knowledgeable on helicopter flight performance calculations and on criteria for selection of power plants
4. Acquaint students with lateral and longitudinal stability characteristics of helicopter and the differences between stability and control
5. Elucidate students on the structural problems peculiar to helicopter rotor like rotor vibration

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom' s Level
CO 1	Perform the Aerodynamics calculation of Rotor blade	Apply
CO 2	Identify the stability and control characteristics of Helicopter.	Apply
CO 3	Solve the control Rotor vibration.	Apply
CO 4	Relate the stability characteristics of a helicopter.	Understand
CO 5	Demonstrates the role of rotor vibrations in helicopter design.	Apply

Course Contents

Module - I Introduction **9**

Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotor, Blade loading, Effect of solidity, profile drag, compressibility etc., Blade area required, number of Blades, Blade form, Power losses, Rotor efficiency. Application of helicopter in disaster management.

Module - II Aerodynamics of Rotor Blade **9**

Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.

Module - III Power Plants and Flight Performance **9**

Piston engines, Gas turbines, Ramjet principle, scramjet principle, Comparative performance, Horsepower required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.

Module - IV Stability and Control **9**

Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.

Module - V Rotor Vibrations **9**

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.

Total: 45 Periods

Text Book

1. John Fay, Helicopter: history, piloting and How It Flies, Himalayan Books 2016.
2. Lalit Gupta, Helicopter Engineering; Himalayan Books New Delhi 2024.
3. Rathakrishnan E, Helicopter Aerodynamics, PHI Learning Pvt. Ltd, New Delhi, 2019.

References

1. Joseph Schafer, Basic Helicopter Maintenance (Aviation Technician Training Course JS 312642), Jeppesen 2020.
2. Prouty R W, Helicopter Aerodynamics, Phillips Pub Co, 2023.

Additional references:

1. https://nptel.ac.in/courses/101/104/101104017/
2. https://www.digimat.in/nptel/courses/video/101104071/L01.html

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2		2	2							3	2	1
CO 2	3	2	2	2	2	2							3	2	1
CO 3	3	3	2	2	2	2							3	2	1
CO 4	3	2	2	2	2	2							3	2	1
CO 5	3	3	2	2	2	2							3	2	1
	3	**High**				**2**	**Medium**					**1**	**Low**		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE) (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	30	30	30	40
Apply	10	10	10	40
Analyze				
Evaluate				
Create				

23AEE65	Airframe Maintenance and Repair	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft Structural Mechanics				

Course Objectives

The course is intended to

1. Learn the maintenance procedures and quality inspection of structural components and repair processes.
2. Acquire knowledge on plastic and composite repairs in modern aircraft structures.
3. Demonstrate aircraft jacking, rigging, and balancing procedures in fixed-wing and rotary-wing aircraft.
4. Troubleshoot and service hydraulic, pneumatic, and auxiliary aircraft systems.
5. Build aircraft maintenance safety standards and practices to ensure airworthiness and workplace safety.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Apply the repair procedures for metallic aircraft structures using appropriate tools and NDT.	Apply
CO 2	Understand the types, uses, and repair methods of plastic and composite materials in aircraft.	Understand
CO 3	Demonstrate aircraft jacking, C.G. measurement, and rotor balancing procedures.	Apply
CO 4	Troubleshoot and service hydraulic, pneumatic, and other auxiliary systems in aircraft.	Apply
CO 5	Identify and apply best safety practices in aircraft maintenance operations.	Apply

Course Contents

Module – I Maintenance of Aircraft Structural Components **9**

Equipment used in welding shops and their maintenance - Ensuring weld quality — welding jigs, fixtures, soldering, brazing, and laser welding - Sheet metal repair and maintenance: material selection, repair schemes, and patch fabrication - Tools: hand and power tools – repair techniques – peening — use of sealing compounds — forming and shaping techniques - Riveted repair design, close tolerance fasteners, damage investigation, and reverse engineering - Calculation of weight of completed repair and its impact on adjacent structures - Inspection techniques: visual and non- destructive testing (NDT)

Module – II **Plastics and Composites in Aircraft** **9**

Types and uses of plastics in aircraft — repair methods for cracks and holes - Cleaning and surface prep for FRP materials - FRP/honeycomb sandwich and laminated skin repair - Vacuum bag process — repair tools and break tests - Use of autoclaves — special precautions

Module – III **Aircraft Jacking, Assembly, and Rigging** **9**

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces - Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

Module – IV **Hydraulic, Pneumatic, and Auxiliary Systems Maintenance** **9**

Troubleshooting and inspection of hydraulic systems — actuators, reservoirs - Pneumatic systems: pressure regulation, leak detection, servicing - Landing gear maintenance: shock struts, tires, brakes - Air-conditioning and pressurization systems — water and waste system checks - Instruments: installation, calibration, and inspection - Auxiliary systems: windshield rain removal, position/warning indicators, APU

Module – V **Aircraft Maintenance Safety Practices** **9**

Hazardous materials storage and handling, Aircraft furnishing practices - Equipment. Trouble shooting. Theory and practices.

Total : 45 Periods

Text Books

1. Kroes, Watkins & Delp, Aircraft Maintenance and Repair, McGraw-Hill Education, 2021.
2. Larry Reithmaier, Standard Aircraft Handbook for Mechanics and Technicians, McGraw-Hill, 2008.

Reference Books

1. FAA AC 43.13-1B, Acceptable Methods, Techniques, and Practices — Aircraft Inspection and Repair, FAA.
2. Dale Crane, A&P Technician Airframe, ASA, 2020.
3. Jeppesen, Aircraft Maintenance Technician Series – Airframe, Jeppesen Sanderson.

Additional References

1. Federal Aviation Administration (FAA) https://www.faa.gov
2. NPTEL - https://nptel.ac.in/courses/101104062

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

COs	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	1	2	1								3	3	1
CO 2	3	3	1	2	1								2	3	1
CO 3	3	2	3	2	1								3	2	1
CO 4	3	2	1	2	2								3	3	1
CO 5	2	3	1	2	2								3	2	1
	3- High				2- Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEE66	Aero Engine Maintenance and Repair	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Air Breathing Propulsion				

Course Objectives

The course is intended to

1. Learn the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for an overhaul of aero engines
2. Acquire the knowledge of the inspection and overhaul of both piston and jet engines
3. Apply propeller Systems maintenance procedures
4. Demonstrate the requirements for overhauling
5. Troubleshoot and service the aerospace engine components

Course Outcomes

On successful completion of the course the students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Classify the working principle of the piston engine and its components	Understand
CO2	Utilize the internal inspection and troubleshooting procedures for jet engine components	Apply
CO3	Develop the construction assembly and installation procedure for engine systems.	Apply
CO4	Identify the outline the maintenance procedure for jet engines	Apply
CO5	Apply the repairs schedules for overhaul procedures of engine components	Apply

Course Contents:

Module - I Piston Engines **9**

Carburation and Fuel injection systems - Ignition system components - spark plug detail — Engine operating conditions at various altitudes - Induction, Exhaust, and cooling system - Inspection and maintenance -troubleshooting - engine components Daily and routine checks – Compression testing of cylinders -case studies of fatigue-damaged pistons

Module - II Jet Engines **9**

Bearings and seals - Inlets - compressors- turbines-exhaust section Details of control, starting around running and operating procedures - Inspection and Maintenance- permissible limits of damage and repair criteria - internal inspection - compressor washing- field balancing of compressor fans- Component & Systems maintenance procedures - instruments for online maintenance Foreign Object Damage(FOD) Blade damage

Module - III Propellers **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.

