

B.E. AERONAUTICAL ENGINEERING REGULATIONS- 2019 CURRICULAM

SEMESTER 1										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1101	Engineering Mathematics - I	3	*	0	3	50	50	1
2	Theory	SPHA1101	Physics for Engineers	3	1	0	4	50	50	3
3	Theory	SBTA1101	Environmental Science and Engineering	2	0	0	0	-	-	5
4	Theory	SCSA1103	Programming in C	3	*	0	3	50	50	6
5	Theory	SMEA1101	Engineering Graphics	1	0	4	3	50	50	8
6	Theory	SAEA1202	Fundamentals of Aeronautical Engineering	3	0	0	3	50	50	9
7	Practical	SPHA2101	Physics Lab	0	0	2	1	25	25	10
8	Practical	SCSA2104	Programming in C Lab	0	0	4	2	50	50	11
9	Practical	SMEA2101	Computer Aided Design Lab	0	0	4	2	50	50	12
Total Credits for Semester 1 - 21										
Total Marks for Semester 1 - 750										

SEMESTER 2										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SHSA1101	Technical English	3	0	0	3	50	50	13
2	Theory	SMTA1201	Engineering Mathematics - II	3	0	0	3	50	50	17
3	Theory	SEEA1101	Basic Electrical and Electronics Engineering	3	0	0	3	50	50	18
4	Theory	SCYA1101	Engineering Chemistry	3	1	0	4	50	50	19
5	Theory	SMEA1202	Engineering Mechanics	3	*	0	3	50	50	21
6	Theory	SAEA1201	Aircraft Materials	3	0	0	3	50	50	22
7	Practical	SCYA2101	Engineering Chemistry Lab	0	0	2	1	25	25	24
8	Practical	SMEA2201	Workshop Practice	0	0	4	2	50	50	25
Total Credits for Semester 2 – 22										
Total Marks for Semester 2 – 750										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION

SEMESTER 3										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1301	Engineering Mathematics – III	3	0	0	3	50	50	26
2	Theory	SAEA1301	Aero Engineering Thermodynamics	3	0	0	3	50	50	27
3	Theory	SAEA1302	Aircraft Production Techniques	3	0	0	3	50	50	28
4	Theory	SAEA1303	Aircraft Systems and Instruments	3	0	0	3	50	50	29
5	Theory	SAEA1304	Introduction to Aerodynamics	3	0	0	3	50	50	30
6	Theory	SAEA1305	Introduction to Aircraft Structures	3	0	0	3	50	50	31
7	Practical	SMEA2301	Fluid Mechanics and Machinery Lab	0	0	4	2	50	50	32
8	Practical	SAEA2301	Aircraft Structures Lab - I	0	0	4	2	50	50	33
Total Credits for Semester 3 – 22										
Total Marks for Semester 3 – 800										

SEMESTER 4										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1401	Engineering Mathematics – IV	3	0	0	3	50	50	34
2	Theory	SMEA4003	INDUSTRY 4.0 FOR DESIGN AND MANUFACTURING	2	0	0	2	50	50	36
3	Theory	SAIC4003	UNIVERSAL HUMAN VALUES	3	0	0	3	50	50	37
4	Theory	SAEA1401	Aircraft Propulsion	3	0	0	3	50	50	39
5	Theory	SAEA1402	Aircraft Structures	3	0	0	3	50	50	40
6	Theory	SAEA1403	Low Speed Aerodynamics	3	0	0	3	50	50	41
7	Theory	SAEA1404	Avionics	3	0	0	3	50	50	42
8	Practical	SAEA2401	Aerodynamics Lab	0	0	4	2	50	50	44
9	Practical	SAEA2402	Aircraft Structures Labs - II	0	0	4	2	50	50	45
Total Credits for Semester 4 - 21										
Total Marks for Semester 4 - 800										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION

ESE – END SEMESTER EXAMINATION

SEMESTER 5										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SAEA1501	Aircraft Performance	3	0	0	3	50	50	46
2	Theory	SAEA1502	Aerospace Propulsion	3	0	0	3	50	50	47
3	Theory	SAEA1503	Computational Fluid Dynamics for Aerospace Application	3	0	0	3	50	50	48
4	Theory	SAEA1504	Finite Element Methods for Aircraft Structures	3	0	0	3	50	50	49
5	Theory	SAEA1505	High Speed Aerodynamics	3	0	0	3	50	50	50
6	Theory		Open Elective - I (Humanities)	3	0	0	3	50	50	-
7	Practical	S 19 APT1	Professional Training	0	0	4	2	50	50	-
8	Practical	SAEA2501	Aircraft Systems and Instruments Lab	0	0	4	2	50	50	51
9	Practical	SAEA2502	Propulsion Lab	0	0	4	2	50	50	52
Total Credits for Semester 5 – 24										
Total Marks for Semester 5 – 900										

SEMESTER 6										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SAEA1601	Aircraft Stability and Control	3	0	0	3	50	50	53
2	Theory	SAEA1602	Theory of Vibration and Aero Elasticity	3	0	0	3	50	50	54
3	Theory		Elective - I	3	0	0	3	50	50	-
4	Theory		Elective - II	3	0	0	3	50	50	-
5	Theory		Open Elective - II	3	0	0	3	50	50	-
6	Practical	SAEA2603	Aircraft Design Project Lab	0	0	4	2	50	50	55
7	Practical	SAEA2604	Aircraft Maintenance and Repair Lab	0	0	4	2	50	50	56
8	Project	S19APT2	Interdisciplinary Project	0	0	6	3	-	100	-
Total Credits for Semester 6 – 22										
Total Marks for Semester 6 – 800										

L-LECTURE HOURS, T-TUTORIAL HOURS, P-PRACTICAL HOURS, C-CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION

ESE – END SEMESTER EXAMINATION

SEMESTER 7										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SAEA1701	Aircraft Composite Materials and Structures	3	0	0	3	50	50	57
2	Theory	SAEA1702	Unmanned Aerial Vehicle Design	3	0	0	3	50	50	58
3	Theory		Elective - III	3	0	0	3	50	50	-
4	Theory		Elective - IV	3	0	0	3	50	50	-
5	Theory		Open Elective - III	3	0	0	3	50	50	-
6	Practical	SAEA2701	Aircraft Composite Material Testing Lab	0	0	4	2	50	50	59
7	Project	S19APROJ1	Project Work (Phase – I)	0	0	6	3	50	50	-
Total Credits for Semester 7 – 20										
Total Marks for Semester 7 – 700										

SEMESTER 8										
Sl. No.	Course Type	Course Code	Course Title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory		Elective - V	3	0	0	3	50	50	-
2	Theory		Elective - VI	3	0	0	3	50	50	-
3	Project	S19APROJ2	Project Work (Phase – II)	0	0	14	7	50	50	-
Total Credits for Semester 8 – 13										
Total Marks for Semester 8 – 300										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION

ESE – END SEMESTER EXAMINATION

LIST OF ELECTIVES

PROFESSIONAL ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SMEA3001	Additive Manufacturing	3	0	0	3	50	50	53
2	SAEA3001	Theory of Elasticity	3	0	0	3	50	50	54
3	SAEA3002	Aviation Management	3	0	0	3	50	50	55
4	SAEA3003	Airframe Maintenance and Repair Practices	3	0	0	3	50	50	56
5	SAEA3004	Aircraft Design	3	0	0	3	50	50	57
6	SAEA3005	Industrial Aerodynamics	3	0	0	3	50	50	58
7	SAEA3006	Cryogenic Engineering	3	0	0	3	50	50	59
8	SAEA3007	Rocket and Space Mechanics	3	0	0	3	50	50	60
9	SAEA3008	Mechanical Behavior of Aircraft Materials	3	0	0	3	50	50	61
10	SAEA3009	Advanced Flight Dynamics	3	0	0	3	50	50	62
11	SAEA3010	Launch Vehicles and Spacecraft Propulsion	3	0	0	3	50	50	63
12	SAEA3011	Plates and Shells	3	0	0	3	50	50	64
13	SAEA3012	Missile Technology	3	0	0	3	50	50	65
14	SAEA3013	Airport Engineering	3	0	0	3	50	50	66
15	SAEA3014	Boundary layer Theory	3	0	0	3	50	50	67
16	SAEA3015	High Temperature Materials	3	0	0	3	50	50	68
17	SAEA3016	Flight Vehicles' Guidance and Control	3	0	0	3	50	50	69
18	SAEA3017	Manned Space Mission	3	0	0	3	50	50	70
19	SAEA3018	Helicopter Maintenance	3	0	0	3	50	50	71
20	SAEA3019	Orbital Mechanics	3	0	0	3	50	50	72
21	SAEA3020	HEAT TRANSFER TECHNIQUES	3	1	0	4	50	50	73

OPEN ELECTIVE COURSES									
Sl. No.	Course Code	Course Title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SALA4001	Intellectual Property Law	3	0	0	3	50	50	A1
2	SAEA4002	Fundamentals of Aerospace Technology	3	0	0	3	50	50	A2
3	SBAA4001	Fundamentals of Management	3	0	0	3	50	50	A3
4	SBAA4002	Principles of Management and Professional Ethics	3	0	0	3	50	50	A4
5	SBTA4001	Biology for Engineers	3	0	0	3	50	50	A5
6	SBMA4001	Neurology	3	0	0	3	50	50	A6
7	SBMA4002	Modelling of Physiological Systems	3	0	0	3	50	50	A7
8	SBMA4003	Drug Delivery System	3	0	0	3	50	50	A8
9	SBMA4004	Fundamentals of Mechatronics	3	0	0	3	50	50	A9
10	SBMA4005	Virtuality and Augmented Reality	3	0	0	3	50	50	A10
11	SBMA4006	Medical Optics and Laser Applications	3	0	0	3	50	50	A11
12	SBMA4007	Forensic Science	3	0	0	3	50	50	A12
13	SBMA4008	Artificial Intelligence and Expert Systems	3	0	0	3	50	50	A13
14	SBMA4009	Human Factors in Engineering and Design	3	0	0	3	50	50	A14
15	SCHA4001	Corrosion Engineering	3	0	0	3	50	50	A15
16	SCHA4002	Energy Engineering	3	0	0	3	50	50	A16
17	SCHA4003	Environmental Impact Assessment	3	0	0	3	50	50	A17
18	SCHA4004	Environmental Pollution and Control	3	0	0	3	50	50	A18
19	SCIA4001	Disaster Management	3	0	0	3	50	50	A19
20	SCSA4001	R Programming	3	0	0	3	50	50	A20
21	SCSA4002	5 G Networks	3	0	0	3	50	50	A21
22	SECA4001	Software Tools for Engineering Applications	3	0	0	3	50	50	A22
23	SMEA4001	Resource Management Techniques	3	0	0	3	50	50	A23
24	SMEA4002	Wind and Solar Energy	3	0	0	3	50	50	A24

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CAE - CONTINUOUS ASSESSMENT EXAMINATION,

ESE - END SEMESTER EXAMINATION

Semester	Theory Courses (including elective courses)			Practical Courses (including PT and project)		
	Total no.	Total Credits	Total Marks	Total no.	Total Credits	Total Marks
1	6	16	500	3	5	250
2	6	19	600	2	3	150
3	6	18	600	2	4	200
4	6	17	600	2	4	200
5	6	18	600	3	6	300
6	5	15	500	3	7	300
7	5	15	500	2	5	200
8	2	6	200	1	7	100
Overall Total	42	124	4100	17	41	1700

Overall total credits for B.E Aeronautical Engineering	165
Overall total marks for B.E Aeronautical Engineering	5800

SAEA1201	AIRCRAFT MATERIALS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying the Materials to Aircraft.
- To make the student understanding the concept of Mechanical Behaviors of Materials.
- To understand the basics of Corrosion & heat treatment.
- To understand the basics of Ceramics and High temperature materials.

UNIT 1 ELEMENTS OF AEROMATERIALS

9 Hrs.

Structure of solid materials – Atomic structure of materials – crystal structure – miller indices – density – packing factor – space lattices – x-ray diffraction – imperfection in crystals – physical metallurgy – general requirements of materials for aerospace applications.

UNIT 2 MECHANICAL BEHAVIOUR OF MATERIALS

9 Hrs.

Linear and nonlinear elastic properties – Yielding, strain hardening, fracture, Baughinger's effect – Notch effect testing and flaw detection of materials and components – creep and fatigue – comparative study of metals, ceramics plastics and composites.

UNIT 3 CORROSION & HEAT TREATMENT OF METALS AND ALLOYS

9 Hrs.

Types of corrosion – effect of corrosion on mechanical properties – stress corrosion cracking – corrosion resistance materials used for space vehicles heat treatment of carbon steels – aluminum alloys, magnesium alloys and titanium alloys – effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys.

UNIT 4 CERAMICS AND COMPOSITES

9 Hrs.

Introduction – powder metallurgy – modern ceramic materials – cutting tools – glass ceramic – production of semi-fabricated forms – plastics and rubber – carbon/carbon composites, fabrication processes involved in metal matrix composites – shape memory alloys – applications in aerospace vehicle design, open and close mould processes.

UNIT 5 HIGH TEMPERATURE MATERIALS CHARACTERIZATION

9 Hrs.

Classification, production and characteristics – methods and testing – determination of mechanical and thermal properties of materials at elevated temperatures – application of these materials in thermal protection systems of aerospace vehicles – super alloys.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the role of corrosion in Aircraft.

CO2 - Comprehend the sound foundation in the design principles of heat treatment processes.

CO3 - Knowledge in usage of composite materials in aircraft component design.

CO4 - Exposure to high temperature materials for space applications.

CO5 - Understand the principle and performance of Ceramics.

CO6 - Applying the importance of Materials in Aerospace.

TEXT / REFERENCE BOOKS

1. Titterton.G., "Aircraft Materials and Processes", V Edition, Pitman Publishing Co., 2010.
2. Martin, J.W., "Engineering Materials, Their properties and Applications", Wykeham Publications (London) Ltd., 2011.
3. Van Vlack.L.H., "Materials Science for Engineers", Addison Wesley, 2011.
4. Raghavan.V., "Materials Science and Engineering", Prentice Hall of India, New Delhi, 2012.
5. S.O.Kasap, Principles of Electronic Materials and Devices, Tata McGraw Hill Edition, New Delhi, 2013.
6. C. G. Krishnadas Nair "Handbook of Aircraft Materials" Interline, 1993.

SAEA1304	INTRODUCTION TO AERODYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of fluids and its properties.
- To evaluate the performance of fluids and fluid flows in International standard atmosphere.
- To know the basic functions of fluids and fluid flows and measuring instruments.
- To discuss fluid properties in the basis of the structural, aerodynamics.

UNIT 1 FLUID PROPERTIES & EQUATIONS OF MOTION

9 Hrs.

Properties of fluids—Specific gravity, specific weight, viscosity, compressibility, vapor pressure and gas laws – capillarity and surface tension. Flow characteristics: concepts of system and control volume. Application of control volume to continuity equation, energy equation, momentum equation and Bernoulli's principle and its applications—Orifice meter, venturimeter, pitot –tube.

UNIT 2 DIMENSIONAL ANALYSIS AND FLUID FLOW IN CLOSED CONDUITS

9 Hrs.

Dimensional Analysis Buckingham Pi - theorem, Derivations and applications of important dimensionless numbers, basic modeling and similitude. Pipe friction, Darcy-Weisbach equation and chezy's formula, Pipe losses - Major and Minor losses - Problems of parallel, series and branched pipes.

UNIT 3 FLUID FLOW OVER BODIES AND BOUNDARY LAYER THEORY

9 Hrs.

Boundary layer theory-boundary layer development on a flat plate, displacement thickness, momentum thickness, Energy thickness, momentum integral equation, drag on flat plate.

UNIT 4 PUMPS AND TURBINES

9 Hrs.

Impact of jets Centrifugal Pumps, Hydraulic Turbines: Classification of hydraulic turbines – Working principle of Pelton wheel, Francis and Kaplan turbines –velocity triangles- Propeller fundamentals.

UNIT 5 BASIC AERODYNAMICS

9 Hrs.

Types of flow - velocity field and acceleration. Viscous fluid flow - Laminar and turbulent flow. Theory of streamline, Stream function, velocity potential, relation between stream function and velocity potential, circulation. Basic elementary flows— Source, sink, free and forced vortex, uniform parallel flow.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

- CO1 - Study the applications of the conservation laws to flow through pipes and hydraulic machines.
- CO2 - Understand the importance of dimensional analysis.
- CO3 - Understand the importance of various types of flow in pumps and turbines.
- CO4 - Understand the properties of basic flows.
- CO5 - Analyze the fluid behaviors.
- CO6 - Distinguish the basics of fluid statics and fluid dynamics.

TEXT / REFERENCE BOOKS

1. Bansal.R.K., "Fluid Mechanics & Hydraulics Machines", 9th Edition, Laxmi Publications, 2010.
2. Kumar, K.L., Fluid Mechanics, 2nd Edition, Tata McGraw-Hill, New Delhi, 2012.
3. Irving H. Shames, Fluid Mechanics, 3rd Edition, McGraw-Hill, 2012.
4. Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, 5th Edition, John Wiley and Sons, Inc., U.K.
5. Douglas.J.F., Gasiorek.J.M., Swaffield.J.A., "Fluid Mechanics ELBS", 4th Edition, Prentice Hall, 2000.

SAEA1305	INTRODUCTION TO AIRCRAFT STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- At the end of this course, the student will have knowledge about the behavior of aircraft structural members.
- Subjected to various types of forces. The subject can be mastered best by solving numerous problems.

UNIT 1 CONCEPT OF SIMPLE STRESSES AND STRAINS

9 Hrs.

Concept of stress and strain, Hooke's law-Tension, Compression, and Shear, stress-strain diagram-Poisson's ratio, elastic constants and their relationship- Deformation of simple and compound bars. Principal plane, principal stress, maximum shearing stress - Uniaxial, biaxial state of stress-Mohr's circle for plane stresses.

UNIT 2 ANALYSIS OF BEAMS

9 Hrs.

Types of beams and loads-shear force and bending moment diagrams for cantilevers, simply supported and overhanging beams. Theory of pure bending- assumptions in the simple bending theory, Flexure formula: its application to beams of rectangular, circular and channel, I&T Sections,: Combined direct and bending stresses in fore mentioned sections.

UNIT 3 DEFLECTION OF BEAMS

9 Hrs.

Differential Equation of the Elastic Axis-Deflection and slope of beams-Double Integration, Area Moment and Macaulay's methods for simply supported, Cantilever and overhanging beams.

UNIT 4 STRESSES IN SHAFTS, HELICAL SPRINGS AND THIN PRESSURE VESSELS

9 Hrs.

Torsion of Circular Shafts—Shear Stresses and Twist in Solid and Hollow Shafts. Close and open Coil Helical springs. Stresses in Thin Walled Pressure Vessels.

UNIT 5 COLUMNS AND FAILURE THEORIES

9 Hrs.

Columns- Member subjected to combined bending and axial loads, Euler's theory, Crippling load, Rankine's theory. Failure theories - Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Analysis of different types of stresses and strains.
- CO2 - Analysis of different types of beams and loads acting on it.
- CO3 - Analysis of deflections in beams.
- CO4 - Analysis of stresses in shafts, helical springs and pressure vessels.
- CO5 - Analysis of Column structure and understanding of failure theories.

TEXT / REFERENCE BOOKS

1. Malhotra, D.R. and Gupta, H.C., "The Strength of Materials", Satya Prakashan Tech. India Publications, New Delhi, 2011.
2. Kazimi, S.M.A., "Solid Mechanics", Tata McGraw Hill, 1976. Dym, C.L. and Shames I.H., "Solid Mechanics", McGraw Hill, Kogakusha, Tokyo, 2012.
3. Timoshenko, S., Young, "Elements of Strength of Material", Vol. I & II, T. Van Nostrand Co Inc, Princeton, N.J. 2012.
4. Ferdinand P. Beer, and Russell Johnston, E., "Mechanics of Materials", SI Metric Edition, McGraw Hill, 2011.
5. Rajput, R.K., "Strength of materials", Fourth Edition, S. Chand Limited, 2007.

SAEA2301	AIRCRAFT STRUCTURE LAB - I	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- Experimental analysis of various structures used in aerospace industry.

SUGGESTED LIST OF EXPERIMENTS

1. Tensile testing using UTM, Mechanical and Electrical extensometers. Stress Strain curves and strength tests for Steel and Aluminum.
2. Comparison of hardness values of steel, copper and aluminum using Brinell and Rockwell hardness measuring machines.
3. Compression test on Aircraft Materials.
4. Estimation of spring constant under tension and compression.
5. Estimation of notch toughness of Steel using Charpy / Izod impact testing machine
6. Tensile tests on riveted and bolted joints.
7. Verification of Castigliano's theorems. Influence coefficients
8. Bending tests, Stress and deflection of beams with various end conditions.
9. Verification of Maxwell's theorem.
10. Compression tests on long columns. Critical buckling loads, Euler load by Southwell plot.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Compare the hardness values of steel, copper and aluminium.

CO2 - Perform tensile and compression tests on given specimens.

CO3 - Estimation of toughness of the given specimen.

CO4 - Verification of Maxwell's and Castigliano's theorem.

CO5 - Understand about Critical buckling loads.

CO6 - Understand about rivets.

SAEA1401	AIRCRAFT PROPULSION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying Aero thermodynamics to air breathing propulsion.
- To familiarize the student's ability to analyze the concepts of compressor.
- To understand the basics of Axial Turbine.
- To understand the basics of Ramjet and Scramjet.

UNIT 1 THERMODYNAMICS OF AIR BREATHING PROPULSION

9 Hrs.

History and classifications of Aero engines, Working of gas turbine engine – Thrust equation – Factors affecting thrust – Engine performance parameters – Efficiency, Specific fuel consumption, Methods of thrust augmentation – The propeller, turboprop, turbofan and turbojet engines characteristics.

UNIT2 INLETS, COMBUSTION CHAMBER AND NOZZLES

9 Hrs.

Introduction-Subsonic inlets-Supersonic inlets-Modes of Inlet operation- Gas turbine combustors-Types of combustion chamber-Fuel injector- Flame Tube cooling-Flame Stabilization-Flame holders- Theory of flow in isentropic nozzles – Losses in nozzles –Nozzle efficiency—nozzle choking –Over expanded and under expanded nozzles – Ejector and variable area nozzles.

UNIT 3 AIR COMPRESSOR

9 Hrs.

Compressor and its classification- Centrifugal compressor - Work and compression ratio -Performance characteristics- Centrifugal compressor staging- Axial compressor-Work and compression ratio- Degree of reaction- Characteristic performance of a single stage axial compressor- Characteristic performance of a multistage axial compressor- Cascading of axial compressor-Compressor efficiency.

UNIT 4 AXIAL TURBINES

9 Hrs.

Axial turbine stage -Velocity triangles and Power output - Elementary theory - Vortex theory- Limiting Factors of gas turbine design-Turbine performance- Turbine Blade cooling- Axial flow Turbine and compressor matching.

UNIT 5 RAMJET AND SCRAMJET

9 Hrs.

Operating principle of RAMJET engine- RAMJET with afterburner- RAMJET performance- SCRAMJET working principle- Problems faced in supersonic combustion.

Max 45 Hrs.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - Understand the working principles of gas turbine.

CO2 - Comprehend the sound foundation in the design principles of inlets, combustion chambers, nozzles used in aircraft engines.

CO3 - Learn the operation of compressors in aircraft engines.

CO4 - Understand the concept of turbines in gas turbine propulsion systems.

CO5 - Understand the principle and performance of ramjet and scramjet propulsion.

CO6 - Applying the importance of Propulsion to Aircraft system.

TEXT / REFERENCE BOOKS

1. Philip Hill and Carl Peterson, "Mechanics and thermodynamics of propulsion", Pearson India, second edition 2010.
2. V. Ganesan., "Gas Turbines", Tata McGraw-Hill Education, third edition, 2010.
3. Cohen. H, Rogers. G. F. C. and Saravanamuttoo. H. I. H., "Gas turbine theory". Pearson education, fifth edition, 2001.
4. Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", Prentice-Hall India, 2012.
5. Saeed Farokhi, "Aircraft Propulsion", John Wiley & Sons, Inc., 2009. Rolls Royce Jet Engine – 5th Edition – 1996.

SAEA1401	AIRCRAFT PROPULSION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To provide the students various methods for analysis of aircraft wings and fuselage.
- To provide the behaviour of major aircraft structural components.

UNIT1 STATICALLY DETERMINATE AND INDETERMINATE STRUCTURE

9 Hrs.

Truss: Analysis of plane truss–Method of joints–3D Truss. - Load transmission in multiple span beam–Clapeyron's Three Moment Equation.

UNIT2 ENERGY METHODS

9 Hrs.

Strain Energy due to axial, bending and Tensional loads–Castiglano's theorem–Maxwell's Reciprocal theorem, Unit load method, The principle of virtual work- application to beams, trusses, -redundant center.

UNIT 3 UNSYMMETRICAL BENDING

9 Hrs.

Bending stresses in beams of unsymmetrical sections– Bending of symmetric sections with skew loads.

UNIT4 SHEAR FLOW IN OPEN AND CLOSED SECTIONS

9 Hrs.

Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections. Bredt–Batho formula, Shear flow in single & multi cell structure under torsion.

UNIT5 STRESS ANALYSIS IN WING AND FUSELAGE

9 Hrs.

Structural lay out of the Airplane and components, loads acting on major components such as wing, fuselage, tails, landing gear etc., Concept of allowable stress and margin of safety. Procedure–Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and nonparallel flanges, Shear resistant web beams, Tension field web beams(Wagner's).

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Analysis of plane truss and load transmission techniques in multiple span beam.
- CO2 - Analysis of various loads in beams and trusses and strain energy.
- CO3 - Analysis of Bending stresses in beams of unsymmetrical sections.
- CO4 - Analysis of shear flow, shear center in open and closed sections.
- CO5 - Analysis of Structural lay out of the Airplane and components.
- CO6 - Analysis of loads acting on major components such as wing, fuselage, tails, landing gear.

TEXT / REFERENCE BOOKS

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 2012.
2. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri–state off set Company, USA, 2015.
3. Millard V.Barton, "Fundamentals of Aircraft Structures " Prentice Hall, 2012.
4. Timoshenko, S., "Strength of Materials", Vol.I and II, Princeton D. Von Nostrand Co, 2012.
5. Donaldson, B.K., "Analysis of Aircraft Structures– An Introduction", McGraw-Hill, 2011.

SAEA1403	LOW SPEED AERODYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
- To make the student understand the concept of vorticity, irrotationality, theory of airfoils and wing sections.
- To introduce the basics of viscous flow.

UNIT1 REVIEW OF BASIC AERODYNAMICS

9 Hrs.

Atmosphere- Air speeds- Aerodynamic definitions Types of Drag- General Aerodynamic characteristics of airfoil sections- Complex potential-Singularities-Equations of Vortex-doublet and Rankine oval - Lift and Drag on cylinder and Aero foil.

UNIT2 LOW SPEED FLOW

9 Hrs.

Models of the fluid: control volumes and fluid elements. Continuity, Momentum and energy equations. Substantial derivative, incompressible Bernoulli's equation.

UNIT3 AIRFOIL AND CONFORMAL TRANSFORMATION

9 Hrs.

Airfoils Nomenclature and NACA series, Airfoil Characteristics, Vortex sheet, Kelvin Circulation theorem Thin aerofoil theory and its applications. Joukowski transformation and its application to fluid flow problems.

UNIT 4 WING THEORY

9 Hrs.

Introduction to Finite wing, Downwash and Induced Drag, Biot -Savart law and Helmholtz's theorems, Horse shoe vortex, Prandtl's Classical Lifting line theory and its limitations.

UNIT 5 VISCOUS FLOW

9 Hrs.

Derivation of Navier-Stokes equation for two-dimensional flows, boundary layer approximations, laminar boundary equations and boundary conditions, Blasius solution, qualitative features of boundary layer flow under pressure gradients, Integral method, aspects of transition to turbulence, turbulent boundary layer properties over a flat plate at low speeds. Separation of flow over bodies stream lined and bluff bodies, Lift and Drag on cylinder and Aero foil.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Apply aerodynamics concepts.
- CO2 - Develops mathematical modelling ability.
- CO3 - Differentiate between ideal and real flows.
- CO4 - Model flow over wing.
- CO5 - Understand the real time viscous flow.
- CO6 - Understand the Boundary Layer behaviour.

TEXT / REFERENCE BOOKS

1. Aerodynamics for. Engineering Students. Sixth Edition. E.L. Houghton. P.W. Carpenter. Steven H. Collicott. Daniel T. Valentine, 2013 Elsevier, Ltd.
2. Bertin, John J., Aerodynamics for Engineers, Pearson Education Inc., 2002.
3. John J. Bertin, Russell M. Cummings, "Aerodynamics for Engineering students", Sixth Edition, Pearson, 2013.
4. Anderson J.D., "Fundamentals of Aerodynamics", Sixth Edition, McGraw Hill Book Co., New York, 2017.
5. Schlichting H., "Boundary layer theory", Seventh Edition, McGraw Hill, New York 2014.

SAEA2401	AERODYNAMICS LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- To predict different aerodynamics used in aero application.

SUGGESTED LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over cylinder.
3. Study of lift, drag characteristics of airfoils using wind tunnel.
4. Study of pitching moment characteristics of airfoil.
5. Measurement of boundary layer thickness.
6. Flow visualization technique by using water flow channel.
7. Computational flow analysis of bluff bodies.
8. Computational flow analysis of wing with different angle of attack.
9. Numerical analysis of shock tube.
10. C_D and C_L formulation using computational flow techniques.
11. Numerical analysis of von Karman vortex sheets.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Measure the velocity of the subsonic wind tunnel at various RPM.

CO2 - Coefficient of Lift and drag for symmetric and unsymmetrical aerofoils are analysed.

CO3 - Identify the various flows acting on the aerofoil.

CO4 - Study the Supersonic flow and characteristics of it.

CO5 - Boundary layer concepts.

CO6 - Simulation of aerodynamics experiments in CFD software.

SAEA2402	AIRCRAFT STRUCTURE LAB - II	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- Experimental and computational analysis of various structures used in aerospace industry.

SUGGESTED LIST OF EXPERIMENTS

1. Unsymmetrical Bending of a Cantilever Beam
2. Combined bending and Torsion of a Hollow Circular Tube
3. Material Fringe Constant of a Photo elastic Model
4. Shear Centre calculation of an open section.
5. Shear Centre calculation of a closed section.
6. Free Vibration of a Cantilever Beam
7. Wagner beam – Tension field beam
8. Computational Methods involving Aerospace Structures
9. Determination of Natural frequency and mode shape of metal plate with various end conditions
10. Determination of Natural frequency and mode shape of composite plate with various end conditions

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Perform computational methods involving Aerospace structures.

CO2 - Determine natural frequency of the given plate.

CO3 - Analyze photo elastic models.

CO4 - Calculate shear center location of the given section.

CO5 - Understand about Wagner beam.

CO6 - Understand about Free Vibration of a Cantilever Beam.

SAEA1501	AIRCRAFT PERFORMANCE	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To evaluate the performance of air vehicles in real atmosphere versus standard atmosphere.
- To study the different forces acting on a vehicle in flight, drag, variation of thrust, performance during different conditions, and flight testing.
- To perform various testing methods to compare different aircrafts performances.

UNIT 1 PREREQUISITES TO EVALUATE AIRCRAFT PERFORMANCE

9 Hrs.

Properties of earth's atmosphere and standard atmosphere, 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.

UNIT 2 ENGINE CHARACTERISTICS

9 Hrs.

Variation of thrust, power with velocity and altitudes for air breathing engines – specific fuel consumption of piston engine and jet engine – ideal efficiency of engines- power plants for flight vehicles – limitations of power plants with Mach number and altitude.

