Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

SCHOOL

of

MECHANICAL & CONSTRUCTION

DEPARTMENT OF

AERONAUTICAL ENGINEERING

VTUR15

Curriculum & Syllabus

Vision and Mission of the Institute

Vision:

To create, translate and share frontiers of knowledge embedded with wisdom and innovation for a positive transformation of emerging society.

Mission

To nurture excellence in teaching, learning, creativity and research; translate knowledge into practice; foster multidisciplinary research across science, medicine, engineering, technology and humanities; incubate entrepreneurship; instill integrity and honour; inculcate scholarly leadership towards global competence and growth beyond self in a serene, inclusive and free academic environment.

Department of Aeronautical Engineering
Vision and Mission of the Department

Vision

Excellence in education and research practices of Aeronautical Engineering

Mission

Nurture quality education ambience by employing modern education pedagogies.

Provide vital state of the art research facilities to students and faculty members with opportunities to create, interpret, apply and disseminate knowledge.

Develop linkages with the world class research organizations and institutions for excellence in teaching and research.

Promote Industry Institute linkages; Nurture entrepreneurship.

Programme Educational Objectives

1. Pursue higher education, research and development in aeronautical and allied domain
2. Practice aeronautical engineering / chosen profession in industries and organizations
3. Solve real world complex problems with social, ethical and business awareness.

Programme outcomes

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes:

13. **Engineering knowledge & Complex Problem analysis:** Apply mathematical and numerical skills to interpret and solve problems for Aircraft Design and for applying core knowledge in aerodynamics, structures, propulsion, dynamics and control to formulate and solve problems in engineering, including the use of current experimental and data analysis techniques
14. **Design & Development of Solutions:** Ability to use the techniques, skills, and modern engineering tools necessary for aerospace engineering practice.

Programme core

S.No	**Course Code**	**Course Name** Theory courses	**L**	**T**	**P**	**C**
1	1151AE101	Introduction to Aerospace Engineering	2	0	0	2
2	1151AE102	Engineering Mechanics	2	2	0	3
3	1151AE103	Strength of Materials	2	2	0	3
4	1151AE104	Fluid Mechanics	2	2	0	3
5	1151AE105	Aero Engineering Thermodynamics	2	2	0	3
6	1151AE106	Linear system Analysis and control	3	0	0	3
7	1151AE107	Incompressible Flow Aerodynamics	3	0	0	3
8	1151AE108	Aircraft Gas Turbine Propulsion	2	2	0	3
9	1151AE109	Airplane Performance	3	0	0	3
10	1151AE110	Compressible flow Aerodynamics	2	2	0	3
11	1151AE111	Rocket and Space Propulsion	3	0	0	3
12	1151AE112	Airplane Stability and control	3	0	0	3
		Total				35
	Course Code	**Integrated Courses**	**L**	**T**	**P**	**C**
1	1151AE213	Numerical Methods using MATLAB	2	0	2	3
2	1151AE214	Aircraft systems and Instruments	1	0	2	2
3	1151AE215	Aircraft Structural Mechanics	1	2	2	3
4	1151AE216	Aircraft Structural Analysis	1	2	2	3
5	1151AE217	Avionics	2	0	2	3
6	1151AE218	Computational Methods for Aeronautical Engineering	2	2	2	4
		Total				18
	Course Code	**Laboratory courses**	**L**	**T**	**P**	**C**
1	1151AE319	Strength of Materials Laboratory	0	0	2	1
2	1151AE320	Thermodynamics Laboratory	0	0	2	1
3	1151AE321	Fluid Mechanics Laboratory	0	0	2	1
4	1151AE322	Aerodynamics Laboratory	0	0	2	1
5	1151AE323	Propulsion Laboratory	0	0	2	1
6	1151AE324	Aero Engine Maintenance and Structural Repair Laboratory	0	0	2	1
7	1151AE325	Flight Mechanics and control Laboratory	0	0	2	1
		Total				7
		Total Credits				60

Programme Electives

S.No	Course Code	Course Name Lecture courses	L	T	P	C
1	1152AE101	Aero Engine Maintenance and structural Repair	3	0	0	3
2	1152AE102	Aeroelasticity	3	0	0	3
3	1152AE103	Air Transportation and Aircraft Maintenance	3	0	0	3
4	1152AE204	Aircraft Design	1	0	4	3
5	1152AE105	Aircraft General Engineering and System Maintenance	3	0	0	3
6	1152AE106	Aircraft Rules and Regulations	3	0	0	3
7	1152AE107	Approximate Methods in Structural Mechanics	3	0	0	3
8	1152AE208	Autopilot Design	2	0	2	3
9	1152AE109	Aviation Safety Management	3	0	0	3
10	1152AE110	Boundary Layer Theory	3	0	0	3
11	1152AE111	Combustion in Jet and Rocket engines	3	0	0	3
12	1152AE112	Composite Materials and Structures	3	0	0	3
13	1152AE213	Computational Fluid Dynamics	2	0	2	3
14	1152AE114	Cryogenic engineering	3	0	0	3
15	1152AE116	Electric propulsion	3	0	0	3
16	1152AE117	Experimental Aerodynamics	3	0	0	3
17	1152AE118	Experimental Stress Analysis	3	0	0	3
18	1152AE219	Flapping Wing Dynamics	2	0	2	3
19	1152AE120	Heat Transfer	3	0	0	3
20	1152AE121	Helicopter Maintenance	3	0	0	3
21	1152AE122	Helicopter Theory	3	0	0	3
22	1152AE123	High Temperature Gas Dynamics	3	0	0	3
23	1152AE124	High Temperature Materials	3	0	0	3
24	1152AE125	Hypersonic Aerodynamics	3	0	0	3
25	1152AE126	Industrial Aerodynamics	3	0	0	3
26	1152AE127	Instrumentation for Thermal Systems	3	0	0	3
27	1152AE128	Lighter Than Air Systems	3	0	0	3
28	1152AE129	Missile aerodynamics	3	0	0	3
29	1152AE130	Navigation Guidance and control	3	0	0	3
30	1152AE131	Propellants and fuel technology	3	0	0	3
31	1152AE132	Propeller Theory	3	0	0	3
32	1152AE133	Ramjet and scramjet propulsion	3	0	0	3
33	1152AE134	Rockets and Missiles	3	0	0	3
34	1152AE135	Spaceflight Mechanics	3	0	0	3
35	1152AE136	Theory of elasticity	3	0	0	3
36	1152AE137	Theory of Plates and Shells	3	0	0	3
37	1152AE138	Theory of Vibrations	3	0	0	3
38	1152AE139	Transonic aerodynamics	3	0	0	3
39	1152AE140	Turbomachinery	3	0	0	3
40	1152AE241	Data Analysis and System Identification	2	0	2	3
41	1152AE142	Nonlinear Systems and Control	3	0	0	3
42	1152AE144	Aircraft Materials	3	0	0	3