Module - IV Testing and Inspection **9**

Symptoms of failure - Fault diagnostics Rectification during testing equipments for overhaul: Tools and types of equipment - requirements for overhauling - Tools for inspection Tools for safety and for visual inspection - Equipment for replacement of parts and their repair. Engine testing and procedures and schedule preparation, Online maintenance.

Module - V Overhauling **9**

Engine Overhaul - Overhaul procedures - Cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for trouble shooting — Condition monitoring of the engine on ground and at altitude engine health monitoring and corrective methods.

Total: 45 Periods

Text Books:

1. Thomas Wild, "Aircraft Power plants", 9th edition TATA McGraw Hill, New Delhi, 2018.
2. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engine, 2nd Edition, 2017.

Reference Books:

1. Dale Crane," Aviation Maintenance Technician – Power plants", 2nd Edition, Aviation Supplies & Academics, Incorporated, 2011.
2. "Federal Aviation Administration, Aviation Maintenance Technician Handbook- Power plant", Volumes 1 and 2, Newcastle, WA: Aviation Supplies & Academics, 2012.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
Cos	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	2								3	2	1
CO2	2	3	2	2	2								3	2	1
CO3	3	3	2	2	2								3	2	1
CO4	2	2	2	2	2								3	2	1
CO5	3	2	3	2	2								3	2	1
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE) (60)**
	IAE- I (5)	**IAE - II (10)**	**IAE - III (10)**	
Remember	20	10	10	20
Understand	30	30	30	60
Apply		10	10	20
Analyze				
Evaluate				
Create				

23AEE67	Total Quality Management	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Deals with Quality concepts and TQM principles focusing on process quality to assure product quality to the customers.
2. Apply the Basic and modern Quality management tools including ISO standards.
3. Demonstrate new management tool procedures
4. Understand the Taguchi's Quality Loss Function
5. Apply the Environmental Management System

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the frame work of Total Quality Management emphasizing the importance of Quality and Customers	Understand
CO 2	Apply TQM principles in a selected enterprise.	Apply
CO 3	Understand and apply the conventional and new management tool procedures for total quality Management	Understand
CO 4	Understand Taguchi's Quality Loss Function, Performance Measures and apply QFD and TPM	Understand
CO 5	Apply Quality Management Systems and Environmental Management System in any organization.	Apply

Course Contents

Module – I INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

Module – II TQM PRINCIPLES **9**

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating

Module – III TQM TOOLS AND TECHNIQUES I **9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark,

Module – IV TQM TOOLS AND TECHNIQUES II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

Module – V QUALITY SYSTEMS 9

Need for ISO 9000 and Other Quality Systems - ISO 9000 : 2015 Quality System — Elements - Implementation of Quality System - Documentation - Quality Auditing - Introduction to TS 16949 - QS 9000 - ISO 14000 - ISO 18000 - ISO 20000 - ISO 22000. Process of implementing ISO - Barriers in TQM implementation.

Total : 45 Periods

Text Books

1. Dale H. Besterfield, "Total Quality Management", 3rd Edition, Pearson Education, New Delhi, 2012
2. Subburaj Ramasamy, "Total Quality Management", Tata McGraw Hill, New Delhi, 2008.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006

Reference Books

1. Joel.E. Ross, "Total Quality Management – Text and Cases", Routledge., 2017.
2. Kiran. D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006.

Additional References

1. NPTEL - https:// nptel.ac.in/courses/110/104/110104080/

	Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)														
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1		3				2						3	2	2	
CO 2		2				3						3	2	2	
CO 3		2				2						3	2	2	
CO 4		2				2						3	3	2	
CO 5		1				3						3	2	2	
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	18	10	10	20
Understand	32	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE68	Production Planning and Control	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Classify the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.
2. Know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).
3. Identify the production planning and control activities
4. Demonstrate Prepare production scheduling
5. Develop the Plan Manufacturing Requirement Planning.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Perform a work study to enhance production planning and control processes.	Understand
CO 2	Do motion study, work measurement, time study and production study.	Understand
CO 3	Prepare production planning and control activities such as product planning and process planning	Apply
CO 4	Prepare production scheduling and material requirement planning	Understand
CO 5	Plan Manufacturing Requirement Planning (MRP II) and Enterprise Resource Planning (ERP).	Apply

Course Contents

Module – I Introduction **9**

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

Module – II Work Study **9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study — work measurement -- Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

Module – III Product Planning and Process Planning 9

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.

Module – IV Production Scheduling 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts- Perpetual loading-Basic scheduling problems Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing — Production Control systems- Periodic batch control- Material requirement planning kanban — Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates

Module – V Inventory Control and Recent Trends In PPC 9

Inventory control - Purpose of holding stock - Effect of demand on inventories -- Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis -- Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP

Total : 45 Periods

Text Books

1. James. B. Dilworth, ”Operations management — Design, Planning and Control for manufacturing and services” Mcgraw Hill International edition 2012.
2. Martand Telsang, “Industrial Engineering and Production Management”, First edition, S. Chand and Company, 2000.

Reference Books

1. Chary. S.N., “Theory and Problems in Production & Operations Management”, Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production / Operations Management”, 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., “Production Planning Control and Industrial Management”, Khanna Publishers, 1990.

Additional References

1. NPTEL - https://nptel.ac.in/courses/112107143

	Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)														
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	1		3								3	2	1
CO 2	3	2	2		3								3	2	1
CO 3	3	2	2	1	3								3	2	1
CO 4	3	2	2	1	3								3	2	1
CO 5	3	3	2		3								3	1	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	18	10	10	20
Understand	32	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE69	Computer Integrated Manufacturing	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Introduce the fundamentals of CAD/CAM and their role in modern manufacturing
2. Familiarize students with production planning and control processes using computer-aided techniques**.**
3. Develop knowledge in group technology, cellular manufacturing, and layout planning.
4. Provide insight into Flexible Manufacturing Systems (FMS) and Automated Guided Vehicle Systems (AGVS).
5. Introduce industrial robotics and their applications in automation and manufacturing.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the concepts of CAD, CAM, CIM, lean production, and levels of automation	Understand
CO 2	Apply knowledge of production planning, MRP, ERP, and computer-aided process planning in manufacturing systems.	Apply
CO 3	Utilize group technology and part classification systems to design efficient cellular manufacturing layouts.	Apply
CO 4	Analyze flexible manufacturing systems and AGVS for real-time manufacturing applications.	Analyze
CO 5	Describe industrial robot configurations, sensors, programming, and their role in modern manufacturing.	Understand

Course Contents

Module – I Introduction **9**

Brief introduction to CAD and CAM –- Introduction to CAD/CAM – Concurrent Engineering- CIM concepts — Computerized elements of CIM system — Types of production Manufacturing models and Metrics – Mathematical models of Production Performance —- Manufacturing Control – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

Module – II Production Planning and Control and Computer Aided Process Planning **9**

Process planning – Computer Aided Process Planning (CAPP) – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) Simple Problems.