UNIT 3 EVALUATION OF UN-ACCELERATED FLIGHT PERFORMANCE

9 Hrs.

Airplane performance in steady level flight - Power available and power required curves. Maximum speed in level flight - Conditions for minimum drag and power required - steady climb descent and glide performance. Climb and Glide Hodograph, Range and Endurance.

UNIT 4 ACCELERATED AND MANOEUVERING FLIGHT PERFORMANCE

9 Hrs.

Accelerated level flight - Climbing and gliding flight, Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide –Take off – Landing-Turning performance. Bank angle and load factor – limitations on turn - V-n diagram.

UNIT 5 FLIGHT TESTING METHODS TO EVALUATE PERFORMANCE

9 Hrs.

Flight - testing: Altitude definitions, Speed definitions, Air speed, altitude and temperature measurements. Errors and calibration. Measurement of engine power, charts and corrections. Flight determination of drag polar.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the need for ISA.

CO2 - Analyze the flight performance with variations of pressure and density with altitude.

CO3 - Estimation of total drag and drag polar that influence the performance.

CO4 - Analyze the performance in un-accelerated flight conditions.

CO5 - Determination of speed limit, load limit, landing and takeoff distances of the aircraft.

CO6 - Know different testing methods to evaluate aircraft performance.

TEXT / REFERENCE BOOKS

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son., Inc, NY, 2011.
2. McCornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 2010.
3. McCornick B. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 2011.
4. Babister, A.W., "Aircraft Stability and Response", Pergamon Press, 1980.
5. McCormik, B. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, 1995.

SAEA1502	AEROSPACE PROPULSION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying Aero thermodynamics to non air breathing propulsion.
- To familiarize the student's ability to analyze the concepts of Advance Propulsion.
- To understand the basics of Solid Propellant, Liquid Propellant and Cryogenics.
- To understand the basics of Micro propellants.

UNIT1 FUNDAMENTALS OF ROCKET PROPULSION

9 Hrs.

History and evolution of rockets - Rocket principle and Rocket equation - Classification of rockets - Mass ratio of rocket- Rocket Nozzles - Classifications - Nozzle Performance - Nozzle area ratio - Mass flow rate Characteristic velocity - Thrust coefficient-Performance parameters and Efficiencies of rocket - Staging and Clustering.

UNIT 2 SOLID PROPELLANT ROCKET

9 Hrs.

Hardware components and its functions - Mechanism of burning - Ignition system and igniter types- Propellant grain configuration and its applications - Burn rate - Factors influencing burn rates-Burn rate index for stable operation - Action time and burn time - Design of Solid Propellant rocket.

UNIT3 LIQUID AND CRYOGENIC PROPELLANT ROCKET

9 Hrs.

Classifications - Hardware components and its functions-Propellant feed systems and Turbo pump feed system - Injectors and types - Thrust chamber and its cooling-Cryogenic propulsion system, Special features of cryogenic systems. Thermo- physical Properties of Cryogenic Propellants; Geysering Phenomenon.

UNIT 4 ADVANCE PROPULSION TECHNIQUES

9 Hrs.

Hybrid propellant rocket and gelled propellants - Electrical rockets - Electro-thermal, Electro-static and Electro-magnetic propulsion system- Arc-jet thruster - Ion thruster - Hall Effect Thruster - Magneto plasma dynamic thruster- Nuclear rockets - Solar sail.

UNIT 5 MICRO PROPULSION SYSTEM

9 Hrs.

Recent Micro Spacecraft Developments; Micro propulsion Options; Primary Set of Micro propulsion Requirements; Chemical Propulsion Options; Review of Electric Propulsion Technologies for Micro and Nano- satellites; Emerging Technologies: MEMS and MEMS- Hybrid Propulsion System.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Understand the working principles of non air breathing engine.
- CO2 - Comprehend the sound foundation in the design principles of solid propellants.
- CO3 - Learn the operation of Liquid and Cryogenic Propellant Rocket.
- CO4 - Understand the concept of Advance Propulsion Techniques.
- CO5 - Understand the principle and performance of. Micro propulsion system.
- CO6 - Applying the importance of Advance Propulsion in Aerospace.

TEXT / REFERENCE BOOKS

1. George P. Sutton and Oscar Biblarz. "Rocket Propulsion Elements" 9th Edition, Wiley Publication, 2016.
2. Ramamurthi.K: "Rocket propulsion" Macmillan Publishing Co, India. 1st Edition. 2010.
3. Hill.P.G. and Peterson.C.R: "Mechanics and thermodynamics of propulsion" 2nd Edition .Pearson Education, 1999.
4. V.Ganesan., "Gas Turbines", Tata McGraw-Hill Education, 3rd Edition, 2010.
5. Philip Hill and Carl Peterson, "Mechanics and thermodynamics of propulsion", Pearson India, 2nd Edition, 2010.
6. Cohen.H, Rogers.G.F.C. and Saravanamuttoo.H.I.H, "Gas turbine theory". Pearson education, 5th Edition, 2001
7. Saeed Farokhi, "Aircraft Propulsion", John Wiley & Sons, Inc., 2009.

SAEA1504	FINITE ELEMENT METHODS FOR AIRCRAFT STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of finite elements methods.
- To evaluate the characteristics of structural members.
- To know the basic methods to solve the solid mechanics problems.
- To discuss the structural mechanics and its applications.

UNIT1 INTRODUCTION

9 Hrs.

Basic finite element concepts-Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method, Application: Axial deformation of bars, Axial spring element.

UNIT 2 BEAMBENDING

9 Hrs.

Governing differential equation for beam bending, two node beam element, Exact solution for uniform beams subjected to distributed loads using superposition, Calculation of stresses in beams, Thermal stresses in beams

UNIT3 ANALYSISOFTRUSSESANDFRAMES

9 Hrs.

Two dimensional truss element, three dimensional space truss element, Stresses due to lack of fit and temperature changes. Plane frame element, Thermal stresses in frames, Three dimensional space frame element

UNIT 4 TWODIMENSIONAL ELASTICITY AND AXISYMMETRIC ELASTICITY

9 Hrs.

Governing differential equations, Constant strain triangular element, Four node quadrilateral element, Eight node isoperimetric element. Problems-Governing equations for axisymmetric elasticity, Axisymmetric linear triangular element, Axisymmetric four nodes isoperimetric element

UNIT5 APPLICATIONFINITEELEMENTMETHODS

9 Hrs.

Applications of FEM software to solve simple problems, types of solver, Applications based on general two dimensional boundary value Problem-Ideal fluid flows around an irregular object, Two dimensional steady state heat flow, Torsion of prismatic bars

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Recall history and evolution of finite element methods and analysis.

CO2 - Compare the mathematical modeling and numerical methods.

CO3 - Understand the working methodology of various finite element methods.

CO4 - Recognize the various functions of approximation methods.

CO5 - Analyze the quality of structural grids and suitable shapes and methods for it.

CO6 - Distinguish the problems application based.

TEXT / REFERENCE BOOKS

1. J.N.Reddy. "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 2011.
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2012.
3. Segerlind L.J, "Applied Finite Element Analysis", John Wiley, 2012.
4. Rao. S.S, "Finite Element Method in Engineering", Pergamon Press, 2013.
5. Chandrupatla & Belagundu, "Finite Elements in Engineering", Prentice Hall of India Private Ltd., 1997.
6. Cook, Robert Davis et al, "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 1999.
6. George R Buchanan, "Schaum's Outline of Finite Element Analysis", McGraw Hill Company, 1994.
7. Taylor.C and Hughes.J.B. "Finite Element Programming of the Navier Stoke equation" Pineridge Press Limited, UK 1981.

SAEA1505	HIGH SPEED AERODYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of compressibility.
- To make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows.
- To introduce the methodology of measurements in Supersonic flows.

UNIT 1 CONCEPTS OF COMPRESSIBLE FLOW

9 Hrs.

Basic concepts of compressible flow, Review of continuity, energy and momentum equations. One dimensional inviscid flow; Stagnation quantities; Isentropic conditions. Speed of sound and Mach number; Isentropic relations; Area-velocity relation. Flow through constant area duct.

UNIT 2 COMPRESSION AND EXPANSION WAVES

9 Hrs.

Normal shock –Prandtl equation and Rankine–Hugoniot relation .Oblique shock and supersonic compression by turning. Weak shocks and Mach waves; Super sonic expansion by turning. Prandtl-Meyer expansion fan; Reflection and intersection of shocks. Shock detachment and bow shock; Shock Expansion theory with application to thin airfoils.

UNIT 3 FLOW THROUGH DUCTS

9 Hrs.

Flow through converging and converging diverging ducts. Flow through constant area duct with friction (Fanno flow)-fanno flow equations and solutions-variation of flow properties- variation of Mach number with duct length. Flow through constant area duct with heat addition (Rayleigh flow)- Rayleigh line, Rayleigh flow equations-variation of flow properties.

UNIT 4 AIRFOIL IN HIGH SPEED FLOWS

9 Hrs.

Lower and upper critical mach numbers, Lift and drag divergence, shock induced separation, characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock-expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircraft.

UNIT 5 EXPERIMENTAL TECHNIQUES FOR HIGH SPEED FLOWS

9 Hrs.

Blow down, indraft and induction tunnel layouts and their design features. Transonic, supersonic and hypersonic tunnels and their peculiarities. Helium and gun tunnels, Shock tubes, Optical methods of flow visualization.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the basic knowledge in mathematics, science and engineering. CO2 - Analyze how the aerodynamics affects the aircraft design and operation. CO3 - Analyze the concept of oblique shock waves and expansion waves.

CO4 - Evaluate the one dimensional inviscid compressible flows.

CO5 - Analyze the effect of presence of airfoil, wing and cone section in supersonic flows. CO6 - Analyze flow in transonic regime.

TEXT / REFERENCE BOOKS

1. Radhakrishnan, Ethirajan., Gas Dynamics, John Wiley & Sons,2010.
2. Anderson J. D., Jr., Modern Compressible Flow with Historical Perspective, McGraw Hill Publishing Co.,2004.
3. H W Liepmann and A Roshko, Elements of Gas Dynamics, John Wiley & Sons.
4. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronold Press.
5. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., New York.
6. Clancy,L,J., "Aerodynamics", Pitman, Shroff Publishing co.,2006.

SAEA1601	AIRCRAFT STABILITY AND CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To stability of aircraft at various flight conditions.
- To stability, control, and dynamic characteristics of aircraft.
- To evaluate the flight and handling qualities.
- To know the advances in flight dynamics and controls.

UNIT 1 BASIC CONCEPTS

9 Hrs.

Aircraft Axis System, Coordinate Transformation, Aircraft Force and moment Equations, Basic Concept of Stability and Control, Types of stability.

UNIT 2 LONGITUDINAL DYNAMIC STABILITY AND CONTROL

9 Hrs.

Longitudinal stability, Contribution of wing and Tail, Total contribution, Stick fixed and stick free stability, control effectiveness, hinge moment, tabs. Determination Of Neutral Points And Maneuver Points In Flight Tests. Aerodynamic balancing.

UNIT 3 MANEUVERABILITY

9 Hrs.

Effects of freeing the stick. Control forces and force gradients. Critical conditions for stability and control. Effect of manoeuvres. Longitudinal dynamic stability, stability derivatives, characteristic equation for stick fixed case, modes and stability criterion, effect of freeing the stick.

UNIT 4 DYNAMIC STABILITY

9 Hrs.

Brief description of lateral and directional dynamic stability- spiral, divergence and Dutch roll. Response, automatic control, autorotation and spin.

UNIT 5 MODERN CONTROL THEORY

9 Hrs.

Classical vs modern control theory, introduction – state-space modelling, canonical transformation, controllability and observability, state-feedback design, application of modern control theory to aircraft autopilot design- stability augmentation, autopilot design, state observer, optimal control, problems. Introduction to aircraft autopilot design using classic control theory.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to
CO1 - Study the applications of the conservation laws to flow.
CO2 - Understand the importance of stability and control.
CO3 - Understand the stability equations.
CO4 - Understand the properties control system.
CO5 - Analyze the modern control systems.
CO6 - Distinguish the basics of autopilot systems.

TEXT / REFERENCE BOOKS

1. Thomas R. Yechout, 'An introduction to Aircraft Flight Mechanics', AIAA educational Series, 2003.
2. Bernard Etkin, Lloyd Duff Reid, Dynamics of Flight, Stability & Control, 3rd Edition, John Wiley & Sons, 1995.
3. Malcom J. Abzug, E.E. Larrabee, Airplane Stability & Control, 2nd Edition, Cambridge University Press, 2002.
4. Nelson. R.C., Flight Stability and Automatic Control, McGraw Hill, 1989.
5. Perkins C.D. and Hage R.E., Airplane Performance, Stability and Control, Wiley Toppan, 1974.

SAEA1602	THEORY OF VIBRATIONS AND AEROELASTICITY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of vibration and aero elasticity.
- To evaluate the characteristics of structural members.
- To know the basic methods to solve the solid mechanics problems.
- To discuss the structural mechanics and its applications.

UNIT 1 BASIC NOTIONS

9 Hrs.

Simple harmonic motion – Terminologies – Newton's Law – D' Alembert's principle – Energy Methods.

UNIT 2 SINGLE DEGREE OF FREEDOM SYSTEMS

9 Hrs.

Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Vibration measuring instruments. Undamped vibration absorbers, Vibration isolation. Lagrangian's and Hamilton Equations.

UNIT 3 MULTIDEGREES OF FREEDOM SYSTEMS

9 Hrs.

Two degrees of freedom systems – Static and Dynamic couplings vibration absorber Principal coordinates, Principal modes and orthogonal condition – Eigen value problems. Hamilton's principle- Lagrangean equation and application – Vibration of elastic bodies Vibration of strings- Longitudinal, Lateral and Torsional vibrations.

UNIT 4 APPROXIMATE METHODS

9 Hrs.

Rayleigh's and Holzer Methods to find natural frequencies. Timoshenko beam, vibration of plates, collocation method, Myklested - prohl method.

UNIT 5 ELEMENTS OF AEROELASTICITY

9 Hrs.

Concepts – Coupling – Aero elastic instabilities and their prevention – Basic ideas on wing divergence, loss and reversal of aileron control – Flutter and its prevention.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

- CO1 - Recall history and evolution of vibration and aero elasticity.
- CO2 - Compare the mathematical modeling and numerical methods.
- CO3 - Understand the working methodology of various mechanical systems.
- CO4 - Recognize the various functions of approximation methods.
- CO5 - Analyze the quality of structural grids and suitable shapes and methods for it
- CO6 - Distinguish the problems application based.

TEXT / REFERENCE BOOKS

1. Bisplinghoff R.L., Ashley Hand Hoffman R.L., "Aeroelasticity" – Addison Wesley Publication, New York, 2010.
2. Tse. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 2011.
3. Scanlan R.H. & Rosenbaum R., "Introduction to the study of Aircraft Vibration and Flutter", John Wiley and Sons. New York, 1982.
4. Tongue. B. H., "Principles of Vibration", Oxford University Press, 2000.

SAEA3019	ORBITAL MECHANICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of satellite injection.
- To evaluate the satellite perturbations, trajectory computation.
- To know the basic functions of travel and flight of ballistic missiles.
- To discuss the stages of separation.

UNIT 1 BASIC CONCEPTS

9 Hrs.

The solar system -Reference frames and coordinate systems –The celestial sphere -The ecliptic - Motion of vernal equinox – Sidereal time-Solar time-Standard time-The earth's atmosphere. Types of orbit.

UNIT 2 THE GENERAL N-BODY PROBLEM

9 Hrs.

The Many body problem - Lagrange - Jacobi identity - The circular restricted three body problem – Libration points-Relative Motion in the N-body problem-The two-body problem-Satellite orbits - Relations between position and time-Orbital elements.

UNIT 3 SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS

9 Hrs.

General aspects of satellite injections-Satellite orbit transfer-Various cases-Orbit deviations due to injection errors-Special and general perturbations-Cowell's Method - Encke's method – Method of variations of orbital elements General perturbations approach.

UNIT 4 INTERPLANETARY TRAJECTORIES BALLISTIC MISSILE -TRAJECTORIES

11 Hrs.

Two-dimensional inter planetary trajectories –Fast interplanetary trajectories –Three dimensional interplanetary trajectories- Launch of interplanetary spacecraft –Trajectory about the target planet. The boost phase-The ballistic phase -Trajectory geometry -Optimal flights -Time of flight-Re-entry phase –The position of the impact point Influence coefficients.

UNIT 5 MATERIALS FOR SPACECRAFT

7 Hrs.

Space environment-Peculiarities -Effect of space environment on the selection of materials of spacecraft.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to CO1 - Study the basic concepts of orbits and its types.

CO2 - Understand the satellite perturbations, trajectory computation. CO3 - Understand the importance of missile performance.

CO4 - Understand the properties control system.

CO5 - Analyze the trajectory calculations and materials.

CO6 - Distinguish the basics of fluid statics and fluid dynamics for propulsion.

TEXT / REFERENCE BOOKS

1. George .P.Sutton , Oscar Biblarz "Rocket Propulsion Elements", Wiley Publishers 8th Edition, 2010.
2. J.ohn H. Blakelock, "Automatic control of aircraft and missiles", 2nd Edition, Wiley Publishers, 2011.
3. George.M.Siouris "Missile guidance and control systems", Springer 2nd Edition, 2004.
4. Tactical and Strategic Missile Guidance, 5th Edition, Paul Zarchan, Progress in Astronautics and Aeronautics, AIAA, 2007, ISBN-10: 1-56347-874-9.
5. Missile Guidance and Control Systems, George M. Siouris, Springer-Verlag, 2004, ISBN: 0-387-00726.

A **B.E. AERONAUTICAL ENGINEERING** **NG** REGULATIONS- 2015 CURRICULAM

SEMESTER 1

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1.	SHS1101	English for Science and Technology /					1
	SCH1101	Environmental Science and Engineering	3	0	0	3	10
2.	SMT1101	Engineering Mathematics – I	3	1	0	4	2
3.	SPH1101	Physics of Engineering Materials	3	0	0	3	3
4.	SCY1101	Engineering Chemistry	3	0	0	3	4
5.	SME1101	Engineering Mechanics	3	1	0	4	5
6.	SAE1101	Fundamentals of Aeronautical Engineering	3	0	0	3	6
PRACTICAL							
7.	SPH4051	Engineering Physics Lab	0	0	2	1	7
8.	SCY4051	Engineering Chemistry Lab	0	0	2	1	8
9.	SME4051	Engineering Graphics – I	1	0	2	2	9
TOTAL CREDITS							24

SEMESTER 2

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1.	SHS1101	English for Science and Technology/					1
	SCH1101	Environmental Science and Engineering	3	0	0	3	10
2.	SMT1105	Engineering Mathematics – II	3	1	0	4	11
3.	SPH1102	Physics for Electronics Devices					13
	SPH1103	Engineering Physics /					12
	SPH1104	Applied Biophysics	3	0	0	3	14
4.	SCY1102	Chemistry of Electronic Materials					15
	SCY1103	Chemistry of Industrial Materials					16
	SCY1104	Bio-organic Chemistry					17
	SCY1105	Physical Chemistry	3	0	0	3	18
5.	SCS1102	Fundamentals of programming /					19
	SCS1202	Object Oriented Programming	3	0	0	3	20
6.	SAE1102	Aircraft Production Techniques	3	0	0	3	21
PRACTICAL							
7.	SCS4101	Programming in C Lab	0	0	4	2	22
8.	SAE4051	Aircraft Production Technology Lab	0	0	4	2	23
TOTAL CREDITS							23

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

SEMESTER 3

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SMT1201	Engineering Mathematics – III	3	1	0	4	24
2	SME1206	Dynamics of Machinery	3	1	0	4	25
3	SAE1201	Avionics	3	0	0	3	26
4	SAE1202	Aircraft Electrical and Electronics Systems	3	0	0	3	27
5	SAE1203	Introduction to Aerodynamics	3	1	0	4	28
6	SAE1204	Introduction to Aircraft Structures	3	1	0	4	29
PRACTICAL							
7.	SME4054	Fluid Mechanics and Machinery Lab	0	0	4	2	30
8.	SAE4052	Aircraft Structures Lab	0	0	4	2	31
TOTAL CREDITS							26

SEMESTER 4

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SMT1204	Engineering Mathematics – IV /					32
	SMT1206	Number Theory and Linear Algebra /					33
	SMT1207	Graph Theory /					34
	SMT1208	Applied Statistics/					35
	SMT1209	Foundations of Mathematics	3	1	0	4	36
2	SME1201	Engineering Thermodynamics	2	1	0	3	37
3	SAE1205	Aerodynamics - I	3	1	0	4	38
4	SAE1206	Aircraft Control Engineering	2	1	0	3	39
5	SAE1207	Aircraft Systems and Instruments	3	0	0	3	40
6	SAE1208	Aircraft Performance	2	1	0	3	41
PRACTICAL							
7	SAE4053	Aircraft Component Design and Drawing Lab	0	0	4	2	42
8	SAE4054	Aerodynamics Lab	0	0	4	2	43
9	S26PT1	Professional Training - 1	0	0	10	5	44
TOTAL CREDITS							29

SEMESTER 5

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1.	SME1306	Theory of Vibrations	3	0	0	3	45
2.	SAE1301	Aerodynamics – II	3	1	0	4	46
3.	SAE1302	Aircraft Propulsion	3	0	0	3	47
4.	SAE1303	Aircraft Structures	3	1	0	4	48
5.	SAE1304	Aircraft Stability and Control	3	1	0	4	49
6.	SAE1305	Experimental Aerodynamics	3	0	0	3	50
PRACTICAL							

7	SAE4055	Aircraft Structures and Composites Lab	0	0	4	2	51
8	SAE4056	Computation Lab	0	0	4	2	52
TOTAL CREDITS							25

SEMESTER 6

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SME1308	Finite Element Analysis	3	0	0	3	53
2	SPR1307	Resource Management Techniques	2	1	0	3	54
3	SAE1306	Heat Transfer Techniques for Aerospace Applications	3	1	0	4	55
4	SAE1307	Aerospace Propulsion	2	1	0	3	56
5	SAE1308	Aircraft Design	2	1	0	3	57
6		Elective – 1	3	0	0	3	
PRACTICAL							
7	SAE4057	Propulsion Lab	0	0	4	2	58
8	SAE4058	Aircraft Design Project Lab - I	0	0	4	2	59
9	S26PT2	Professional Training - 2	0	0	10	5	60
TOTAL CREDITS							28

SEMESTER 7

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SAE1401	Aircraft Composite Materials and Structures	3	0	0	3	61
2	SAE1402	Rocketry and Space Dynamics	3	0	0	3	62
3		Elective - 2	3	0	0	3	
4		Elective - 3	3	0	0	3	
PRACTICAL							
5	SAE4059	Aircraft Design Project Lab-II	0	0	4	2	63
6	SAE4060	Aircraft System and Maintenance Lab	0	0	4	2	64
7		Project Work (Phase - 1)					
TOTAL CREDITS							16

SEMESTER 8

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
THEORY							
1	SBA1101	Principles of Management and Professional Ethics	3	0	0	3	65
2	SAE1403	Aviation Management	3	0	0	3	66
3		Elective - 4	3	0	0	3	

4

S26PROJ

Project Work (Phase -
1 & 2)

0 0 30 15

TOTAL CREDITS 24

TOTAL CREDITS FOR THE PROGRAMME 195

ELECTIVE COURSES (GROUP A)

Sl. No.	COURSE CODE	COURSE TITLE	L	T	P	C	PAGE No.
1	SME1607	Computational Fluid Dynamics	3	0	0	3	67
2	SME1614	Experimental Stress Analysis	3	0	0	3	68
3	SME1620	Theory of Elasticity	3	0	0	3	69
4	SAE1601	Advanced Flight Dynamics	3	0	0	3	71
5	SAE1602	Aero Elasticity	3	0	0	3	72
6	SAE1607	Hypersonic Aerodynamics	3	0	0	3	73
7	SAE1608	Helicopter Aerodynamics	3	0	0	3	74
8	SAE1610	Industrial Aerodynamics	3	0	0	3	75
9	SAE1613	Plates and Shells	3	0	0	3	76
10	SAE1616	Mechanical Behavior of Aircraft Materials	3	0	0	3	77

**ELECTIVE COURSES
(GROUP B)**

1	SME1609	Cryogenic Engineering	3	0	0	3	70
2	SAE1603	Airframe Maintenance and Repair Practices	3	0	0	3	78
3	SAE1604	Airline Operations and Management	3	0	0	3	79
4	SAE1605	Airport Engineering	3	0	0	3	80
5	SAE1606	Civil Aircraft Rules and Regulations	3	0	0	3	81
6	SAE1609	Helicopter Maintenance	3	0	0	3	82
7	SAE1611	Launch Vehicles and Spacecraft Propulsion	3	0	0	3	83
8	SAE1612	Missile Technology	3	0	0	3	84
9	SAE1614	Spacecraft Technology	3	0	0	3	85
10	SAE1615	UAV System Design	3	0	0	3	86

SAE1201	AVIONICS (For Aeronautical)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the basic of avionics and its need for civil and military aircrafts
- To impart knowledge about the avionics architecture and various avionics data buses
- To gain more knowledge on various avionics subsystems.

COURSE OUTCOMES

- CO1: Identify the different cockpit display technologies in aircrafts systems.
- CO2: Analyze the avionics bus architecture in aircraft system interface.
- CO3: Construct the air data sensors, antennas and Radar system utilized in aircrafts.
- CO4: Classify the different navigation systems for landing gears used in aircrafts.
- CO5: Assess the communication technologies utilized in ATC system. CO6: Inspect the airborne surveillance system followed for navigation aids.

UNIT 1 DISPLAYS TECHNOLOGY

10 Hrs.

Basics of Avionics-Basics of Cockpits-Need for Avionics in civil and military aircraft and space systems –Early flight deck-Attitude Direction Indicator-The Horizontal Situation Indicator-altimeter-Airspeed Indicator (ASI) -glass cockpit-Display system architectures-Electronic flight instrument systems -Combined EFIS ,EICAS/ECAM systems – CRT-The Active Matrix Liquid Crystal Display-Large area HDD-Three-dimensional and four-dimensional display formats -Touch screen – Direct voice input (DVI) -ARINC 818-Civil cockpit and military cockpit-MFDS, PFDS-HUD, HMD, HMI

UNIT 2 AVIONICS TECHNOLOGY

10 Hrs.

Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-AFDX/ARINC-664-MIL STD 1553 B– ARINC 429–ARINC 629- Aircraft system Interface Digital data buses -integration of aircraft systems -Fiber-optic buses-avionics packaging – LRU-Integrated Modular Avionics-System design-Key agencies and documentation-certification techniques-US and European Specifications -Fault Tree Analysis-Failure Modes and Effects Analysis (FMEA)-Component reliability-Dispatch reliability-Systems Integration -Open architecture -definition of IMA cabinets – first-, second-, and third-generation Implementations - 'V' diagram -ETOPS and LROPS requirements

UNIT 3 SENSORS

8 Hrs.

Air data - Air Data and Inertial Reference Systems (ADIRS) -Magnetic sensing - Magnetic Heading Reference System (MHRS) - Inertial navigation -Inertial platforms – Strap down systems - Antenna Fundamentals ~Common Types of Antennas ~Fundamentals and Definitions-Nature of Radar and Applications, Simple form of Radar Equation, Radar Block Diagram and Operation, Prediction of Range Performance, Minimum Detectable Signal, Radar Receivers Radar sensors -Radar altimeter - Doppler radar -Weather radar.

UNIT 4 NAVIGATION&LANDING AIDS

8 Hrs.

Basic navigation - Radio navigation - Oceanic crossings - Inertial navigation - Satellite navigation -GPS - Differential -Integrated navigation- phases of flight -Flight Management System (FMS)-FMS Control and Display Unit (FMS CDU) -FANS -Terrain Awareness and Warning System (TAWS)-GPWS and EGPWS - Satellite navigation systems-Instrument Landing System-Transponder Landing System -Microwave Landing System (MLS)

UNIT5 COMMUNICATIONS AND NAVIGATION AIDS

9 Hrs.

Radio Frequency spectrum -Communications systems-HF-VHF-Satellite communications-Air Traffic Control (ATC) transponder -Traffic Collision and Avoidance System-Communications control system-Navigation aids - Automatic Direction Finding - Very High Frequency Omni-Range-Distance Measuring Equipment –TACAN-VORTAC - - Airborne early warning -Ground surveillance -Electronic warfare principles

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Collinson R.P.G. "Introduction to Avionics", Chapman & Hall Publications, 1996.
2. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
3. Civil Avionics Systems ,Ian Moir , Allan G Sea bridge, Professional Engineering

Publishing Limited, London, UK, 2003

4. Myron Kyton, Walfred Fried, Avionics Navigation systems, 2nd edition, John Wiley & Sons, 1997.
5. Albert D Helfrick, Modern Aviation Electronics: 2nd Ed., PHI, 1994
6. Skolnik M.I, Introduction to Radar Systems, McGraw hill, 2000.

SAE1202	AIRCRAFT ELECTRICAL AND ELECTRONIC SYSTEMS (For Aeronautical)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

To study the basics of Electronics and electrical systems used for aircrafts.

COURSE OUTCOMES

CO1: Functions of diodes, transistors, stable, bi-stable and bus systems in aircraft electronic systems.

CO2: Inspect the type of generators, motors and batteries used in Aircraft power generation systems.

CO3: Examine the components of AC and DC power generators in Aircraft electrical systems.

CO4: Discover the components of power distribution system used in larger commercial aircrafts.

CO5: Assess the lightning technologies utilized in Aerodrome and Airport for passenger mobility.

CO6: Select the cabin pressurization system technologies suitable for passenger comfortability.

UNIT 1 INTRODUCTION

5 Hrs.

Electrical fundamentals - Electronic fundamentals -Semiconductor theory - Diodes - 2.3 Transistors- Digital fundamentals-Logic gates-Combinational logic systems – Mono stable devices - Bistable devices -Decoders - Encoders – Multiplexers - Bus systems-microprocessors –microcontrollers - Computers

UNIT 2 GENERATORS AND MOTORS BATTERIES & POWER SUPPLIES

9 Hrs.

Description and applications of single - phase and three - phase motors. Connection and starting of three - phase induction motors by star - delta starter. Motors used for driving pumps, compressors, centrifuge, Generator and motor principles - AC generators - Three- phase generation and distribution - AC motors - Practical aircraft generating systems – Storage cells - Lead-acid batteries - Nickel-cadmium batteries - Lithium batteries - Nickel-metal hydride batteries- Battery locations - Battery venting - Battery connections - Regulators - External power - Inverters - Transformer rectifier units - Transformers - Auxiliary power unit (APU) - Emergency power - Wiring and circuit protection - Construction and materials - specifications - Shielding/screening - Circuit protection - Electrical and magnetic fields - Electromagnetic interference - EMI reduction

UNIT 3 AC POWER GENERATION DC POWER GENERATION BASICS

12 Hrs.

Types of alternator – alternator rectifier unit – constant speed alternator – wild frequency alternator – brush less alternator – alternator control unit - synchronizing of alternator – charging and cooling - Disconnection and connection GCU: - Line contactors/ Transfer contactors Static invertors- testing the operation. Auto transformers. Current transformers-differential protection APU – purpose – operation – starting of engine– precautions to be observed before starting — limitations of starting APU. DC generators – construction – Starter generator – checking and testing of generator parts – functional check of generator on aircraft. Paralleling of DC buses. TRUs and DC power generation.