43	1152AE145	Computer Integrated Manufacturing	3	0	0	3
44	1152AE246	Aircraft Component Design	1	0	4	3
45	1152AE147	Design Thinking	1	0	0	1
46	1152AE249	Unmanned Systems	2	0	2	3
47	1152AE150	Applied Unconventional Energy Engineering	3	0	0	3
48	1152AE151	Aircraft Rules and Regulations-II	3	0	0	3
49	1152AE252	Finite Element Methods	2	0	2	3
50	1152AE253	UAV Design	1	0	4	3
51	1152AE254	Material Characterization	2	0	2	3
52	1152AE155	High-Speed Jet Flows	3	0	0	3
53	1152AE156	Advanced Lightweight & Composite Structures	2	0	0	2
54	1152AE157	Space Flight Systems	3	0	0	3
55	1152AE158	Introduction to CFD	3	0	0	3
56	1152AE159	Characterization of Light Weight Structures	3	0	0	3
57	1152AE160	Sensors Actuators & Data Acquisition System	3	0	0	3
58	1152AE261	Finite Element Methods	2	0	2	3
59	1152AE262	Python Programming for Aeronautical Engineers	2	2	6	5
60	1152AE263	Product Development for Aeronautical Engineers	2	2	6	5
61	1152AE264	ELECTRO MECHANICAL SYSTEM	2	0	2	3
Total (students should choose minimum 18 credits**)**						18

Allied Elective

S.No	Course Code	Course Name Lecture courses	L	T	P	C
1	1153AE101	Airport Planning	3	0	0	3
2	1153AE102	Constructal Theory and Design	3	0	0	3
3	1153AE103	Maintenance and Reliability engineering	3	0	0	3
4	1153AE104	Smart Structures	3	0	0	3
5	1153AE105	Wind Engineering	3	0	0	3
6	1153AE106	Introduction to UAV	3	0	0	3
7	1153AE107	Fatigue and fracture mechanics	3	0	0	3
8	1153AE108	Additive Manufacturing	3	0	0	3
Total (students should choose minimum six credits**)**						6

Institute Elective

S.No	Course Code	Course Name Lecture courses	L	T	P	C
1	1154AE201	Autonomous Navigation for flying robots	2	0	2	3
2	1154AE102	Disaster Management	3	0	0	3
3	1154AE103	Introduction to Astronomy and Astrophysics	3	0	0	3
4	1154AE104	Satellite launch vehicles	3	0	0	3
5	1154AE205	Unmanned Aerial Vehicle	2	0	2	3

6	1154AE206	Structural Health Monitoring	2	0	2	3
7	1154AE107	Aerial Survey using UAV	1	0	0	1
8	1154AE208	Strain Gauge and Transducers Design	1	0	4	3
9	1154AE109	Electronic Warfare	3	0	0	3
10	1154AE210	Aerial Photography	1	0	2	2
11	1154AE111	Space Exploration	1	0	0	1
12	1154AE112	Aviation: Aircraft Systems	1	0	0	1
13	1154AE113	Aviation: Aircraft Instruments	1	0	0	1
14	1154AE114	Micro Electro Mechanical Systems	3	0	0	3
15	1154AE115	Rapid prototyping	2	0	0	2
16	1154AE116	Introduction to aerial robotics	3	0	0	3
17	1154AE117	Airplane Systems	2	0	0	2
18	1154AE218	Design of Unmanned Aerial Vehicle	2	0	8	6
19	1154AE219	Smart Vehicles: IoT	4	0	4	6
20	1154AE120	Astrobiology and hunting for Exoplanets	3	0	0	3
Total (students should choose minimum 10 credits**)**						10

Value Education Elective

S.No	Course Code	Lecture courses	L	T	P	C
1	1155AE101	Human Values & Occupational Ethics	1	0	0	1
Total (students should choose minimum 4 credits**)**						

Independent learning

Course Code	Course Name	**L**	**T**	**P**	**C**
	Technical Seminar (2 Credits)				
1156AE501	Technical Seminar-I				1
1156AE502	Technical Seminar-II				1
	Total				2
	Online Courses				2
	Mini Project				
1156AE601	Aircraft Design Project – I				2
1156AE602	Mini Project (Aircraft design) – II				2
	Total				4
1156AE701	Major Project				12
TOTAL CREDITS					**20**

Industry / Higher Institute Learning Interaction

Course Code	Course Name	L	T	P	C
1157AE801	In plant Training – I				1
1157AE802	In plant Training – II				1
1157AE803	In plant Training – III				2
	Industry/International course				2

Complementary Skill Courses

Group	Category
Group-I	Soft Skills
	Aptitude Proficiency
	English Proficiency Certification
Group-II	Sports/Yoga
	National Cadet Corps
	National Service Scheme
	Extra-Curricular Activities
Group-III	Value Added Courses
	Globally accepted Certification Courses
	Co-curricular Activities
	Foreign Languages

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE101	INTRODUCTION TO AEROSPACE ENGINEERING	2	0	0	2

Course Category:
Programme core

a. Preamble :
The course aims at introducing basic knowledge on aerospace vehicles and their configurations. The course has its emphasis on presenting the students with the concepts of atmospheric properties, principles of flight, aerodynamics, power plants, structures& materials, and flight mechanics

b. Prerequisite Courses:
- Nil

c. Related Courses:
- Aircraft Systems and Instruments
- Aircraft Rules and Regulations
- Helicopter Theory

d. Course Educational Objectives:
- To discuss in general, the aerospace history and to explain the configurations of aerospace vehicles.
- To provide a broad understanding on the concepts of Flight principles, Aerodynamics, Propulsive systems, Structures and Materials, and Flight Mechanics

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Tell the evolution of aerospace vehicles and identify the various components of such vehicles.	K2
CO2	Distinguish among various flight vehicle configurations and describe their features	K3
CO3	Describe the properties and structure of atmosphere, and state the aerodynamic forces and moments acting on aircraft	K2
CO4	Describe the aerodynamics of wings and aerofoils and express the performance equations	K2
CO5	Outline the various aerospace power plants and discuss the structures and materials of aerospace structures	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H					H						
CO2	H					H						
CO3	H			H		H		M				
CO4	H			H		H		M				
CO5	H					H						

H- High; M-Medium; L-Low

g. Course Contents:

UNIT I - HISTORY AND FLIGHT VEHICLES COMPONENTS L-6

Historical evolution of airplanes - Aircraft axes and attitude definitions - Different types of flight vehicles, Components and functions of an airplane and space vehicles, components of rocket and missiles. Parts of helicopter and their functions, Indian aerospace developments.

UNIT II - FLIGHT VEHICLES CONFIGURATIONS L-6

Different types of wing configurations of aircraft, Different types of tail configurations of aircraft, configurations based on speed and engines.

UNIT III -PRINCIPLES OF FLIGHT L-6

Physical properties and structure of the atmosphere, Temperature, Pressure and altitude relationships, stability of the atmosphere, Evolution of lift, drag and moment. Different types of drag. Pressure and skin friction coefficients.

UNIT IV - AERODYNAMICS AND PERFORMANCE L-6

Airfoil nomenclature, classification of NACA airfoils, Angle of attack, Mach number, pressure distribution over different aerodynamic profile, aero foil characteristics- lift, drag curves - Wing geometry -aspect ratio, wing loading, center of pressure and aerodynamic center - Aircraft Equation of Motions - Aircraft maneuvers.

UNIT V - PROPULSION AND AIRPLANE STRUCTURES L-6

Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production, Principle of operation of rocket, Rocket engines types, General types of construction, Monocoque, semi-monocoque. Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminum alloy, titanium, stainless steel and composite materials.