Module – III Cellular Manufacturing **9**

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system — Production flow Analysis — Cellular Manufacturing —

Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method Arranging Machines in a GT cell – Hollier Method – Simple Problems.

Module – IV **Flexible Manufacturing System (FMS) and Automated Guided Vehicle System (AGVS)** **9**

Types of Flexibility - FMS — FMS Components — FMS Application & Benefits — FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS)– AGVS Application — Vehicle Guidance technology — Vehicle Management & Safety.

Module – V **Industrial Robotics** **9**

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability Industrial Robot Applications – Robot Part Programming– Simple Problems.

Total: 45 Periods

Text Books

1. Mikell.P.Groover “Automation, Production Systems and Computer IntegratedManufacturing”, Prentice Hall of India, 2008.
2. Radhakrishnan P, Subramanyan S.and Raju V., “CAD/CAM/CIM”, 2nd Edition, New AgeInternational (P) Ltd, New Delhi, 2004

Reference Books

1. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach”Chapman & Hall, London, 1995.
2. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India,2003.
3. Rao. P, N Tewari &T.K. Kundra, “Computer Aided Manufacturing”, Tata McGraw HillPublishing Company, 2000.

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

COs	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	2		2								3	2	3
CO 2	3	3	2	2	3								3	3	3
CO 3	2	3	3		3								3	3	3
CO 4	2	2	3	2	3								3	3	3
CO 5	2	2	3		3								3	3	3
	3- High				2- Medium				1- Low						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	10	20
Understand	30	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				

23AEE70	Additive Manufacturing	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Aircraft Materials				

Course Objectives

The course is intended to

1. Introduce the fundamentals and evolution of additive manufacturing technologies.
2. Explore different AM processes, materials, and their applications.
3. Understand design considerations and CAD modelling for AM.
4. Gain the knowledge about process planning, post-processing, and quality control in AM.
5. Study current trends and real-world applications of AM in industry.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Classify the Principles and scope of additive manufacturing	Understand
CO 2	Describe and compare major AM processes and their industrial relevance.	Understand
CO 3	Identify appropriate materials and their properties for different AM techniques.	Apply
CO 4	Apply design and modeling techniques specific to additive manufacturing.	Apply
CO 5	Demonstrate the importance of process planning, post processing, and quality in AM.	Understand

Course Contents

Module – I Introduction to Additive Manufacturing 9

History and evolution of AM - Comparison with traditional manufacturing- Advantages, limitations, and classifications of AM processes- Applications in automotive, aerospace, biomedical, and consumer goods.

Module – II Additive Manufacturing Processes 9

Vat photopolymerization: Stereolithography (SLA) - Material extrusion: Fused Deposition Modeling (FDM) - Powder bed fusion: Selective Laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM)

Module – III Materials for AM 9

Polymers, metals, ceramics, and composites - Material properties, compatibility, and selection criteria - Material challenges and sustainability issues

Module – IV Design for Additive Manufacturing (DfAM) 9

CAD modeling, STL file format - Topology optimization, lattice structures - Design rules and constraints - Support structures and build orientation - Reverse engineering and 3D scanning

Module – V Process Planning and Post-Processing 9

Slicing, path planning, and layer thickness - post-processing: cleaning, curing, heat treatment, machining - Inspection and quality control - Tolerances, defects, and resolution

Total: 45 Periods

Text Books

1. Additive Manufacturing Technologies – Ian Gibson, David Rosen, Brent Stucker, 2022.
2. Rapid Manufacturing – Pham and Dimov, 2011.
3. ASTM F42 Standards on Additive Manufacturing

Reference Books

1. Recent research papers and case studies from journals and industry reports, 2012.
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David Rosen, Brent Stucker, Springe, 2010.

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2										3	2	2
CO 2	3	3	2										3	2	2
CO 3	2	3	3										3	2	2
CO 4	2	2	3										3	2	2
CO 5	2	2	3										3	2	2
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	18	18	10	20
Understand	32	32	30	60
Apply			10	20
Analyse				
Evaluate				
Create				

23AEE71	Lean Manufacturing	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Manufacturing Technology				

Course Objectives

The course is intended to

1. Describe and differentiate between Lean Manufacturing and Conventional Manufacturing methods, focusing on principles, goals, and efficiency improvements.
2. Remember the concepts of cellular manufacturing, JIT and TPM
3. Impart knowledge of Set Up Time Reduction, TQM, 5S, VSM
4. Understand the Six Sigma process
5. Apply the industrial problem to analyse the solution of lean manufacturing

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO1	Understand the concept of lean and conventional manufacturing	Remember
CO2	Recall the concepts of Cellular Manufacturing, JIT, TPM	Understand
CO3	Apply the Set Up Time Reduction, TQM, 5S, VSM to production line.	Apply
CO4	Illustrate the Six Sigma process	Understand
CO5	Analyse the industrial problems based on the Case studies.	Analysis

Course Contents

Module – I **Introduction to Lean Manufacturing** **9**

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools.

Module – II **Cellular Manufacturing, JIT, TPM** **9**

Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM — Pillars of TPM, Principles and Implementation of TPM.

Module – III **Set Up Time Reduction, TQM, 5S, VSM** **9**

Set up time reduction – Definition, philosophies and reduction approaches. TQM – Principles and Implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles

Module – IV **Six Sigma** **9**

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation

Module – V **Case Studies** **9**

Various case studies of implementation of lean manufacturing at industries.

Total : 45 Periods

Text Books

1. Design and Analysis of Lean Production Systems, Ronald G. Askin & Jeffrey B. Goldberg, John Wiley & Sons, 2003
2. MikellP.Groover(2002)_Automation,ProductionSystemsandCIM.

Reference 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.
   .

Additional References

1. NPTEL - https://onlinecourses.swayam2.ac.in/imb24_mg119/preview

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

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	40	30	30	60
Apply		10		10
Analyse			10	10
Evaluate				
Create				

23AEE72	Professional Ethics in Engineering	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. EnablethestudentstocreateanawarenessonEngineeringEthicsandHumanValues
2. Understand the ethics in society
3. Demonstrate the ethical issue related to engineering
4. Understand and realize the responsibilities
5. Demonstrate the rights in the society

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO1	Learn the Human values of Professional ethics	Understand
CO2	Classify the moral issues and senses of engineering ethics in society.	Understand
CO3	Demonstrate the social experimentations and codes of ethics.	Understand
CO4	Interpret the safety and realize the responsibilities of engineers.	Understand
CO5	Relate the global issues on environments and moral leadership.	Understand

Course Contents

Module – I Human Values **9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management

Module – II Engineering Ethics **9**

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

Module – III Engineering as Social Experimentation **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law

Module – IV Safety, Responsibilities and Rights **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk-- Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Module – V Global Issues **9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility.

Total : 45 Periods

Text Books

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.