UNIT 4 DISTRIBUTION OF POWER SUPPLIES

12 Hrs.

single engine/general aviation - Twin engine general aviation aircraft - Larger aircraft systems - Split bus system - Parallel bus system - Split/parallel bus system - Standby and essential power - Battery charging - Control and protection - Load shedding - Fire and overheat protection - Engine/APU fire detection - Cargo bay/baggage area - Fire extinguishing

UNIT 5 CABIN SYSTEMS & LIGHTS

7 Hrs.

Lighting technologies - Flight compartment lights - Passenger cabin lights - Exterior lights - Passenger address system - Galley equipment -In-flight entertainment (IFE) - Satellite communications -Multiplexing - Fiber optics -Air conditioning -Pressurization Air stairs

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Aircraft Electrical and Electronic Systems : Principles, operation and maintenance , Mike Tooley and David Wyatt,
2. Butterworth-Heinemann is an imprint of Elsevier USA , First edition, 2009
3. EHJ Pallet: A/C Electrical system
4. Theraja B.L. Electrical Technology
5. Bent Mckinley: A/C Electicityand Electronics
6. Mehta VK Basic Electronics;S Chand and Co., New Delhi

SAE4052	AIRCRAFT STRUCTURES LAB (For Aeronautical)	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OUTCOMES:

At the end of the laboratory course, the student shall be able to:

- CO1 - Perform tensile and compression tests on given specimens.
- CO2 - Verify the Maxwell's and Castigliano's theorem.
- CO3 - Estimate the Critical buckling loads.
- CO4 - Determine the Shear centre for open section and Closed Section
- CO5 - Determine the Stress in unsymmetrical bending of Cantilever beam
- CO6 - Determine the free vibration of cantilever beam, Wagner beam and estimate the stresses in pressure vessels.

SUGGESTED LIST OF EXPERIMENTS

1. Tensile testing using UTM, Mechanical and Electrical extensometers for Stress Strain curves and strength tests for Steel and Aluminum
2. Verification of Castigliano's theorems and Influence coefficients
3. Verification of Maxwell's theorem.
4. Compression tests on long columns. Critical buckling loads, Euler load by South well plot.
5. Unsymmetrical Bending of a Cantilever Beam
6. Combined bending and Torsion of a Hollow Circular Tube
7. Material Fringe Constant of a Photo elastic Model
8. Shear Centre calculation of an open section. 9. Shear Centre calculation of a closed section.
10. Wagner beam – Tension field beam

SAE1208	AIRCRAFT PERFORMANCE (For Aeronautical)	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES

To study the performance of airplanes under various operating conditions and the static and dynamic response of aircraft for both voluntary and involuntary changes in flight conditions

COURSE OUTCOMES

CO1: Calculate the forces and moments acting on a flight vehicle and to estimate the drag polar of flight vehicles.

CO2: Inspect the performance of an air breathing engines and rockets.

CO3: Interpret the performance of airplane in different mission profiles.

CO4: Measure the performance of airplane in various maneuvering conditions.

CO5: Examine the flight testing at different altitudes and spotting of errors and its calibration.

CO6: Measure the performance of Engine power during flight by determining the drag polar.

UNIT 1 FORCE AND DRAG

9 Hrs.

International Standard Atmosphere, Forces and moments acting on a vehicle in flight.

Equations of motion of a rigid flight vehicle Various types of drags. Drag polar of vehicles from low speeds to hypersonic speeds.

UNIT 2 AIR BREATHING ENGINES AND ROCKETS

9 Hrs.

Review of the variation of thrust/power and SFC with altitude and velocity, for various air breathing engines and rockets.

UNIT3 UNACCELERATED FLIGHT

8 Hrs.

Performance of airplane in level flight, range, endurance. glide, climb, Maximum speed in level flight - Conditions for minimum drag and power required

UNIT4 ACCELERATED FLIGHT

9 Hrs.

Accelerated flight, turn, maneuvers, take-off and landing. Flight limitations of pull up and push over - V-n diagram and load factor

UNIT5 FLIGHT TESTING

10 Hrs.

Flight - testing: Altitude definitions, Speed definitions, Air speed, altitude and temperature measurements. Errors and calibration. Measurement of engine power, charts and corrections. Flight determination of drag polar.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Edward Lewis Houghton, N. B. Carruthers, Aerodynamics for Engineering Students, Butterworth-Heinemann, 2003
2. Anderson J. D., Jr., Airplane Performance and Design, McGraw Hill Publishing Co., 1999
3. Jan Roskam, chuan- Tau Edward Lan, Airplane Aerodynamics and Performance, DAR Corporation, 2007.
4. Warren. F. Phillips, Mechanics of Flight, John Wiley and Sons, 2004.
5. Bandu N.Pamadi, Performance, Stability, Dynamics and Control of Airplane, AIAA, 2004

SAE4053	AIRCRAFT COMPONENT DESIGN AND DRAWING LAB (For Aeronautical)	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OUTCOMES

CO1: Design of simple structural components and drafting of various welded joints.

CO2: Interpret the design of control components of cam, gear and bell crank.

CO3: Illustrate the three-view diagram of a typical aircraft such as commercial, civil and military ones.

CO4: Illustrate the layout of typical wing structure, fuselage structure and landing gear.

CO5: Illustrate the design of blower components and control system surfaces.

CO6: Illustrate the dimensional design of blower and radial piston engine assembly.

SUGGESTED LIST OF EXPERIMENTS

1. Layout of simple structural components.
2. Design and drafting of welded joints.
3. Design and drafting control components cam
4. Design and drafting control components bell crank
5. Design and drafting control components gear
6. Three view diagram of a typical aircraft
7. Layout of typical wing structure.
8. Layout of typical fuselage structure.
9. Layout of landing gear structure
10. Dimensional Design of blower components
11. Layout of control system surfaces (Flaps, aileron, elevator, rudder etc.)
12. Dimensional Design of radial engine components
13. Blower assembly.
14. Radial piston engine assembly
15. Dimensional Design of typical aircraft

SAE4054	AERODYNAMICS LAB (For Aeronautical)	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OUTCOMES

CO1: Estimate the calibration of subsonic wind tunnel and utilization of precision measurement instrument.

CO2: Evaluate the pressure distribution over cylinder and airfoil models.

CO3: Extend the work for estimating the lift, drag and pitching moment of airfoils from the pressure distribution calculation.

CO4: Inspect the model by flow visualization technique called water flow channel to visualize the boundary layer separation.

CO5: Inspect the model by smoke flow visualization technique to visualize the boundary layer separation in airfoil and cylindrical.

CO6: Extend the work for Pressure, Mach number and temperature measurements for supersonic wind tunnel that possess Schlieren image.

SUGGESTED LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over cylinder.
3. Pressure distribution over symmetric airfoils.
4. Pressure distribution over cambered airfoils
5. Study of lift, drag characteristics of airfoils using wind tunnel.
6. Study of pitching moment characteristics of airfoil.
7. Flow visualization technique by using water flow channel
8. Flow visualization studies in low speed flows over cylinders and Airfoils using smoke techniques.
9. Calibration of supersonic wind tunnel.
10. Supersonic flow visualization with Schlieren system.

SAE1302	AIRCRAFT PROPULSION	L	T	P	Credits	Total Marks
	(For Aeronautical)	3	0	0	3	100

(Usage of Gas table is permitted for End Semester Examination)

COURSE OBJECTIVE

To introduce basic concepts and salient features of engine components of jet propelled engines which are operated in atmosphere to students. This course is also aimed at making students familiarize with advanced jet propulsion methods like hypersonic propulsion

COURSE OUTCOMES

CO1: Comprehend the performance and characteristics of turboprop, turbofan and turbojet.
CO2: Illustrate the performance of inlets and nozzles and its modes of operation with respect to Mach number regimes.
CO3: Interpret the process and performance of combustion chambers and its cooling methods.
CO4: Contrast the compressor blades by utilizing the elementary theory of compressors.
CO5: Categorize the different types of turbines and its elementary theory of blades.
CO6: Estimate the stage performance and overall turbine performance for matching the compressors and turbines.

UNIT 1 FUNDAMENTALS OF GAS TURBINE ENGINES

9 Hrs.

Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust– Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.

UNIT 2 INLETS AND NOZZLES

9 Hrs

Types of inlet, Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Supersonic inlets – Starting problem on supersonic inlets – Modes of inlet operation. Theory of flow in isentropic nozzles – nozzle choking – – Nozzle efficiency – Losses in nozzles – – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust reversal.

UNIT 3 COMBUSTION CHAMBERS

9 Hrs.

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders – Numerical problems.

UNIT4 COMPRESSORS

8 Hrs.

Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional flow – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.

UNIT 5 TURBINES

10 Hrs.

Impulse and reaction blading of gas turbines – Velocity triangles and power output – Elementary theory – Choice of blade profile pitch and chord – Estimation of stage performance – Limiting factors in gas turbine design-Overall turbine performance –Methods of blade cooling – Matching of turbine and compressor.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Longman, 1989.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
3. "Rolls Royce Jet Engine" – Third Edition – 1983.
4. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 1999.
5. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley 1990.

SAE1303	AIRCRAFT STRUCTURES	L	T	P	Credits	Total Marks
	(For Aeronautical)	3	1	0	4	100

COURSE OBJECTIVES

To provide the students various methods for analysis of aircraft wings and fuselage. To provide the behavior of major aircraft structural components.

COURSE OUTCOMES

CO1: Illustrate the trusses and beams using method of joints and moment distribution method.

CO2: Contrast the stresses using energy methods in trusses, beams, frames and rings of the aircraft structure.

CO3: Interpret the bending stresses in beams under skew loads and calculate the non linear stress distributions during unsymmetrical bending cases.

CO4: Contrast the shear flow and shear centre for open and closed loop sections.

CO5: Estimate the stress analysis in airplane wing and its components.

CO6: Evaluate the stress analysis in airplane fuselage and its components.

UNIT 1 STATICALLY DETERMINATE AND INDETERMINATE STRUCTURES 14 Hrs.

Truss: Analysis of plane truss–Method of joints–3D Truss. - Load transmission in multiple span beam-Clapeyron's Three Moment Equation- Moment Distribution Method.

UNIT 2 ENERGY METHODS 12 Hrs.

Strain Energy due to axial, bending and Tensional loads-Castigliano's theorem-Maxwell's Reciprocal theorem, Unit load method, The principle of virtual work- application to beams, trusses, Circular frames, rings, - redundant center.

UNIT 3 UNSYMMETRICAL BENDING 10 Hrs.

Bending stresses in beams of unsymmetrical sections– Bending of symmetric sections with skew loads. non linear stress distribution.

UNIT 4 SHEAR FLOW IN OPEN AND CLOSED SECTIONS 13 Hrs.

Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending. unsymmetrical beam sections. Bredt–Batho formula, Shear flow in single & multi cell structure under torsion.

UNIT 5 STRESS ANALYSIS IN WING AND FUSELAGE 11 Hrs.

Structural lay out of the Airplane and components, Structural design V-n diagram, loads acting on major components such as wing, fuselage, tails, landing gear etc., Concept of allowable stress and margin of safety. Procedure–Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and nonparallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).

Max: 60 Hours

TEXT / REFERENCE BOOKS

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995.
2. Bruhn. E.H. "Analysis and Design of Flight Vehicles Structures", Tri-state office set company, USA, 1985.
3. Millard V. Barton, "Fundamentals of Aircraft Structures" Prentice Hall, 1948
4. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990.
5. Donaldson, B.K., "Analysis of Aircraft Structures– An Introduction", McGraw-Hill, 1993.

SAE1304	AIRCRAFT STABILITY AND CONTROL (For Aeronautical)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

To get clear cut idea about the stability of aircraft at various flight conditions.

COURSE OUTCOMES

CO1: Functions of aircraft axis system and measurement of stability and control of aircraft through fundamental equations.

CO2: Determine the longitudinal dynamic stability and control of stick-fixed and stick-free control surfaces.

CO3: Discuss the concept of stability criterion in maneuverability of aircraft operated in stick-fixed and stick-free control surfaces.

CO4: Perform the dynamic stability criterion for different maneuver points in flight tests.

CO5: Design the aircraft autopilot system using modern control theory.

CO6: Solve the non-linear problems in aircraft flight dynamics.

UNIT 1 BASIC CONCEPTS

11 Hrs.

Aircraft Axis System, Coordinate Transformation, Aircraft Force Equations, Moment Equations, Basic Concept Of Stability And Control, Longitudinal And Lateral- Directional Equations, Kinematic Equation

UNIT 2 LONGITUDINAL DYNAMIC STABILITY AND CONTROL

12 Hrs.

Stick - fixed stability, control effectiveness, hinge moment, tabs, aerodynamic balancing, effects of freeing the stick. Control forces and force gradients. Critical conditions for stability and control.

UNIT 3 MANEUVERABILITY

11 Hrs.

Effect of maneuvers. Longitudinal dynamic stability, equations of motion of a disturbed aircraft, stability derivatives, characteristic equation for stick fixed case, modes and stability criterion, effect of freeing the stick.

UNIT 4 DYNAMIC STABILITY

11 Hrs.

Brief description of lateral and directional dynamic stability- spiral, divergence and Dutch roll. Response, automatic control, autorotation and spin. Determination Of Neutral Points And Maneuver Points In Flight Tests

UNIT5 MODERN CONTROL THEORY

15 Hrs.

Classical Vs modern control theory, introduction – state-space modeling, canonical transformation, controllability and observability, state-feedback design, application of modern control theory to aircraft autopilot design- stability augmentation, autopilot design, state observer, optimal control, problems . Introduction to aircraft autopilot design using classic control theory. Introduction to nonlinear problems in aircraft flight dynamics - Inertia coupling. - High angle of attack phenomena - Flexibility effects -Divergence.

Max.60 Hours

TEXT / REFERENCE BOOKS

1. Thomas R. Yechout, 'An introduction to Aircraft Flight Mechanics', AIAA educational Series; 2003.
2. Bernard Etkin, Lloyd Duff Reid, Dynamics of Flight, Stability & Control, 3rd ed, John Wiley & Sons, 1995
3. Malcom J Abzug, E E. Larrabee, Airplane Stability & Control , 2nd ed, Cambridge University Press,, 2002
4. Nelson. R.C., Flight Stability and Automatic Control, McGraw Hill, 1989.

SAE1305	EXPERIMENTAL AERODYNAMICS (For Aeronautical)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

To get knowledge about various experimental methods in aerodynamics To know about the functions of various wind tunnels. To get idea about flow visualization techniques.

COURSE OUTCOMES

CO1: Classify the wind tunnels and its utilities with respect to simulation of aircraft models.

CO2: Measure the losses and calibration of low speed wind tunnels

CO3: Measure the losses and calibration of high-speed wind tunnels

CO4: Discuss the flow visualization techniques and analogue method for visualizing the flow characteristics of aircraft models.

CO5: Measure the forces and moments of the aircraft models inside the wind tunnel using three and six component balancing mechanism.

CO6: Calculate the flow properties of the aircraft models using intrusive and non-intrusive methods of flow calibrations.

UNIT 1 WIND TUNNEL TESTING

5 Hrs.

Introduction - Need of experiments - Wind tunnel - Classification of wind tunnels- Applications of wind tunnels - Model making, non-dimensional simulation Parameters

UNIT 2 LOW SPEED WIND TUNNELS

11 Hrs.

Irregularities of flow in low speed tunnels, Reduction of turbulence - Effect of screens on turbulence - Honeycombs - Wind tunnel contractions -The diffuser, Losses in wind tunnel circuit, Power requirements, Power economy by pressurization - Power economy by choice of working fluid - Power economy by reduction in stagnation temperature.

UNIT 3 HIGH SPEED WINDTUNNEL

13 Hrs.

Types of high speed tunnels , Supersonic wind tunnels - Test section flow parameters - Dynamic pressure - Mass flow rate - Test section velocity -Maximum velocity - Free stream Reynolds's number, Components of supersonic wind tunnels - Air storage tanks - Settling chamber /wide angle diffusers -Convergent-divergent (C-D) nozzle - Diffuser, Power required for the operation of supersonic wind tunnels, Closed circuit supersonic wind tunnel, Actual flow in the supersonic wind tunnel - Starting the wind tunnel with the model in the test section, Sizing of the wind tunnel model, Problems in the operation of the supersonic wind tunnel - Condensation and Liquefaction, Shock tubes –operation and equations.

UNIT 4 FLOW VISUALIZATION AND ANALOGUE METHODS

7 Hrs.

Principles of Flow Visualization – Hele-Shaw apparatus - Interferometer – Fringe-Displacement Method, Schlieren system – Shadowgraph -.Smoke and tuft grid techniques – dye injection special techniques- Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

UNIT 5 MEASUREMENT TECHNIQUES

9 Hrs.

Steady and unsteady pressure, velocity and temperature measurements – Force and moment measurements, three components and six components balances – internal balances – Principles of Hotwire anemometer, PIV, LDV.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Bendat J. S., and Peirsol A. G., "Random Data Analysis and Measurement Procedures", 4th Edition, Wiley, 2010.
2. Rathakrishnan. E "Instrumentation, Measurement and Experiments in Fluids" ,CRC Press, London, 2007
3. Goldstein R. J. (Ed.), Francis T., "Fluid Mechanics Measurements", Taylor Francis, Washington 1996.
4. W-J Yang, "Handbook of Flow Visualization", 2nd Edition, Taylor and Francis, 2001.
5. Tropea C., Yarin A., Foss F. J. (Eds.), "Handbook of Experimental Fluid Mechanics", Springer, 2007

SAE4056	COMPUTATION LAB (For Aeronautical)	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OUTCOMES

CO1: Apply the concept of governing equations of the fluid and boundary conditions.

CO2: Design and meshing of the model which is kept for fluid flow simulation.

CO3: Construct the airfoil and wing with a flow domain having different boundary conditions for simulation.

CO4: Interpret the results and plots from the simulation of swept back wings and calculation of lift and drag over it.

CO5: Simplify the complex problem of aircraft engine combustion chamber through numerical simulation.

CO6: Design of Convergent Divergent nozzle and simulation of fluid flow in subsonic and supersonic speeds.

SUGGESTED LIST OF EXPERIMENTS

1. Introduction to Fluid mechanics.
2. Introduction to computational fluid mechanics.
3. Introduction to grid generation techniques
4. Introduction to cfd solvers
5. Flow over the airfoil(2D)
6. Flow over the wing(3D)
7. Cl, Cd formulation for swept back wing.
8. Supersonic flow analysis of delta wing.
9. Jet impinging
10. Flow analysis of Aircraft engine combustion chamber.
11. Nozzle flow analysis (CD nozzle).

SAE1306	HEAT TRANSFER TECHNIQUES FOR AEROSPACE APPLICATIONS	L	T	P	C	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES:

The aim of the course is to:

- To impart knowledge on various modes of heat transfer and methods of solving problems.
- To give exposure to numerical methods employed to solve heat transfer problems.

COURSE OUTCOMES:

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

- CO1: Compare the various modes of heat transfer and analyse the conduction heat transfer in various systems in both steady and unsteady state conditions
- CO2: Distinguish natural and forced convection phenomena and measure the heat transfer coefficient in external and internal fluid flow problems.
- CO3: Apply the laws of radiation, analyse the radiation exchange between surfaces and the effect of radiation shields
- CO4: Discriminate the types of heat exchangers and design the heat exchanger with LMTD and NTU approach
- CO5: Describe the principles of high-speed flow heat transfer and analyse the heat transfer problems in gas turbine combustion chamber
- CO6: Describe the application of high-speed flow heat transfer in aerospace components and analyse the heat transfer by numerical methods.

COURSE SYLLABUS:

UNIT	TOPICS COVERED	DURATION
I	INTRODUCTION AND CONDUCTION HEAT TRANSFER Basic modes of heat transfer – One dimensional steady state heat conduction – Cartesian, cylindrical and spherical coordinates – Composite medium – Critical thickness – Effect of variation of thermal conductivity – Extended surfaces. Conduction with heat generation. Unsteady state heat conduction – Heat transfer analysis of Lumped system, Semi infinite and infinite solids – Use of Transient-Temperature charts - Applications of numerical techniques.	12 h
II	CONVECTIVE HEAT TRANSFER Introduction-Forced convection-Development of velocity and thermal boundary layer by a flow on a vertical flat plate – Laminar and turbulent convective heat transfer analysis in flows over a flat plate, circular pipe and spherical surface. Free convective heat transfer over vertical flat plate, cylinders and spheres – Empirical relations , applications of numerical techniques in problem solving.	12 h
III	RADIATIVE HEAT TRANSFER Introduction – Physical mechanism of radiation – Radiation properties – Characteristics of surfaces- Emissivity – Radiation shaper factor – Heat exchange between non-black bodies – Radiation shields.	12 h
IV	HEAT EXCHANGERS Classification of heat exchangers – Temperature distribution – Overall heat transfer coefficient – Heat exchange analysis – LMTD Method and E-NTU Method.	12 h
V	HIGH SPEED FLOW HEAT TRANSFER High-Speed flow heat transfer - Heat transfer problem in gas turbine combustion chamber- ablative heat transfer Aerodynamic heating – Rocket thrust chambers - Numerical treatment.	12 h

TEXT / REFERENCE BOOKS

- Holman J.P, "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 6th Edition, 1991.
- Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003
- S.C. Sachdeva, "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, 1981.
- John H. Lienhard, "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
- MathurM.Sharma, R.P., "Gas Turbine and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 1988

SAE4057	PROPULSION LAB (For Aeronautical)	L	T	P	Credit s	Total Marks
		0	0	4	2	100

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: Estimate the flash point and fire point of the aviation fuel.

CO2: Evaluate the characteristics of free jet, wall jet and axial flow compressor.

CO3: Demonstrate the pressure distribution of Convergent and Divergent Nozzle.

CO4: Perform the study of Aircraft piston and Turbojet engine

CO5: Evaluate the free and forced convection heat transfer.

CO6: Elucidate the performance of Gas turbine Engine

SUGGESTED LIST OF EXPERIMENTS

1. Determination of heat of combustion of aviation fuel
2. Determination of free jet characteristics and velocity profile.
3. Determination of wall jet characteristics and velocity profile.
4. Determination of axial flow compressor performance.
5. Estimation of pressure distribution in Convergent nozzle passage.
6. Estimation of pressure distribution in Divergent nozzle passage.
7. Study of Aircraft piston and Turbojet engine propeller.
8. Study of free convective heat transfer over a square plate.
9. Study of forced convective heat transfer over a cylindrical duct.
10. Evaluation of performance of Gas turbine Engine.

SAE4058	AIRCRAFT DESIGN PROJECT LAB - I (For Aeronautical)	L	T	P	Credit s	Total Marks
		0	0	4	2	100

SUGGESTED LIST OF EXPERIMENTS

1. Data collection.
2. Comparative graphs and selection of main parameters.
3. Preliminary weight estimation.
4. Airfoil selection, Wing tail and control surfaces
5. Flap selection
6. Power plant selection
7. Balance diagram.
8. Drag estimation.
9. Rate of climb calculations at various altitudes, Turn performance
10. Range and Endurance, Takeoff and landing distance calculation
11. Stability calculations
12. Lift and Drag calculation of the entire aircraft using CFD tools.

SAE1401	AIRCRAFT COMPOSITE MATERIALS AND STRUCTURES (For Aeronautical)	L	T	P	C r e d i t s	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To make the student understand the analysis of composite laminates under different loading conditions and different environmental conditions.

COURSE OUTCOMES

- CO1: Comprehend the manufacturing processes of composite materials and its classification.
 CO2: Contrast the micromechanics and micromechanics behavior of composite material.
 CO3: Illustrate the failure modes of composite materials and sandwich panels.
 CO4: Estimate the mid plane strain and inter laminar stress of composite material.
 CO5: Evaluate the bending and buckling of laminated beams for different boundary conditions
 CO6: Examine the natural frequency of laminated beams and plates under in-plane loads.

UNIT 1 INTRODUCTION AND COMPOSITE FUNDAMENTALS

7 Hrs.

Composite Fundamentals- Role of constituent materials, Factors contribute to mechanical performance. Constituent Materials for Composites-Classifications of fibers and matrix, properties and applications. Structural applications of Composite Materials-Aerospace, Automobiles, Marine, Electrical, civil, Chemical etc. Manufacturing Processes-various open and closed moulding process.

UNIT 2 MECHANICS OF COMPOSITE LAMINA

11 Hrs.

Review of Basic Equations of Mechanics and Materials and Linear Elasticity in 3D and 2 -D plane stress and plane strain - Number of elastic constants for different materials. Stress-Strain Relations for a unidirectional and orthotropic lamina using macro Mechanics Analysis. Micro Mechanics-Effective Moduli of a continuous fiber-reinforced lamina - Models based on mechanics of materials, theory of elasticity.

UNIT 3 MECHANICS OF COMPOSITE LAMINA AND SANDWICH PANELS

9 Hrs.

Failure of Continuous Fiber -reinforced orthotropic Lamina, Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion. Hygrothermal effects on material properties on response of composites. Basic concepts of sandwich construction-Materials used for sandwich construction -Failure modes of sandwich panels.

UNIT 4 MECHANICAL BEHAVIOUR OF COMPOSITE LAMINATES

7 Hrs.

Classical lamination theory- A, B, D matrix for symmetric, Anti-symmetric, non-symmetric and quasi isotropic laminates. Determination of mid plane strains and curvatures. Inter laminar stresses. Effects of stacking sequence, Design guidelines.

UNIT 5 BENDING, BUCKLING AND VIBRATIONS OF LAMINATED BEAMS AND PLATES

11 Hrs.

Governing equations and boundary conditions, Solution techniques, deflection of composite beams and plates under transverse loads for different boundary conditions, buckling of laminated beams and plates under in -plane loads, vibration of laminated beams and plates under different boundary conditions.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Autar K .Kaw Mechanics of Composite Materials, CRC Press 1997
2. Jones, R.M., Mechanics of Composite Materials, 2ndEdition, Taylor &Francis, Philadelphia, PA, 1999
3. Kollar L. P, George S, " Mechanics of Composite Structures" -. Springer, Cambridge University Press.
4. Agarwal, B.D.,and Broutman, L.J., "Analysis and Performance of Fiber Composites", John Wiley and sons. Inc., New York, 1995.
5. Madhujit Mukhopadhyay, Orient Longman "Mechanics of Composite Materials and Structures".

SAE1402	ROCKETRY AND SPACE DYNAMICS (For Aeronautical)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

To give exposure on important topics like rocket motion, rocket aerodynamics and staging & control of rockets to students to enrich their knowledge in the area of missile flight

COURSE OUTCOMES

CO1: Illustrate the ignition system and type of injectors used in rockets systems.

CO2: Comprehend the aerodynamic forces and moments of rockets in motion.

CO3: Interpret the motion of body in space and earth's atmosphere with respect to celestial system.

CO4: Contrast the motion of two body and three body problem of satellite orbits.

CO5: Interpret the equation of motion of a particle in center field using Kepler orbits.

CO6: Discriminate the equation of motion of a particle in center field using Perturbed orbits.

UNIT 1 ROCKETS SYSTEM

9 Hrs.

Ignition System in rockets – types of Igniters – Igniter Design Considerations – Design Consideration of liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks Outlet and Helium Pressurized and Turbine feed Systems – Propellant Slosh and Propellant Hammer – Elimination of Geysering Effect in Missiles – Combustion System of Solid Rockets.

UNIT 2 AERODYNAMICS OF ROCKETS

9 Hrs.

Airframe Components of Rockets – Forces Acting on a Rocket While Passing Through Atmosphere – Classification of rockets – methods of Describing Aerodynamic Forces and Moments – Lateral Aerodynamic Moment – Lateral Damping Moment and Longitudinal Moment of a Rocket – lift and Drag Forces – Drag Estimation – Rocket Dispersion – Numerical Problems

UNIT 3 BASIC CONCEPTS

9 Hrs.

The Solar System – References Frames and Coordinate Systems – The Celestial Sphere – The Ecliptic – Motion of Vernal Equinox – Sidereal Time – Solar Time – Standard Time – The Earth's Atmosphere.

UNIT 4 THE GENERAL N-BODY PROBLEM

9 Hrs.

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 – Orbital Elements.

UNIT 5 ORBIT DYNAMICS

9 Hrs.

Basic physical principles, Two body problem, Moment of momentum, Equation of motion of a particle in a central force field, Time and Keplerian orbits, Keplerian orbits in space, Perturbed orbits: Non -Keplerian orbits, Perturbing forces and their influence on the orbit, Perturbed geostationary orbits, Euler –Hill equations

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 1993.
2. Van de Kamp, P., "Elements of Astro-mechanics", Pitman, 1979.
3. Parker E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982
4. Cornelisse, J.W., "Rocket Propulsion and Space Dynamic", W.H. Freeman & Co., 1984.

SAE4059	AIRCRAFT DESIGN PROJECT LAB - II (For Aeronautical)	L	T	P	Credits	Total Marks
		0	0	4	2	100

SUGGESTED LIST OF EXPERIMENTS

1. V-n diagram
2. Wing and fuselage Design.
3. Shear force and bending moment diagrams of various aircraft structures.
4. Structural weight distribution.
5. Bending stress calculation.
6. Torque diagram
7. Shear flow calculations
8. Flexural shear flow
9. 3-view diagram based on the detailed design
10. Landing gear Design.
11. Detailed CAD drawings of wing, fuselage ,tail surfaces and control surfaces and their stress analysis using structural software
12. Detailed Design project report.

SAE4060	AIRCRAFT SYSTEMS AND MAINTENANCE LAB (For Aeronautical)	L	T	P	Credit s	Total Marks
		0	0	4	2	100

SUGGESTED LIST OF EXPERIMENTS

1. Aircraft "Jacking Up" and "Leveling" procedures
2. Aircraft "Symmetry" and control system "Rigging check" procedures
3. Checks on primary controls and electrically operated Flap Controls
4. Dismantling, Servicing, assembling and bleeding of brake unit.
5. Lap joint on the given sheet metal by riveting
6. Butt joint on the given sheet metal by riveting
7. Repair on panels by insertion Joint
8. Welding practice on aluminum sheets by TIG welding
9. Welding practice on mild steel by MIG and SPOT welding.
10. Tube bending and fairing practice.

SAE1403	AVIATION MANAGEMENT (For Aeronautical)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To apply planning, controlling and organizing principles in the air transportation sectors

COURSE OUTCOMES

CO1: Outline the service standards of Aviation sector company regulatory under International Air Transport Association.

CO2: Plan of aircraft regulations, guidance and policies for aviation services companies under International Civil Aviation Organization.

CO3: Summarize the distinctiveness and content of International Aviation law for global alliances.

CO4: Make use of Aircraft Management Interagency Committee for Aviation Policy Safety Standards for Federal flight programs.

CO5: Outline of Aviation Industry profitability and marketing strategies of contemporary Global industry.

CO6: Predict the marketing strategies in present state of Air Transport Industry.