Total periods: 30

h. **Learning Resources**

i. Text Books:

1. Anderson, J.D., “Introduction to Flight”, 6th edition, McGraw-Hill Higher Education,2015
2. Steven Brandt, “Introduction to Aeronautics: A Design Perspective” 3rd edition, AIAA Education series, 2015

ii. References:

1. David J.Newman, "Interactive Aerospace Engineering and Design," International student edition Edition, McGraw-Hill Higher Education.
2. Gregg Angles, "Introduction to Aeronautics", Random Exports, 2013
3. Richard S. Shevell, "Fundamentals of Flight", 2^{nd} edition, Prentice Hall, 1988
4. A.C. Kermode, "Flight without Formulae", 5^{th} edition, Pearson Education, 2008
5. A.C. Kermode, R.H.Barnard, D.R. Philpott, "Mechanics of Flight", 12^{th} Edition, Pearson,2012
6. LalitGupta, O P Sharma, "Fundamentals of Flight Basic Aerodynamics, Aircraft Structures, Aircraft Propulsion, Aircraft Systems (Vol 1 to 4), 1^{st} edition, 2006
7. John Cutler, "Understanding Aircraft Structures", 4^{th} Edition, Wiley, 2014
8. Dorothy Kent, "Aircraft Materials & Processes", 5th Edition,1998
9. A. Kanni Raj, "Materials: Aircraft & Aerospace", Create Space Independent Publishing Platform, 2015
10. S.K. Ojha," Flight performance of aircraft", AIAA Education Series,1995
11. E L; Carruthers, N B Houghton, "Aerodynamics for engineering students", 3^{rd} edition, Hodder Arnold, 1982

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE102	ENGINEERING MECHANICS	2	2	0	3

Course Category:
Programme core

a. Preamble :

This course provides an introduction to the basic concepts of forces, inertias, centroids, and moments of area and techniques of finding their effects on motion. It introduces the phenomenon of friction and its effects. It introduces students to cognitive learning in applied mechanics and develops problem-solving skills in both theoretical and engineering oriented problems.

b. Prerequisite Courses:

- Introduction to Engineering
- Engineering Mathematics I

c. Related Courses:

- Spaceflight Mechanics

d. Course Educational Objectives :

- To inculcate the basic knowledge in mechanics in the areas of applied engineering.
- To develop the skills in the areas of forces and their effects and in the concept of free body diagram

e. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Solve engineering problems using the principles of statics of particles	K2
CO2	Establish the magnitude of forces and moments acting on rigid bodies	K2
CO3	Define properties and theories related to surfaces and solids	K3
CO4	Solve engineering problems using the principles of dynamics of particles	K3
CO5	Describe the principles of various types of friction	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**			**H**			**M**	**H**	**L**			
CO2	**H**			**H**			**M**	**H**	**L**			
CO3	**H**			**H**			**M**	**H**	**L**			
CO4	**H**			**H**			**M**	**H**	**L**			
CO5	**H**			**H**			**M**	**H**	**L**			

H- High; M-Medium; L-Low

g. Course Contents:

UNIT I BASICS & STATICS OF PARTICLES L-6 T-6
Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and Triangular Law of forces – Vectors – Vectorial representation of forces and couples – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES L-6 T-6
Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis –Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III PROPERTIES OF SURFACES AND SOLIDS L-6 T-6
Determination of Areas and Volumes – First moment of area and the Centroid of sections –Second and product moments of plane area – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia

UNIT IV DYNAMICS OF PARTICLES L-6 T-6
Displacement, Velocity and Acceleration, their relationship – Relative motion – Curvilinear motion – Newton's laws – Work-Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION L-6 T-6
Frictional force – Laws of Coloumb friction – simple contact friction – Belt friction – Roller friction. Translation and Rotation of Rigid Bodies – General Plane motion.

Total Periods: 30 + 30 = 60

h. Learning Resources

i. Text Books:

1. Hibbeller, R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2015.

2. S. Timoshenko, D.H. Young, J.V. Rao, SukumarPati, Engineering Mechanics, McGraw Hill Education (India) Private Limited., 2013.

ii. References:

1. Palanichamy, M. S., and Nagan, S., Engineering Mechanics (Statics and Dynamics), Tata McGraw Hill, New Delhi 2012.
2. Kumar, K. L., Engineering Mechanics, Tata McGraw- Hill, New Delhi, 2011.
3. Shames, I. H., and Krishna Mohana Rao, G., Engineering Mechanics (Statics and Dynamics), Dorling Kindersley India) Pvt. Ltd. (Pearson Education), 2011.
4. Beer, F. P., and Johnston, E. R., Vector Mechanics for Engineers – Dynamics and Statics, Tata McGraw-Hill, New Delhi, 2011.
5. Natarajan, K.V., Engineering Mechanics, Dhanalakshmi Publishers, 2011.
6. Rajasekaran, S. and Sankarasubramanian, G., Engineering Mechanics, Vikas Publishing House Pvt Ltd, 2011.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE103	**STRENGTH OF MATERIALS**	**2**	**2**	**0**	**3**

Course Category:
Programme core

a. Preamble :

The course provides an introductory study on stresses and strainson deformable solids. It focuses on the analysis of members subjected to axial, bending, and torsional loads. The course discusses in detail, the shear force and bending moments on beams. It introduces the concept of principal stresses in the analysis of structural members. In a nutshell, the course aims at developing the skill to solve engineering problems on strength of materials

b. Prerequisite Courses:

- Engineering Mathematics II

c. Related Courses:

- Aircraft structural mechanics
- Approximate Methods in structural Mechanics
- Composite Materials and Structures
- Experimental Stress Analysis
- High Temperature Materials
- Theory of Elasticity

d. Course Educational Objectives:

- To develop understanding of the basic concepts related to tensile, compressive and shear stresses in engineering components.
- To discuss the basic principles of torsion in shafts, shear force and bending moment in beams, deflection in springs and beams and to analyze the axial stresses of thin cylinders and spherical shells

e. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Quote the stress and strain relationship and also distinguish the determinate an indeterminate structures.	K2
CO2	Determine the shear force and bending moment diagrams for various beams.	K3
CO3	Solve deflection of beams under various loading conditions	K3
CO4	Estimate the torsional load over shaft.	K5

CO5	Illustrate principle stresses, knowledge of calculating deformation in thin cylindrical and spherical shells.	K4

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M		H			M	H	L	H		
CO2	H	M		H			M	H	L	H		
CO3	H	M		H			M	H	L	H		
CO4	H	M		H			M	H	L	H		
CO5	H			H			M	H	L	H		

H- High; M-Medium; L-Low

g. Course Contents:

UNIT I - BASICS AND AXIAL LOADING L-6 T-6

Stress and Strain – Hooke's Law – Elastic constants and their relationship– Statically determinate cases - statically indeterminate cases –composite bar. Thermal Stresses – stresses due to freely falling weight.

UNIT II - STRESSES IN BEAMS L-6 T-6

Shear force and bending moment diagrams for simply supported and cantilever Beams-Bending stresses in straight Beams-Shear stresses in bending of beams with rectangular, I&T, etc. cross sections-beams of uniform strength

UNIT III - DEFLECTION OF BEAMS L-6 T-6

Double integration method – McCauley's method - Area moment method – Conjugate beam Method-Principle of super position-Castigliano's theorem and its application

UNIT IV –TORSION L-6 T-6

Torsion of circular shafts - shear stresses and twist in solid and hollow circular shafts – closely coiled helical springs. –

UNIT V - BI AXIAL STRESSES L-6 T-6

Stresses in thin circular cylinder and spherical shell under internal pressure – volumetric Strain. Combined loading – Principal Stresses and maximum Shear Stresses - Analytical and Graphical methods. **Total Periods: 30 + 30 = 60 periods**

h. Learning Resources

i. Text Books:

1. James M. Gere, Timoshenko, "Mechanics of Materials" 2nd edition, CBS Publisher,2006

2. Timoshenko.S. and Young D.H. – “Elements of strength materials Vol. I and Vol. II”., T. Van Nostrand Co-Inc Princeton-N.J. 1990.

ii. References:

1. William Nash, “Strength of Materials”, Schaum's Outlines, 4th edition, 1998

2. Irving H. Shames, James M. Pitarresi, “Introduction to Solid Mechanics”, Pearson, 3rd edition, 1999

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE104	FLUID MECHANICS	2	2	0	3

Course Category:
Programme core

a. Preamble :
The course aims at providing the students with a broad understanding of fluid statics and dynamics. It deals with the dimensional analysis of models and introduces analysis of flow through pipes. It outlines the elementary concepts of boundary layer theory.

b. Prerequisite Courses:
- Engineering Mathematics II

c. Related Courses:
- Incompressible flow aerodynamics
- Boundary layer theory
- Turbomachinery

d. Course Educational Objectives:
- To develop a strong foundation in the fundamentals of fluid mechanics.
- To provide understanding of dimensional analysis and its importance in the experimental study of fluid mechanics
- To have a basic understanding of flow through pipes and boundary layer theory.