Reference Books

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013.
6. World Community Service Centre, 'Value Education', Vethathiri publications, Erode, 2011.

Additional References

1. NPTEL : http://kcl.digimat.in/nptel/courses/video/110105097/L03.html

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

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	14	16	14	40
Understand	36	34	36	60
Apply				
Analyse				
Evaluate				
Create				

23AEE73	Principal of Management	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended

1. Understand the fundamentals and evolution of management and its applications in various business organizations.
2. Learn the techniques and importance of planning and decision-making in organizational contexts.
3. Gain knowledge about the organizational structure and human resource functions.
4. Understand the principles of directing, including motivation, leadership, and communication in management.
5. Analyze the controlling function in management using modern tools and understand the role of IT in performance management.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO1	Understand the basic concepts, definitions, evolution, and current trends in management, and differentiate types of business organizations.	Understand
CO2	Explain planning principles and tools, and understand the decision-making process in business management.	Understand
CO3	Illustrate the organizational structure, formal/informal roles, Authority, decentralization, and HRM practices such as recruitment, selection, and performance management.	Understand
CO4	understand the individual and group behaviour in organizations and apply leadership and motivation theories for effective direction and communication	Understand
CO5	Analyse various control methods, budgeting techniques, and the use of IT in performance management and productivity improvement.	Analyse

Course Contents

Module – I Introduction to Management and Organizations 9

Definition of Management — Science or Art — Manager Vs Entrepreneur — types of managers - managerial roles and skills — Evolution of Management — Scientific, human relations, system and contingency approaches — Types of Business organization — Sole proprietorship, partnership, company-public and private sector enterprises — Organization culture and Environment — Current trends and issues in Management

Module – II Planning **9**

Nature and purpose of planning — planning process — types of planning — objectives — setting objectives — policies — Planning premises — Strategic Management — Planning Tools and Techniques — Decision making steps and process..

Module – III Organising **9**

Nature and purpose — Formal and informal organization — organization chart — organization structure — types — Line and staff authority — departmentalization — delegation of authority — centralization and decentralization — Job Design — Human Resource Management — HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management

Module – IV Directing **9**

Foundations of individual and group behaviour — motivation — motivation theories — motivational techniques — job satisfaction — job enrichment — leadership types and theories of leadership –communication — process of communication — barrier in communication — effective communication –communication and IT.

Module – V Controlling **9**

System and process of controlling — budgetary and non-budgetary control techniques — use of computers and IT in Management control — Productivity problems and management — control and performance — direct and preventive control — reporting.

Total : 45 Periods

Text Books

1. Harold Koontz, Heinz Weihrich “Essentials of Management: An International Perspective”, McGraw Hill Education, 10th edition.
2. Charles W. L. Hill, Steven McShane “*Principles of Management”* McGraw Hill Education

Reference Books

1. Stephen P. Robbins and Mary Coulter “Management”, Pearson Education.
2. James A. F. Stoner, R. Edward Freeman, Daniel R. Gilbert “Management”, Pearson Education.
3. Tripathi P.C., Reddy P.N. ”*Principles of Management”* Tata McGraw Hill

Additional References

1. NPTEL : https://archive.nptel.ac.in/courses/110/107/110107150/

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

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations (IAE) (40)**			**End Semester Examinations (ESE)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	14	16	14	40
Understand	36	34	20	50
Apply	-	-	-	
Analyse	-	-	16	10
Evaluate				
Create				

OPEN ELECTIVE

23AEO01	Drone Design and Development	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	NIL				

Course Objectives

The course is intended to

1. Provide a comprehensive understanding of the history, classification, and evolution of UAVs,
2. Familiarize students with the components of unmanned aerial systems, including AI-based flight control, propulsion, and communication systems.
3. Develop knowledge of drone anatomy, assembly processes, and advanced technologies such as drone swarming and real-time coordination
4. Explore diverse civil and military applications of drones and innovations like LiDAR and photogrammetry for precision mapping.
5. Understand regulatory frameworks, operational considerations, and future trends shaping the UAV industry, including case studies of mini and micro UAVs.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Apply the concepts of historical development, classifications, and emerging electric/hybrid UAV technologies.	Apply
CO2	Identify the key components of UAS platforms, propulsion, AI-based flight controls, and communication systems	Understand
CO3	Demonstrate knowledge of drone assembly, multi-rotor systems, and advanced concepts like drone swarming and autonomous coordination.	Apply
CO4	Analyze the applications of UAVs in various sectors and utilize innovations such as LiDAR and photogrammetry for high-precision data collection	Analyze
CO5	Interpret UAV operational regulations and challenges, and apply knowledge from case studies to real-world UAV deployments and future prospects.	Apply

Course contents:

Module I Introduction **9**

History of UAV – Classifications – UAV System composition – UAS – Drones- Evolution of drones – Concepts of flight - Emergence of Electric and Hybrid-Electric UAVs for Sustainable Aviation

Module II Unmanned Aerial System Components **9**

UAS - Platforms, installation and utilization - propulsion - on-board flight control communications - Telemetry-tracking launch / recovery systems ground control stations- Integration of AI-based Flight Control Systems in UAVs

Module III Drone Anatomy and Assembly **9**

Multi rotor introduction - Drone Anatomy: Motor – Propeller ESC – Flight controller – Transmitter– Receiver Sensors – Assembly – Autonomous system - Drone Swarming Technology and Real-time Coordination.

Module IV Applications and Innovations of Drones **9**

Military – Civil : Health care – Public safety – Disaster Management Wild life monitoring – Railways Data collection – Environmental Science – Product delivery Surveying – Traffic Management – Agriculture – Construction – Entertainment- Drone-based LiDAR and Photogrammetry for High-Precision Mapping.

Module V Operational Considerations and Future Scope **9**

DGCA regulations –CAR - NPNT – fly zones - Digital sky platform - Federal Aircraft Regulations Future Prospects and Challenges- Case Studies – Mini and Micro UAVs

Total: 45 Periods

Text books:

1. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 1998.
2. Reg Austin “Unmanned Aircraft Systems UAV design, development and deployment”, Wiley, 2010.

References:

1. Dr. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin Aeronautics Company,2001.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc,1998.
3. MirosawAdamski, "Power units and power supply systems in UAV", New Edition, Taylor and Francis Group publishers, 2014.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
CO2	3	3	2	1	-	-	-	-	-	-	-	-	3	2	1
CO3	3	3	3	2	1	-	-	-	-	-	-	-	3	3	2
CO4	3	2	3	2	1	-	-	-	-	-	-	-	3	3	3
CO5	3	3	2	2	1	-	-	-	-	-	-	-	3	3	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Apply	Online Quiz	5	15
Analyze	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	20	10	40
Apply	30	20	20	30
Analyze			10	10
Evaluate				
Create				

23AEO02	Non-Destructive Testing	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Impart knowledge on fundamental concepts of NDT.
2. Provide knowledge on different methods of NDE.
3. Impart knowledge on the concept of Thermography and Eddy current testing.
4. Acquire knowledge on the concept of Ultrasonic Testing and Acoustic Emission.
5. Provide knowledge on the concept of Radiography.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO1	Apply the various NDT principle and concept for Testing	Apply
CO2	Relate the application of Surface NDT methods.	Apply
CO3	Explore the concept of Thermography and Eddy current testing	Apply
CO4	Exhibit the concept of Ultrasonic Testing and Acoustic Emission	Apply
CO5	Illustrate the concept of Radiography	Understand

Course Contents

Module – I Overview of NDT **9**

Introduction of Non-Destructive Testing vs Mechanical testing, Overview of the NDT Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.