Introduction to Aviation Management – Aviation – Aviation Sector in India - Civil Aviation – Airport – Air Traffic Control – International Air Transport Association (IATA) – Fact Sheet – Financial Services – IATA at the Air Transport Industry - IATA Industrial Priorities – IATA Partners – IATA Corporate and Corporate Governance Structure – IATA Human Capital – IATA Committee's – Cargo. Mandate. Environment. Financial, Legal, Operations, Industry Affairs – Rules and Regulations of the Industry Committee		9 Hrs.
UNIT 2 ICAO	International Civil Aviation Organization – Aerosol Aviation Services Corporation – Aviation Management Consulting Group - AOPA – International Association of Airport Executives – Federal Aviation Interactive Reporting Systems - Aircraft Regulations and Guidance – Convention on International Civil Aviation – Inter Agency Committee for Aviation Policy – Active Level of Services Reviews – Aircraft Engineers International Affiliation – AVSEC Rules and Regulations – Overview of Indian Air Travel – Case Study	9 Hrs.
UNIT 3 AIR LAW	The Distinctiveness and Content of International Aviation Law - Introduction to the Chicago Convention - The Geneva Convention (1948) - The Tokyo Convention (1963)- The Hague Convention (1970)- The Montreal Convention (1971) - The Cape Town Convention (2001)The International Civil Aviation Organization - Public and Private International Aviation Law The Role of International - The Freedoms of the Air - The International Law Regime for Airline Investment - and Global Alliances - . Circumventing the Nationality Rule: Global Alliances - The International Law Regime for Aircraft Financing - and Aircraft Nationality - International Aircraft Financing - Third-Party Effects of Secured Financing of Aircraft - Overview of International Aircraft Leasing	9 Hrs.
UNIT 4 AIR SAFETY	Air Safety – FAA Aviation Safety Draft Documents – Aircraft Management Interagency Committee for Aviation Policy Safety Standards – Aircraft Management Safety Standards Guidelines for Federal Flight Programmes – National Transportation Safety Board – Airline Water Supplies – JFIM	9 Hrs.
UNIT 5 AVIATION INDUSTRY	Overview of Contemporary Global Industry – Airline Industry Profitability – Present State of the Air Transport Industry – Aviation Industry – Global Aviation Industry – Indian Aviation- Case Studies	9 Hrs.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Ratandeep Singh, "Aviation Management", Kanishka Publishers, 2008
2. "Aircraft Manual – Volume 1 and Volume 2", Sterling Book House.
3. Kathleen M. Sweet, "Aviation and Airport Security", Pearson Education, 2004
4. "Aircraft Manual – Volume 1 and Volume 2", Sterling Book House
5. Senguttuvan P.S, "Fundamentals of Air Transport Management", Excel Books, First Edition 2006

SAE1610	INDUSTRIAL AERODYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle building aerodynamics and problems of flow induced vibrations.

COURSE OUTCOMES

CO1: Model and simulation in wind tunnels for analyzing the structure of turbulent flows in the winds.
CO2: Calculate the efficiency and performance of Horizontal axis and Vertical Axis Wind Turbines.
CO3: Estimate the aerodynamic performance and characteristics of automobiles and Hovercraft.
CO4: Identify the architectural aerodynamics of buildings for construction.
CO5: Determine the vortex shedding on wake formation in turbulent flows across wind galloping.
CO6: Determine the vortex shedding on launch vehicles and tall structures containing cylindrical shapes.

UNIT 1 ATMOSPHERE

6 Hrs.

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows. Roughness parameters, simulation techniques in wind tunnels

UNIT 2 WIND ENERGY COLLECTORS

8 Hrs.

Horizontal and vertical axis machines, energy density of different rotors, Power Coefficient, Betz coefficient by momentum theory.

UNIT 3 VEHICLE AERODYNAMICS

11 Hrs.

Boundary layers and separation, two dimensional wake and vortex formation Strouhal and Reynolds numbers, Separation and reattachments, Power requirements and drag coefficients of automobiles, Effects of cut back angle, aerodynamics of trains and Hovercraft

UNIT 4 BUILDING AERODYNAMICS

9 Hrs.

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

UNIT 5 FLOW INDUCED VIBRATIONS

11 Hrs.

Vortex shedding, lock & effects of Reynolds number on wake formation in turbulent flows across wind galloping-Wake galloping-along wind galloping of circular cables-oscillation of tall structures and launch vehicles under Wind loads-stall flutter.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Rose McCallen, Fred Browand, James Rose, "The aerodynamics of heavy vehicle- Trucks, buses and trains" Springer Berlin Heidelberg ,Newyork, 2004
2. Sovran, M(ed), "Aerodynamic drag mechanism of bluff bodies and road vehicles", Plenum Press, N.Y, 1978
3. Calvert N.G, "Wind Power Principles", Charles Griffin & Co London, 1979.
4. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 1978.
5. Sachs. P., "Winds forces in Engineering", Pergamon Press, 1978.

SAE1603	AIRFRAME MAINTENANCE	L	T	P	Credits	Total Marks
	AND REPAIR PRACTICES	3	0	0		

COURSE OBJECTIVE

To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures.

COURSE OUTCOMES

CO1: Extend the safety practices to be followed for handling ground support equipment and shop cleanliness.

CO2: Compare the hydraulic and pneumatic system handled for aircraft control systems and its devices.

CO3: Classify the different procedures for inspection, maintenance and blade tracking for aircraft and helicopters.

CO4: Inspect the corrossions in aircraft assemble and sub assemble parts and its preventive methods.

CO5: Inspect the sheet metal repair with one or two techniques which is reponsbile for your present work.

CO6: Check whether the given repair design may possess safe life design or fail safe design.

UNIT 1 SAFETY PRACTICES

9 Hrs.

Safety – Importance of Flight Safety, Maintenance of Ground Support Equipments, refueling, de-refueling, fire equipments, Hazardous materials storage and handling, Environmental and shop cleanliness – precautions, Aircraft furnishing -practices, Equipments, Hazard zones.

UNIT 2 REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM

9 Hrs.

Trouble shooting theory and Procedure, Inspection and maintenance of Hydraulic, Pneumatic, Fuel, Landing gear, Inspection and maintenance of Air conditioning, Pressurization systems Oxygen, De-icing, Fire Protection Installation and maintenance of instruments – Handling - Testing – Inspection, Position and warning system Auxiliary Power Units (APUs)

UNIT 3 AIRCRAFT JACKING, ASSEMBLY AND RIGGING

9 Hrs.

Airplane, Jacking and Weighing and C.G. Location. Rigging of control surfaces – Inspection, maintenance.

Helicopter flight controls, Tracking and balancing of main rotor.

UNIT 4 INSPECTION CORROSION AND ITS PREVENTIVE METHODS

9 Hrs.

General Inspection, inspections techniques, special inspection , aircraft publications, aircraft logs, check list, special instructions from manufacturer. Corrosion – types and classifications prevention, NDT checks.

UNIT 5 SHEET- METAL CONSTRUCTION, INSPECTION AND REPAIR

9 Hrs.

Design philosophies, factors affecting sheet metal part and joint design, sheet-metal inspection, types of inspection and classification of damage, stresses in structural members, repair of small holes and cracks, general rivet repair design guide lines, safe life design, fail safe design, damage-tolerance design, riveting procedure, application of safety factors

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Larry Reithmeir, Aircraft Repair Manual – Palamar Books, Marquette, 1992.
2. BrimmD.J.Bogges H.E., Aircraft Maintenance – Pitman Publishing Corp. New York, 1940.
3. Howard Curtis, Antonio Fillippone, Aerospace Engineering Reference, Butterworth – Heinmann, 2009
4. Micheal .J. Kroes, James .R. Rardon, Aircraft : Basic Science with Student Study Guide, McGraw Hill, 2007
5. Micheal J. Kroes, Alfred Watkins, Frank Delp, Aircraft Maintenance and Repair, 6th edition, McGraw Hill, New York, 1993

SAE1611	LAUNCH VEHICLES AND SPACECRAFT PROPULSION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To give exposure on important topics like satellite integration, rocket propulsion to students to enrich their knowledge in the area of Launch vehicles

COURSE OUTCOMES

- CO1: Design of the ramjet engine and scramjet engine ducts and performance calculations.
CO2: Determine the specific impulse of a rocket engine and internal ballistics of rocket performance.
CO3: Inspect the ignition system and injector used for propellant feed systems for rocket engine.
CO4: Select the appropriate type of propellants for solid, liquid and hybrid rocket engine.
CO5: Interpret the electric and ion propulsion functions used for interplanetary motion.
CO6: Utilize the solar sail, nuclear rocket and nozzle less propulsion for interplanetary motion.

UNIT 1 INTRODUCTION

10 Hrs.

Introduction - Historical Note / Basic Propulsion Devices - Architectural description of Launch Vehicles and Satellites - Rocket Equation / Staging / Payload - Launch weight relation - Propulsion Requirements / Thrust and time requirements - Types of rockets / propellants / choices.

UNIT 2 NOZZLE FLOWS AND AEROTHERMO CHEMISTRY

8 Hrs.

Nozzle flows / Introduction - Performance parameters - Review of aero thermo chemistry - Propellant and burning
- Internal Ballistics - Grains / Ignition etc.

UNIT 3 PROPELLANTS AND HEAT TRANSFER

10 Hrs.

System Description / Propellants - Combustion / Heat Transfer / Cooling - Feed Systems - R-4 Auxiliary Components - Monopropellants / Catalytic systems - Ignition / Restart / Environmental problems.

UNIT 4 SATELLITE INTEGRATION

8 Hrs.

Cold gas systems - Thruster satellite integration - Propellant management in spacecraft - Propellant access in microgravity.

UNIT 5 PROPULSION OPTIONS

9 Hrs.

Air breathing options in launch vehicles - Non chemical propulsion options - Nuclear Rockets.
Electrostatic and Electromagnetic propulsion. Special thermal and integration problems

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. G.P. Sutton : Rocket Propulsion Elements, Wiley, New York, 2006
2. C.D. Brown: Spacecraft Propulsion, AIAA Education Series, AIAA Inc., Washington DC, 1996 .

SAE1612	MISSILE TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To give exposure on important topics like missile systems, control of missile system and missile trajectory motion to students to enrich their knowledge in the area of missile technology

COURSE OUTCOMES

CO1: Identify the ignition system and type of injectors used in rockets systems.

CO2: Estimate the aerodynamic forces and moments of rockets in motion.

CO3: Determine the motion of body in space and earth's atmosphere with respect to celestial system.

CO4: Determine the motion of two body and three body problem of satellite orbits.

CO5: Solve the equation of motion of a particle in center field using Kepler orbits.

CO6: Solve the equation of motion of a particle in center field using Perturbed orbits.

UNIT 1 MISSILE SYSTEMS

9 Hrs.

Introduction - history - classification - missile system elements - missile ground systems - radars - launchers - coordinate frames - basics of trajectory dynamics - Missile equations of motion - coordinate systems - Rigid body equations of motion - D - Alembert principle.

UNIT 2 MISSILE CONTROL SYSTEMS

9 Hrs.

Introduction - Roll stabilization - Root locus for roll stabilization system - Transfer function - control of aerodynamic missiles - Missile auto pilot - boost autopilot - Transfer function for a ballistic type missile - Van guard control system - block diagram - root locus - Alternate control system.

UNIT 3 PROPULSION

9 Hrs.

Principles of jet propulsion and rocketry - nozzle theory and characteristic parameters - rockets solid and liquid propellant - Ramjet and Turbo jet engines - evaluation of flight performance - forces acting on vehicle - basic relations of motion - multi stage vehicles.

UNIT 4 NAVIGATION, GUIDANCE & CONTROL

9 Hrs.

Navigation - types - INS - GPS - radar based terrain mapping, guidance - explicit - Proportional Navigation guidance - Augmented Proportional Navigation guidance - Comparison of guidance system performance - Autopilot - control surfaces and actuators - Back to turn missile guidance.

UNIT 5 MISSILE TRAJECTORY CALCULATIONS

9 Hrs.

Vertical, inclined and gravity turn trajectories - determination of range and altitude ballistic missile intercept - missile tracking equations of motion - numerical computation of ballistic trajectories - Dynamics of stage separation.

Max.45 Hours

TEXT / REFERENCE BOOKS

1. George .P.Sutton ,OscarBiblarz "Rocket Propulsion Elements" Wiley publishers 8 th edition ,2010
2. J.ohn.H.Blakelock "Automatic control of aircraft and missiles" second edition wiley publishers 2011.
3. George.M.Siouris "Missile guidance and control systems " Springer second edition 2004.
4. Tactical and Strategic Missile Guidance , Fifth Edition, Paul Zarchan, Progress in Astronautics and Aeronautics, AIAA, 2007, ISBN-10: 1-56347-874-9
5. Missile Guidance and Control Systems, George M. Siouris, Springer-Verlag, 2004, ISBN: 0-387-00726.

SAE1615	UAV SYSTEM DESIGN	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To make the students to understand the basic concepts of UAV systems design.

COURSE OUTCOMES

CO1: Distinguish the model and prototype of UAV based on different applications.

CO2: Build a MAV using 3d printing techniques and calculate the aerodynamic performance.

CO3: Appraise the gyro actuators and servo accelerometer for autopilot system.

CO4: Show the payloads and telemetry tracking aerial controls and ground test analysis for trouble shooting.

CO5: Describe the way points navigation of UAV.

CO6: Describes the recent trends in UAV based on different case studies.

UNIT 1 INTRODUCTION TO UAV

9 Hrs.

History of UAV –classification –basic terminology-models and prototypes –applications

UNIT 2 BASICS OF AIRFRAME

9 Hrs.

Airframe –dynamics –modeling- structures –wing design- engines types-equipment maintenance and management-control surfaces-specifications. Study of low Reynolds number Aerodynamics-Building MAVs using rapid prototyping/3-D printing techniques.

UNIT 3 AVIONICS HARDWARE

9 Hrs.

Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply processor, integration, installation, configuration, and testing

UNIT 4 COMMUNICATION PAYLOADS AND CONTROLS

9 Hrs.

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback- radio control frequency, range –SAS-flight director-commands and videos-elements of control loops-flight computer, sensor-displays-parameter settings modems-memory system-simulation-ground test-analysis trouble shooting

UNIT 5 PATH PLANNING AND MAV

9 Hrs.

Waypoints navigation-ground control software-Recent trends in UAV-Case Studies

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Jane's Unmanned Aerial Vehicles and Targets, Jane's Information Group; ASIN: 071 061 2575,1999
2. R. Said and H. Chayeb, "Power supply system for UAV", KTH, 2002.
3. Robert C. Nelson, Flight Stability and Automatic Control, McGraw -Hill, Inc, 1998.
4. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316 X.34, 2002
5. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
6. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc,1998,
7. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001.

SAE1203	INTRODUCTION TO AERODYNAMICS (For Aeronautical)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

- To Study the applications of the conservation laws to flow through pipes and hydraulic machines.
- To understand the importance of dimensional analysis.
- To understand the importance of various types of flow in pumps and turbines.
- To understand the properties of basic flows.

COURSE OUTCOMES

- CO1: Estimate the applications of fluid flow governing equations through the identification of fluid properties.
- CO2: Illustrate the fluid flow problems theoretically through dimensional analysis and losses in pipes.
- CO3: Compile the combinations of elementary flow models utilized for solving the practical flow problems.
- CO4: Solve the boundary layer problems for streamlined and bluff bodies.
- CO5: Discriminate the types of pumps and its performance curves.
- CO6: Distinguish the different types of hydraulic turbines and its characteristics.

UNIT 1 FLUID PROPERTIES & EQUATIONS OF MOTION 14 Hrs.

Properties of fluids—Specific gravity, specific weight, viscosity, compressibility, vapor pressure and gas laws – capillarity and surface tension. Flow characteristics: concepts of system and control volume. Application of control volume to continuity equation, energy equation, momentum equation and Bernoulli's principle and its applications— Orifice meter, venturimeter, pitot –tube.

UNIT 2 DIMENSIONAL ANALYSIS AND FLUID FLOW IN CLOSED CONDUITS 13 Hrs.

Dimensional Analysis -, Buckingham Pi - theorem, Derivations and applications of important dimensionless numbers, basic modeling and similitude. Types of flow - velocity field and acceleration. Viscous fluid flow - Laminar and turbulent flow . Hagen - Poiseuille flow in circular pipes, Development of flow in pipes, Pipe friction, Darcy-Weisbach equation and Chezy's formula, Pipe losses - Major and Minor losses - Problems of parallel, series and branched pipes.

UNIT3 DYNAMICS 11 Hrs.

Equation of streamline, Stream function, velocity potential, relation between stream function and velocity potential, circulation. Basic elementary flows—Source, sink, free and forced vortex, uniform parallel flow and their combinations, pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows. Magnus effect, D'Alembert's paradox and Karman vortex street.

UNIT 4 FLUID FLOW OVER BODIES 11 Hrs.

Boundary layer theory-boundary layer development on a flat plate, displacement thickness, momentum thickness, Energy thickness, momentum integral equation, drag on flat plate- Nature of turbulence, Separation of flow over bodies- stream lined and bluff bodies, Lift and Drag on cylinder and Aero foil

UNIT5 PUMPS AND TURBINES 11 Hrs.

Impact of jets Centrifugal Pumps: Definition—Operations—Velocity Triangles—Performance curves—Cavitations— Multistaging. Hydraulic Turbines: Classification of hydraulic turbines – Working principle of Pelton wheel, Francis and Kaplan turbines –velocity triangles –draft tube—hydraulic turbine characteristics.

Max.60 Hours

TEXT / REFERENCE BOOKS

1. Bansal.R.K, "Fluid Mechanics & Hydraulics Machines", 9th Edition, Laxmi Publications, 2005
2. Kumar, K.L., Fluid Mechanics, 2nd Edition, Tata McGraw-Hill, New Delhi, 2000.
3. Irving H. Shames, Fluid Mechanics, 3rd Edition, McGraw-Hill.
4. Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, 5th Edition, John Wiley

SAE1204	INTRODUCTION TO AIRCRAFT STRUCTURES (For Aeronautical)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

At the end of this course, the student will have knowledge about the behavior of aircraft structural members

Subjected to various types of forces. The subject can be mastered best by solving numerous problems

COURSE OUTCOMES

CO1: Infer the stress and strain relationship through direct method and Mohr's circle method.

CO2: Analyze the shear force and bending moment for beams and sections.

CO3: Deduct the deflection of beams through moment-area and Macaulay's method.

CO4: Simplify the twisting moment and stresses in solid shafts and thin walled pressure vessels.

CO5: Solve the crippling load of the column through Rankine's and Euler's Theory.

CO6: Classify the different types of failure theories subjected to stress, strain, distortion and energy.

UNIT 1 CONCEPT OF SIMPLE STRESSES AND STRAINS

14 Hrs.

Concept of stress and strain, Hooke's law-Tension, Compression, and Shear, stress-strain diagram-Poisson's ratio, elastic constants and their relationship- Deformation of simple and compound bars. Thermal stresses- simple and Composite bars. Principal plane, principal stress, maximum shearing stress - Uniaxial, biaxial state of stress-Mohr's circle for plane stresses.

UNIT2 ANALYSIS OF BEAMS 14 Hrs.

Types of beams and loads-shear force and bending moment diagrams for cantilevers, simply supported and overhanging beams. Theory of pure bending- assumptions in the simple bending theory, Flexure formula: its application to beams of rectangular, circular and channel, I&T Sections,: Combined direct and bending stresses in fore mentioned sections, composite/ flitched beams.

UNIT 3 DEFLECTION OF BEAMS 11 Hrs.

Differential Equation of the Elastic Axis-Deflection and slope of beams-Double Integration, Area Moment and Macaulay's methods for simply supported, Cantilever and overhanging beams.

UNIT4 STRESSES IN SHAFTS, HELICAL SPRINGS AND THIN PRESSURE VESSELS 10 Hrs.

Torsion of Circular Shafts-Shear Stresses and Twist in Solid and Hollow Shafts. Closely Coiled Helical springs. Stresses in Thin Walled Pressure Vessels

UNIT5 COLUMNS AND FAILURE THEORIES 11 Hrs.

Columns- Member subjected to combined bending and axial loads, Euler's theory, Crippling load, Rankine's theory Failure theories - Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory

Max.60 Hours

TEXT / REFERENCE BOOKS

1. Malhotra, D.R. and Gupta, H.C., "The Strength of Materials", Satya Prakashan Tech. India Publications, New Delhi, 1987.
2. Kazimi, S.M.A., "Solid Mechanics", Tata McGraw Hill, 1976. Dym, C.L. and Shames I.H., "Solid Mechanics", McGraw Hill, Kogakusha, Tokyo, 1973.
3. Timoshenko, S., Young, "Elements of Strength of Material", Vol I & II, T. Van Nostrand Co Inc, Princeton, N.J. 1988.
4. Ferdinand P. Beer, and Russell Johnston, E., "Mechanics of Materials", SI Metric Edition, McGraw Hill, 2011.
5. Rajput, R.K., "Strength of materials", Fourth Edition, S. Chand Limited, 2007.

SAE1205	AERODYNAMICS- I	L	T	P	C r e d i t s	Total Marks
	(For Aeronautical)	3	1	0	4	100

COURSE OBJECTIVES

To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.

To make the student understand the concept of vorticity, irrotationality, theory of airfoils and wing sections.

To introduce the basics of viscous flow.

COURSE OUTCOMES

CO1: Design of airfoil section from the circular cylinder section using Joukowski transformation.

CO2: Interpret the coordinates of airfoil section utilizing thin airfoil theory.

CO3: Comprehend the vortex model of the wing influence of taper, twist, sweep back and Delta wing.

CO4: Estimate the lift, drag and moment characteristics of the airfoil section using 2D panel methods.

CO5: Simplify the boundary layer equations through integral method and Blasius solution.

CO6: Examine the effect of turbulence and various turbulence modelling for aircraft models.

UNIT1 GENERAL INTRODUCTION AND POTENTIAL FLOW

12 Hrs.

Atmosphere, Air speeds, Aerodynamic definitions Types of Drag, General Aerodynamic characteristics of airfoil sections. Complex potential, Singularities, Conformal mapping, Kutta-Joukowski transformation and Joukowski airfoil sections. Blasius integral theorem, Kelvin's circulation theorem. Generalized Kutta-Joukowski theorem and its applications.

UNIT2 AIRFOILS

10 Hrs.

Joukowski, Karman Trefftz Profiles, Von Mises airfoils, Starting vortex, Kutta condition-Glauert's thin airfoil theory-symmetrical and cambered airfoil, Thickness problem for thin airfoils.

UNIT 3 SUBSONIC WING THEORY

14 Hrs.

Downwash & induced drag, Vortex line, Horse Shoe Vortex, Biot and Savart Law, Flow past finite wings-vortex model of the wing-induced drag-Prandtl's lifting line theory-elliptic wing-influence of taper and twist applied to wings, Simplified horse shoe vortex, influence of downwash on tail plane. Effect of Sweep back, Delta wings in incompressible flows.

UNIT4 ADVANCED AIRFOIL THEORIES

10 Hrs.

2D Panel methods- Non-lifting flow solver arbitrary bodies, Source panel method, lifting flow solver arbitrary bodies vortex panel method, Numerical approach to lifting line theory, Vortex Lattice method.

UNIT 5 VISCOUS FLOWS

14 Hrs.

Derivation of Navier-Stokes equation for two-dimensional flows, boundary layer approximations, laminar boundary equations and boundary conditions, Blasius solution, qualitative features of boundary layer flow under pressure gradients, Integral method, aspects of transition to turbulence, turbulent boundary layer properties over a flat plate at low speeds. Effect of turbulence and various turbulence modeling.

Max.60 Hours

TEXT / REFERENCE BOOKS

1. Clancy, L.J., Aerodynamics, Pitman, 1986.
 2. Bertin, John J., Aerodynamics for Engineers, Pearson Education Inc., 2002
 3. Houghton, E.L., and Carruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
 4. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw Hill Book Co., New York, 1985
- Schlichting, H., Boundary layer theory McGraw Hill, New York 2004.

SAEA1303	AIRCRAFT SYSTEMS AND INSTRUMENTS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge of the hydraulic and pneumatic systems components.
- To understand the types of instruments and its operation including navigational instruments to the students.

UNIT 1 AIRCRAFT SYSTEMS 9 Hrs.

Hydraulic Systems – Types of Hydraulic oil -and its properties. Study of Typical Workable System – Components– Hydraulic System Components – Modes of Operation – Pneumatic Systems – Advantages – Working Principles –Components, case studies in modern aircrafts

UNIT 2 LANDING GEAR SYSTEMS 9 Hrs.

Landing Gear Systems – Classification – Purpose and types of Shock Absorbers. construction and its operation– LG - Retraction/extension Mechanism. Brake System types, components and advantages, antiskid system. Conventional and tubeless tires construction, advantages and common defects, modern advancements in tyre technologies. Brake systems.

UNIT 3 FUEL AND PRESSURIZING SYSTEM 9 Hrs.

Fuel system – Layout, Types of fuel tanks, locations, control pressure, sequence of fuel consumption, Basic Air Cycle Systems – Vapour Cycle Systems. Pressurization system – Principle-components-limitation- Oxygen systems – Fire Protection Systems, Deicing and Anti Icing Systems.

UNIT 4 AIRPLANE CONTROL SYSTEMS 9 Hrs.

Conventional Systems –Modern Flight Control Systems Control Actuation Digital Fly by Wire systems – Autopilot System. Active Control Technology – CCV, The Control Problem, Principles of actuation systems, Types of actuation systems.

UNIT 5 AIRCRAFT INSTRUMENTS 9 Hrs.

Flight Instrument and Navigation Instruments – Accelerometers, Air data instruments- airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack, Air Speed Indicators – Mach Meters – Altimeters – Gyroscopic Instruments – principles and Operation and types– Study of Various Types of Engine Instruments – Tachometers – Temperature Gauges – Pressure Gauges – Operation and Principles.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Describe the basic concepts of various hydraulic and pneumatic systems components in aircraft.
- CO2 - Recognize various types of Aircraft instruments.
- CO3 - Understanding the basics of various fuel and pressurizing system.
- CO4 - Understanding the working principle of Modern Flight Control Systems.
- CO5 - Understanding gyroscopic instruments in aircraft production.
- CO6 - Understanding the Flight Instrument and Navigation Instruments used in aircraft Production.

TEXT / REFERENCE BOOKS

1. Mekinly, J.L. and Bent, R.D., “Aircraft Power Plants”, McGraw Hill, 1993.
2. Pallet, E.H.J., “Aircraft Instruments & Principles”, Pitman & Co., 1993.
3. Treager, S., “Gas Turbine Technology”, McGraw Hill, 1997.
4. Mckinley, K.L., and Bent, R.D., “Aircraft Maintenance & Repair”, McGraw Hill 1993
5. General Hand Books of Airframe and Powerplant Mechanics”, U.S. Dept. of Transportation, Federal Aviation Administration, .the English Book Store, New Delhi, 1995.

SAEA1503	COMPUTATIONAL FLUID DYNAMICS FOR AEROSPACE APPLICATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of fluid dynamics computationally.
- To evaluate the characteristics of flows.
- To know the basic methods of various computational methods.
- To discuss the structural grid generation and turbulence models.

UNIT1 INTRODUCTION

9 Hrs.

Historical Background-of Computations - Classification of Partial Differential Equations- Introduction to Navier-Stokes System of Equations. Comparison of numerical, analytical and experimental.

UNIT2 FINITE DIFFERENCE METHODS AND SOLUTIONS

9 Hrs.

Finite Difference Methods-Finite Element Methods - Finite Volume Methods, Neumann Boundary Conditions, Dirichlet Boundary Conditions Burgers' Equation- Coordinate Transformation for Arbitrary Geometries.

UNIT3 INCOMPRESSIBLE VISCOUS FLOWS AND COMPRESSIBLE FLOWS

9 Hrs.

Pressure Correction Methods -Semi-Implicit Method for Pressure-Linked Equations -Pressure Implicit with Splitting of Operators -Marker-and-Cell (MAC) Method.

UNIT 4 STRUCTURED AND UNSTRUCTURED GRID GENERATION

9 Hrs.

Grid Generation: Introduction, Types of grid, Factors affecting the grid, Grid transformation, Prandtl-Mayer expansion waves, Stretched grids. : Numerical grid generation; basic ideas; transformation and mapping.

UNIT5 COMPUTING TECHNIQUES AND APPLICATION

9 Hrs.

Domain Decomposition Methods- Multigrid Methods- Parallel Processing- Turbulence Models- Zero-Equation Models- One- Equation Models -Two-Equation Models -Second Order Closure Models (Reynolds Stress Models) - Algebraic Reynolds Stress Models -Compressibility Effects- Direct Numerical Simulation- RANS- LES.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

- CO1 - Recall history and evolution of computational fluid dynamics.
- CO2 - Compare the mathematical modeling and numerical methods.
- CO3 - Understand the working methodology of various computational fluid methods.
- CO4 - Recognize the various functions of major turbulence models.
- CO5 - Analyze the quality of structural grids and suitable shapes and methods for it.
- CO6 - Distinguish the problems application based.

TEXT / REFERENCE BOOKS

1. Chung T.J Computational fluid dynamics, second edition –Cambridge University press USA, 2010.
2. Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", Taylor and Francis, 2011.
3. Principles of Computational Fluid Dynamics by P. Wesseling., 2011.
4. Shaw C T, "Using Computational Fluid Dynamics" Prentice Hall, 1992.
5. Anderson.J.D.Jr. "Computational Fluid Dynamics: An Introduction", 3rd Edition, 2012.

PRACTICAL SAEA2603	AIRCRAFT DESIGN PROJECT LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVES

- To classify the types of Aircrafts and its data collection.
- To estimate the weight of an Aircraft pertaining to preliminary hand calculations
- To select the appropriate airfoil, wing tail, control surface and power plant for the preliminary design Aircraft.
- To analyze the performance of the preliminary design Aircraft.
- To perform the structural analysis of the preliminary design Aircraft.
- To design the landing gear opted for the newly designed Aircraft.

SUGGESTED LIST OF EXPERIMENTS

1. Data collection.
2. Preliminary weight estimation.
3. Airfoil selection, Wing tail and control surfaces
4. Power plant selection
5. Balance diagram.
6. Drag estimation.
7. Rate of climb calculations at various altitudes, Turn performance
8. Range and Endurance, Takeoff and landing distance calculation
9. Stability calculations
10. V-n diagram
11. Wing and fuselage Design.
12. Shear force and bending moment diagrams of various aircraft structures.
13. Structural weight distribution.
14. Landing gear Design.
15. Detailed CAD drawings of wing, fuselage, tail surfaces and control surfaces and their stress analysis using structural software
16. Detailed Design project report.

COURSE OUTCOMES

At the end of the course, student will be able to:

- CO1: Categorize the types of Aircraft and its specifications to perform the conceptual design of new Aircraft.
- CO2: Estimate the gross weight and payload weight of an Aircraft for the preliminary designed Aircraft.
- CO3: Deduct the appropriate selection of airfoil, wing-tail configuration for the preliminary Aircraft.
- CO4: Analyze the preliminary designed Aircraft's performance and its control.
- CO5: Evaluate the structural analysis of airframe parts of the preliminary designed Aircraft.
- CO6: Design the appropriate landing gear that suits the preliminary designed Aircraft.

SAEA2602	AIRCRAFT MAINTENANCE AND REPAIR LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

➤ To make the students to understand the Airframe components and the tools used to maintain the components.

SUGGESTED LIST OF EXPERIMENTS

1. Performing the stripping of piston Engine procedures.
2. Engine (Piston Engine) – cleaning, visual inspection, NDT checks.
3. Piston Engine Components – dimensional checks.
4. Piston Engine reassembly procedures.
5. Estimation of the propeller pitch setting.
6. Performing the stripping of a Jet Engine.
7. Jet Engine – Identification of components & defects, NDT checks, and dimensional checks.
8. Performing the Jet Engine – reassembly.
9. Training and Performing the ground run engine of propeller-powered aircraft.
10. Perform the startup procedure for a piston-powered aircraft.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Perform the study of the Aircraft Piston and its components.
- CO2 – Examine the damages through Inspection checks.
- CO3 – Demonstrate the procedure for Engine stripping
- CO4 – Evaluate the propeller pitch and twist.
- CO5 – Perform the propeller efficiency of the piston-engine aircraft.
- CO6 – Elucidate the engine startup procedures.

SAEA1702	UNMANNED AERIAL VEHICLE DESIGN	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying aerodynamics to UAV Design.
- To familiarize the student's ability to analyse the concepts of Avionics.
- To understand the basics of navigation in UAV Design.
- To understand the basics of Image Processing.