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Discuss the basic properties of fluids and solve typical fluid statics problems	K3
CO2	Develop the governing fluid dynamic equations and solve typical fluid dynamic problems	K3
CO3	Use dimensional analysis to design physical and numerical experiments and to apply dynamic similarity.	K3
CO4	Explain the flow through pipes and solve typical numerical problems	K3
CO5	Describe the boundary layer concepts and solve typical numerical problems	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L		H		L	H	H	L	H		
CO2	H	M		H		L	H	H	L	H		
CO3	H			H		L	H	H	L	H		
CO4	H	M		H		L	H	H	L	H		
CO5	H			H		L	H	H	L	H		

H- High; M-Medium; L-Low

g. Course Content:

UNIT-I BASIC CONCEPTS AND FLUID STATICS L-6 T-6

Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges

UNIT-II FLIUD KINEMATICS AND FLUID DYNAMICS L-6 T-6

Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net – fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube

UNIT-III DIMENSIONAL AND MODEL ANALYSIS L-6 T-6

Need for dimensional analysis – Dimensional homogeneity -Methods of dimensional analysis – Similitude –types of similitude -Dimensionless parameters- application of dimensionless parameters – Model Analysis-Model laws- classification of models

UNIT-IV FLOW THROUGH PIPES L-6 T-6

Laminar and turbulent flow- Boundary layer flow – Boundary layer thickness - Reynolds number and its Significance-Laminar fully developed pipe Flow-Hagen-Poiseuille Flow-Coefficient of Friction-Head loss – Darcy-Wiesbach Equation-Hydraulic gradient- Total Energy Lines-Moody’s Diagram-Turbulent flow through pipes

UNIT-V BOUNDARY LAYER THEORY L-6 T-6

Introduction, laminar boundary Layer-Turbulent Boundary Layer-Laminar sublayer- boundary layer thickness- displacement thickness- momentum thickness- energy thickness-shape factor - Drag force on a flat plate due to boundary Layer-Separation of boundary layer, Drag and Lift on immersed bodies, Numerical problems.

Total Periods: 30 + 30 = 60 Periods

h. Learning Resources

i. Text Books:

1. Kumar, K.L., “Engineering Fluid Mechanics”, Eurasia Publishing House (P) Ltd., New Delhi (7th edition), 1995.
2. Bansal, R.K., “Fluid Mechanics and Hydraulics Machines”, (5th edition), Laxmi publications (P) Ltd., New Delhi, 1995

ii. References:

1. Philip J. Pritchard, “Fox and Mcdonald's Introduction to Fluid Mechanics”, John Wiley & Sons Inc, 8th edition, 2011
2. YunusCengel, John Cimbala, “Fluid Mechanics in SI Units”, McGraw Hill Education (India) Private Limited, 3rd edition, 2014
3. Frank White, “Fluid Mechanics”, McGraw-Hill Education, 8th edition, 2015
4. Streeter, V.L., and Wylie, E.B., “Fluid Mechanics”, McGraw-Hill, 1983.
5. White, F.M., “Fluid Mechanics”, Tata McGraw-Hill, 5th Edition, New Delhi, 2003.
6. Ramamirtham, S., “Fluid Mechanics and Hydraulics and Fluid Machines”, DhanpatRai and Sons, Delhi, 1998.
7. Som, S.K., and Biswas, G., “Introduction to fluid mechanics and fluid machines”, Tata McGraw-Hill, 2nd edition, 2004.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE105	AERO ENGINEERING THERMODYNAMICS	2	2	0	3

Course Category:
Programme core

a. Preamble :

The course provides an introduction to the elementary concepts of thermodynamics, First law of thermodynamics and Energy, second law, Entropy and energy, Ideal and real gases and non-reactive ideal gas mixtures and general thermodynamic property relations. The course aims at developing the problem solving skills with both theoretical and engineering oriented problems in basic thermodynamics.

b. Prerequisite Courses:

- Basic Mechanical Engineering

c. Related Courses:

- Aircraft Gas Turbine Propulsion
- Propulsion Lab
- Heat Transfer
- Turbomachinery

d. Course Educational Objectives :

- To develop understanding on the concepts of first and second law of thermodynamics and their application in designing the engineering systems
- To analyse various air standard cycles and to solve the problems related to that.
- To discuss in detail, the operations of air conditioning and refrigeration systems and air compressors

e. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Apply first law of thermodynamics to solve typical problems	K3
CO2	Apply second law of thermodynamics to solve typical problems	K3
CO3	Perform air standard analyses of internal combustion engines by modeling the engines as Otto Cycle, Diesel Cycle, Dual Cycle and Brayton cycle	K3
CO4	Apply theoretical and mathematical principles to vapour compression and vapour absorption refrigeration systems.	K3
CO5	Estimate the performance of air compressors	K2

f. **Correlation of COs with POs:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L		H		L	M	H	L	H		
CO2	H	L		H		L	M	H	L	H		
CO3	H	L		H		L	M	H	L	H		
CO4	H	L		H		L	M	H	L	H		
CO5	H	L		H		L	M	H	L	H		

H- High; M-Medium; L-Low

g. **Course Contents:**

UNIT-I BASIC CONCEPTS AND FIRST LAW L-6 T-6

Concept of continuum, macroscopic approach, thermodynamic systems – closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics- concept of temperature and heat, internal energy, specific heat capacities, enthalpy - concept of ideal and real gases. First law of thermodynamics - applications to closed and open systems - steady flow processes with reference to various thermal equipment's.

UNIT-II SECOND LAW AND ENTROPY L-6T-6

Second law of thermodynamics – kelvin Planck and Clausius statements of second law. Reversibility and irreversibility - Carnot theorem. Carnot cycle, reversed Carnot cycle, efficiency, COP - thermodynamic temperature scale - Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy.

UNIT III AIR STANDARD CYCLES L-6T-6

Otto, Diesel, Dual combustion and Brayton combustion cycles – Air standard efficiency - Mean effective pressure – Actual and theoretical PV, TS diagrams of two stroke and four stroke IC Engines.

UNIT IV REFRIGERATION AND AIR CONDITIONING L-6T-6

Principles of refrigeration, Air conditioning - Heat pumps - Vapour compression - Vapour absorption types - Coefficient of performance, Properties of refrigerants.

UNIT V AIR COMPRESSORS L-6T-6

Classification and working principle of compressors (Descriptive Treatment). Isothermal and Isentropic efficiency of air compressors.