Module – II Surface NDT Methods **9**

Liquid Penetrant Testing Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure. Magnetic Particle Testing-Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Module – III Thermography and Eddy Current Testing (ET) **9**

Thermography- Principles - Contact and non-contact inspection methods - Advantages and limitation Instrumentations and methods, applications - Eddy Current Testing --Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements- Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Module – IV Ultrasonic Testing (UT) and Acoustic Emission (AE) **9**

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Acoustic Emission Technique –Principle, AE parameters, Applications.

Module – V Radiography (RT) **9**

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films. Fluoroscopy-XeroRadiography, Computed Radiography, Computed Tomography.

Total: 45 Periods

Text Books

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

Reference Books

1. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
3. Charles, J. Hellier," Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol.1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

Additional References

1. **NPTEL** -https://archive.nptel.ac.in/courses/113/106/113106070/

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

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	14	14	14	20
Understand	20	6	20	64
Apply	16	30	16	16
Analyse				
Evaluate				
Create				

23AEO03	Air Traffic Control	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	NIL				

Course Objectives

The course is intended to

1. Understand the fundamental concepts and structure of air traffic control (ATC) systems.
2. Learn the classification of airspaces and regulations governing VFR and IFR operations
3. Gain in-depth knowledge about radar systems, flight information services, and coordination procedures.
4. Analyze aerodrome characteristics and the parameters affecting runway design and layout.
5. Explore emerging technologies and their applications in ATC.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the basic concepts of air traffic control	Understand
CO2	Apply knowledge of airspace classification, separation standards, and flight procedures to ensure safe and efficient air traffic management.	Apply
CO3	Describe the functions and operations of radar systems, including identification techniques, coordination, and emergency handling in ATC	Understand
CO4	Analyze aerodrome data such as reference codes, runway specifications, and obstacle limitations relevant to air traffic operations	Analyze
CO5	Evaluate the role of emerging technologies like GNSS, AR/VR, blockchain, and Urban Air Mobility in shaping the future of air traffic control systems.	Evaluate

Course contents:

Module - I Basic Concepts **9**

Objectives of air traffic control systems Parts of ATC services – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Various kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

Module - II Air Traffic Systems **9**

Area control service, assignment of cruising levels minimum flight altitude ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance –ATC clearances – Flight plans – position report

Module - III Flight Information Systems **10**

Radar service, Basic radar terminology – Identification procedures using primary / secondary radar – performance checks – use of radar in area and approach control services – assurance control and coordination between radar / non-radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air.

Module - IV Aerodrome Data **9**

Aerodrome data Basic terminology – Aerodrome reference code – Aerodrome reference point – Aerodrome elevation – Aerodrome reference temperature – Instrument runway, physical Characteristics; length of primary / secondary runway – Width of runways – Minimum distance between parallel runways etc. – obstacles restriction.

Module - V Navigation Aids and Emerging Technologies **8**

Global Navigation Satellite Systems (GNSS) and augmentation systems- Integration of augmented reality (AR) and virtual reality (VR) in ATC training- Blockchain applications in aviation data management- Digital twin technology for airspace and airport modeling- Future trends: Urban Air Mobility (UAM) and its impact on ATC

Total: 45 Periods

Text Book

1. AIP (India) Vol. I & II, “The English Book Store”, 17-1, Connaught Place, New Delhi.

References

1. “Aircraft Manual (India) Volume I”, latest Edition – The English Book Store, 17-1, Connaught Place, New Delhi.
2. “PANS – RAC – ICAO DOC 4444”, Latest Edition, The English Book Store, 17-1, Connaught Place, New Delhi.

Additional references:

1. https://nptel.ac.in/courses/105/101/105101008/
2. https://nptel.ac.in/courses/101/108/101108047/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2		-	-	-	-	-		-		3	-	-
CO2	3	3	2	2		-	-	-	-		-		3	2	-
CO3	3	2	2	3		-	-	-	-		-		3	3	-
CO4	2	2	1	2	-	-	-	-	-		-		3	2	
CO5	2	2	1	2		-	-	-	-		-		2	2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	40	20	20	40
Apply		20	10	20
Analyze			10	20
Evaluate				
Create				

23AEO04	Automobile aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Apply basic principles of aerodynamics for the design of vehicle body
2. Learn the basics of fluid mechanics on vehicle motion
3. Expose to the optimization techniques followed in automotive industry
4. Reducing aerodynamics drag, fuel consumption and improving vehicle stability
5. Apply the numerical procedure and experimental testing of aerodynamics

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Know the forces & moments influencing drag	Understand
CO 2	Solve simple numerical related to fuel economy & drag	Apply
CO 3	Interpret the techniques of optimization practiced in industry	Apply
CO 4	Learn the relation between drag, stability & fuel economy	Understand
CO 5	Expose to fundamentals of numerical & experimental testing	Apply

Course Contents

Module – I Introduction **9**

Scope – historical development trends – Fundamentals of fluid mechanics – Flow phenomenon related to vehicles –External & Internal flow problems – Resistance to vehicle motion – Performance – Fuel consumption and performance – Potential of vehicle aerodynamics

Module – II Aerodynamic Drag of Car **9**

Car as a bluff body – Flow field around car – Drag force – Types of drag force – analysis of aerodynamic drag – Drag coefficient of cars – Strategies for aerodynamic development – Low drag profiles.

Module – III Shape Optimization of Car **9**

Front and modification – front and rear wind shield angle – Boat tailing – Hatch back, fast back and square back –Dust flow patterns at the rear – Effect of gap configuration – Effect of fasteners - Supersonic drag reduction technology

Module – IV Vehicle Handling **9**

The origin of force and moments on a vehicle – Side wind problems – Methods to calculate forces and moments –Vehicle dynamics Under side winds – Effects of forces and moments – Characteristics of forces and moments – Dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles.

Module – V Wind Tunnels for Automotive Aerodynamics **9**

Introduction – Principles of wind tunnel technology – Limitation of simulation – Stress with scale models – Full scale wind tunnels – Measurement techniques – Equipment and transducers – Road testing methods – Numerical methods.

Total : 45 Periods

Text Books

1. Hucho,W.H., “Aerodynamics of Road vehicles”, Butter worths Co. Ltd., 2023.
2. Pope, A., “Wind Tunnel Testing”, John Wiley & Sons, 3rd Edition, New York, 2021.