UNIT 1 INTRODUCTION TO UAV

9 Hrs.

History of UAV –classification –basic terminology- The Systemic Basis of UAV-System Composition- Conceptual Phase- Preliminary Design-Selection of the System- Some Applications of UAV- Characteristics Of Aircraft Types.

UNIT 2 BASICS OF AERODYNAMICS AND AIRFRAME CHARACTERISTICS OF UAV

9 Hrs.

Lift-induced Drag - Parasitic Drag - Rotary-wing Aerodynamics - Response to Air Turbulence- Airframe –dynamics – modelling- structures –wing design- engines types-equipment maintenance and management-control surfaces- specifications.

UNIT 3 AVIONICS HARDWARE

9 Hrs.

Geysering Phenomenon. Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply processor, integration, installation, configuration, and testing.

UNIT 4 COMMUNICATION PAYLOADS, CONTROLS AND NAVIGATION

9 Hrs.

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency , range –SAS-flight director- commands and videos-elements of control loops-flight computer, - Sensors- Waypoints navigation.

UNIT 5 DIGITAL IMAGE PROCESSING FOR UAV

9 Hrs.

Principles of digital aerial photography- Sensors for aerial photography - Photo-interpretation, objective analysis and image quality - Image Recognition - Image Classification – Image Fusion – Colour Image Processing - Video Motion Analysis.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Understand the working principles of Unmanned Aerial Vehicle.
- CO2 - Comprehend the sound foundation in the Aerodynamics and Airframe characteristics. CO3 - Learn the operation of Avionics Hardware.
- CO4 - Understand the concept of Communication payloads.
- CO5 - Understand the principle and performance of control and navigation. CO6 - Applying the importance of Digital image processing for UAV.

TEXT / REFERENCE BOOKS

1. Kimon P. Valavanis, George J. Vachtsevanos, "Handbook of Unmanned Aerial Vehicles " Volume Set- FIRST Edition, ISBN-13: 978-9048197064, 2015.
2. R. Jha. "Theory, Design, and Applications of Unmanned Aerial Vehicles". 1st Edition, 2015.
3. Jane's Unmanned Aerial Vehicles and Targets, Jane's Information Group; ASIN: 071 061 2575, 1999.
4. Alex Elliott, "Build Your Own Drone Manual: The practical guide to safely building, operating and maintaining an Unmanned Aerial Vehicle (UAV)". 2016.
5. R. Said and H. Chayeb, "Power supply system for UAV", KTH, 2002.
6. Robert C. Nelson, Flight Stability and Automatic Control, McGraw -Hill, Inc, 1998.
7. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316 X.34, 2002.
8. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007.

SAEA3014	BOUNDARY LAYER THEORY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the importance of boundary layer in Aerodynamics.
- To understand various types of boundary layers and their applications.

UNIT 1 VISCOUS FLOW EQUATIONS

9 Hrs.

Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekman drift.

UNIT 2 LAMINAR BOUNDARY LAYER

9 Hrs.

Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness - Momentum and energy thicknesses for two dimensional flow – Two dimensional boundary layer equations – Similarity solutions - Blasius solution.

UNIT 3 TURBULENT BOUNDARY LAYER

9 Hrs.

Physical and mathematical description of turbulence, two-dimensional turbulent boundary layer equations, Velocity profiles – Inner, outer and overlap layers, Transition from laminar to turbulent boundary layers, turbulent boundary layer on a flat plate, mixing length hypothesis.

UNIT 4 APPROXIMATE SOLUTION TO BOUNDARY LAYER EQUATIONS

9 Hrs.

Approximate integral methods, digital computer solutions – Von Karman – Polhausen method.

UNIT 5 THERMAL BOUNDARY LAYER

9 Hrs.

Introduction to thermal boundary layer – Heat transfer in boundary layer - Convective heat transfer, importance of non dimensional numbers – Prandtl number, Nusselt number, Lewis number etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Apply the basic fundamentals of Different types of Boundary layer thickness.
- CO2 - Analyze the behavior of the fluid flow under static condition.
- CO3 - Understand the basics of Different types of flow such as Laminar, turbulent and compressible flow, Incompressible flow, Viscid and Inviscid flow.
- CO4 - Basics of Boundary layer Control.
- CO5 - Flow through pipe of different types of flow.
- CO6 - Importance of non-dimensional numbers.

TEXT / REFERENCE BOOKS

1. Schlichting H., "Boundary Layer Theory", McGraw Hill, New York, 2010.
2. Frank White, Viscous Fluid flow, McGraw Hill, 2011.
3. Reynolds A.J., "Turbulent flows in Engineering", John Wiley & Sons, 2013.
4. Ronald L., Panton, "Incompressible fluid flow", John Wiley & Sons, 1984.

SAEA3015	HIGH TEMPERATURE MATERIALS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To learn damage mechanism and failure of components of elevated temperatures.
- To know the basic functions of creep and fracture of materials.
- To discuss the oxidation and hot corrosion.

UNIT1 CREEP

9 Hrs.

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.

UNIT2 DESIGNFORCREEPRESISTANCE

9 Hrs.

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monk man-Grant relationship.

UNIT3 FRACTURE

9 Hrs.

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides.

UNIT4 OXIDATIONANDHOTCORROSION

9 Hrs.

Oxidation, Pilling, Bed worth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion.

UNIT5 SUPERALLOYSANDOTHERMATERIALS

9 Hrs.

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

- CO1 - Recall the basics of materials.
- CO2 - Understand the behavior of creep and fracture.
- CO3 - Understand the oxidation and hot corrosion.
- CO4 - Recognize the functions of super alloys.
- CO5 - Analyze the ductile and brittle materials.
- CO6 - Analyze the temperature strain rate.

TEXT /REFERENCE BOOKS

1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals USA, 2011.
2. Hertzberg R.W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 2012.
3. Courtney T.H, "Mechanical Behaviour of Materials", McGraw Hill, USA, 2012.
4. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 2013.
5. Bressers.J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
6. McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985.

SAEA3016	FLIGHT VEHICLES' GUIDANCE AND CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of guidance and control of flight vehicles.
- To evaluate the performance of flight vehicle's transformation.
- To know the basic functions of navigation.
- To discuss the methodology of modeling of aerospace vehicles.

UNIT1 GUIDANCE

9 Hrs.

Over view of flight vehicles: The initial conceptual sketches, L / D estimation. Initial takeoff weight build-up, empty weight estimation, historical trends, fuel fraction estimation, mission profiles, mission segment weight fractions, Review of governing equations of motion for aerospace vehicles, Linear systems analysis of aerospace systems, Applications - aircraft, spacecraft, missiles, launch vehicles.

UNIT 2 FLIGHTVECHICE'STRANSFORMATION

9 Hrs.

Introduction to the concepts of navigation guidance and control: General principles of early conventional navigation systems. Geometric concepts of navigation. Reference frames. Direction cosine matrix, Euler angles, Transformation of angular velocities, Quaternion representation in co-ordinate transformation. Comparison of transformation methods.

UNIT3 NAVIGATION

9 Hrs.

Navigation: Navigation computation and error modeling, Inertial navigation systems, External navigation aids - GPS, Doppler radar, Star trackers, Multi-sensor fusion.

UNIT4 PERFORMANCE

9 Hrs.

Guidance: Guidance mission and performance, Guidance algorithm - guidance laws, single-dual-multi-mode guidance, Advanced guidance system design.

UNIT5 MODELLING

9 Hrs.

Modeling of Aerospace vehicles: Linear system analysis, Stabilization and Control of space crafts, Missile control systems and Autopilots, Launch vehicle flight control systems. Longitudinal and lateral autopilots for aircraft. Radar systems command and housing guidance system.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

- CO1 - Recall basics of flight mechanics.
- CO2 - Understand the basic working principle of guidance and control of flight vehicles.
- CO3 - Understand the working of flight transformation in various planes.
- CO4 - Recognize the functions guidance algorithm.
- CO5 - Understand the missile control system.
- CO6 - Distinguish the basics of functions of radar and launch vehicle flight control system.

TEXT / REFERENCE BOOKS

1. Flight without Formulae by A.C Kermode, Pearson Education, 10th Edition, 2011.
2. Mechanics of Flight by A.C Kermode, Pearson Education, 5th Edition, 2012.
3. Fundamentals of Flight, Shevell, Pearson Education, 2nd Edition, 2013.
4. 'Modern Navigation, Guidance and Control Processing, Ching-Fang Lin, Prentice Hall Inc., Englewood Cliffs, New Jersey, 2011.
5. 'Guided Weapon Control Systems', Garnele P, Pergamon, 1980.

SAEA3017	MANNED SPACE MISSIONS		T	P	Credits	Total Marks
			0	0	3	100

COURSE OBJECTIVES

- Know the advanced concepts of manned space missions to the engineers.
- Understand the space and environment and its conditions.
- Apply the concept of life supporting devices.

UNIT1 FUNDAMENTALS OF SPACE MISSIONS

9 Hrs.

The physics of space, Current missions: space station, Moon mission and Mars missions, Engineering challenges on Manned vs. unmanned missions, Scientific and technological gains from space programs, Salient features of Apollo and Space station missions, space shuttle mission.

UNIT2 SPACE VS EARTH ENVIRONMENT

9 Hrs.

Atmosphere: Structure and Composition, Atmosphere: Air Pressure, Temperature, and Density, Atmosphere: Meteoroid, Orbital Debris & Radiation Protection, Human Factors of Crewed Spaceflight, Safety of Crewed Spaceflight, Magnetosphere, Radiation Environment: Galactic Cosmic Radiation (GCR), Solar Particle Events (SPE), Radiation and the Human Body, Impact of microgravity and g forces on humans, space adaptation syndrome.

UNIT 3 LIFE SUPPORT SYSTEMS AND COUNTERMEASURES

9 Hrs.

Life Support Systems and Space Survival Overview, Environment Controlled Life Support Systems (ECLSS), Human / Machine Interaction, Human Factors in Control Design, Crew Accommodations.

UNIT4 MISSION LOGISTICS AND PLANNING

9 Hrs.

Group Dynamics: Ground Communication and Support, Space Resources and Mission Planning - Space Mission Design: Rockets and Launch Vehicles - Orbital Selection and Astrodynamics, Entry, Descent, Landing, and Ascent, Designing and Sizing Space elements, Transfer, Entry, Landing, and Ascent Vehicles, Designing, Sizing, and Integrating a Surface Base, Planetary Surface Vehicles.

UNIT5 SUBSYSTEMS

9 Hrs.

Spacecraft Subsystems: Space Operations, Space Architecture, Attitude Determination and Control- Designing Power Systems, Extravehicular Activity (EVA) Systems, Space Robotics, Mission Operations for Crewed Spaceflight - Command, Control, and Communications Architecture.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 - Understand the working principles of basic control system.
- CO2 - Comprehend the sound foundation in the various subsystems.
- CO3 - Learn the advanced concepts of manned space missions to the engineers.
- CO4 - Understand the space and environment and its conditions.
- CO5 - Understand the the principle and performance of various subsystems.
- CO6 - Applying the importance of the mission logistics and planning.

TEXT / REFERENCE BOOKS

1. Larson, W. J. and Pranke, L. K., Human Spaceflight: Mission Analysis and Design, McGraw-Hill Higher Education, Washington, DC, 1999
2. McNamara, Bernard. 2010. Into the Final Frontier: The Human Exploration of Space (Brooks/Cole Publishing), 2012.
3. Larson, W. J. and Pranke, L. K., Human Spaceflight: Mission Analysis and Design, McGraw-Hill Higher Education, Washington, DC, 1999
- 2 McNamara, Bernard. 2013. Into the Final Frontier: The Human Exploration of Space, 2012.
4. Connors, M.M., Harrison, A.A., and Akins, F.R. 2005. Living Aloft: Human Requirements for Extended Spaceflight, University Press of the Pacific, Honolulu, Hawaii.

SAEA3020	HEAT TRANSFER TECHNIQUES	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

- To learn the various modes of heat transfer and understand the basic concepts of mass transfer
- To understand the applications of various experimental heat transfer correlations in engineering applications.
- To discuss the thermal analysis and sizing of heat exchangers
- To understand the concepts of high speed flow heat transfer

UNIT 1 INTRODUCTION AND CONDUCTION HEAT TRANSFER

9 Hrs.

Basic modes of heat transfer – One dimensional steady state heat conduction – Cartesian, cylindrical and spherical coordinates – Composite medium – Critical thickness – Effect of variation of thermal conductivity – Extended surfaces. Conduction with heat generation. Unsteady state heat conduction – Heat transfer analysis of Lumped system, Semi-infinite and infinite solids – Use of Transient-Temperature charts - Applications of numerical techniques.

UNIT 2 CONVECTIVE HEAT TRANSFER

9 Hrs.

Introduction-Forced Convection-Development of velocity and thermal boundary layer by a flow on a vertical flat plate – Laminar and turbulent convective heat transfer analysis in flows over a flat plate, circular pipe and spherical surface. Free convective heat transfer over vertical flat plate, cylinders and spheres – Empirical relations, applications of numerical techniques in problem solving.

UNIT 3 RADIATIVE HEAT TRANSFER

9 Hrs.

Introduction – Physical mechanism of radiation – Radiation properties – Characteristics of surfaces- Emissivity – Radiation shaper factor – Heat exchange between non-black bodies – Radiation shields.

UNIT 4 HEAT EXCHANGERS

9 Hrs.

Classification of heat exchangers – Temperature distribution – Overall heat transfer coefficient – Heat exchange analysis – LMTD Method and E-NTU Method.

UNIT 5 HEAT TRANSFER IN HIGH SPEED FLOW

9 Hrs

High-Speed flow heat transfer - Heat transfer in gas turbine combustion chamber-ablative heat transfer- Aerodynamic heating – Rocket thrust chambers - Numerical treatment.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Compare the various modes of heat transfer and analyse the conduction heat transfer in various systems in both steady and unsteady state conditions

CO2: Distinguish natural and forced convection phenomena and measure the heat transfer coefficient in external and internal fluid flow problems.

CO3: Apply the laws of radiation, analyse the radiation exchange between surfaces and the effect of radiation shields

CO4: Distinguish the types of heat exchangers and design the heat exchanger with LMTD and NTU approach

CO5: Describe the principles of high speed flow heat transfer and analyse the heat transfer problems in gas turbine combustion chamber

CO6: Describe the application of high speed flow heat transfer in aerospace components and analyse the heat transfer by numerical methods.

TEXT / REFERENCE BOOKS

1. Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 7th Edition, John Wiley, 2011.
2. Holman, J.P., Heat Transfer, 10th Edition, Tata McGraw-Hill, 2010.
3. Cengel, Y.A., Heat Transfer - A Practical Approach, 2nd Edition, McGraw-Hill, 2002.
4. Sachedva, R.C., Fundamentals of Heat and Mass Transfer, 4th Edition, New Age International, 2012
5. Desmond E. Winterbone and Ali Turan; Advanced Thermodynamics for Engineers, Elsevier Ltd, 2015
6. Bengt Sunden and Juan Fu., Heat Transfer in Aerospace Applications, Academic Press, 2016

SAE1308	AIRCRAFT DESIGN (For Aeronautical)	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES

To get clear cut idea about aerodynamic design, aircraft structural design and power plant design

COURSE OUTCOMES

- CO1: Identify the type of aircraft design specifications and estimate the overall takeoff weight.
CO2: Calculate the design load factor for cruise and stall conditions of the aircraft to be designed.
CO3: Plot the shear force and bending moment diagram for the aircraft wing to be designed.
CO4: Select the appropriate power plant for the aircraft to be designed and estimation of thrust.
CO5: Design of supersonic aircraft wings and its optimization technique to achieve the desired performance.
CO6: Interpret the design features of V/STOL and rotary wing aircrafts.

UNIT 1 PRELIMINARY DESIGN

11 Hrs.

Introduction, Aircraft Design Requirements, specifications, role of users, Aerodynamic and Structural Consideration, Importance of weight. Airworthiness requirements and standards. Classifications of airplanes. Special features of modern airplane, Airplane Weight Estimation, Weight estimation based on type of airplane, trends in wing loading, weight-estimation based on mission requirements, iterative approach.

UNIT 2 AERODYNAMIC DESIGN AND PERFORMANCE

10 Hrs.

Basics of Wing Design, Selection of airfoil selection, influencing factors. Span wise load distribution and plan form shapes of airplane wing. Stalling, take-off and landing considerations. Wing drag estimation. High lift devices, Air Loads in Flight, Symmetrical measuring loads in flight, Basic flight loading conditions, Load factor, Velocity - Load factor diagram, gust load and its estimation, Structural limits.

UNIT 3 STRUCTURAL DESIGN

10 Hrs.

Cockpit and aircraft passenger cabin layout for different categories, types of associated structure, features of light airplanes using advanced composite materials, Structural aspects of design of airplane, Bending moment and shear force diagram. Design principles of all metal stressed skin wing for civil and military applications.

UNIT 4 POWER PLANT DESIGN

7 Hrs.

Estimation of Horizontal and Vertical tail volume ratios. Choice of power plant and various options of locations, considerations of appropriate air –intakes. Integration of wing, fuselage, empennage and power plant. Estimation of center of gravity.

UNIT 5 ADVANCED DESIGN CONCEPTS

7 Hrs

Supercritical Wings, relaxed static Stability, controlled configured vehicles, V/STOL aircraft and, rotary wing vehicles. Layout peculiarities of supersonic aircraft – optimization of wing loading to achieve desired performance – loads on undercarriages and design requirements.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Raymer D.P. "Aircraft Conceptual design", AIAA Series, 1988.
 2. Corning G. "Supersonic & Subsonic Airplane Design", II Edition, Edwards Brothers Inc., Michigan, 1953.
 3. Bruhn E.F, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.
 4. Torenbeek E, "Synthesis of Subsonic Airplane Design", Delft University Press, London, 1976.
- Lebedenski A.A, "Notes on airplane design", Part-I, I.I.Sc., Bangalore

SAE1605	AIRPORT ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To know about the airport planning, airport design and air traffic control

COURSE OUTCOMES

CO1: Describes the structure of the Airport and its infrastructure coming under AAI and IAAI.

CO2: Construct the Airport infrastructure as per FAA and ICAO standards.

CO3: Design of the airport terminal infrastructure as per FAA Pavement design methods and joints in cement concrete pavements.

CO4: Design of the runway lightning, marking centerline and sign operation for aircraft taxiway guidance system.

CO5: Develop the Air Traffic Control by Network control method in airports for landing the aircrafts in touch down point.

CO6: Develop the Air Traffic Control by Tower control Flight service station for landing and takeoff the aircrafts.

UNIT 1 INTRODUCTION

10 Hrs.

Significance of Air Transport -Economic Significance - History of Aviation - Air Transportation in India – Indian Airlines Corporation - Air India - International Corporation - International – Airport Authority of India - (IAAI) – Civil Aviation – Open Sky Policy – Airport Terminology - Component Parts of Airplane – Characteristics of The Jet Aircraft – Civil and Military Aircrafts Classification of Aerodromes, Classification Of Airports – Flying Activities - Aircraft Characteristics - Dimensional Standards - Landing Gear Configurations - Aircraft Weight - Engine Types - Wind Speed And Direction - Payload And Range -Runway Performance - Air Traffic Management - Flight Service Stations - Airspace Classifications And Airways - Area Navigation - Air Traffic Separation Rules - Longitudinal Separation - Lateral Separation In The Airspace - Navigational Aids - Ground-Based Systems

UNIT 2 AIRPORT PLANNING

10 Hrs.

The Airport System Plan - Master Plan - Project Plan - Continuing Planning Process - Levels Of Forecasting - Forecasting Methods - Time Series Method - Market Share Method - Econometric Modeling - Airport Design Standards – ICAO Standards - FAA Standards - Airport – Surveys –types Of Surveys - drawings - Capacity – Improving –Traffic Forecast – Planning – Airport Site Selection – Different Conditions - Zoning Laws – Airport Architecture - Environmental- Factors - Runway Orientation - Head Wind, - Cross Wind - Component- Wind rose – Runway Length – Corrections - Geometric Design Of Runways - Balanced Field - Concept - Airport Capacity – Runway – Patterns- Runway Types - Geometric Design Of Runway Intersection – Layout Of Taxiways Arrangement, Geometric Standards For Taxiway - Gradient - Exit Taxiways Air Traffic Control – Angle Of Turn, Compound Curve - Occupancy Time – Shape Of Taxiway – Loading Aprons – Holding Aprons - Configuration - Entry Runway - Holding Bays - Location – Peak Demands – Simple Problems - Capacity And Delay - Formulation Of Runway Capacity Through - Formulation Of Ultimate Capacity - Hourly Capacity -Parameters Required For Runway Capacity - Computation Of Delay On Runway Systems -Graphical Methods For Approximating - Simulation Models - Gate Capacity - Analytical Models For Gate Capacity.

UNIT 3 TERMINAL AREA DESIGN

9 Hrs.

Terminal Building Design Objectives – Passenger Flow – Parking – Size Of Apron – Hangars - Jet Blast – Typical Airport Layouts-Military Layouts – Types Of Pavements – Design Factors – Design Of Flexible, Rigid Pavements – LCN Method – Pavement failures – Maintenance ,Evaluation Of Airport Pavements – The CBR test - The Plate Bearing Test - Young's Modulus (E Value) - Effect Of Frost On Soil Strength -Subgrade Stabilization - FAA Pavement Design Methods –Aircrafts-Pavement Classification – Joints In Cement Concrete Pavements - Pumping – Design –Pavements – Drainage – Importance Of Grading –Basic Requirements Of Airport Drainage- Surface Drainage – Design Procedure – Subsurface Drainage – Types Of Pipes

UNIT 4 AIRPORT LIGHTING, MARKING, AND SIGNAGE

8 Hrs.

The Requirements For Visual Aids - The Airport Beacon - The Aircraft Landing Operation - Alignment Guidance - Height Information - Approach Lighting -Visual Approach Slope Aids - Visual Approach Slope Indicator Precision Approach Path - Threshold Lighting - Runway Lighting - Runway Edge Lights - Runway Centerline And Touchdown Zone Lights - Runway Stop Bar - Runways - Runway Designators -Runway Threshold Markings – Different Types Of Markings - Taxiway Guidance Sign System - Signing Conventions - SignOperation

UNIT 5 AIR TRAFFIC CONTROL

8 Hrs.

Importance – Air Traffic Control – Flight Rules - Meaning,- Responsibility – Type Of Control – Air Traffic Control Network –Control - Towers – Flight Service Stations - Air Traffic Control Aids — GPS Air Traffic Control-Free Flight Types - Heliports- Stolports – Planning Of Heliport Ports – Characteristics of Stolports- Planning of StolPorts

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Airport Engineering ,Rangwala , Charotar Publishing House Pvt. Ltd . Anand 388 001 India , 14th Edition ,2014
2. Planning And Design Of Airports, Fifth Edition Robert Horonjeff, Francis Mckelvey, William Sproule, Seth Young ,McGraw Hill Pvt Ltd, New Delhi, 2013
3. Airport Engineering: Planning, Design And Development Of Development Of 21st Century Airports, Norman J. Ashford, Saleh Mumayiz, Paul H. Wright - 2011 - - 4thEdition,
4. Airport Planning &Design ,S. K. Khanna, M. G. Arora , NemChand Publishers ,New Delhi,1999

SAE1606	CIVIL AIRCRAFT RULES AND REGULATIONS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To get knowledge about the rules and regulations of civil Aircrafts

COURSE OUTCOMES

CO1: Describes the CAR series A procedure for civil air worthiness regulations and safety of engineering activities.

CO2: Extend the CAR series B to CAR series C for cockpit and voice recording system for black box.
CO3: Examine the aircraft maintenance programmes and engine reliability are approved through CAR series D.

CO4: Outline the procedure for registration of aircraft and certification of airworthiness through CAR series E, F, L and M.

CO5: List the flight testing of aircraft registration marking through CAR series T.

CO6: List the aircraft log book and Indian document application for aircraft registration through CAR series X.

UNIT 1 SERIES A

9 Hrs.

C.A.R. SERIES 'A' – procedure for civil air worthiness requirements and responsibility operators vis-à-vis air worthiness directorate -Responsibilities of operators / owners- Procedure of CAR issue, amendments etc.-, Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators.

UNIT 2 SERIES B AND C

9 Hrs.

C.A.R. SERIES 'B' – issue approval of cockpit check list, MEL, CDL: deficiency list (MEL & CDL); Preparation and use of cockpit checklist and emergency list.

C.A.R. SERIES 'C' – defect recording, monitoring, investigation and reporting -Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.

UNIT 3 SERIES D

9 Hrs.

C.A.R. SERIES 'D' –aircraft maintenance programmes- Reliability Programmes (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 periods and component TBOs – Initial & revisions.

UNIT 4 CAR SERIES E, F, L AND M

9 Hrs.

C.A.R. SERIES 'E' – APPROVAL OF ORGANISATIONS - 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.**C.A.R. SERIES 'L&M'** Issue of AME Licence, its classification and experience requirements, Mandatory Modifications / Inspections.

UNIT 5 SERIES 'T'&'X'

9 Hrs.

C.A.R. SERIES 'T'&'X' - Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued. Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. "Aircraft Manual (India) Volume" – Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
2. Advisory Circulars from DGCA 2012.
3. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" – Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi 2010.
4. Aeronautical Information Circulars (relating to Airworthiness) from DGCA 2012

SAE1206	AIRCRAFT CONTROL ENGINEERING (For Aeronautical)	L	T	P	Credit	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES

To introduce the mathematical modeling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.

To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.

To introduce sampled data control system.

COURSE OUTCOMES

CO1: Model the mechanical control and feedback control systems of aircraft components. CO2:

Develop the time response feedback control systems for calculating the error coefficients. CO3:

Design of aircraft feedback systems by root-locus method.

CO4: Perform the frequency response analysis for aircraft control systems.

CO5: Make use of Routh's stability criterion for stability of aircraft flight control systems.

CO6: Determine the controllability and observability of aircraft control systems.

UNIT 1 INTRODUCTION TO CONTROL SYSTEMS

12 Hrs.

Introduction - Examples of Control Systems - Closed-Loop Control Versus Open-Loop Control -1 An Overview and Brief History of Feedback Control- Perspective on Feedback Control- Simple Feedback System-First Analysis of Feedback-Examples of Aircrafts systems - Mathematical Modeling of Control Systems - Transfer Function and Impulse-Response Function - Automatic Control Systems - Mathematical Modeling of Mechanical Systems signal flow graphs- block diagram reduction techniques - Mathematical Modeling of Electrical Systems ,Fluid Systems , Pneumatic Systems, Hydraulic Systems, Thermal Systems.

UNIT 2 TIME RESPONSE ANALYSIS

10 Hrs.

Time response- test signals- order-First-Order -Second-Order -time domain specifications- type number - Steady-State Errors in Unity-Feedback Control Systems - static error constants-steady state errors- generalized error coefficients-

UNIT3 DESIGN BY ROOT-LOCUS METHOD

7 Hrs.

Root-Locus Plots - Root-Locus Plots of Positive Feedback Systems - Root-Locus Approach to Control-Systems Design - Lead Compensation Lag Compensation - Lag-Lead Compensation - Parallel Compensation - problems in aircraft systems

UNIT4 FREQUENCY-RESPONSE ANALYSIS

9 Hrs.

Bode Diagrams - Polar Plots -Nyquist Stability Criterion - Closed-Loop Frequency Response of Unity-Feedback Systems -Control Systems Design by Frequency-Response Approach - Lead Compensation Lag Compensation Lag-Lead Compensation - problems in aircraft systems

UNIT 5 STABILITY, CONTROLLERS, STATE SPACE METHODS

7 Hrs.

The Concept of Stability - ,Routh's Stability Criterion -Automatic Control Systems-Controllers-response with , PI,PD,PID-Effects of Integral and Derivative Control Actions on System Performance - Control Systems Analysis in State Space -Representations of Transfer-Function- Invariant State Equation - Controllability - Observability - Aircraft Flight Control System Example.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Katsuhiko Ogata, Modern Control Engineering, 4th Edition, Prentice Hall of India publishers, New Delhi, 2006.
2. Norman S Nise, Control Systems Engineering, Wiley India, 4th ed, 2003
3. D'Azzo, Houpis, Feedback Control System Analysis and Synthesis, CRC Press, 2007
4. Gopal M. ,Control systems, Principle and Design, Tata McGraw Hill publishing NewDelhi, 1997.
5. Kuo B.C., Automatic control systems, Prentice Hall India Ltd, New Dehli, 1995.
6. Mutambara, Design and Analysis of Control Systems, CRC Press, 2008
7. Roy Langton, Stability and Control of Aircraft Systems introduction to classical feedback control , john Wiley and Sons, USA, 2006

SAE1207	AIRCRAFT SYSTEMS AND INSTRUMENTS (For Aeronautical)	L	T	P	Credit	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

To impart knowledge of the hydraulic and pneumatic systems components and types of instruments and its operation including navigational instruments to the students

COURSE OUTCOMES

CO1: Select the suitable hydraulic and pneumatic systems for different modes of operation in aircraft systems.

CO2: Functions of landing gear systems possessing retraction/extension mechanism of an aircraft.

CO3: Appraise the airplane control systems and control actuation systems utilized in control surfaces.

CO4: Identify the different types of fuel systems and environmental control systems of aircraft components.

CO5: Categorize the flight navigation instruments of aircraft components.

CO6: Classify the types of gyroscopic and engine instruments used in aircrafts.

UNIT 1 AIRCRAFT SYSTEMS 9 Hrs.

Hydraulic Systems – Types of Hydraulic oil -and its properties. Study of Typical Workable System – Components– Hydraulic System Components – Modes of Operation – Pneumatic Systems – Advantages – Working Principles –Components, case studies in modern aircrafts

UNIT 2 LANDING GEAR SYSTEMS 9 Hrs.

Landing Gear Systems – Classification – Purpose and types of Shock Absorbers. construction and its operation– LG -Retraction/extension Mechanism. Brake System types, components and advantages, anti-skid system. conventional and tubeless tires construction, advantages and common defects, modern advancements in tyre technologies

UNIT 3 AIRPLANE CONTROL SYSTEMS 9 Hrs.

Conventional Systems –Modern Flight Control Systems Control Actuation Digital Fly By Wire systems – Autopilot System -Active Control Technology – CCV. The Control Problem. Principles of actuation systems. Types of actuation systems. Actuators, Valves, Servo amplifiers pick-offs, Synchronous data transmission system

UNIT 4 FUEL AND ENVIRONMENTAL CONTROL SYSTEM 9 Hrs.

Fuel system – Layout, Types of fuel tanks, locations, control pressure, sequence of fuel consumption, venting Basic Air Cycle Systems – Vapour Cycle Systems,– Evaporative Vapour Cycle systems – Evaporative air Cycle systems –Pressurization system – Principle-components-limitation- Oxygen systems – Fire Protection Systems, Deicing and Anti Icing Systems

UNIT 5 AIRCRAFT INSTRUMENTS 9 Hrs.

Flight Instrument and Navigation Instruments – Accelerometers, Air data instruments-airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack, Air Speed Indicators – Mach Meters – Altimeters – Gyroscopic Instruments – principles and Operation and types– Study of Various Types of Engine Instruments – Tachometers –Temperature Gauges – Pressure Gauges – Operation and Principles.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Mekanly, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw Hill, 1993.
2. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993.
3. Treager, S., "Gas Turbine Technology", McGraw Hill, 1997.
4. Mckinley, K.L., and Bent, R.D., "Aircraft Maintenance & Repair", McGraw Hill 1993
5. General Hand Books of Airframe and Power plant Mechanics", U.S. Dept. of Transportation, Federal Aviation Administration, . the English Book Store, New Delhi, 1995.