Total Periods: 30 + 30 = 60

h. **Learning Resources**

i. Text Books:

1. Yunus A Cengel / Michael A Boles, "Thermodynamics - An Engineering Approach", (SI Units), Tata Mc Graw Hill India, 7th edition, Special Indian Edition 2011.
2. P K Nag, "Engineering Thermodynamics", Tata McGraw Hill, New Delhi, 6th Edition, 2008.
3. Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", Prentice-Hall India, 2005

ii. References:

1. Yadav R., "Thermodynamics and Heat Engines", Vol 1, Central Publishing House, 2011.
2. Jones J.B and Dugan R.E., "Engineering Thermodynamics", Prentice Hall of India, 2010.
3. Roy Choudry T., "Basic Engineering Thermodynamics", Second Edition, Tata McGraw Hill, 2012.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE106	LINEAR SYSTEM ANALYSIS AND CONTROL	3	0	0	3

Course Category:
Programme core

a. Preamble :
The course aims at developing the concepts of elements of control system, analysis and design techniques.

b. Prerequisite Courses:
- Transforms and Partial differential Equations

c. Related Courses:
- Airplane stability and control
- Navigation guidance and control

d. Course Educational Objectives:
- To understand the history and elements of control systems
- To familiarize with stability analysis and design of control systems.

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe fundamentals and Classify control system techniques	K2
CO2	Apply root locus technique to explain the concepts of stability in time domain	K3
CO3	Analyze the system stability using bode plots and Nyquist plot	K4
CO4	Summarize the concepts of control design	K5
CO5	Solve control system problems using state space approach	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H		H	H	H		H		
CO2	H			H		H	H	H		H		
CO3	H			H		H	H	H		H		
CO4	H			H		H	H	H		H		
CO5	H			H		H	H	H		H		

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I INTRODUCTION & SYSTEM MODELLING L-9

Introduction, History of control systems, Needs and types of Mathematical models, Definitions of different control techniques - "Robust, Adaptive, Optimal &Intelligent control system", Transfer function, State variable Modelling, Conversation between state space and transfer function, Nonlinearities, Linearization.

UNIT-II TIME DOMAIN ANALYSIS L-9

Standard test signals, Time response of first order systems- Characteristic equation of feedback control systems, Transient response of second order systems - Time domain specifications - Steady state errors and error constants-effects of PD, PI systems. Concepts of stability - Routh's stability criterion - Root locus technique.

UNIT-III FREQUENCY RESPONSE ANALYSIS L-9

Introduction, Frequency domain specifications and transfer function from the Bode diagram - Phase margin and gain margin - Stability analysis from Bode Plots, Nyquist plot stability analysis.

UNIT-IV CONTROL DESIGN TECHNIQUE L-9

Compensation techniques - Lag, Lead, and Lead-Lag controllers design in time domain, PID controllers.

UNIT-V STATE SPACE ANALYSIS: L-9

Concepts of state, state variables and state models, derivation of state models from block diagrams, diagonalization - solving the time invariant state equations - State transition matrix and its properties - Concepts of controllability and observability, feedback, Pole placement.

Total Periods: 45

h. Learning Resources

i. Text Books:

1. Norman S. Nisei, “Control Systems Engineering”, 7th Edition, John wiley and sons, 2015
2. Katsuhiko Ogata, “Modern Control Engineering”, 5th edition, Pearson, 2009

ii. References:

1. Constantine H. Houpis, Stuart N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, 6th edition, CRC Press, 2013
2. M. Gopal, “Modern Control System Theory”, 3rd edition, New Age International Publishers Ltd, 2014

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE107	**INCOMPRESSIBLE FLOW AERODYNAMICS**	**3**	**0**	**0**	**3**

Course Category:
Programme core

a. Preamble :
The primary objective of this course is to teach students how to determine aerodynamic lift and drag over an airfoil and wing at incompressible flow regime by analytical methods.

b. Prerequisite Courses:
- Fluid Mechanics

c. Related Courses:
- Airplane Performance
- Compressible flow Aerodynamics
- Aero elasticity
- Flapping wing dynamics
- Industrial aerodynamics
- Transonic Aerodynamics

d. Course Educational 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 air foils and wing sections.
- To introduce the basics of viscous flow.

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Apply the physical principles to formulate the governing aerodynamics equations	K3
CO2	Find the solution for two dimensional incompressible inviscid flows	K3
CO3	Apply conformal transformation to find the solution for flow over airfoils and also find the solutions using classical thin airfoil theory	K3
CO4	Apply Prandtl's lifting-line theory to find the aerodynamic characteristics of finite wing	K3
CO5	Find the solution for incompressible flow over a flat plate using viscous flow concepts	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L		H		L	M	H		H		
CO2	H	L		H		L	M	H		H		
CO3	H	L		H		L	M	H		H		
CO4	H	L		H		L	M	H		H		
CO5	H	L		H		L	M	H		H		

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I INTRODUCTION TO LOW SPEED FLOW L-9

Models of the fluid: control volumes and fluid elements. Continuity, Momentum and energy equations. Substantial derivative, Vorticity and circulation, stream function, irrotational flow, velocity potential, Euler equation, incompressible Bernoulli's equation.

UNIT-IITWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW L-9

Laplace Equation, Elementary flows and their combinations, Ideal Flow over a circular cylinder, Alembert's paradox, Magnus effect, Kutta joukowski's theorem, real flow over smooth and rough cylinder

UNIT-III AIRFOIL THEORY L-9

Cauchy-Riemann relations, complex potential, methodology of conformal transformation, Kutta-Joukowski transformation and its applications, Kutta condition, kelvin'scirculation theorem, starting vortex, thin airfoil theory and its applications.

UNIT-IV WING THEORY L-9

Vortex filament, Biot-savart law, Helmholtz Theorems bound vortex and trailing vortex, horse shoe vortex, lifting line theory and its limitations.

UNIT-V VISCOUS FLOW L-9

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

Total Periods: 45

h. **Learning Resources**

i. Text Books:

1. Houghton, E.L., and Carruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989

2. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 2010.

3. Bertin J.J., and Russell M. Cummings., "Aerodynamics for Engineers" 6th edition, Prentice-Hall,2013

ii. References:

1. Clancy, L.J., "Aerodynamics", Pitman, 5th Edition.

2. Houghton, E.L., and P. W. Carpenter., "Aerodynamics for Engineering students", 6th Edition, Butterworth-Heinemann, 2012.

3. Tapan K. Sengupta, "Theoretical and Computational Aerodynamics", 1st edition, Wiley 2014

4. Radhakrishnan.E, “Theoretical Aerodynamics”, John Wiley & Sons, 2013
5. Karamcheti K., (1966), Principles of Ideal-Fluid Aerodynamics, John Wiley & Sons Inc.
6. Kuethe A. M. and Chow C.-Y., (1986), “Foundations of Aerodynamics: Bases of Aerodynamic Design” Wiley India, 2009
7. Kundu P.K. & Cohen I.M., (2008), Fluid Mechanics, Elsevier Inc.
8. Milne Thomson, L.H., “Theoretical aerodynamics”, Macmillan, 1985.
9. Ion Paraschivoiu, “SubsonicAerodynamics”, Pressesinternationals Polytechnique,2003

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE108	AIRCRAFT GAS TURBINE PROPULSION	2	2	0	3

Course Category:
Programme core

a. Preamble :
This provides the descriptive knowledge towards concept of air breathing engine such as gas turbine engine and its practical applications. This subject also links with some of the other basic prerequisite courses such as Aero Engineering Thermodynamics, Fluid Mechanics and rockets and missiles. This course provides experimental approach to the students to investigate gas turbines.

b. Prerequisite Courses:
- Aero Engineering Thermodynamics

c. Related Courses:
- Rocket and space propulsion
- Ramjet and Scramjet Propulsion
- Combustion in Jet and Rocket Engines

d. Course Educational Objectives:
- To understand and analyse the gas turbine engine and its components.
- To realize and analyse the thermodynamics of various component of a gas turbine engine.
- To synthesize and recognize how the engine integrates into an aircraft system and how to link the engine requirements to an aircraft's mission requirements.