Reference Books

1. R.H.Barnard - “Road vehicle aerodynamic design, An Introduction” , Mechaero publications, Fourth edition-2021
2. Automotive Aerodynamics: Update SP-706, SAE, 2017.
3. Vehicle Aerodynamics, SP-1445, SAE, 2016

Additional References

1. https://nptel.ac.in/courses/101/106/101106035/

Mapping of Course Outcomes (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes (PSO’s)															
COs	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	1	1	1	2	-	-	-	-	-		3	2	1
CO 2	3	2	1	1	1	2	-	-	-	-	-		3	2	1
CO 3	3	2	2	2	1	2	-	-	-	-	-		3	2	1
CO 4	3	2	1	2	1	2	-	-	-	-	-		3	2	1
CO 5	3	2	1	1	1	2	-	-	-	-	-		3	2	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**End Semester Examination**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

23AEO05	Space Engineering	L	T	P	C
		3	0	0	3

Nature of Course	Open Elective
Pre requisites	Materials Physics

Course Objectives:

The course is intended to

1. Learn the standard atmosphere tables and equations.
2. Find lift and drag coefficient data from NACA plots.
3. Apply the concept of static stability to flight vehicles.
4. Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
5. Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Illustrate the history of aircraft & developments over the years	Understand
CO2	Ability to identify the types & classifications of components and control systems.	Apply
CO3	Apply the basic concepts of flight & Physical properties of Atmosphere	Apply
CO4	Identify the types of fuselage and constructions.	Understand
CO5	Compare the types of Engines and explain the principles of Rocket	Apply

Course Contents:

Module - I Standard Atmosphere **6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

Module - II Aerodynamics **10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

Module - III Performance and Propulsion **9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations thrust/power available and thrust/power required.

Module - IV Aircraft Stability and Structural Theory **10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

Module - V Space Applications **10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newton's law of gravitation.

Total: 45 Periods

Text Books:

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York, 2015.
2. E Rathakrishnan, “Introduction to Aerospace Engineering: Basic Principles of Flight”, John Wiley, NJ, 2021.
3. Stephen. A. Brandt, & quot; Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics, 1997.

References:

1. Kermode, A.C., “Mechanics of Flight”, Himalayan Book, 1997

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1	2	1	-	-	-	-	-	-	-	2	1	1
CO2	3	2	3	2	3	-	-	-	-	-		-	2	1	1
CO3	2	2	2	2	2	-	-	-	-	-		-	2	1	1
CO4	3	2	3	2	3	-	-	-	-	-		-	2	1	1
CO5	3	2	2	2	2	-	-	-	-	-		-	2	1	1
	3	**High**				**2**	**Medium**					**1**	**Low**		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**End Semester Examination (60)**
	IAE– I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	18	18	18	20
Understand	32	22	22	60
Apply		10	10	20
Analyze				
Evaluate				
Create				

20AEO06	Aircraft Power Plant	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Familiarize about reciprocating engine construction
2. Acquire the knowledge about landing Gear Systems
3. Learn about the principles of lubricating system and fire Protection Systems
4. Understand about Seat Safety Systems
5. Learn about the general maintenance practices in aircraft systems

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand about the reciprocating engine construction	Understand
CO 2	Apply Knowledge about the landing Gear Systems	Apply
CO 3	Familiarize on lubricating system and fire Protection Systems	Apply
CO 4	Interpret the applications of Seat Safety Systems	Apply
CO 5	Gain knowledge about General Maintenance Practices	Understand

Course Contents

Module – I Reciprocating engine construction 9

Crankcase – bearings- crankshaft – connecting rod assemblies – pistons – cylinders-valves and associated parts – accessory section – propeller reduction gears

Module – II Landing Gear Systems 9

Types of landing gears and their design principles - shock absorbing devices - retracting mechanisms - wheels and brakes - antiskid system - steering systems - indications and warnings

Module – III Lubricating system and Fire Protection Systems 9

Lubrication Systems: Types of lubrication systems: lubricants: cleaning agents.
Fire Protection Systems: Types of systems - Flame proofing - Fire walls: Fire detection systems - Fire extinguishing systems

Module – IV Seat Safety Systems 9

Ejection seats - Survival packs – Parachutes - Pilot's personal equipment - life rafts- Doors, Windows and Emergency exits, Seat belts.

Module – V General Maintenance Practices 9

Jacking, levelling, and mooring - refuelling and defuelling of aircraft - safety precautions. Hydraulic and fluid systems - precautions against contamination - Identification colour coding, symbols and other markings to identify the fluid systems.

Total : 45 Periods

Text Books

1. J V Casamassa and RD Bent, Jet Aircraft Power Systems, McGraw Hill.2010.
2. E H J Pallet, Automatic Flight Control, BSP Profession Books.2023
3. Civil Aircraft Inspection Procedures (CAP 459), Himalayan Books, 2002.

Reference Books

1. W Thomson, Thrust for Flight, Sir Issac Pitman.2021
2. 2. Michacl J. Kroes Thomas W.Wild, Aircraft Power Plants, McGraw Hill
3. 3. Michacl J. Kroes, William A Watkins and Frank Delp, Aircraft Maintenance and Repair, McGraw Hill 2022
4. Airframe and Power Plant, Mechanics General Hand Book (EA-AC 65-9A), Himalayan Books 2024

Additional References

1. Standard Specification for Aircraft Power plant Control, Operation, and Indication- https://store.astm.org/f3064_f3064m-21.html
2. NPTEL - https://onlinecourses.nptel.ac.in/noc24_ae17/preview
3. MOOC Courses - https://worldwide.erau.edu/massive-open-online-courses

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2	2	2	-	-	-	-	-	-	-	3	2	1
CO 2	3	3	2	2	2	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	2	2	-	-	-	-	-	-	-	3	2	1
CO 4	3	3	2	2	2	-	-	-	-	-	-	-	3	2	1
CO 5	3	3	2	2	2	-	-	-	-	-	-	-	3	2	-
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	18	18	18	20
Understand	32	16	16	40
Apply		16	16	40
Analyse				
Evaluate				
Create				

23AEO07	Basics of Aeronautical Science	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	Materials Physics				

Course Objectives:

The course is intended to

1. Introduce the basic concepts of aircrafts, rockets, satellites and their development.
2. Impart knowledge about the basic parts and their function and construction.
3. Know the basics of propulsion and application of rockets.
4. Provide the knowledge on structure and materials.
5. Emphasize the principles of aircraft propulsion.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Classify the evolution of aircrafts and flying vehicles.	Understand
CO2	Examine the parts and function of aircrafts.	Apply
CO3	Obtain knowledge on principles of flight.	Apply
CO4	Compare the fundamentals of structures and materials used.	Understand
CO5	Develop the principles of aircraft and rocket propulsion.	Apply

Course Contents:

Module - I History of Aeronautical Engineering **9**

Historical evolution**;** Developments in aerodynamics, materials, structures and propulsion over the years, Uses of new trends in war

Module - II Classification Aircraft **9**

Components of an airplane and their functions; Different types of flight vehicles, classifications; Basic instruments for flying.

Module - III Principles of Flight **9**

Principles of flight**-** Evolution of lift, drag and moment; altitude and standard atmosphere – Airfoil and nomenclature – Basic aerodynamics.

Module - IV Aircraft Materials and Structures **9**

General types of Aircraft construction, Fuselage and Wing Structure; Aerospace materials, metallic and non-metallic materials, Nanomaterials used in Aeroplane.