B.E. AERONAUTICAL ENGINEERING REGULATIONS-2010-CURRICULUM

SEMESTER I

SI. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
THEORY							
1	SMTX 1001	Engineering Mathematics – I	3	1	0	4	1
2	SCHX 1001	Environmental Science & Engineering	3	0	0	3	2
3	SPHX 1001	Physics of Materials	3	0	0	3	3
4	SCYX 1001	Engineering Chemistry	3	0	0	3	4
5	SCSX 1002	Programming in C	3	0	0	3	5
6	SMEX 1001	Engineering Graphics	2	1	0	3	6
7	SMEX 1002	Engineering Mechanics	2	1	0	3	7
PRACTICALS							
8	SCSX 4002	Programming in C Lab	0	0	4	2	8
9	SPR 4002	CAD Lab – I	0	0	4	2	8
TOTAL CREDITS						26	

SEMESTER II

SI. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
THEORY							
1	SMTX 1002	Engineering Mathematics – II	3	1	0	4	9
2	SHSX 1001	English For Science & Technology	3	0	0	3	10
3	SPHX 1002	Applied Physics	3	0	0	3	11
4	SCYX 1003	Chemistry of Industrial Materials	3	0	0	3	12
5	SCSX 1003	Programming in C++	3	0	0	3	13
6	SEEX 1002	Basic Electrical & Electronics Engineering	2	1	0	3	14
7	SAEX 1001	Aircraft Production Techniques	3	0	0	3	15
PRACTICALS							
8	SPRX4007	Production Technology Lab - I	0	0	4	2	16
9	SCSX4007	Programming in C++ Lab	0	0	4	2	16
TOTAL CREDITS						26	

L - Lecture hours; T - Tutorial hours; P - Practical hours; C - Credits

SEMESTER III

SI. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
THEORY							
1	SMTX 1009	Engineering Mathematics – III	3	1	0	4	17
2	SMEX 1004	Engineering Thermodynamics	3	0	0	3	18
3	SMEX 1005	Fluid Mechanics & Machinery	3	0	0	3	19
4	SAEX 1002	Solid Mechanics	3	0	0	3	20
5	SMEX 1007	Machine Drawing	3	0	0	3	21
6	SAEX 1003	Introduction to Aeronautics	3	0	0	3	22
7	SAEX 1004	Mechatronics & Microprocessors	3	0	0	3	23
PRACTICALS							
8	SAEX 4001	Aero CAD Lab - I	0	0	4	2	24
9	SPRX 4003	Strength of Materials Lab	0	0	2	1	24
10	SPRX 4004	Fluid Mechanics & Machinery Lab	0	0	2	1	24
TOTAL CREDITS						26	

SEMESTER IV

SI. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
THEORY							
1	SMTX 1010	Engineering Mathematics – IV	3	1	0	4	25
2	SAEX 1005	Modern Avionics	3	0	0	3	26
3	SPRX 1005	Mechanics of Machines	3	1	0	4	27
4	SAEX 1006	Aerodynamics	3	0	0	3	28
5	SAEX 1007	Aircraft Structures – I	2	1	0	3	29
6	SAEX 1008	Aircraft Systems & Instruments	3	0	0	3	30
PRACTICALS							
7	SAEX 4002	Aerodynamics Lab	0	0	4	2	31
8	SAEX 4003	Avionics Lab	0	0	2	1	31
9	SAEX 4004	Aero Modeling Lab	0	0	2	1	31
TOTAL CREDITS						24	

SEMESTER V

Sl. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
THEORY							
1	SMTX 1011	Applied Numerical Methods	3	1	0	4	32
2	SAEX 1009	Supersonic Aerodynamics	3	0	0	3	33
3	SAEX 1010	Aircraft Structures – II	3	1	0	4	34
4	SAEX 1011	Experimental Stress Analysis	3	0	0	3	35
5	SAEX 1012	Aircraft Performance	3	0	0	3	36
6	SAEX 1013	Airframe Maintenance and Repair Practices	3	0	0	3	37
7	SAEX 1014	Control Systems for Aircraft	3	0	0	3	38
PRACTICALS							
8	SAEX 4005	Aircraft Structures – lab	0	0	4	2	39
9	SAEX 4006	Computation Lab	0	0	2	1	39
10	SAEX 4007	Aircraft Systems Lab	0	0	2	1	39

TOTAL CREDITS 27**SEMESTER VI**

Sl. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
THEORY							
1	SMEX 1017	Resource Management Techniques	3	0	0	3	40
2	SAEX 1015	Aircraft Stability and Control	3	0	0	3	41
3	SAEX 1016	Propulsion – I	3	0	0	3	42
4	SAEX 1017	Finite Element Methods	3	1	0	4	43
5		Elective I	3	0	0	3	
6		Elective II	3	0	0	3	

PRACTICALS

8	SAEX 4008	Aircraft Structural Repair & Practice Lab	0	0	4	2	44
9	SAEX 4009	Propulsion Lab	0	0	4	2	44

TOTAL CREDITS 23

SEMESTER VII

Sl. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
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THEORY

SBAX 1001	Principles of Management & Professional Ethics	3	0	0	3	45
SMEX 1018	Heat and Mass Transfer	3	1	0	4	46
SAEX 1018	Propulsion – II	3	0	0	3	47
SAEX 1019	Theory of Vibrations	3	1	0	4	48
	Elective – III	3	0	0	3	
	Elective – IV	3	0	0	3	

PRACTICALS

SAEX 4010	Aircraft Design Project	0	0	4	2	44
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TOTAL CREDITS 22**SEMESTER VIII**

Sl. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
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THEORY

SAEX 1020	Aircraft Composite Materials	3	0	0	3	49
SAEX 1021	Rockets and Missiles	3	0	0	3	50
SAEX 1022	Aircraft Engine Maintenance & Repair Practices	3	0	0	3	51

PRACTICALS

SAEX 4011	Composite Structures Lab	0	0	2	1	52
SAEX 4012	Aircraft Engine Repair and Maintenance Lab	0	0	2	1	52
S26X PROJ	Project Work & Viva Voce	0	0	30	15	52

TOTAL CREDITS 26**TOTAL CREDITS FOR THE COURSE 200**

LIST OF ELECTIVES

Note: ONE SUBJECT IS TO BE CHOSEN FROM EACH GROUP COMPULSORILY

Sl. No.	SUBJECT CODE	SUBJECT TITLE	L	T	P	C	Page No.
Group I: AERODYNAMICS							
1	SAEX 1023	Computational Fluid Dynamics	3	0	0	3	53
2	SAEX 1024	Wind Tunnel Techniques	3	0	0	3	54
3	SAEX 1025	Aircraft Design	3	0	0	3	55
4	SAEX 1026	Helicopter Aerodynamics	3	0	0	3	56
5	SAEX 1027	Advanced Flight Dynamics	3	0	0	3	57
Group II: AIRCRAFT MAINTENANCE							
6	SAEX 1028	Helicopter Maintenance	3	0	0	3	58
7	SAEX 1029	Air Transportation and Aircraft Maintenance	3	0	0	3	59
8	SAEX 1030	Aircraft Rules and Regulations	3	0	0	3	60
9	SAEX 1031	Airline Operations and Management	3	0	0	3	61
10	SAEX 1032	Aircraft Maintenance Management	3	0	0	3	62
Group III: AIRCRAFT STRUCTURES							
11	SAEX 1033	Computer Aided Design and Analysis	3	0	0	3	63
12	SAEX 1034	Aircraft Materials	3	0	0	3	64
13	SAEX 1035	Aeroelasticity	3	0	0	3	65
Group IV: AVIONICS AND AEROSPACE							
14	SAEX 1036	Advanced Control System Design for Aerospace Vehicles	3	0	0	3	66
15	SAEX 1037	Aircraft Navigation, Guidance and Control	3	0	0	3	67
16	SAEX 1038	Flight Control Systems Design	3	0	0	3	68
17	SAEX 1039	Unmanned Aircraft Systems	3	0	0	3	69
18	SAEX 1040	Robotics Engineering	3	0	0	3	70
19	SAEX 1041	Cryogenics	3	0	0	3	71
20	SAEX 1042	Spacecraft Technology	3	0	0	3	72
21	SAEX 1043	Launch Vehicles and Spacecraft Propulsion	3	0	0	3	73
22	SAEX 1044	Orbital Mechanics	3	0	0	3	74

SAEX1001	AIRCRAFT PRODUCTION TECHNIQUES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I CLASSIFICATION OF TOOLS AND QUALITY CONTROL PROCESSES IN AIRCRAFT INDUSTRY

10 hrs.

Tools, Classification, Basic, detail and assembly tools - Interchangeability. Hand tools - precision instruments - special tools and equipments in an airplane maintenance shop - identification terminology - specification and correct use of various aircraft hardware i.e., nuts, bolts, rivets and screws etc., - American and British system of specification threads, gears, bearings etc., Drills, taps and reamers. Identification of all types of fluid line fittings. Materials, metallic and non-metallic.

UNIT II CONVENTIONAL MACHINING PROCESSES

10 hrs.

General principles of working, Types and commonly performed operation in the following machines:- Lathe, Shaper, Planer, Milling Machine, Drilling Machine, Grinding Machine & Machining Centre

UNIT III UNCONVENTIONAL MACHINING PROCESSES

10 hrs.

Principles and Application of the following Processes - Abrasive Jet Machining, Ultrasonic Machining, Electric Discharge Machining, Electrochemical Machining, Chemical Machining, LASER Beam Machining, Electron Beam Machining, Plasma Arc Machining.

UNIT IV FABRICATION AND SURFACE FINISHING PROCESSES

10 hrs.

Basic moulding, casting and welding processes - Corrosion - Types of Corrosions - Prevention - Protective treatments.

UNIT V STRUCTURAL ASSEMBLY

10 hrs.

Stages - Riveting types and techniques - Equipment - Fasteners - Integral tanks - Final assembly of aircraft - Flight testing.

TEXT BOOK:

1. Keshu, S.C., Ganapathy K.K., Aircraft Production Techniques - Interline Publishing House, Bangalore.

REFERENCE BOOKS:

1. Kanna. O.P. Lal. M., Production Technology - Dhanpat Rai Publication, New Delhi, 1997.
2. Champman W.A.J., Production Technology, 4th Edition, Arnold Publisher, New Delhi, 1994.
3. Kroes, Watkins Delp, "Aircraft maintenance and repair", McGraw Hill.
4. A & P Mechanics, "Aircraft Handbook - F.A.A. Himalayan book house, New Delhi.

SAEX1003	INTRODUCTION TO AERONAUTICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

Early Airplanes- Pre Wright Brothers era, Wright Flyer, Components of an Airplane and their functions. Different Types of Flight Vehicles, Classifications. Conventional Control, Powered Controls, basic Instruments for flying, Typical Systems for control Actuation.

UNIT II AERODYNAMICS

10 hrs.

Evolution of Lift, Drag and Moment., types of wing planforms, aerodynamic characteristics of Airfoils, concept of boundary layer, Mach Number, Maneuvers.

UNIT III AIRPLANE PROPULSION

10 hrs.

Requirement of power to fly, balance of forces, various means of producing power for forward flight Basic Ideas about Piston, Turboprop and Jet Engines, Use of Propeller and Jets for Thrust Production. Comparative Merits, Principles of Operation of Rocket, Types of Rocket and typical applications, Exploration into Space.

UNIT IV AIRPLANE STRUCTURES AND MATERIALS

10 hrs.

General Types of Construction, Monocoque, Semi Monocoque and Geodesic Construction, Typical Wing and Fuselage Structure. Different materials from wood to super alloys for airplane and engine applications. Materials for space vehicles, FRP materials.

UNIT V AIRWORTHINESS

10 hrs.

Airplane design, type certification and airworthiness certificate, Air Safety, Role of DGCA in air safety and regulatory authority, accident investigation

TEXT BOOK:

1. Anderson, J.D., "Introduction to flight", McGraw Hill, 1995

REFERENCES:

1. Ralph D. Bent & James L. Mackinley, Aircraft Basic Science, 1988
2. Kroes et Aircraft Maintenance and Repair al, GLENCOE, 1993
3. Clark O. Millikan Airplane Aerodynamics, Wiley and sons 1942 Clark B. Millikan, 1942
4. Richard S. Shevel, Fundamentals of flight Prentice Hall, 2010

SAEX1005	MODERN AVIONICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I DESIGN CONSIDERATIONS & DISPLAY SYSTEMS

10 hrs.

Importance and role of avionics, avionic environment, Regulatory and advisory agencies
-Displays and man-machine interaction: Head -glass cockpit- Cathode Ray Tube (CRT), Active Matrix Liquid Crystal Display (AMLCD), Head Down Display (HDD), Head Up Display (HUD), Helmet Mounted Display (HMD), OLEDs, Night Vision Goggles, LASERS, Integrated Standby Instrument System (ISIS), data fusion, intelligent displays management, Displays technology, control and data entry, instrument placements

UNIT II AIRCRAFT INSTRUMENTS

10 hrs.

Inertial reference systems, attitude derivation. RMI, HSI, ADI Magnetic Heading Reference System (MHRS.); Outside world sensor systems: Radar systems - Radar Sensing - Radar Altimeter (RADALT), Doppler Radar, Weather Radar, RADOME, Infrared systems, AWACS, Aircraft Lighting, Runway Lighting Systems

UNIT III NAVIGATION SYSTEMS

10 hrs.

Principles of navigation, Automatic Direction Finding, Very High Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), landing aids (ILS & MLS), Inertial Navigation, GPS-global positioning system, terrain reference navigation, RNAV, FMS, GPWS, TCAS, GNSS

UNIT IV SURVEILLANCE & COMMUNICATIONS SYSTEMS

10 hrs.

HF, VHF, UHF, Microwaves Signals and Noise, Modulation and demodulation, Antennas, propagation, data links, Telemetry, Transponders, Typical Systems in Aircrafts, Basic Radar Systems and types, ATC Electronic Warfare Basics

UNIT V DATA BUSES:

10 hrs.

Evolution of avionics architecture, integrated modular avionics, MIL-STD-1553B, ARINC 429, MIL-STD-1553B, STAGNAG 3910, JWIA, hi speed data bus, PI Bus, TM Bus, COTS Data buses, Fibre Channel options, IEEE 1394 firewire, TTE, commercial off-the shelf (COTS) TTE Bus, modern data buses, Gigabit Ethernet

TEXT BOOKS:

1. Cary R. Spitzer, The Avionics Handbook, 2nd Edition, CRC Press LLC, 2006
2. Ian Moir, Allan G. Seabridge, Military Avionics Systems, John Wiley & Sons, Ltd, 2009

REFERENCES:

1. Ian Moir, Allan G. Seabridge, Aircraft Systems : Mechanical, Electrical, Avionics Subsystems Integration, 3rd Edition, John Wiley & Sons, Ltd 2008
2. Cary R. Spitzer., Digital Avionics Systems Principles and Practices, 2nd ed, McGraw-Hill, Inc, 1993.
3. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993.
4. Collinson RPG, Introduction to Avionics, Second Edition, Kluwer Academic Publishers, Chapman & Hall, 2003.

Don Middleton., Avionic Systems (Longman Aviation Technology Series), Longman, 1989

SAE1101	FUNDAMENTALS OF AERONAUTICAL ENGINEERING (For Aeronautical)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

To familiarize with the basics of aircraft structures, aerodynamics systems instruments. To give exposure to the power plants cased in Aircraft.

COURSE OUTCOMES:

CO1: Identify the components of airplane and its flying instruments.

CO2: Determine the aerodynamic characteristics of airfoils in flying machines.CO3: Classify the air breathing engines utilized for flying machines.

CO4: Categorize the materials and structures of flying machines.

CO5: Examine the airplane design data possessing type certification data sheet.

CO6: Assess the air safety and regulatory authority and air crash investigation.

UNIT 1 INTRODUCTION 10 Hrs.

Early Airplanes- Pre Wright Brothers era, Wright Flyer, Components of an Airplane and their functions. Different Types of Flight Vehicles, Classifications. Conventional Control, Powered Controls, basic Instruments for flying, Typical Systems for control Actuation.

UNIT 2 AERODYNAMICS 7 Hrs.

Evolution of Lift, Drag and Moment., types of wing plan forms, aerodynamic characteristics of Airfoils, concept of boundary layer, Mach Number, Maneuvers.

UNIT 3 AIRPLANE PROPULSION 11 Hrs.

Requirement of power to fly, balance of forces, various means of producing power for forward flight Basic Ideas about Piston, Turboprop and Jet Engines, Use of Propeller and Jets for Thrust Production. Comparative Merits, Principles of Operation of Rocket, Types of Rocket and typical applications, Exploration into Space.

UNIT 4 AIRPLANE STRUCTURES AND MATERIALS 10 Hrs.

General Types of Construction, Monocoque, Semi Monocoque and Geodesic Construction, Typical Wing and Fuselage Structure. Different materials from wood to super alloys for airplane and engine applications. Materials for space vehicles, FRP materials.

UNIT 5 AIRWORTHINESS 7 Hrs.

Airplane design, type certification and airworthiness certificate, Air Safety, Role of DGCA in air safety and regulatory authority, accident investigation

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Ralph D. Bent & James L. Mackinley, Aircraft Basic Science, 1988
2. Kroes et al, Aircraft Maintenance and Repair , GLENCOE,1993
3. Clark O. Millikan Airplane Aerodynamics, Wiley and sons 1942 Clark B.Millikan,1942
4. Richard S. Shevel, Fundamentals of flight Prentice Hall, 2010
5. Anderson, J.D., "Introduction to flight", McGraw Hill, 1995
(Computational problems can be given as assignments)

SAEX1006	AERODYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I REVIEW OF BASIC FLUID MECHANICS

10 hrs.

Continuity, Momentum and Energy Equations. Applications of Bernoulli's theorem

UNIT II TWO DIMENSIONAL FLOWS

10 hrs.

Complex Potential, Point Source and Sink, Potential Vortex, Uniform Parallel flow and their Combinations, Pressure and Velocity Distributions on Bodies with and Without Circulation in Ideal and Real fluid Flows. Kutta Joukowski's Theorem.

UNIT III CONFORMAL TRANSFORMATION

10 hrs.

Complex potential function, Blasius theorem, principles of conformal transformation, Kutta - Joukowski transformation of a circle into flat plate, airfoils & ellipses.

UNIT IV AIRFOILS

10 hrs.

Joukowski, Karman Trefftz Profiles, Von Mises airfoils -Glauert's thin airfoil theory, symmetrical airfoil, cambered airfoil, flapped airfoil, determination of mean camber line shapes for uniform & linear distribution of circulation. elements of panel method

UNIT V SUBSONIC WING THEORY

10 hrs.

Downwash & induced drag, Vortex line, Horse Shoe Vortex, Biot and Savart Law, Flow past finite wings - vortex model of the wing - induced drag – Prandtl's lifting line theory - elliptic wing –influence of taper and twist applied to wings – effect of sweep back – delta wings.

(Computational problems must be given as assignments for each unit)

TEXT BOOK:

1. Anderson, J.D., "Fundamentals Of Aerodynamics", McGraw Hill Book Co., New York 2005.

REFERENCES:

1. Houghton, E.L., and Carruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
2. Milne Thomson, L.H., "Theoretical Aerodynamics", Dover Publication, 2008
3. Clancy, L.J., "Aerodynamics", Pitman, 1986.

SAEX1007	AIRCRAFT STRUCTURES I	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I STATICALLY DETERMINATE STRUCTURES 10 hrs.

Analysis of plane truss – Method of joints – 3 D Truss - Plane frames.

UNIT II STATICALLY INDETERMINATE STRUCTURES 10 hrs.

Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

UNIT III ENERGY METHODS 10 hrs.

Strain Energy due to axial, bending and Torsional loads - Castigliano's theorem - Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

UNIT IV COLUMNS 10 hrs.

Columns with various end conditions – Euler's Column curve – Rankine's formula
Column with initial curvature - Eccentric loading – South well plot – Beam column.

UNIT V FAILURE THEORY 10 hrs.

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

(Computational problems must be given as assignments for each unit)

TEXT BOOK:

1. E F Bruhn, "Analysis and Design of Flight Vehicles Structures", 1st Tristate offset co, USA, 1985

REFERENCES:

1. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990.

SAEX1009	SUPERSONIC AERODYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I CONCEPTS OF COMPRESSIBLE FLOW

10 hrs.

Introduction to isentropic flow-Scope of compressible flow-Review of continuity, momentum and steady flow energy equations and entropy considerations- Energy and momentum equations for compressible fluid flow reference velocities-stagnation states-velocity of sound-critical states-mach number-critical Mach number. Types of waves- mach cones mach angle-effect of Mach number on compressibility flow regimes.

UNIT II SHOCKS AND EXPANSION WAVES

10 hrs.

Development of normal shocks-governing equations-Stationery and moving normal shock waves-applications, applications to supersonic wind tunnel. Shock tubes, Shock polars, supersonic pitot probes. Oblique shock - Reflection of flow- Prantl- Meyer expansion flow. Under and over expanded nozzles, shock expansion method for flow over airfoils

UNIT III FLOW IN CONSTANT AREA DUCT WITH FRICTION AND HEAT TRANSFER

10 hrs.

Fanno flow and Rayleigh flow - flow equations and solutions- variation of flow properties-variation of Mach number with duct length-tables and charts for Fanno flow and Rayleigh flow

UNIT IV BRIEF INTRODUCTION TO THE METHODS OF CHARACTERISTICS

10 hrs.

Method of characteristics – Prandtl - Glauert and Goethert rules - Ackeret's supersonic airfoil theory. Small perturbation equations for subsonic, transonic, supersonic and hypersonic flow. Experimental characteristics of Airfoils in compressible flow.

UNIT V EXPERIMENTAL METHODS

10 hrs.

Transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance-Flow visualization methods of supersonic flows.

(Computational problems must be given as assignments for each unit)

TEXT BOOK

1. Radhakrishnan, Ethirajan., Gas Dynamics, John Wiley & Sons,2010
2. Yahya, S. M., Fundamentals of Compressible flow with Aircraft and Rocket Propulsion, 3rd edition, New Age International Ltd.Publishers,2003

REFERENCE BOOKS:

1. Shapiro, Ascher. H., The Dynamics and Thermodynamics of Compressible Fluid Flow (Vol I and II),Ronald Press,1953.
2. Anderson J. D., Jr., Modern Compressible Flow with Historical Perspective, McGraw Hill Publishing Co.,2004
3. Edward.R.C. Miles, Supersonic Aerodynamics, Dover, New York, 1950.
4. Clancy, L.J., Aerodynamics, Pitman, 1986
5. Anderson J. D., Jr., Fundamentals to Aerodynamics, McGraw Hill Publishing Co., 3rd edition, 2001

SAEX1010	AIRCRAFT STRUCTURES II	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I UNSYMMETRICAL BENDING

10 hrs.

Bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with skew loads.

UNIT II SHEAR FLOW IN OPEN SECTIONS

10 hrs.

Thin walled beams. Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.

UNIT III SHEAR FLOW IN CLOSED SECTIONS

10 hrs.

Bredt – Batho formula. Single and multi – cell structures. Approximate methods. Shear flow in single & multi-cell structures under torsion. Shear flow in single and multi-cell under bending with walls effective and ineffective.

UNIT IV BUCKLING OF PLATES

10 hrs.

Thin Plate theory-Pure bending of thin plates, plates subjected to bending and twisting. Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods, Thin walled column strength. Sheet stiffener panels. Effective width, inter rivet and sheet wrinkling failures.

UNIT V STRESS ANALYSIS IN WING AND FUSELAGE

10 hrs.

Procedure – Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, cut- outs in fuselages. Thin webbed beam. With parallel and non parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's). Airframe loads-Inertia, Maneuver, Gust load

(Computational problems must be given as assignments for each unit)

Text Book:

1. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw-Hill, N.Y., 1993.

REFERENCE BOOKS:

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Butterworth-Heinemann, 2007.
2. Elmer Franklin Bruhn. "Analysis and Design of Flight vehicles Structures", Jacobs Publication, 1973
3. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, 1993.
4. C. T. Sun, Mechanics of Aircraft Structures, Wiley-Inter Science Publication, 2006

SAEX1011	EXPERIMENTAL STRESS ANALYSIS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT 1 MEASUREMENTS

10 hrs.

Principles of measurements-Accuracy, Sensitivity and range of measurements. Measurement of force or load, Measurement of torque., Strain measurement of rotating shaft, Measurement of pressure or vacuum.

UNIT II EXTENSOMETERS

10 hrs.

Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages. Review of bridge circuits

UNIT III ELECTRICAL RESISTANCE STRAIN GAUGES

10 hrs.

Principle of operation and requirements-Types and their uses-Materials for strain gauge. Calibration and temperature compensation-cross sensitivity, Rosette analysis –Delta, Tee, rectangular Rosette -- Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements- strain indicators. Characteristics of strain gauges-Transverse sensitivity of gauge, Temperature effect.

UNIT IV THEORY OF PHOTOELASTICITY

10 hrs.

Electromagnetic wave representation of light, polarization, refraction, stress and birefringence, Isoclinic and Isochromatic fringe analysis. Stress analysis by two and three dimensional photoelasticity-interpolation of stress patterns-Typical applications-Description and uses of reflection polariscope

UNIT V NON-DESTRUCTIVE TESTING

10 hrs.

Fundamentals of NDT-Radiography-ultrasonics -Magnetic particle inspection-Fluorescent penetrant technique-Eddy current testing- Acoustic Emission Technique-Fundamentals of brittle coating methods- Introduction to Moire techniques- Holography-Ultrasonic C-Scan- Thermography, Fibre-optic Sensors.

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

1. Dally, J. W., and Riley, W. F., Experimental Stress Analysis, McGraw Hill Inc., New York, 1978.
2. Hetenyi, M., Hand Book of Experimental Stress Analysis, John Wiley and Sons Inc., New York, 1972.
3. Dr. Sadhu Singh, "Experimental stress analysis", Khanna Publications, 1996.
4. James Doyle, Modern Experimental Stress Analysis: completing the solution of partially specified problems. John Wiley & Sons, Ltd, 2004

REFERENCE BOOKS

1. Srinath, L. S., Raghava, M.R., Lingaiah, K.Gargesha, G.Pant B., and Ramachandra, K., Experimental Stress Analysis, Tata McGraw Hill, New Delhi, 1984.
- Pollock, A. A., Acoustic Emission in Acoustics and Vibrations Progress, ed. by Stephens R.W.B., Chapman and Hall, 1983.

SAEX1013	AIRFRAME MAINTENANCE AND REPAIR PRACTICES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I WELDING IN AIRCRAFT STRUCTURAL COMPONENTS

10 hrs.

Equipments used in welding shop and their maintenance – Ensuring quality welds – Soldering and Brazing.

UNIT II SHEET METAL REPAIRS AND MAINTENANCE

10 hrs.

Inspection of damage – Classification – Repair or replacement – Sheet metal inspection – N.D.T Testing – Riveted repair design, Damage investigation, Types of plastics, Maintenance and repair of plastic components, Reverse technology. Repair of cracks, holes etc., and various repairs schemes – Scopes. Inspection – Repair of composite components – Special precautions – Autoclaves.

UNIT III AIRCRAFT JACKING, ASSEMBLY AND RIGGING

10 hrs.

Airplane, Jacking and Weighing and C.G. Location. Rigging of control surfaces – Inspection, maintenance.

Helicopter flight controls, Tracking and balancing of main rotor.

UNIT IV REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM

10 hrs.

Trouble shooting theory and Procedure, Inspection and maintenance of Hydraulic, Pneumatic, Fuel, Landing gear, Inspection and maintenance of Air conditioning, Pressurization systems Oxygen, De-icing, Fire Protection Installation and maintenance of instruments – Handling - Testing – Inspection, Position and warning system Auxiliary Power Units (APUs)

UNIT V SAFETY PRACTICES

10 hrs.

Safety – Importance of Flight Safety, Maintenance of Ground Support Equipments, refueling, de-refueling, fire equipments, Hazardous materials storage and handling, Environmental and shop cleanliness – precautions, Aircraft furnishing -practices, Equipments, Hazard zones.

(Computational problems must be given as assignments for each unit)

TEXT BOOK

1. Micheal J. Kroes, Alfred Watkins, Frank Delp, Aircraft Maintenance and Repair, 6th edition, McGraw Hill, New York, 1993

REFERENCE BOOKS

1. Larry Reithmeir, Aircraft Repair Manual – Palamar Books, Marquette, 1992.
 2. Brimm D.J.Bogges H.E., Aircraft Maintenance – Pitman Publishing Corp. New York, 1940.
 3. Howard Curtis, Antonio Fillippone, Aerospace Engineering Reference, Butterworth – Heinmann, 2009
 4. Micheal .J. Kroes, James .R. Rardon, Aircraft : Basic Science with Student Study Guide, McGraw Hill, 2007
- Douglas. S. Carmody, Airplane Maintenance & Repair : A Manual for Owners, Builders, Technicians & Pilots, McGraw, 1997

SAEX4007	AIRCRAFT SYSTEMS LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Aircraft "Jacking Up" procedure
 2. Aircraft "Leveling" procedure
 3. Control System "Rigging check" procedure
 4. Aircraft "Symmetry Check" procedure
 5. Flow test" to assess of filter element clogging
 6. Aircraft rudder control
 7. Hydraulically operated landing Gear
 8. Electrically operated Flap Control
 9. Aircraft fuel system, oil systems.
 10. "Brake Torque Load Test" on wheel brake units
 11. "Pressure Test" To assess hydraulic External/Internal Leakage
 12. "Functional Test" to adjust operating pressure of hydraulic systems.
 13. "Pressure Test" procedure on fuel system components
 14. Maintenance and rectification of snags in hydraulic and fuel systems.
- Removal stroke installation of wheels and brakes and overhauling of brake units.

SAEX1016	PROPULSION I	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I FUNDAMENTALS OF GAS TURBINE ENGINES

10 hrs.

Basic concepts of air standard cycles .Illustration of working of gas turbine engine - Air-standard Brayton cycle, actual gas turbine engine cycle The thrust equation - Factors affecting thrust - Effect of pressure, velocity and temperature changes of air entering compressor - Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet - Performance characteristics.

UNIT II SUBSONIC AND SUPERSONIC INLETS FOR JET ENGINES

10 hrs.

Internal flow and Stall in Subsonic inlets - Boundary layer separation - Major features of external flow near a subsonic inlet - Relation between minimum area ratio and external deceleration ratio - Diffuser performance -Supersonic inlets - Starting problem in supersonic inlets - Shock swallowing by area variation – External deceleration - Modes of inlet operation.

UNIT III COMBUSTION CHAMBERS

10 hrs.

Classification of combustion chambers - various arrangements, simplex and duplex burners. line design Important factors affecting combustion chamber design – Combustion process - Combustion chamber performance - effect of operating variables on performance - Flame tube cooling- Flame stabilization - Use of flame holders - Numerical problems.

UNIT IV NOZZLES

10 hrs.

Theory of flow in isentropic nozzles – design, Convergent nozzles and nozzle choking - Nozzle throat conditions Nozzle efficiency - nozzle operating characteristics for isentropic flow, nozzle flow and shock waves Losses in nozzles

- Over expanded and under-expanded nozzles - Ejector and variable area nozzles - Interaction of nozzle flow with adjacent surfaces - Thrust reversal.

UNIT V PROPELLERS

10 hrs.

Ideal momentum theory and blade element theory and their relative merits, numerical problems on the performance of propellers using propeller charts, selection of propellers, fixed, variable and constant speed propellers, prop-fan, material for propellers, shrouded propellers helicopter, rotor in hovering.