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the working concept of various types of gas turbine engines	K2
CO2	Differentiate between a subsonic and a supersonic inlet and further relate it to aerospace applications	K4
CO3	Analyze the working concept of various types of compressor	K4
CO4	Examine the suitability of the combustion chamber & nozzle for a given gas turbine engine	K4
CO5	Illustrate the operational and designing concepts of gas turbine blade and estimate performance of turbines	K4,

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	**H**			**H**			**M**	**H**				
CO2	**H**			**H**			**M**	**H**				
CO3	**H**			**H**			**M**	**H**				
CO4	**H**			**H**			**M**	**H**				
CO5	**H**			**H**			**M**	**H**				

H- High; M-Medium; L-Low

g. Course Contents:

UNIT I - FUNDAMENTALS OF GAS TURBINE ENGINES L-6T-6

Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature of air entering through gas turbine engines – Methods of thrust augmentation – Characteristics of turbojet, turboprop, turbofan, turbo shaft and ramjet – Performance Characteristics-Materials for gas turbine engines.

UNIT II - SUBSONIC AND SUPERSONIC INLETS L-6T-6

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 on supersonic inlets – Shock swallowing by area variation – External declaration – Models of inlet operation.

UNIT III – COMPRESSORS L-6T-6

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

UNIT IV - COMBUSTION CHAMBERS AND NOZZLES L-6T-6

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 – simplex and Duplex type of Burners. Theory of flow in isentropic nozzles – Convergent nozzles and nozzle choking – Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under expanded nozzles – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust Reversal-Numerical problems

UNIT V - GAS TURBINES L-6T-6

Impulse and reaction blading of gas turbines – Velocity triangles and power output – Elementary theory – Vortex 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 – Numerical problems.

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Total Periods: 30+30= 60

h. Learning Resources

i. Text Books:

1. Hill, P.G. & Peterson, C.R., Mechanics and Thermodynamics of Propulsion, Pearson India, 2nd Edition 2009.

2. Jack Mattingly, Elements of Gas Turbine Propulsion, Tata McGraw Hill Education (India) Pvt Ltd, 1st Edition, 2005

ii. References:

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, HIH and Straznicky, Gas Turbine Theory, Sixth Edition, Pearson Further Education, 2009
2. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, Taylor & Francis Group, 1st Edition, CRC press, 2008
3. Ganesan V, Gas Turbines, 3rd Edition, Tata McGraw-Hill Education (India) Pvt Ltd, Delhi, 2010
4. Saeed Farokhi, Aircraft Propulsion, John Wiley & Sons Inc; 1st edition (2008)
5. Rolls Royce Jet Engine – Technical Publications Department, Rolls-Royce Plc, Derby, England, Fifth Edition – 1996.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE109	AIRPLANE PERFORMANCE	3	0	0	3

Course Category:
Programme core

a. Preamble :
This course deals with performance of airplanes under various flight conditions like take off, cruise, landing, climbing, gliding, turning etc.

b. Prerequisite Courses:
- Incompressible flow Aerodynamics
- Engineering Mechanics

c. Related Courses:
- Airplane stability and control
- Aircraft Design

d. Course Educational Objectives:
- To understand basic concepts of ISA and compute various airspeeds
- To familiarize the concepts of drag polar and aircraft flight performance

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describes the International standard atmosphere and fundamentals of airplane performance	K2
CO2	Examine effects of altitude and Mach number on drag polar	K3
CO3	Estimate steady level flight performance	K3
CO4	Estimate Gliding and climbing flight performance	K3
CO5	Estimate accelerated flight performance	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H			M	H				
CO2	H			H			M	H				
CO3	H			H			M	H				

CO4	**H**			**H**			**M**	**H**				
CO5	**H**			**H**			**M**	**H**				

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I GENERAL CONCEPTS: L-9

International Standard atmosphere, IAS, EAS, TAS, Propeller theory- Blade element theory, Propeller co-efficient, Use of propeller charts, Performance of fixed and variable pitch propellers, Effect of power plant on aircraft performance - variation of thrust and SFC with altitude, velocity & Mach number, High lift devices, Thrust augmentation.

UNIT-II DRAG POLAR: L-9

Streamlined and bluff body, Types of drag, Effect of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes, Drag polar, Effect of Mach number on drag polar, NACA Airfoils, Effect of Aspect ratio and sweep angle on lift and drag.

UNIT-III STEADY LEVEL FLIGHT L-9

Steady level flight, thrust required and Power required, thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Effect of drag divergence on maximum velocity, Range and Endurance of Propeller and Jet airplanes.

UNIT-IV GLIDING AND CLIMBING FLIGHT: L-9

Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller and jet aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph.

UNIT-V ACCELERATD FLIGHT: L-9

Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, bank angle and load factor, Constraints on load factor, pull up and pull down maneuvers, maximum turn rate, V-n diagram.

Total Periods: 45

h. **Learning Resources**

i. Text Books:

1. Anderson, J.D., Aircraft Performance and Design, Mc Graw-Hill International Edition 1999

2. Clancy, L.J., Aerodynamics, Pitman, 1986

ii. References:

1. PerPerkins, C.D., and Hage, R.E., Airplane Performance and Stability and Control, Wiley Toppan, 1974

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE110	**COMPRESSIBLE FLOW AERODYNAMICS**	**2**	**2**	**0**	**3**

Course Category:
Programme core

a. Preamble :
This course provides the student with an introduction to the basic concepts of compressible flows, where the density variations are important and must be taken into account. This requires the knowledge on the science of thermodynamics and the basic laws of fluid mechanics. Emphasis will be placed on understanding the physical mechanisms involved in both compressible external and internal flows.

b. Prerequisite Courses:
- Incompressible flow Aerodynamics

c. Related Courses:
- Experimental Aerodynamics
- Hypersonic Aerodynamics
- High Temperature Gas Dynamics
- Missile Aerodynamics
- Ramjet and Scramjet propulsion

d. Course Educational Objectives:
- To introduce the students how the thermodynamic concepts, apply to compressible flow aerodynamics and to analyze 1-D and quasi 1-D flows in typical aerospace applications
- To familiarize the students with the features of inviscid compressible flows, including shock and expansion waves and the governing differential equation of motion of steady compressible flows
- To familiarize the students to estimate the lift and drag for basic aerodynamic shapes in compressible inviscid flows

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Discuss the fundamental concepts involved in compressible flow	K2
CO2	Solve typical variable area flow, standing& moving normal –shock, Fanno & Rayleigh flow problems by use of the appropriate equations and tables.	K3
CO3	Solve typical problems involving oblique shock waves and expansion waves (2-D waves) by use of the appropriate equations and tables.	K3