Module - V Aircraft Propulsion **9**

Basic ideas about piston, turboprop and jet engines, hypersonic propulsion, Basic Propeller theory; Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

Total: 45 Periods

Text books:

1. John D Anderson Jr, "Introduction to Flight", Tata McGraw Hill Education Private Limited, New Delhi, 5th Edition, 2009.
2. A.C Kermode, "Flight without Formulae" , Pearson Education,5th Edition, 2008.

References:

1. Anderson. David, Wand Scott Eberhardt. "Understanding Flight". 2nd ed. McGraw-Hill Professional, 2009.
2. Ashish Tewari, "Basic Flight Mechanics: A Simple Approach Without Equations", Springer, 2016.
3. Lloyd Dingle, Mike Tooley, "Aircraft engineering principles", Second Edition, Butter worth Heinemann, 2005.
4. Jim Winchester, "Concept Aircraft" Thunder Bay Press, 2005

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	1	-	-	-	-		-	-	3	2	1
CO2	3	2	1	-	2	-	-	-	-		-	-	3	2	1
CO3	3	2	2	1	1	-	-	-	-		-	-	3	2	1
CO4	3	1	2	2	-	-	-	-	-		-	-	3	1	1
CO5	2	2	2	1	1	-	-	-	-		-	-	3	2	1
	3	**High**				**2**	**Medium**					**1**	**Low**		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	18	18	18	20
Understand	32	22	22	60
Apply		10	10	20
Analyze				
Evaluate				
Create				

23AEO08	Airport Management	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Provide an overview of airport operations and infrastructure.
2. Understand the regulatory framework of airport management.
3. Analyze the planning and development aspects of airports.
4. Introduce airport financial, safety, and environmental management.
5. Study airline-airport interface and customer service.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Summarize the types, roles, and organizational structure of airports and key regulatory bodies.	Understand
CO 2	Illustrate the principles involved in airport layout, terminal design, and master planning.	Understand
CO 3	Demonstrate knowledge to examine airside and landside operations in an airport environment.	Apply
CO 4	Utilize planning methods to assess financial and commercial strategies in airport management.	Apply
CO 5	Implement environmental and safety practices in managing modern airport systems.	Apply

Course Contents

Module – I Introduction to Airports **9**

History and evolution of airports - Types of airports: domestic, international, military - Organizational structure of airports - Roles of airports in the aviation system - ICAO and AAI structure, DGCA roles.

Module – II Airport Planning and Design **9**

Site selection and airport layout - Runway orientation and terminal design - Apron, taxiway, hangars - Terminal planning – passenger flow, baggage handling - Airport zoning and master planning.

Module – III Airport Operations **9**

Airside and landside operations - Ground handling and services - Airport security systems and procedures - Cargo operations - Emergency procedures and fire safety.

Module – IV Airport Finance and Commercial Management **9**

Airport revenue streams: aeronautical and non-aeronautical - Concession management - Public-Private Partnerships (PPP) in airport development - Budgeting and financial planning - Economic regulation of airports.

Module – V Environmental and Safety Management **9**

Noise management and pollution control - Sustainable airport practices - Wildlife hazard management - Airport safety audits - Crisis and disaster management planning.

Total: 45 Periods

Passed in Board of Studies

CHAIRMAN-BOARD OF STUDIES

Approved in Academic Council

Text Books

1. Ashford, N., Mumayiz, S., & Wright, P. – Airport Engineering: Planning, Design and Development of 21st Century Airports, Wiley, 2010.
2. Wells, A.T. & Young, S.B. – Airport Planning & Management, McGraw-Hill Education, 2000.
3. Kazda, A. & Caves, R.E. – Airport Design and Operation, Elsevier, 2008.

Reference Books

1. ICAO Annexes and Airport Manuals
2. DGCA and AAI Publications.

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)															
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	2	2	2						1	2			3	3	3
CO 2	3	2	2	2					1	2			3	3	3
CO 3	2	2	2	2					1	2			3	3	3
CO 4	2	2	2						1	2			3	3	3
CO 5	2	2	2						1	2			3	3	3
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total Marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	10	10	10	10
Understand	40	10	10	40
Apply		30	30	50
Analyse				
Evaluate				
Create				

23AEO09	Rocket and Space Science	L	T	P	C
		3	0	0	3

Nature of Course	Open Elective
Pre requisites	Chemistry for materials science

Course Objectives

The course is intended to

1. Introduce concepts of system design used for space exploration.
2. Knowledge on mission design parameters from first principles of mechanics.
3. Understand the fundamentals of orbital mechanics.
4. Introduce sub-systems of a space vehicle.
5. Identify the communication systems for space vehicles

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Perform mission design calculations using specialized software.	Understand
CO2	Evaluate the orbits of space vehicles using classical methods.	Apply
CO3	Analyze dynamics of space vehicles.	Understand
CO4	Identify design requirements for different phases of a space exploration program**.**	Apply
CO5	Explain the variations of design concepts implemented in recent space missions	Understand

Course contents:

Module- I Environment and Mission Design **9**

Earth environment, launch environment, atmosphere, space and upper atmosphere; earth-bound orbits, lunar and deep space missions, advanced missions, launch vehicle selection, launching and deployment Classification of missiles.

Module - II Trajectory of a Rocket **10**

Mass ratio and propellant mass fraction; equation of motion of an ideal rocket; motion of a rocket in a gravitational field; simplified vertical trajectory; burn-out velocity and burn-out height; step-rockets; ideal mission velocity and losses; effect of launch angle; factors causing dispersion of rockets in flight; dispersion of finned rockets; stability of flight.

Module - III Astrodynamics **8**

Tactical Orbits and trajectories, Kepler's laws, orbital velocity and periods, eccentric elliptical orbits; effect of injection conditions, effect of earth’s rotation, perturbation analysis; parking orbit, transfer trajectory, impulsive shot; rendezvous; recent interplanetary missions

Module - IV Atmospheric Entry, Attitude Determination and Control **10**

Entry flight mechanics, entry heating, entry vehicle design, aero-assisted orbit transfer; concepts and terminology of attitude determination, rotational dynamics, rigid body dynamics, disturbance torques, passive attitude control, active control, attitude determination, system design considerations.

Module - V Configuration, Structural Design, and Communications **8**

Design drivers and concepts, mass properties, structural loads; power sources, design drivers and practice, command subsystems, redundancy and autonomy, radio communications, tracking.

Total: 45 Periods

Text books:

1. M.D. Griffin and J.R. French, Space Vehicle Design. 2nd Edition, AIAA Education Series(2004).
2. J.W. Cornelisse, H.F.R. Schöyer, and K.F. Wakkar. Rocket Propulsion and Spacecraft Dynamics. 1st Edition, Pitman (2000).

References:

1. E. Stuhlinger and G. Mesmer. Space Science and Engineering. 1st Edition, McGraw-Hill, New York (1965).
2. W.N. Hess. Space Science. 1st Edition, Blackie and Son (1965).