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

1. Philip Hill and Carl Peterson, Mechanics and Thermodynamics of Propulsion, 2nd Edition, Addison -Wesley Publishing Company, Singapore, 1992

REFERENCE BOOKS

1. Rolls-Royce, Jet Engine, 3rd edition, 1983.
 2. Oates, G.C., Aerothermodynamics of Aircraft Engine Components, AIAA Education Series, New York, 1985.
 3. Cohen, H, Rogers., G.F.C. and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman, 1989.
 4. Mattingly, J.D., Heiser, W.H., and Pratt, D.T., Aircraft Engine Design, AiAA Education Series, New York, 2002.
 5. Thomas. A. Ward, Aerospace Propulsion Systems, John Wiley & Sons, 2010
 6. Aircraft Gas Turbine Engine- operations, Components & Systems, (Jet Propulsion), Wexford, 2008.
 7. Ahmed F. El-Sayed, Aircraft propulsion and gas turbine engines, CRC Press, 2008
- Tony Giampaolo, Gas turbine handbook: principles and practice, The Fairmont Press, Inc., 2009

SAEX1017	FINITE ELEMENT METHODS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

FEM- Examples Areas of Application- General Steps in Finite Element Analysis- Examples of Finite Element Modeling

UNIT II ONE DIMENSIONAL PROBLEMS

10 hrs.

Direct stiffness method – spring element- Derivation of the stiffness matrix- Example of a spring assemblage-Assembly of global stiffness matrix-Types of boundary conditions- The Potential energy approach –Examples Prismatic bar under axial loading-bending of beams Introduction- Finite Element Modeling – Element Division-Numbering Scheme- Coordinate and Shape Functions- The Potential Energy Approach- Assembly of Global Stiffness Matrix and Load Vector- Treatment of Boundary Conditions- Temperature Effects- Shear Force and Bending Moment-Examples.

UNIT III TWO DIMENSIONAL PROBLEMS

10 hrs.

Plane truss structure-Introduction- Plane Trusses-Coordinate Transformation – Local & Global Coordinate- The Element Stiffness Matrix- Stress Calculations- Temperature Effects -Examples plane stress & strain – cst element –Introduction- Finite Element Modeling-Constant Strain Triangle (CST)- Isoparametric Representation- Potential Energy Approach - Element Stiffness; Force Terms Stress Calculations- Temperature Effects- Examples

UNIT IV SCALAR FIELD PROBLEMS

10 hrs.

One-dimensional steady-state heat transfer- Introduction- One-Dimensional Heat Conduction- The Governing Equation-Boundary Conditions- The One-Dimensional Element-Functional Approach – The Element Conductivity Matrix and Heat Rate Vector- Heat Flux Boundary Conditions; Examples one-dimensional heat transfer in thin fins – Introduction- The Governing Equation - The Boundary Conditions- The Convection Matrix and Heat Rate Vector; Global System of Linear Equations; Example

UNIT V FINITE ELEMENT MODELING & SOFTWARE

10 hrs.

Finite element modeling- Rectangular Plate- Plane Stress & Plane Strain Condition-Pipe Under Internal Pressure- Axisymmetric Condition- Symmetry Consideration MSC nastran software – Introduction- Analysis steps in Nastran- Laboratory sessions (depending on availability of laboratory facilities.)

(Computational problems must be given as assignments for each unit)

REFERENCE BOOKS

1. T. R. Chandrupatla and A. D. Belegundu, "Introduction to Finite Elements in Engineering", 2nd Edition, Prentice Hall, New Jersey, 1997.
2. Daryl L. Logan, "A First Course in the Finite Element Method", 2nd Edition, PWS Publishing Company, Boston, 1993.
3. Dr. S. S. Rao, "The Finite Element Method In Engineering", Pergamon Press, 1989
4. K. H. Huebner, D. L. Dewhirst, D. E. Smith and T. G. Byron, "The Finite Element Method for Engineers", 4th Edition, John Wiley & Sons Inc., New York, 2001.
5. J. N. Reddy, "An Introduction to the Finite Element Method", 2nd Edition, McGraw-Hill, Inc., New York, 1993.
6. Concepts and Applications of Finite Element Analysis: COOK. D. Robert. Malus. S. David, Plesha E. Michel, John Wiley & sons 3rd Ed. New York, 2000

SAEX4008	AIRCRAFT STRUCTURAL REPAIR & PRACTICE LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Introduction to aircraft structural repairs and preparation of repair scheme
2. Flaring of aluminum tubes
3. Patch repair on transparent plastics
4. Repair of panels by insertion patch repair.
5. Repair by splicing on wooden spares
6. Tube bending
7. Make channel section by hand forming Riveting practices : Lap joint, Butt Joint
8. Gas Welding, Arc Welding, TIG Welding, MIG Welding, Spot Welding
9. Introduction to Modern methods in aircraft structural repair practices

SAEX4010	AIRCRAFT DESIGN PROJECT LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Comparative studies of different types of airplanes and their specifications and performance details.
2. Preliminary weight estimations, selection of main parameters, Power plant selection, Aerofoil selection, Wing, tail and control surfaces.
3. Preparation of lay outs of balance diagram and three view drawings.
4. Drag estimation, Detailed performance, Calculations and stability estimates. V-n diagram.
5. Preliminary design of an Aircraft wing – Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams
6. Detailed design of an aircraft wing – design of spars and stringers, bending stress and shear flow calculations
– buckling analysis of wing panels.
7. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage.
8. Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels.
9. Preparation of a detailed design report with CAD drawings

SAEX1018	PROPULSION II	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I TURBINES

10 hrs.

Introduction to turbine analysis, mean radius stage calculations, stage parameters, stage loading and flow coefficients degree of reaction, stage temperature ratio and pressure ratio, blade spacing, radial variation, velocity ratio. Axial flow turbine, stage flow path, Dimensional stage analysis.; Steps of turbine design: single stage and two stages. Turbine performance. Blade cooling

UNIT II COMPRESSOR

10 hrs.

Principal of operation of centrifugal compressor - Work done and pressure rise Euler's Turbo machinery equations. Axial flow compressor analysis, cascade action, flow field. Euler's equation, velocity diagrams, flow annulus area stage parameters. Degree of reaction, cascade airfoil nomenclature and loss coefficient, diffusion factor, stage loading and flow coefficient, stage pressure ratio, Blade Mach No., repeating stage, repeating row

UNIT III RAMJET PROPULSION

10 hrs.

Operating principle – Subcritical, critical and supercritical operation - Combustion in ramjet engine – Ramjet performance - Sample ramjet design calculations - Introduction to scramjet - Preliminary concepts in supersonic combustion - Integral ram rocket - Numerical problems.

UNIT IV FUNDAMENTALS OF ROCKET PROPULSION

10 hrs.

Operating principle - Specific impulse of a rocket - Internal ballistics - Rocket nozzle classifications – Rocket performance considerations - Numerical problems. Electric, ion, Nuclear rocket propulsion -Principles

UNIT V CHEMICAL ROCKETS

10 hrs.

Solid propellant rockets - Selection criteria of solid propellants - Important hardware components of solid rockets
- Propellant grain design considerations - Liquid propellant rockets - Selection of liquid propellants Thrust control in liquid rockets - Cooling in liquid rockets - Limitations of hybrid rockets - Relative advantages of liquid rockets over solid rockets –Numerical Problems

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

1. Philip Hill, and Carl Peterson, Mechanics and Thermodynamics of Propulsion, 2nd edition, Pearson Education Ltd, 2009.
2. Mathur, M., and Sharma, R. P., Gas Turbines and Jet and Rocket Propulsion, Standard Publishers, New Delhi, 1988.
3. Gorden, C. V., Aerothermodynamics of Gas Turbine & Rocket Propulsion, AIAA Education Series, New York, 1997

REFERENCE BOOKS

1. George .P .Sutton, Oscar Biblarz, Rocket Propulsion Elements, John Wiley & Sons Inc., New York, 5th Ed., 2010
2. Cohen, H., Rogers, G. F. C. and Saravanamuttoo, H.I.H., Gas Turbine Theory, Prentice Hall India Ltd, 2001
3. Mattingly, J.D., Heiser, W. H., and Pratt, D. T., Aircraft Engine Design, AIAA Education Series, New York, 2002.
4. Saced Farokhi, Aircraft Propulsion, Volume 10, John Wiley & sons, 2008
5. Ahmed F.El-Sayed, Aircraft Propulsion & Gas Turbine Engine, CRC Press, 2008

SAEX1019	THEORY OF VIBRATIONS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

Simple harmonic motion, definition of terminologies, Review of Newton's, Laws, D'Alembert's principle, Energy methods

UNIT II SINGLE DEGREE OF FREEDOM SYSTEM

10 hrs.

Free vibrations free damped vibrations, forced excitations with and without damping, support excitation, vibration measuring instruments

UNIT III TWO-DEGREE OF FREEDOM SYSTEMS

10 hrs.

Two degrees of freedom systems, Static and dynamic couplings, vibration absorber, Principal coordinates, Principal modes, orthogonality conditions. Hamilton's Principle, Lagrangean equation and applications.

UNIT IV THREE DEGREES OF FREEDOM

10 hrs.

Three degrees of freedom systems, Static and dynamic couplings Principal modes, orthogonality conditions,- For coupled systems – Dunkerley's method, Rayleigh Ritz method- Applications.

UNIT V VIBRATIONS OF ELASTIC BODIES

10 hrs.

Vibrations of elastic bodies, String or stretched cord, Longitudinal vibration, Lateral vibration, Torsional vibration.

Approximate methods for calculating natural frequencies. Eigen value extraction methods – Subspace hydration method,

Lanczos method – Eigen value reduction method – Dynamic response of large systems – Implicit and explicit methods

(Computational problems must be given as assignments for each unit)

Total No
hours: 50

TEXT BOOKS

1. William T Thomson, "Theory Of Vibration With Applications, Taylor & Francis, 1993

REFERENCES

1. S.Singiresu Rao, Mechanical Vibrations, 5th edition, Pearson Education, Canada, 2010
2. Ramamurti, V., Mechanical Vibration Practice with Basic Theory, 1st edition, Narosa Publishing House, Chennai, 2000
3. Meirovitch, L., "Elements of Vibration Analysis", McGraw-Hill Inc., 1986.
4. Francis Sing Tse, Ivan .E. Morse and Rolland Theodore Hinkle, "Mechanical Vibrations", Prentice Hall of India, 1984.
5. Fung, Y.C., "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 1985.
6. Rao.J.S. and Gupta K., "Theory and practice of Mechanical Vibrations" Wiley Eastern Ltd., New Delhi.,1999.
7. Timoshenko,S., "Vibration Problems in Engineering", John Wiley & Sons Inc., 1987
8. Jan R Wright, Jonathan E Copper, Introduction to Aircraft Aeroelasticity & Loads, John n Wiley & Sons, 2007
9. Robert . C.Sapri, Mechanical Vibrations : Measurements, Effects & Control, Nova Science Publishers, 2009
5. Graham Kelly, Mechanical Vibrations, Schuam's Outlines, Tata Mc GRaw Hill, 2007

SAEX1020	AIRCRAFT COMPOSITE MATERIALS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION AND COMPOSITE FUNDAMENTALS

10 hrs.

Types of Composites; Why composites; History of applications, Nano, Micro and Macro behavior of composites Anisotropic and tailored-made properties Fundamental reinforcing mechanisms Key differences between composites and metals-Properties and functions of fibers and Matrix. Advantages and application of composite materials– Generalized Hooke's Law – Elastic constants for anisotropic, orthotropic and isotropic materials

UNIT II METHODS OF ANALYSIS

10 hrs.

Micro mechanics – Mechanics of materials approach, elasticity approach to determine material properties – Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of material properties. Experimental characterization of lamina - Problems

UNIT III CLASSICAL LAMINATION THEORY AND FAILURE ANALYSIS

10 hrs.

In-plane forces, bending and twisting moments, Derivation of classical lamination theory, Shear coupling in unbalanced laminates Bending and stretching of unsymmetric laminates Failure criteria for composites- Maximum stress/strain criteria, Tsai- Hill criterion, Tsai-Wu criterion–Example problems

UNIT IV HYGROTHERMAL BEHAVIOR OF COMPOSITES AND SANDWICH CONSTRUCTION

10 hrs.

Hygrothermal stress-strain relations for a lamina General CLT with hygrothermal effects Hygrothermal effects on material properties -Skill check problems .Basic concepts of sandwich construction -Materials used for sandwich construction - Failure modes of sandwich panels.

UNIT V FABRICATION PROCESS

10 hrs.

Various Open and closed mould processes. Manufacture of fibers – Types of resins and properties and applications – Netting analysis.

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

1. Autar K.Kaw Mechanics of Composite Materials, CRC Press 1997
2. Jones, R. M., Mechanics of Composite Materials, 2nd Edition, Taylor & Francis, Philadelphia, PA, 1999

REFERENCES

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
 2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
 3. Niu, Michael, Composite Airframe Structures, Conmilit Press, 1992
 4. Alan.A.Baker, Stuart Dutton, Donald Kelly, Donald W.Kelly Composite Materials for Aircraft Structures, AIAA, 2004
- Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998.

SAEX1022	AIRCRAFT ENGINE MAINTENANCE & REPAIR PRACTICES	L	T	P	Credits	Total Marks
		3	0	0	3	100

(A) INSPECTION, MAINTENANCE, OPERATION AND TROUBLE SHOOTING OF PISTON ENGINES

UNIT I PISTON ENGINE

10 hrs.

Types of piston engines – Principles of operation – Function of components – Materials used – Details of starting the engines – Details of carburetion and injection systems for small and large engines – Ignition system components – Spark plug details – Engine operating conditions at various altitudes – Lubrication system, Maintenance and inspection checks to be carried out.

Inspection and maintenance and troubleshooting – Inspection of all engine components – Daily and routine checks – Overhaul procedures – Compression testing of cylinders – Special inspection schedules – Engine fuel, control and exhaust systems – Engine mount and super charger.

UNIT II PROPELLER

6 hrs.

General Inspection procedures – checks on constant speed propellers – Pitch setting – Engine starting procedure, Installation and maintenance checks.

UNIT III FAILURE & FAULT DIAGNOSIS

10 hrs.

Symptoms of failure – Fault diagnostics – Case studies of different engine systems – Rectification during testing equipments for overhaul: Tools and equipment requirements for various checks and alignment during overhauling – visual inspection – methods and instruments for non destructive testing techniques. Engine testing: Engine testing procedures and schedule preparation – on line maintenance.

UNIT IV INSPECTION, MAINTENANCE, OPERATION AND TROUBLE SHOOTING OF JET ENGINE

14 hrs.

Types of jet engines – Principles of operation – Function of components – Details of starting and operating procedures

– gas turbine engine inspection and check ups. – use of instruments for on line maintenance – special inspection procedures: foreign object damage and blade damage, lubrication, fuel and pneumatic systems, engine surge and stall

Gas turbine engine Schedule & Non schedule maintenance procedures of gas turbine – trouble shooting and rectification procedures – system maintenance procedures.

Engine Testing and storage: gas turbine testing procedures – test schedule procedure – storage of engine – preservation and de-preservation procedures.

UNIT V ENGINE OVERHAUL PROCEDURE

10 hrs.

Engine overhaul – Overhaul procedures- inspection and cleaning of the components – repair schedules for overhaul- balancing of gas turbine components

Trouble shooting: procedures for trouble shooting – condition monitoring of the engine on ground and at flight – engine health monitoring and corrective methods.

TEXT BOOK:

1. Michael J. Kroes, Aircraft power plants - Aviation technology series, 7th Edition, McGraw-Hill, 1990
2. Dale Crane, Aviation Maintenance Technician: Powerplants, 2nd edition, Aviation Supplies & Academics Inc, 2005

REFERENCE BOOKS:

1. Turbomeca, "Gas turbine engines", The English Book Store, New Delhi, 1993.
2. Ujited Technologies Pratt & Whitney, "Aircraft Gas turbine engine and its operation, The English Book Store, New Delhi, 1993
3. Treager, Aircraft: Gas Turbine Engine Technology, Tata McGraw-Hill, 2002
4. Ralph .D. Bent, James .L. McKinsley, Aircraft & Powerplants, Gregg Division, McGraw Hill, 1985
5. Larry Reithmaier, Lawrence .W. Reithmaier, Standard Aircraft Handbook for Mechanics and Technicians, McGraw Hill Professional, 6th Edition, 1999
6. Douglas .S.Carmody, Airplane Maintenance & repair : Manual for owner, builders, technicians & pilots, McGraw Hill Publishing, 1997
7. Jeppesen Sanderson, Standard Aviation Maintenance Handbook, Jeppesen & Company, 2003
8. Dale Crane, Aviation Maintenance Handbook, Aviation Supplies & Academics Inc, 2006
9. R .P. Chatteerjee, Airforce Maintenance & Planning, Pentagon Press, 2010

SAEX4011	COMPOSITES STRUCTURES LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Fabrication of glass epoxy laminates using vacuum bag method
2. Fabrication of Carbon polyester laminate using compression moulding
3. Fabrication of glass fiber filament wound pipes using filament winding machine
4. Calculation of material properties of bi directional composite laminate
5. Determination of material properties of cross ply laminate
6. Determination of shear modulus of composite laminate
7. Fabrication of sandwich beam
8. Determination interlaminar strength of a composite laminate
9. Failure analysis of composite laminate using matlab
10. Determination of material properties using plate theory.

SAEX4012	AIRCRAFT ENGINE MAINTENANCE AND REPAIR PRACTICES LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Stripping of a piston engine
2. Engine (Piston Engine) - cleaning, visual inspection, NDT checks.
3. Piston Engine Components - dimensional checks.
4. Piston – Engine reassembly.
5. Propeller Pitch Setting, Propeller Blade, Vertical, horizontal Balancing
6. Stripping of a jet engine
7. Jet Engine – identification of components and defects.
8. Jet Engine – NDT checks and dimensional checks
9. Jet Engine – reassembly.
10. Engine starting procedures.

SAEX1026	HELICOPTER AERODYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I ELEMENTS OF HELICOPTER AERODYNAMICS

10 hrs.

Configuration based on Torque Reaction – Jet Rotors and Compound Helicopters – Method of Control – Collective and Cyclic Pitch Changes – Lead – Lag and Flapping Hinges.

UNIT II IDEAL ROTOR THEORY

10 hrs.

Hovering performance – Momentum and Simple Blade Element Theories – Figure of Merit – Profile and Induced Power Estimation - Constant Chord and Ideal Twist Rotors.

UNIT III POWER ESTIMATES

10 hrs.

Induced, Profile and Parasite Power requirements in Forward Flight – Performance Curves with Effects of Altitude – Preliminary Ideas on Helicopter Stability.

UNIT IV LIFT, PROPULSION AND CONTROL OF V/STOL AIRCRAFT

10 hrs.

Various Configuration – Propeller, Rotor, Ducted Fan and Jet Lift – Tilt Wing and Vectored Thrust – Performance of VTOL and STOL Aircraft in Hover, Transition and Forward Motion.

UNIT V GROUND EFFECT MACHINES

10 hrs.

Types – Hover Height, Lift Augmentation and Power Calculation for Plenum Chamber and Peripheral Jet Machine – Drag of Hovercraft on Land and Water. Applications of Hovercraft.

(Computational problems must be given as assignments for each unit)

REFERENCE BOOKS:

1. Gessow, A., Aerodynamics of Helicopter, MacMillan & CO., N.Y., 1987
2. McCormick. B.W., Aerodynamics of V/STOL Flight, Academic Press, 1987
3. Johnson. W., Helicopter Theory, Princeton University Press, 1980
4. Seddon. J. ., Sion Newton, Basic Helicopter Aerodynamics, Blackwell Science, 2002
5. Gordon. J. Leishman, Principles of Helicopter Dynamics, Cambridge University press, 2006
6. Raymon W. Prouty, Helicopter Aerodynamics, PJS Publications, 1985
7. Gupta, L., "Helicopter Engineering", Himalayan Books, 1996.

SAEX1027	ADVANCED FLIGHT DYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I ATMOSPHERIC AND SPACE FLIGHT

10 hrs.

Atmospheric and space flight –modeling and simulation-attitude and kinematics of of ordinate frames – basic definitions and vector operations-coordinate systems and rotation matrix-Euler axis and principal angle-Euler angles-Euler symmetric parameters (quaternion)-Rodrigues parameters –Gibbs vectors-attitude kinematics

UNIT II GRAVITY AND MOTION

10 hrs.

Newton's law of gravitation –gravity of an asymmetric planet-gravitational anomalies-Particle kinematics in moving plane-Newton's law of motion –energy, movements and angular movements –two body problem

UNIT III CELESTIAL FRAME AND ELEMENTS

10 hrs.

Celestial frame and orbital elements –planet fixed frame –lamberts problem-perturbation acceleration-effects of planetary oblateness - effects of atmospheric drag-numerical solution to perturbed problem-three body problem-equations of motion langrage solution-restricted three body problem

UNIT IV TRAJECTORIES

10 hrs.

Atmospheric and trajectory trajectories – equations of motion –airplane flight paths-long range cruising flight –steady wind on airplane-take off maneuver-rocket ascent trajectories

UNIT V ROTATIONAL MOTION AND CONTROL SYSTEMS

10 hrs.

Euler equation for a rotational motion-rotational kinematic energy-principal body frame –torque free rotation of spacecraft – attitude motion in atmospheric flight – implementation of control systems elements-single axis closed loop attitude control-multi axis closed loop attitude control-Six-degrees of freedom simulation-wing rock motion of a aircraft simulation

(Computational problems must be given as assignments for each unit)

REFERENCE BOOKS

1. Ashish tewari, atmospheric and space flight dynamics: modeling and simulation with Matlab and Simulink, Birkhauser, spinger international edition,2007.
2. Pamadi, B. "Performance, stability, dynamics and control of airplanes", AIAA 2004.
3. Etkin, B. and Reid L.D. "Dynamics of Flight-Stability and Control" 3rd edition, John Wiley, 1996.
4. Stengel, R.F. "Flight dynamics" Princeton University Press, Princeton, N.J., USA, 2004.
5. Kaplan, Marshall H., Modern Spacecraft Dynamics and Control, John Wiely & Sons, New York. 1976
6. Wiesel, William E., Spaceflight Dynamics, Tata McGraw Hill Publishing Company Limited, New Delhi. 1997
7. Thomson, William T., Introduction to Space Dynamics, Dover Publication, Inc. New York. 1986
8. Sidi, Marcel J., Spacecraft Dynamics and Control, Cambridge University Press, U.K. 2000

SAEX1028	HELICOPTER MAINTENANCE	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I HELICOPTER FUNDAMENTALS

10 hrs.

Basic directions – Ground handling, bearings – Gears, construction of fuselage and tail boom.

UNIT II MAIN ROTOR SYSTEM

10 hrs.

Head maintenance – blade alignment – Static main rotor balance – Vibration – Tracking— Span wise dynamic balance – Blade sweeping –Electronic balancing – Dampener-maintenance – Counter weight adjustment – Auto rotation adjustments – Mast & Flight-Control Rotor - Mast – Stabilizer, dampeners – Swash plate flight control systems Collective
– Cyclic – Push pull tubes – Torque tubes – Bell cranks – Mixer box –Gradient unit control boosts – Maintenance & Inspection control rigging.

UNIT III MAIN ROTOR TRANSMISSIONS

10 hrs.

Engine transmission coupling – Drive shaft – Maintenance clutch – Free wheeling units –Spray clutch – Roller unit – Torque meter – Rotor brake – Maintenance of components – vibrations and monitoring systems- Mounting systems – Transmissions.

UNIT IV POWER PLANTS & TAIL ROTORS

10 hrs.

Fixed wing power plant modifications – Installation – Different type of power plant maintenance. Tail rotor system – Servicing tail rotor track – System rigging.

UNIT V AIRFRAMES AND RELATED SYSTEMS

10 hrs.

Fuselage maintenance – Airframe Systems – Special equipment, types of undercarriages and their operations.

TEXT BOOK

1. Jeppesen, "Helicopter Maintenance", Jeppesen and Sons Inc., 2000.,

REFERENCES

1. "Civil Aircraft Inspection Procedures", Part I and II, CAA, English Book House, New Delhi, 1986.
2. Larry Reithmier, "Aircraft Repair Manual", Palamar Books Marquette, 1992.

SAEX1029	AIR TRANSPORT AND AIRCRAFT MAINTENANCE	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

Development of air transportation, comparison with other modes of transport – Role of IATA, ICAO – The general aviation industry, airline – Factors affecting general aviation, use of aircraft, airport: airline management and organisation – levels of management, functions of management, Principles of organizations, planning the organisation – chart, support departments & line departments.

UNIT II AIRLINE ECONOMICS

10 hrs.

Forecasting – Fleet size, Fleet planning, fleet commonality, factors affecting choice of fuels, aircraft evaluation, the aircraft selection process, operating cost, passenger capacity, load factor etc. – Passenger fare and tariffs – Influence of geographical, economic & political factors on routes, route selection and capital acquisition.

Valuation & Depreciation – Budgeting, Cost planning – Aircrew evaluation – Route analysis

UNIT III PRINCIPLES OF AIRLINES SCHEDULING

10 hrs.

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations, equipments and types of schedule – hub & spoke scheduling, advantages / disadvantages & preparing flight plans – Aircraft scheduling in line with aircraft maintenance practices.

UNIT IV AIRCRAFT RELIABILITY

10 hrs.

Aircraft reliability and alert level determination – The maintenance schedule & its determinations – hardtime, On condition, Condition monitoring maintenance– Extended range operations (EROPS) & ETOPS – Ageing aircraft maintenance production.

UNIT V TECHNOLOGY IN AIRCRAFT MAINTENANCE

10 hrs.

Airlines scheduling (with reference to engineering) – Product support and spares – Maintenance sharing – Equipments and tools for aircraft maintenance – Aircraft weight control – Budgetary control. On board maintenance systems – Engine monitoring – Turbine engine oil maintenance –Turbine engine vibration monitoring in aircraft – Life usage monitoring – Current capabilities of NDT – Helicopter maintenance – Future of aircraft maintenance.

TEXT BOOKS

1. Fedric J.H., "Airport Management", 2000.
2. C.H. Friend, "Aircraft Maintenance Management", 2000.

REFERENCES

1. Gene Kropf, "Airline Procedures". Himalayan Book house 1949
 2. Wilson & Bryon, "Air Transportation". 2006
 3. Philip Locklin D, "Economics of Transportation". Richard D. Irwing 1972
 4. "Indian Aircraft manual" – DGCA Pub. 1975
- Alexander T Wells, "Air Transportation", Wadsworth Publishing Company, California, 1993.

SAEX1030	AIRCRAFT RULES AND REGULATIONS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I C.A.R. SERIES 'A' & SERIES 'B'

10 hrs.

Responsibilities of operators / owners – Procedure of CAR issue, amendments etc., – Objectives and targets of airworthiness directorate – Airworthiness regulations and safety oversight of engineering activities of operators.

C.A.R. Series 'B' – Issue Approval of Cockpit Check List, MEL, CDL - Deficiency list (MEL and CDL) – Preparation and use of cockpit checklist and emergency list.

UNIT II C.A.R. SERIES 'C' & SERIES 'D'

10 hrs.

Defect recording, reporting, investigation, rectification and analysis – Flight report – Reporting and rectification of defects observed on aircraft – Analytical study of in-flight readings and recordings – Maintenance control by reliability Method. **C.A.R. Series 'D'** – Aircraft Maintenance Programme - Reliability Programmes (Engines) – Aircraft maintenance programme and 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 periods and component TBOs – Initial and revisions.

UNIT III C.A.R. SERIES 'E' & SERIES 'F'

10 hrs.

Approval of organizations in categories A, B, C, D, E, F, and 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.

UNIT IV C.A.R. SERIES 'I', 'L', 'M', 'S' AND SERIES 'R'

10 hrs.

Issue of AME License – Classification and experience requirements – Mandatory modifications/inspections.

UNIT V C.A.R. Series 'T' & Series 'X'

10 hrs.

Flight testing of (Series) aircraft for issue of C of A – Flight testing of aircraft for which C of A had been previously issued – Registration Markings of aircraft – Weight and balance control of an aircraft – Provision of first aid kits and physician's kit in an aircraft – Use furnishing materials in an aircraft – Concessions – Aircraft log books – Document to be carried on board on Indian registered aircraft – Procedure for issue of tax permit – Procedure for issue of type approval of aircraft components and equipment including instruments, CAR'M'- CAR-145.

TEXT BOOKS

1. Anonymous, "Civil Aviation Requirements with Latest Amendment (Section 2 Airworthiness)", DGCA Publications, 2000.
2. Aeronautical Information Circulars (relating to Airworthiness), DGCA Publications, 2000.

REFERENCES

1. Anonymous, "Aircraft Manual (India) Volume-II", Latest Edition, The English Book Store, 17-1, Connaught Circus, 2003
2. Advisory Circulars from DGCA 2008.

SAEX1032	AIRCRAFT MAINTENANCE MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I AIRLINE ECONOMICS AND MAINTENANCE COST

10 hrs.

Airline economics and the aircraft – Principles of airlines economics – Cost of aircraft maintenance.

UNIT II SCHEDULES AND CONSTRAINTS

10 hrs.

Aircraft reliability –The maintenance schedules and its determinations–hardtime, on condition, conditions monitored maintenance – Extended range operations (EROPS) & ETOPS – Ageing aircraft. Maintenance, corrosion prevention programme

UNIT III MAINTENANCE PRODUCTION

10 hrs.

Airline scheduling (with reference to engineering) – Product support and spares – Maintenance sharing – Equipments and tools for aircraft maintenance – Aircraft weight control – Budgetary control, man power allocation.

UNIT IV COMPUTER IN AIRCRAFT MAINTENANCE

10 hrs.

Computer in aircraft maintenance – Artificial intelligence – Aircraft maintenance software's.

UNIT V TECHNOLOGY IN AIRCRAFT MAINTENANCE

10 hrs.

On board maintenance system – engine monitoring – Turbine engine oil maintenance – Turbine engine vibration monitoring in aircraft – life usage monitoring – current capabilities of NDT – Helicopter maintenance – Future of aircraft maintenance, aircraft loadable softwares- navigation data system, TCAS, EGPWS, EICAS.

TEXT BOOKS

1. C.H. Friend, Aircraft Maintenance Management, Longman, 1993
2. K.C.Batra, Production Management, Stringer, UK, 2005
3. Richardson J.D., Essential of Airlines Management Kendral Hunt, 1995
4. Banfe Charles F., Airline Management, Englewood Cliffs, N J – Prentice Hall 1992

REFERENCES

1. D.Philip Locklin, Economics of Transportation, 7th Edition, 1972.
2. Taneja Nawal K, Airlines in Transition Lexington, Mass, D.C.Health 1981.

SAEX1033	COMPUTER AIDED DESIGN AND ANALYSIS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO CAD

10 hrs.

Introduction to Design process - CAD. Geometric Modeling: Types - Wireframe, surface and solid modeling. Solid modeling techniques: CSG and B-rep - Operations: Boolean - Extrude - Sweep - Revolve. Entities - Line - Circle - Ellipse - Parabola - Cubic Spline, Bezier and B-spline.

UNIT II GRAPHICS TRANSFORMATIONS AND DISPLAY FUNCTIONS

10 hrs.

Coordinate systems - Transformations: translation, scaling, reflection, rotation - Concatenated transformation - Inverse transformation. Hidden line removal - Shading - Colouring - Rendering - Animation (Basic treatment only).

UNIT III SOFTWARE PACKAGES AND TECHNOLOGY

10 hrs.

Commercial solid modeling packages: Important features - Technical comparison - Modules and tools - Format of data exchange standards. Brief outline of feature technology: Classification of features - Design by features - Applications of features - Advantages and limitations - Brief outline of Parametric technology.

UNIT IV FEM INTRODUCTION

10 hrs.

Introduction - Steps involved in FEA: Nodes - Elements and their types, shape function, constraints, forces and nodal displacements - Stiffness matrix - Solution techniques. Analysis of spring element. Simple problems involving stepped bar subject to axial loading and simple structural members with triangular element.