CO4	Apply the compressible equation of motion to calculate lift and drag coefficient of airfoil at subsonic and supersonic regimes and also apply Method of characteristics to design a 2-D supersonic nozzle for aerospace applications (Rockets, Wind tunnels, etc.)	K3
CO5	Examine the aerodynamic characteristics over airfoil, wing and aircraft configurations in compressible flow regime	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H			M	H	L			
CO2	H			H			M	H	L			
CO3	H			H			M	H	L			
CO4	H			H			M	H	L			
CO5	H			H			M	H	L			

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I COMPRESSIBLE FLOW CONCEPTS L-6 T-6

Compressibility -Continuity, Momentum, Energy and state equations, Velocity of sound, realms of fluid motion, physical differences between incompressible, subsonic and supersonic flow, Karman's rules of supersonic flow, Mach number and Mach angle, Classifications of compressible flow, Characteristic Mach number

UNIT-IIONE DIMENSIONAL FLOW L-6T-6

Isentropic flow, Area-velocity relation, Area -Mach number relation, Flow through convergent-divergent passage, Performance under various back pressures. Normal shock relations, Prandtl's relation, Hugoniot equation, Rayleigh Supersonic Pitot tubeequation, Fanno flow and Rayleigh flow

UNIT-III TWO - DIMENSIONAL WAVES L-6T-6

Oblique shock relations, $\theta-\beta-M$ relation, Shock Polar, Reflection of oblique shocks, left running and right running waves, Interaction of oblique shock waves, slip line, shock-boundary layer interaction, transonic lambda shock, compression corner effect, incident shock interaction Shock Diamonds, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions- Shock-Expansion theory

UNIT-IV DIFFERENTIAL EQUATIONS OF MOTION FOR STEADYCOMPRESSIBLE FLOWS L-6T-6

Velocity potential equation-Small perturbation potential theory, Linearized Pressure Coefficient, Prandtl-Glauert Compressibility correction, Improved compressibility correction, Linearized two dimensional supersonic flow theory, Method of Characteristics,2-D supersonic nozzle design

UNIT-V HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATIONS L-6T-6

Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, swept wing, Airfoils for supersonic flows, Lift, drag, pitching moment and Centre of pressure for supersonic profiles, wave drag, supersonic wings, Design considerations for supersonic aircraft- aerodynamic heating

TotalPeriods:30+30=60

h. Learning Resources

i. Text Books:

1. Anderson, J. D., Modern Compressible Flow with Historical Perspective, 3rd ed., McGraw-Hill, 2004
2. Rathakrishnan, E., "Gas Dynamics", Prentice Hall of India, 2003.

ii. References:

1. Hodge.B.K., "Compressible fluid dynamics", 1st edition, Pearson education India, 2016
2. Patrick H. Oosthuizen, William E. Carscallen, "Introduction to Compressible fluid flow", 2nd edition, CRC press, 2013
3. Michel A Saad, "Compressible Fluid Flow", 2nd edition, Prentice Hall, 1992.
4. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronold Press, 1982.
5. Liepmann, H., and A. Roshko, "Elements of Gas Dynamics", Dover Publications, 2002
6. Zucrow, M.J. and Hoffman, J.D., "Gas dynamics", Vol 1, John Wiley 1982
7. McCormick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, New York, 1979.
8. Thompson, P. A. Compressible Fluid Dynamics. Maple Press Company, 1984
9. Zucker, R. D. and Biblarz, O., Fundamentals of Gas Dynamics, 2nd ed., John Wiley (2002).
10. John, J. E. A. and Keith, T., Gas Dynamics, 3rd ed., Prentice Hall (2006).
11. George Emanuel., "Gas dynamics: Theory and Applications", AIAA Education Series, 1986.
12. Yahya, S. M., Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, 3rd ed., New Age International Publishers (2003).

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE111	ROCKET AND SPACE PROPULSION	3	0	0	3

Course Category:
Programme core

a. Preamble:
This course provides an introduction to the basic concepts of chemical, nuclear and electrical rockets. It introduces students to cognitive learning in Aerospace Propulsion and develops problem solving skills with both theoretical and engineering oriented problems.

b. Prerequisite Courses:
- Aircraft Gas Turbine Propulsion

c. Related Courses:
- Electric Propulsion
- Propellants and Fuel Technology
- Rockets and Missiles

d. Course Educational Objectives:
- To teach basic principles of rocket propulsion.
- To teach and apply physical and mathematical methods used in analyzing engineering applications involving rockets.
- To familiarize the students about the various space propulsion techniques used in spacecraft applications

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Discuss the basic concepts of chemical rocket propulsion	K2
CO2	Explain the concepts involved in solid rocket propulsion	K2
CO3	Describe the concepts of liquid rocket propulsion	K3
CO4	Explain the concepts involved in hybrid rocket propulsion	K3
CO5	Select the suitable space propulsion system for a prescribed spacecraft mission	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H			H	H				
CO2	H			H			H	H				
CO3	H			H			H	H				
CO4	H			H			H	H				
CO5	H			H			H	H				

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I FUNDAMENTALS OF CHEMICAL ROCKET PROPULSION L- 9

Operating principle – specific impulse of a rocket – internal ballistics – performance considerations of rockets – types of igniters- preliminary concepts in nozzle-less propulsion – air augmented rockets – pulse rocket motors – static testing of rockets & instrumentation –safety considerations

UNIT-II SOLID ROCKET PROPULSION L- 9

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

UNIT-III LIQUID ROCKET PROPULSION L- 9

Salient features of liquid propellant rockets – selection of liquid propellants – various feed systems and injectors for liquid propellant rockets -thrust control and cooling in liquid propellant rockets and the associated heat transfer problems – combustion instability in liquid propellant rockets – peculiar problems associated with operation of cryogenic engines.

UNIT-IV HYBRID ROCKET PROPULSION L- 9

Introduction to hybrid rocket propulsion – standard and reverse hybrid systems- combustion mechanism in hybrid propellant rockets – applications and limitations

UNIT-V ADVANCED PROPULSION TECHNIQUES L- 9

Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion – Nuclear rocket –comparison of performance of these propulsion systems with chemical rocket propulsion systems –future applications of electric propulsion systems - Solar sail

Total Periods: 45

h. **Learning Resources**

i. Text Books:

1. Anderson, Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.

2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988

ii. References:

1. Hill, P.G. & Peterson, C.R., Mechanics and Thermodynamics of Propulsion, Pearson India, 2nd Edition 2009.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE112	**AIRPLANE STABILITY AND CONTROL**	**3**	**0**	**0**	**3**

Course Category:
Programme core

a. Preamble:

This course introduces about the stability and control of an aircraft. The stability and control are the two important pre-requisites of a safe flight. The six-degree-of-freedom differential equations of motion are introduced. Then the linearized perturbed state equations of motion are derived. Important topics in this course are: Longitudinal static and dynamics stability, stick fixed and free neutral points and static margin, lateral-directional static and dynamic stability, trim condition, longitudinal-lateral-directional coupling, control and maneuverability, stick fixed and free maneuverer points, stability and control derivatives and handling qualities and control response.

b. Prerequisite Courses:

- Linear system analysis and control
- Airplane performance

c. Related Courses:

- Aircraft Design
- Autopilot Design
- Flight Mechanics and Control Laboratory

d. Course Educational Objectives:

- To introduce the concepts of static and dynamic stability of airplanes in stick fixed and stick free conditions.
- To introduce the concept of control of airplanes under various operating conditions

e. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe the concepts of stability and control and Determine static longitudinal stability criteria for a stable airplane	K2
CO2	Determine static longitudinal control derivatives, and Estimate the Maneuvering stability of an aircraft.	K3
CO3	Explain the static lateral and directional stability and control derivatives, and criteria for a stable airplane	K3
CO4	Determine the stability and control derivatives of an airplane	K3
CO5	Discuss the various dynamic instabilities of an aircraft motion	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**L**		**H**			**H**	**H**				
CO2	**H**	**L**		**H**			**H**	**H**				
CO3	**H**	**L**		**H**			**H**	**H**				
CO4	**H**	**L**		**H**			**H**	**H**				
CO5	**H**	**L**		**H**			**H**	**H**				

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I INDRODUCTION TO AIRPLANE STABILITY AND STATIC LONGITUDINAL STABILITY L-9

Degree of freedom of a system - Static and dynamic stability - Need for stability in an airplane - Purpose of controls - Inherently and marginally stable airplanes, Longitudinal Stability criterion – Contribution of wing and tail (Aft tail- Elevator & Forward tail –Canard) to pitching moments - Effect of fuselage and nacelles - Power effects - Stabilizer setting and center of gravity location. Control fixed neutral point. Stability margins.