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO2	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO3	2	3	3	2	-	-	-	-	-	-	-	-	3	2	1
CO4	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO5	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	40	10	10	20
Apply		30	30	60
Analyze				
Evaluate				
Create				

23AEO10	Aircraft Maintenances	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	NIL				

Course Objectives:

The course is intended to

1. Introduce students to the modern classifications and procedures of aircraft maintenance, including predictive and digital approaches.
2. Provide knowledge of advanced ground handling systems and IoT-enabled ground support equipment.
3. Equip students with skills to inspect, maintain, and monitor reciprocating engines and propellers using modern tools.
4. Enhance understanding of gas turbine engine diagnostics, health monitoring, and hybrid-electric propulsion systems.
5. Enable students to apply composite repair methods, AR/VR-based inspections, and understand smart landing gear systems.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Classifydifferent types of aircraft maintenance, inspection schedules, and the role of digital tools in ensuring continuous airworthiness.	Understand
CO2	Describe smart taxiing systems, UAV handling, and IoT-integrated ground support equipment used in modern aircraft operations	Understand
CO3	Relate reciprocating engine faults and perform propeller diagnostics using borescope, laser balancing, and condition-based maintenance concepts	Apply
CO4	Apply theturbine engine performance using EGT, EPR, vibration analysis, and explain the role of digital twins and predictive analytics in engine maintenance	Apply
CO5	Build advanced repair methods for composite structures and explain the use of smart tools and sensors in structural and landing gear maintenance, including UAVs.	Apply

Course Contents

Module–I Basic Concepts **8**

Overview of maintenance types- Scheduled, Unscheduled, Condition-based, and Predictive maintenance- Aircraft inspection schedules: Annual, 100-hour, A/B/C/D checks- Operational life of components and life-limited parts- Digital logbooks and electronic maintenance record-keeping- Airworthiness directives (ADs), service bulletins (SBs), and continuous airworthiness through software-based tracking.

Module –II Ground Handling and Ground Support Equipment's 8

Fire safety principles, extinguishing agents, and risk zones - Aircraft movement—modern taxiing systems, towing procedures with automation aids - Aircraft tie-down in normal and storm conditions, including UAV ground handling - Aircraft fueling precautions and smart fueling systems - Maintenance and role of advanced ground support equipment - electrical power units, hydraulic & air start units with IoT integration, pre-oiling equipment, climate control units, and aircraft jacks

Module –III Reciprocating Engine and Propeller Maintenance 9

Engine overhaul principles- visual, dimensional, and magnetic inspection- Engine health monitoring and borescope inspection - Importance of ground run tests and digital diagnostics- Propeller checks for fixed and variable pitch systems; static/dynamic balancing using laser tools- Condition-based maintenance for piston engines- Limitations and modern replacements for wooden propellers

Module-IV Gas Turbinate Engine Maintenance 10

Division of engine cold section and hot section- Modern damage detection techniques: thermography, vibration analysis- Engine performance monitoring using EGT, RPM, Fuel Flow, EPR- Use of engine digital twins and predictive analytics- Borescope inspection and SHM in gas turbines- Trends in hybrid-electric propulsion systems

Module –V Aircraft Structural Repairs and Maintenance of Landing Gears 10

Fundamentals of sheet metal and composite repairs- Smart rivets, digital callipers, and AR/VR-assisted repair instructions- Inspection and repair of composite structures (CFRP, GFRP) and bonded repairs- Introduction to additive repair technologies (cold spray, 3D printing in repair)- Landing gear system maintenance with sensors and health monitoring- Special inspections: after hard landings, lightning strikes, and turbulence- Maintenance considerations for UAV landing systems.

Total: 45 Periods

Text Books

1. Aircraft maintenance and repair – Kroes – Delp – 2004.
2. Airframe handbook – FAA –ACC 65 – 15A -2008.
3. Power plant Hand book – FAA – AC 65 – 12A.

Reference Books

1. Aircraft and power plants – Kroes and Wild – 2001.
2. Airframe & Power plant mechanics – General Hand book AC 65-9A.
3. Aircraft basic Science – Kroes&Rardon – 2007.

Additional / Web References

1. https://nptel.ac.in/courses/101/104/101104071/
2. https://nptel.ac.in/courses/101/104/101104075/

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	1	-	-	-	-		-	-	3	3	2
CO2	3	2	1	1	1	-	-	-	-		-	-	3	3	2
CO3	3	2	2	2	3	-	-	-	-		-	-	3	3	2
CO4	3	2	2	2	3	-	-	-	-		-	-	3	3	2
CO5	2	2	2	2	3	-	-	-	-		-	-	3	3	2
	3	**High**				**2**	**Medium**					**1**	**Low**		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination (60)**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	40	20	30	50
Apply		20	10	30
Analyze				
Evaluate				
Create				

23AEO11	Industrial Aerodynamics	L	T	P	C
		3	0	0	3
Nature of Course	Open Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Build up necessary background for understand the aerodynamic aspects of wind generators, automobiles, buildings etc.
2. Introduce the basics of wind energy collectors**.**
3. Learn the aerodynamics important in recent vehicle industries.
4. Understand the application of various aerodynamic aspects in vehicles and buildings.
5. Realize the effect of vibrations and Reynolds numbers.

Course Outcomes

On successful completion of the course the students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Classify the basic wind characteristics.	Understand
CO 2	Realize the historical development of wind turbine, its components and classifications.	Apply
CO 3	Apply the aerodynamic effects in road vehicle and analyse the various method of drag reduction.	Apply
CO 4	Develop the aerodynamics of low rise buildings and high rise building for deign good ventilation	Apply
CO 5	Explore the effect of Reynolds number on wake formation of bluff shapes	Understand

Course Contents

Module – I Atmosphere **9**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows

Module – II Wind Energy Collectors **9**

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory, develop advanced model wind well (Prototype).

Module – III Vehicle Aerodynamics **9**

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft

Module – IV Building Aerodynamic **9**

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

Module – V Flow Induced Vibrations **9**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, galloping and stall flutter, basic analysis software.

Total : 45 Periods

Text Books

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 2010.
2. Sachs. P., "Winds forces in Engineering", Pergamon Press, 2005.

Reference Books

1. Blevins. R.D., "Flow Induced Vibrations", Van Nostrand, 2008.
2. Calvent. N.G., "Wind Power Principles", Charles Griffin & Co., London, 2012.

	Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)														
COs	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	3	2	-	2	-	-	-	-	-	-	3	2	1
CO 2	3	3	3	2	-	2	-	-	-	-	-	-	3	2	1
CO 3	3	3	3	2	1	2	-	-	-	-	-	-	3	2	1
CO 4	3	3	3	2	1	2	-	-	-	-	-	-	3	2	1
CO 5	3	3	3	2	1	2	-	-	-	-	-	-	3	2	1
	3- High				**2- Medium**				**1- Low**						

Formative Assessment			
Blooms Taxonomy	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial class / Assignment	5	
Apply			
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**End Semester Examination**
	IAE – I (5)	**IAE – II (10)**	**IAE – III (10)**	**(60)**
Remember	20	10	10	20
Understand	30	30	30	60
Apply		10	10	20
Analyse				
Evaluate				
Create				