UNIT V ANALYSIS FEA in CAD Environment:

10 hrs.

Stages of FEA in CAD environment - Preprocessor - Solver and postprocessor. Demonstration of the above using any one commercial packages. Brief outline of kinematic analysis - Manufacturability analysis and simulation (Basic treatment only).

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

1. Ibrahim Zeid, CAD/CAM - Theory and Practice, Tata Mc Graw-Hill, New Delhi, 2001
2. Radhakrishnan. P., CAD / CAM / CIM - New age international, 2000
3. Chairs McMahon and Jimmie Browne, CAD/CAM, Addison Wesley, New York, 2000

REFERENCE BOOKS

1. Chandupatla and Belagundu, Introduction to Finite Element Methods in Engineering, Prentice Hall of India Private Limited, New Delhi 1997
2. Newman and Sproull R. F., Principles of interactive computer graphics, Tata Mc Graw-Hill, New Delhi, 1997
3. Mikell P. Groover, CAD/CAM, Prentice Hall of India Private Limited, New Delhi, 1997

SAEX1035	AEROELASTICITY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I AEROELASTIC PHENOMENA

10 hrs.

Stability versus response problems - The aero-elastic triangle of forces Aero elasticity in Aircraft Design -Prevention of Aero elastic instabilities.

UNIT II DIVERGENCE OF A LIFTING SURFACE

10 hrs.

Simple two dimensional idealizations - Strip theory - Fredholm integral equation of the second kind – Exact solutions for simple rectangular wings –Semi rigid assumption and approximate solutions – Generalized coordinates -Successive approximations - Numerical approximations using matrix equations

UNIT III STEADY STATE AEROELASTIC PROBLEMS

10 hrs.

Loss and reversal of aileron control - Critical aileron reversal speed - Aileron efficiency – Semi rigid theory and successive approximations - Lift distribution -Rigid and elastic wings.

UNIT IV FLUTTER PHENOMENON

10 hrs.

Non-dimensional parameters - Stiffness criteria Dynamic mass balancing -Model experiments – Dimensional similarity - Flutter analysis - Two dimensional thin airfoils in steady incompressible flow – Quasi steady aerodynamic derivatives - Galerkin method for critical speed - Stability of distributed motion - Torsion flexure flutter - Solution of the flutter determinant - Methods of determining the critical flutter speeds – Flutter prevention and control.

UNIT V EXAMPLES OF AEROELASTIC PROBLEMS IN CIVIL AND MECHANICAL ENGINEERING

10 hrs.

Galloping of transmission lines and flow induced vibrations of tall slender structures and suspension bridges.

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

1. Bisplinghoff., R.L., Ashley, H., and Halfmann, R.L., "Aeroelasticity", Addison Wesley Publishing Co., Inc., II ed, 1987.
2. Fung, Y.C., "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York 1985.

REFERENCE BOOKS:

1. Broadbent, E.G., "Elementary Theory of Aeroelasticity" BunHill Publications Ltd., 1986.

SAEX1039	UNMANNED AIRCRAFT SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO UAS

10 hrs.

History of unmanned aerial vehicles- types- Introduction to Unmanned aircraft systems- Unmanned aerial vehicles –Micro aerial vehicles definitions, history, classification- applications-recent research and development in civil and defense applications – autonomous vehicles -future research in autonomous vehicles – design standards and regulatory aspects introduction to design and selection of systems

UNIT II ASPECTS OF UAS SYSTEMS

10 hrs.

Involvement of different aspects in the development of UAV-aerodynamic configurations -Aspects of airframe design- Stealth design, payload types, communication, navigations & guidance systems, control & stability, launch, recovery and support systems, reliability design

UNIT III MODELING AND CONTROL HELICOPTER MODEL

10 hrs.

Modeling and control of small and miniature unmanned helicopters –single rotor helicopter design – coaxial rotor helicopter design - autonomous control of a mini quadrotor vehicle using LQG controllers – linearization and identification of helicopter model

UNIT IV UAV DESIGN MODELING & CONTROL

10 hrs.

Development of autonomous quad tilt wing – advanced flight control systems for rotorcraft UAV and MAV – mathematical modeling and non linear control of VTOL aerial vehicles

UNIT V DEPLOYMENT OF UAS/UAV SYSTEMS

10 hrs.

Only application point of view of various UAS roles played in civil, defense applications -vision based navigation-company trails- certification of UAS/UAV/MAV systems

(Computational problems must be given as assignments for each unit)

REFERENCES:

1. Reg Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment John Wiley, UK,2010
2. Kenzo Nonami, Farid Kendoul, Satoshi Suzuki, Wei Wang, Daisuke Nakazawa, Modeling and Control of Unmanned Small Scale Rotorcraft Uavs & Mavs, Springer, New York, 2010
3. Laurence R. Newcome, Unmanned aviation: a brief history of unmanned aerial vehicles, American Institute of Aeronautics and Astronautics, New York, 2004
4. Kimon Valavanis, Advances in unmanned aerial vehicles, Springer, Netherlands, 2007
5. Elizabeth Bone, Christopher Bolcom, Unmanned aerial vehicles, Novinka Books, United Kingdom 2004
6. Rogelio Lozano, Unmanned Aerial Vehicles Embedded Control, John Wiley & Sons, 2010
7. Pedro Castillo, Rogelio Lozano, Alejandro E. Dzul, Modelling and control of mini-flying machines, Advances in industrial control (AIC), Springer-Verlag, London,2005
8. Bernard Mettler, Identification modeling and characteristics of miniature rotorcraft, Kluwer Publishers, USA, 2003

SAEX1040	ROBOTICS ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO ROBOTICS

10 hrs.

Basic concepts - Robot anatomy - Manipulators - kinematics: Forward and reverse kinematics - Precision movement, robot specifications and Work volume, Types of Robot drives - Basic robot motions - Point to point control, continuous path control.

UNIT II END EFFECTORS AND CONTROL SYSTEMS

10 hrs.

End effectors - classification - mechanical, magnetic, vacuum and adhesive gripper - gripper force analysis and design. Robot control - unit control system concept - servo and non-servo control of robot joints, adaptive and optimal control.

UNIT III SENSORS

10 hrs.

Sensor devices, Types of sensors - contact, position and displacement sensors, Force and torque sensors - Proximity and range sensors - acoustic sensors - Robot vision systems - Sensing and digitizing - Image processing and analysis.

UNIT IV ROBOT PROGRAMMING

10 hrs.

Robot language classification - programming methods - off and on line programming - Lead through method - Teach pendent method - VAL systems and language, simple program.

UNIT V APPLICATIONS

10 hrs.

Application of robots - Material handling - Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Mobile robot - Recent developments in robotics- safety considerations- Application in Aeronautical Engineering.

(Computational problems must be given as assignments for each unit)

TEXT BOOKS:

1. Deb, S. R., Robotics Technology And Flexible Automation, Tata McGraw Hill Co, New Delhi, 1994
2. Mikell P. Groover, Industrial Robotics Technology Programming And Applications, McGraw Hill Co., Singapore, 1995

REFERENCE BOOKS:

1. Klafter, R. D, Chmielewski, T. A. and Noggins, Robot Engineering : An Integrated Approach, Prentice Hall of India Pvt. Ltd., New Delhi, 1994
2. Fu, K. S., Gonzalez, R. C., & Lee, C.S.G., Robotics Control, Sensing, Vision And Intelligence, McGraw Hill Book Co., Singapore, 1987
3. Craig, J. J., Introduction To Robotics Mechanics And Control, Addison-Wesley, London, 1999

SAEX1041	CRYOGENICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

Historical Background - Introduction to cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen and their properties

UNIT II PRODUCTION OF LOW TEMPERATURE

10 hrs.

Theory behind the production of low temperature - Expansion engine heat exchangers - Cascade process Joule Thompson Effect - Magnetic effect - Ortho and H₂ - Helium₄ and Helium₃

UNIT III EFFICIENCY OF CRYOGENIC SYSTEMS

10 hrs.

Types of losses and efficiency of cycles - specific amount of cooling - The fraction liquified – Cooling coefficient of performance - Thermodynamic efficiency – The energy balance Method

UNIT IV CYCLES OF CRYOGENIC PLANTS

10 hrs.

Classification of cryogenic cycles - The structure of cycles - Throttle expansion cycles - Expander cycles - Thermodynamic analysis - Numerical problems

UNIT V CRYOGENIC IN AEROSPACE APPLICATIONS

10 hrs.

Cryogenic liquids in missile launching and space simulation Storage of cryogenic liquids - Effect of cryogenic liquids on properties of aerospace materials – Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse - Elimination of Geysering effect in missiles

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

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

REFERENCE BOOK

1. Parner, S. F., Propellant Chemistry, Reinhold Publishing Corp., New York 1985

SAEX1042	SPACECRAFT TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I BASIC CONCEPTS

10 hrs.

The solar system - Reference frames and coordinate systems - The celestial sphere - The ecliptic - Motion of vernal equinox - Sidereal time - Solar time - Standard time - The earth's atmosphere.

UNIT II THE GENERAL N-BODY PROBLEM

10 hrs.

The Many body problem - Lagrange - Jacobi identity - The circular restricted three body problem – Libration points - Relative Motion in the N-body problem - The two - body problem - Satellite orbits - Relations between position and time - Orbital elements.

UNIT III SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS

10 hrs.

General aspects of satellite injections - Satellite orbit transfer - Various cases - Orbit deviations due to injection errors - Special and general perturbations - Cowell's Method - Encke's method - Method of variations of orbital elements - General perturbations approach.

UNIT IV INTERPLANETARY TRAJECTORIES BALLISTIC MISSILE - TRAJECTORIES

10 hrs.

Two-dimensional interplanetary trajectories - Fast interplanetary trajectories - Three dimensional interplanetary

trajectories - Launch of interplanetary spacecraft - Trajectory about the target planet. The boost phase - The ballistic phase - Trajectory geometry - Optimal flights - Time of flight - Re-entry phase - The position of the impact point - Influence coefficients.

UNIT V MATERIALS FOR SPACECRAFT

10 hrs.

Space environment - Peculiarities -Effect of space environment on the selection of materials of spacecraft.

(Computational problems must be given as assignments for each unit)

TEXT BOOKS

1. Brown, C. D., Spacecraft Mission Desing, AIAA Education Series, Washington DC, 1992.
2. Sutton, G. P., Rocket Propulsion Elements, John Wiley, 1993.
3. Van de Kamp, P., Elements of Astromechanics, Pitman, 1979.

REFERENCE BOOKS

1. Cornelisse, J. W., Rocket Propulsion and Space Dynamics, W.H. Freeman & Co., 1984.
2. Parker, E. R., Materials for Missiles and Spacecraft, McGraw Hill Book Co., Inc., 1982.

SAEX1043	LAUNCH VEHICLES AND SPACECRAFT PROPULSION	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

Introduction - Historical Note / Basic Propulsion Devices - Architectural description of Launch Vehicles and Satellites - Rocket Equation / Staging / Payload - Launch weight relation - Propulsion Requirements / Thrust and time requirements - Types of rockets / propellants / choices.

UNIT II NOZZLE FLOWS AND AEROTHERMO CHEMISTRY

10 hrs.

Nozzle flows / Introduction - Performance parameters - Review of aero thermo chemistry - Propellant and burning - Internal Ballistics - Grains / Ignition etc.

UNIT III PROPELLANTS AND HEAT TRANSFER

10 hrs.

System Description / Propellants - Combustion / Heat Transfer / Cooling - Feed Systems - R-4 Auxilliary Components - Monopropellants / Catalytic systems -Ignition / Restart / Environmental problems.

UNIT IV SATELLITE INTEGRATION

10 hrs.

Cold gas systems - Thruster satellite integration - Propellant management in spacecrafts - Propellant access in microgravity.

UNIT V PROPULSION OPTIONS

10 hrs.

Air breathing options in launch vehicles - Non chemical propulsion options - Nuclear Rockets. Electrostatic and Electromagnetic propulsion. Special thermal and integration problems

(Computational problems must be given as assignments for each unit)

REFERENCES:

1. G.P. Sutton : Rocket Propulsion Elements, Wiley, New York, 2006
2. C.D. Brown: Spacecraft Propulsion, AIAA Education Series, AIAA Inc., Washington DC, 1996 .

SAEX1044	ORBITAL MECHANICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

Dynamics of point masses kinematics- time derivatives-relative motion – the two body problem-equations of motion in inertial frame, relative motion- angular momentum, circular, elliptical, parabolic, hyperbolic trajectories Lagrange coefficients-three body problem

UNIT II ORBITAL ELEMENTS

10 hrs.

Orbits Vs trajectories, universal variables, orbits as function of time, orbits in three dimensions – Gibbs method, Lambert Problem, sidereal time- top centric coordinate system- gauss method

UNIT III MANEUVERS

10 hrs.

Hofmann transfer-bi-elliptic Hofmann-non Hoffman-plane range-relative motion – rendezvous motion- interplanetary trajectories – gyroscopic instruments-mechanisms-types -operation

UNIT IV RIGID BODY DYNAMICS

10 hrs.

Kinematics-equations of motion, rotational motion-moment of inertia-Euler's equation-kinetic energy-Euler's angles-yaw, pitch and roll angles, dual spin the spinning top problem

UNIT V ATTITUDE DYNAMICS

10 hrs.

Torque free motion - stability –dual spin-rotation damper-coning maneuver -attitude control thrusters-gyroscopic attitude control-gravity-gradient stabilization- rocket vehicle dynamics- thrust equation-rocket performance- staging-optimal staging

(Computational problems must be given as assignments for each unit)

TEXT BOOK:

1. Howard.D.Curtis, Orbital Mechanics for Engineering Students. 2nd ed, Elsevier, 2009
2. William.E.Wiesel, Space Flight Dynamics, 2nd ed, Tata McGraw-Hill, SiE, 2007

REFERENCES:

1. Tewari, Atmospheric and Space Flight Dynamics - Modeling and Simulation with MATLAB and Simulink. Birkhäuser-Spinger, Special Indian Edition, New Delhi, 2009
 2. M.J. Sidi, Spacecraft Dynamics and Control. Cambridge, 1997,
 3. Francis. J. Hale, Introduction to Space Flight. Prentice Hall, 1994
 4. D.A. Vallado, Fundamentals of Astrodynamics and Applications. 2nd Edition, Microcosm, 2001,
 5. G.A. Gurzadyan, Space Dynamics. CRC, 2002,
 6. M.H. Kaplan, Modern Spacecraft Dynamics & Control. 1976, Wiley
- B. Wie, Space Vehicle Dynamics and Control. AIAA, 1998

SAEX4001	AERO CAD LAB - I	L	T	P	Credits	Total Marks
		0	0	4	2	100

Using any Softwares like PRO/E, CATIA, Solid Works, ANSYS, MSC / Nastran

1. *Modeling of various components using any modeling software*
2. *Static analysis on cantilever beam*
3. *Static analysis of forces in a simply supported beam*
4. *Static analysis- Plane truss*
5. *2-D static stress analysis*
6. *3-D static stress analysis*
7. *Stress distribution in a shrink fit*
8. *Natural frequencies of a spring mass system*
9. **Stress and modal analysis of a cylinder under pressure**
10. **Stress distribution and natural frequencies in indeterminate structure**
11. **Analysis of a model airplane wing**

SAEX4004	AERO MODELLING LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Study about historical background of airplanes
2. Component of airplanes and its functions
3. Construction of glider
4. Construction of fuselage
5. Construction of wing
6. Construction of tail plane
7. Assembly of a plane
8. Mounting of engine and controls
9. Training in flight maneuvering through computer simulation
10. Testing of trainer flight model

SAEX1021	ROCKETS AND MISSILES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I ROCKETS SYSTEM

10 hrs.

Ignition System in rockets - types of Igniters - Igniter Design Considerations - Design Consideration of liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks Outlet and Helium Pressurized and Turbine feed Systems - Propellant Slash and Propellant Hammer - Elimination of Geysering Effect in Missiles - Combustion System of Solid Rockets.

UNIT II AERODYNAMICS OF ROCKETS AND MISSILES

10 hrs.

Airframe Components of Rockets and Missiles - Forces Acting on a Missile While Passing Through Atmosphere

- Classification of Missiles - methods of Describing Aerodynamic Forces and Moments - Lateral Aerodynamic Moment
- Lateral Damping Moment and Longitudinal Moment of a Rocket - lift and Drag Forces - Drag Estimation - Body Upwash and Downwash in Missiles - Rocket Dispersion - Numerical Problems

UNIT III ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD

10 hrs.

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 Burnout Velocity.

UNIT IV STAGING AND CONTROL OF ROCKETS AND MISSILES

10 hrs.

Rocket Vector Control – Methods, SITVC termination, Thrust determination, Multi staging of rockets - Vehicle Optimization - Stage Separation Dynamics - Separation Techniques, Types of aerodynamics control in missiles

UNIT V MATERIALS FOR ROCKETS AND MISSILES

10 hrs.

Selection of Materials - Special Requirements of Materials to Perform under Adverse Conditions.

(Computational problems must be given as assignments for each unit)

TEXT BOOK:

1. Sutton, G.P., et al., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1993.

REFERENCE BOOKS:

1. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi 1998.
2. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W., Freeman & Co. Ltd., London, 1982.
3. Parket, E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982.

SAEX1036	ADVANCED CONTROL SYSTEM DESIGN FOR AEROSPACE VEHICLES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION

10 hrs.

Introduction and Motivation for Modern Control Design- Review of Classical Control Systems-Introduction to Basic Flight Mechanics and Flight Control Systems.-State Space Representation of Dynamical Systems.

UNIT II NON LINEAR SYSTEMS

10 hrs.

Linearization of Nonlinear Systems, Linearized Flight Mechanics-Review of Matrix Theory-time Response of Dynamical Systems in State Space form-Stability of Linear Systems-Controllability and Observability of Linear Systems.

UNIT III CONTROL SYSTEM DESIGN

10 hrs.

Pole Placement Control Design.-Pole Placement Observer Design - Static Optimization -Optimal Control Formulation; Linear Quadratic Regulator (LQR) Design- Application of Linear Control Theory to Autopilot Design of Aircrafts and Missiles-Gain Scheduling and Dynamic Inversion Design.

UNIT IV STABILITY ANALYSIS & LYAPUNOV THEORY

10 hrs.

Stability Analysis of Nonlinear Systems Using Lyapunov Theory-Neuro-Adaptive Design for Nonlinear Systems-Advanced Nonlinear Control of Aerospace Vehicles Using Dynamic Inversion and Neuro-Adaptive Design.

UNIT V NONLINEAR CONTROL DESIGN

10 hrs.

Nonlinear Control Design Using Back-stepping-An Overview of LQ Observer and Kalman Filtering- Nonlinear Observer Design.

(Computational problems must be given as assignments for each unit)

REFERENCES

1. N. S. Nise: Control Systems Engineering, 4th Ed., Wiley, 2004.
2. K. Ogata: Modern Control Engineering, 3rd Ed., Prentice Hall, 1999.
3. B. Friedland: Control System Design, McGraw Hill, 1986.
4. E. Bryson and Y-C Ho: Applied Optimal Control, Taylor and Francis, 1975
5. Mathukumalli Vidyasagar, Nonlinear systems analysis, 2nd Edition, SIAM, 2002
6. Hassan K. Khalil, Nonlinear systems, Macmillan Pub. Co., 1992
7. Shankar Sastry, Nonlinear systems: analysis, stability, and control, Springer, 1999

SAEX1037	AIRCRAFT NAVIGATION GUIDANCE AND CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INERTIAL SENSORS

10 hrs.

Gyroscopes-Mechanical-electromechanical-Ring Laser gyro- Fiber optic gyro, Accelerometers

UNIT II INERTIAL NAVIGATION SYSTEMS

10 hrs.

INS components: transfer function and errors-The earth in inertial space, the coriolis effect-Mechanisation. Platform and Strap down, INS system block diagram, Different co-ordinate systems, Schuler loop, compensation errors, Gimbal lock, Alignment.

UNIT III RADIO NAVIGATION

10 hrs.

Different types of radio navigation- ADF, VOR/DME- Doppler –LORAN, DECCA and Omega - TACAN

UNIT IV APPROACH AND LANDING AIDS

10 hrs.

ILS, MLS, GLS - Ground controlled approach system - surveillance systems-radio altimeter, RNAV, Modern Navigation Aids

UNIT V SATELLITE NAVIGATION & HYBRID NAVIGATION

10 hrs.

Introduction to GPS -system description -basic principles -position and velocity determination-signal structure-DGPS, Introduction to Kalman filtering-Estimation and mixed mode navigation-Integration of GPS and INS-utilization of navigation systems in aircraft

(Computational problems must be given as assignments for each unit)

REFERENCES:

1. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons, 2nd edition, 1997
2. Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 1975.
3. George M Siouris, 'Aerospace Avionics System; A Modern Synthesis', Academic Press Inc., 1993.
4. Albert Helfrick, 'Practical Aircraft Electronic Systems', Prentice Hall Education, Career & Technology, 1995.
5. Albert D. Helfrick, 'Modern Aviation Electronics', Second Edition, Prentice Hall Career & Technology, 1994.
6. Sen, A.K. & Bhattacharya, A.B. "Radar System and Radar Aids to Navigation", Khanna Publishers, 1988.
7. Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.

SAEX1038	FLIGHT CONTROL SYSTEM DESIGN	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO CONTROL SYSTEM DESIGN & FCS

10 hrs.

Open vs. Closed Loop Control - Analogue, Digital and Logical Control - Industrial Controllers - Control System Design Objectives - Control System Design Cycle - Introduction to Flight Control Systems - History of FCS - Guidance, Navigation and Control - Flight Control Channels - Flight Control Methods - SAS vs. Autopilot

UNIT II AERODYNAMIC CONSIDERATIONS OF FLIGHT CONTROL SYSTEMS

10 hrs.

Static and Dynamic Stability - Stability and Maneuverability - Static Margin - Variations of the Center of Pressure - Hinge Moment - Aeroelastic Effects- Control System Performance - Canard Control - Wing Control - Tail Control - Fin Configuration Effects- Side Jet Control-Thrust -Vector Control - Variation of Mass and CG

UNIT III SENSORS & ACTUATORS

10 hrs.

Flight Control Sensors – Accelerometers- Gyroscopes-Angle of attack vane - Other sensors - Sensor Selection-Flight Control Actuators- Servomechanism- Reversible vs. Irreversible –Mechanisms-Hydraulic Actuators-Pneumatic Actuators- Electric Actuators

UNIT IV CONTROLLER DESIGN

10 hrs.

An Overview of Controller Design-Design Using Frequency Response-Design Using Root Locus- Pole Placement Methods-Linearization and Transfer Functions of Flying Vehicles- Coordinate Systems-Equations of Motion-Roll, Pitch and Yaw Transfer Functions- Design of Aerodynamic Control System for Missiles-STT vs. BTT -Lateral Control System Design for STT-Roll Control-Control System Design for BTT-MIMO Based Design-Design of Single Channel Flight Control Systems

UNIT V AIRCRAFT CONTROL SYSTEM DESIGN

10 hrs.

Longitudinal Control-Lateral Control- Attitude Control Systems -Flight Path Control Systems- Active Control Systems -Thrust Vector Control - Classifications and Applications - Mathematical Modeling -Control Architectures - Controller Design- Miscellaneous Topics - Sensitivity Analysis-Man in the Loop considerations- Parameter Optimization

(Computational problems must be given as assignments for each unit)

TEXT BOOKS:

1. Garnell, P., "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.
2. McLean, D., "Automatic Flight Control Systems", Prentice Hall International (UK) Ltd, 1990.
3. Blakelock, J. H.; Automatic Control of Aircraft and Missiles, 2nd Edition, John Wiley & Sons, 1990.

REFERENCE:

1. Siouris, G.M. "Missile Guidance and control systems", Springer, 2003.
 2. Fleeman, Eugene L.; Tactical Missile Design, First Edition, AIAA Education series, 2001.
- Roskam, Jan; Airplane flight dynamic and Automatic flight control, 3th Printing, Design, Analysis and Research Corporation, 2001.

SAE4051	AIRCRAFT PRODUCTION TECHNOLOGY LAB (For Aeronautical)	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OUTCOMES:

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

CO1: Join two parts using the lap-, tee- and V- weld joints using the electric arc welding equipment.

CO2: Develop the V-joint and dove tail joint using the fitting tools.

CO3: Perform the external machining operations (facing, turning, knurling, grooving and thread cutting) using a conventional lathe.

CO4: Perform the internal machining operations (drilling, reaming and internal thread cutting) using a conventional lathe.

CO5: Perform the eccentric turning operation using a four jaw chuck in a conventional lathe.

CO6: Perform the taper turning operations using the compound rest swivel method and attachment method.

SUGGESTED LIST OF EXPERIMENTS

Lathe Machine

1. Study of lathe and precision tools
2. Facing, Step, taper and turning
3. Internal and external thread cutting
4. Eccentric turning
5. Grooving & knurling
6. Drilling & Boring

Milling Machine

1. Spur gears

Shaping machine

1. Key way & Angular cutting

Radial Drilling Machine

1. Drilling and Taping

Grinding Machine

Cylinder grinding

SAE1604	AIRLINE OPERATIONS AND MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To get idea about airline scheduling ,airspace management and to get knowledge objectives of International Civil Aviation Organization.

COURSE OUTCOMES

CO1: Utilize the functions of aviation technology transformation and classify the types of aviation industries.

CO2: Select the standard aircraft possessing best operating cost and moderate passenger capacity for economic class.

CO3: Outline the principles of airline scheduling for preparing flight plans in line with aircraft maintenance practices.

CO4: Interpret the functions of Airspace management for the aircraft other than takeoff and landing handling airport infrastructure.

CO5: Summarize the growth and development of civil aviation organizations in different nations.

CO6: Categorize the growth and development of DGCA rules and regulatory for civil aviation companies.

UNIT 1 INTRODUCTION

9 Hrs.

Introduction to Transportation–Modes–Modal Competition– The Economic Importance– Transportation and Economic Development–TransportasaFactorof Production– InternationalTransportation–Importanceof International Transportation–Logistics Management– Concepts and Types of Aviation–History of Civil Aviation Industry–Aviation Technology Transformation (1930 –2003) –Scope of Aviation

UNIT 2 AIRLINE ECONOMICS

9 Hrs.

Forecasting – Fleet Size, Fleet Planning, The Aircraft Selection Process, Operating Cost, Passenger Capacity, Load Factor Etc. – Passenger Fare and Tariffs – Influence of Geographical, Economic & Political Factors on Routes and Route selection. Aircraft Selection Process – Fleet Commonality, Factors affecting choice of fleet, Route Selection and Capital Acquisition – Valuation & Depreciation – Budgeting, Cost Planning – Aircrew Evaluation –Route Analysis – Aircraft Evaluation.

UNIT 3 PRICIPLES OFAIRLINES SCHEDULING

9 Hrs.

Equipment Maintenance, Flight Operations and Crew Scheduling, Ground Operations and Facility Limitations Equipment and Types of Schedule – Hub & Spoke Scheduling, Advantages / Disadvantages & Preparing Flight Plans – Aircraft Scheduling in Line with Aircraft Maintenance Practices

UNIT 4 AIRSPACE MANAGEMENT

9 Hrs.

Aircraft Characteristics – Airport Capacity Management – Terminal Management – Apron Management– Size of Airport Infrastructure – Airports and their Economics in National Economic Growth and Development –Indian Scenario–GlobalEmergingTrendsofAirportInfrastructureIndustry– GlobalStudyonAirportPerformance–Modern Aviation Infrastructure Business Trend – Airspace Management – Airports and Airspace Congestion Issues – Regulatory Management

UNIT 5 GROWTH &DEVELOPMENT

9 Hrs.

International Civil Aviation Organization (ICOA)–Introduction– Objectives –Strategic Planning– Annexes– International Air Transport Association(IATA)– Aims– Two Tier Systems– Growth and Development– World Trade Organization –World Tourism Organization –Federal Aviation Administration (FAA) –Civil Aviation Authority (CAA)–EASA (European Aviation Security Agency) – Director General of Civil Aviation (DGCA) – Functions -Concepts of Bilateral, Multilateral and Plurilateral in Air Trade Agreements–Major Factors that Converge Private Sector Initiatives - Modern Airline Trends–Liberalization in Air Transport –Potential Paths Further Liberalization – Privatization in Indian Civil Aviation Industry – Deregulation in Indian Air Pocket – Airport Internalization – Basic Principle behind Privatization– Airport -Privatization–FormsofAirport- =Privatization–Airport-Privatization Models–Causes–Objectives–Airport Ownership and Governance Models– Airport Privatization in India–Road Map for the Civil Aviation Sector

Max. 45 Hours

TEXT / REFERENCE BOOKS

- Allan Rossmore, Airline Operations, An Inside View 2000,2 ,illustrated ,Kellmark

Aeronautics, Incorporated, 2000.

2. Massoud Bazargan, Airline operations and scheduling, Ashgate Publishing Limited, Hampshire, England, 2008.

3. Alexander T. Wells, Seth B. Young, Airport planning & management, McGraw-Hill, 2004.

4. P. S. Senguttuvan, "Fundamentals of Air Transport Management", Excel Books, First Edition 2006
John G. Wensveen, Air Transportation: A Management Perspective, Ashgate Publishing Company, 2007.

SAEX1014	CONTROL SYSTEMS FOR AIRCRAFT	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO AFCS

10 hrs.

Historical review - control systems applications in aircrafts, missiles, spacecrafts – aircraft flight control systems-models representations – open loop and closed loop -effects of feedback – Transfer function-- Block diagram representation of control systems, Reduction of block diagrams, Signal flow graph representations with applications and problems in aircraft control, systems

UNIT II MODEL REPRESENTATIONS

10 hrs.

mathematical models of physical systems - Simple pneumatic, hydraulic and thermal systems— Mechanical-Electrical systems – Analogies introduction to state space –concept of state variables and state models and derivation of state models from block diagram with reference to aircraft models

UNIT III TIME RESPONSE AND STEADY STATE ERRORS

10 hrs.

Response of systems to different inputs viz., Step input, impulse, ramp, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit. Automatic controls systems – Controllers - P, PI, PID controllers in aircraft FCS

UNIT IV CONCEPT OF STABILITY & ROOT LOCUS TECHNIQUES

10 hrs.

Characteristic equation, location of roots in S-plane, Concept of stability -Routh - Hurwitz criteria of stability - relative stability, Nyquist stability Criterion, Root locus Techniques – construction of root loci, problems in AFCS domain

UNIT V FREQUENCY RESPONSE & APPLICATIONS

10 hrs.

Frequency response of the systems – correlation between time and frequency response – gain and phase margins – bode plot method, Applications & problems in Aircrafts Flight control systems

(Computational problems must be given as assignments for each unit)

TEXT BOOK:

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson, New Delhi. 2010
2. Pallet, E.H.J. "Automatic Flight Control", Shroff Publishers, India, 2004

REFERENCES:

1. Gene F. Franklin, J. D. Powell, Abbas E, Feedback Control of Dynamic Systems, 6th edition, Pearson, 2009
2. Benjamin C. Kuo, Farid Golnaraghi, Automatic control systems, Volume 1, 8th Ed, John Wiley & Sons, 2003
3. Norman S. Nise, Control Systems Engineering, 4th edition, John Wiley, New Delhi, 2004
4. Richard C. Dorf, Robert H. Bishop, Modern control systems, 11th edition, Prentice Hall India, 2008
5. Rao V. Dukkupati., Analysis and design of control systems using MATLAB, New Age International Publishers, India, 2006.
6. Brian D.H, D. T. Valentine, Essential MATLAB for engineers and scientists, 4th ed, Butterworth Heinemann, 2009