UNIT-II STATIC LONGITUDINAL CONTROL AND MANAUVERING STABILITY L-9

Elevator power– Elevator to trim. Trim gradients. Effects of releasing the elevator. Hinge moment coefficients – Control forces to trim. Control free neutral point – Trim tabs. Aerodynamic balancing of control surfaces. Means of augmentation of control. Contribution of pitch damping to pitching moment of flight vehicle - Effect on trim and stability. Control deflections and control forces for trim in symmetric maneuvers and coordinated turns. Control deflection and force gradients. Control fixed and control free maneuver stability. Maneuver points. Maneuver margins.

UNIT-III STATIC LATERAL - DIRECTIONAL STABILITY AND CONTROL L-9

Dihedral effect - Coupling between rolling and yawing moment - Adverse yaw - Aileron power - Aileron reversal. Weather cocking effects – Rudder power. Lateral and directional stability-definition. Control surface deflections in steady sideslips, rolls and turns one engine inoperative conditions - Rudder lock.

UNIT-IV DYNAMIC EQUATIONS FOR FLIGHT VEHICLE: L-9

Equations of motion of a rigid body, Inertial forces and moments. Equations of motion of flight vehicles, aerodynamic forces and moments, Decoupling of longitudinal and lateral-directional equations. Linearization of equations, Aerodynamic stability and control derivatives, Relation to geometry, flight configuration, Effects of power, compressibility and flexibility.

UNIT-V DYNAMIC STABILITY ANALYSIS: L-9

Solutions to the stability quartic of the Linearized equations of motion. The principal modes. Phugoid, Short Period Dutch Roll and Spiral modes - Further approximations. Restricted degrees of motion. Solutions. Response to controls. Auto rotation and spin.

Total Periods: 45

h. **Learning Resources**

i. Text Books:

1. Robert C. Nelson, Flight Stability and Automatic Control, 2nd Edition, McGraw Hill, 1997
2. Courtland D. Perkins, Robert E. Hage, Airplane Performance, Stability and Control, 1st Edition, John Wiley, New York 1949

ii. References:

1. Bernard Etkin, Lloyd Duff Reid, Dynamics of Flight: Stability and Control, 3rd Edition, John Wiley, New York 1995
2. Warren F. Phillips., Mechanics of Flight, Second Edition, Wiley,2009
3. Thomas R. Yacht, Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability, Feedback Control and State-Space Foundations,2nd Revised Edition, AIAA Education Series, 2014
4. Bandu N. Pamadi, Performance, Stability, Dynamics, and Control of Airplanes, 2nd Edition, AIAA Education Series, 2004
5. Louis V. Schmidt, Introduction to Aircraft Flight Dynamics, 1st Edition, AIAA Education Series, 1998
6. Michael V. Cook., Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control, 3rd edition, Butterworth-Heinemann
7. Nandan K. Sinha, N. Ananthkrishnan, Elementary Flight Dynamics with an Introduction to Bifurcation and Continuation Methods, 1st Edition, CRC Press, 2013
8. Roskam, J., Airplane Flight Dynamics and Automatic Flight Controls part I, DAR Corporation, 2001.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE213	NUMERICAL METHODS USING MATLAB	2	0	2	3

Course Category:
Programme core

a. Preamble:
The course focuses on some of the most important numerical methods to solve Aerospace engineering. The numerical software package MATLAB is introduced and used throughout the course.

b. Prerequisite Courses:
- Transforms and Partial differential equations

c. Related Courses:
- Finite element methods
- Approximate Methods in Structural Mechanics
- Computational fluid dynamics

d. Course Educational Objectives:
- To develop the mathematical skills of the students in the area of numerical methods.
- To teach theory and applications of numerical methods in a large number of engineering subjects which require solutions of linear systems, finding eigenvalues, eigenvectors, interpolation and applications, solving ODEs, PDEs and dealing with statistical problems like testing of hypotheses.

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Apply numerical methods to solve algebraic equations using different methods under different conditions, and to analyze the numerical solution of system of algebraic equations.	K3
CO2	Apply various interpolation methods and finite difference concepts.	K3
CO3	Work out numerical differentiation and integration whenever and wherever routine methods are not applicable.	K4
CO4	Work numerically on the ordinary differential equations using different methods through the theory of finite differences	K3
CO5	Work numerically on the partial differential equations using different methods through the theory of finite differences	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H			H	H	L	M		
CO2	H			H			H	H	L	M		
CO3	H			H			H	H	L	M		
CO4	H			H			H	H	L	M		
CO5	H			H			H	H	L	M		

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS L-6 P-6

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method - Eigenvalues of a matrix by Power method. MATLAB based problems

UNIT-II INTERPOLATION AND APPROXIMATION L-6 P-6

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae. MATLAB based problems

UNIT-III NUMERICAL DIFFERENTIATION AND INTEGRATION L-6 P-6

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules. MATLAB based problems

UNIT-IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS L-6 P-6

Single Step methods - Taylor's series method - Euler's method - Modified Euler's method –Fourth order Runge-Kutta method for solving first order equations - Multi step methods - Milne's and Adams-Bash forth predictor corrector methods for solving first order equations. MATLAB based problems

UNIT-V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS L-6 P-6

Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods –One dimensional wave equation by explicit method. MATLAB based problems

Total Periods: 30 + 30 = 60

h. **Learning Resources**

i. Text Books:

1. Grewal. B.S., and Grewal. J.S., " Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007
2. Chapra. S.C., and Canale.R.P., "Numerical Methods for Engineers, 5th Edition, Tata McGraw - Hill, New Delhi, 2007

ii. Reference Books:

1. Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi,2007.

2. Sankara Rao. K., "Numerical methods for Scientists and Engineers", 3rd Edition, Prentice Hall ofIndia Private Ltd., New Delhi, 2007.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE214	AIRCRAFT SYSTEMS AND INSTRUMENTS	1	0	2	2

Course Category:
Programme core

a. Preamble:
The course deals with the basic principles and working of various aircraft systems and instruments. The course aims at enhancing the knowledge of students in aircraft system's handling procedures, maintenance practices and technical aspects of various systems.

b. Prerequisite Courses:
- Introduction to Aerospace Engineering

c. Related Courses:
- Avionics
- Aircraft general engineering and system maintenance

d. Course Educational Objectives:
- To inculcate the basic knowledge and understanding of various aircraft systems, instruments and their applications.
- To introduce the safety precautions and methodology of handling aircraft systems

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Summarize the operations of Hydraulic, Pneumatic and Landing gear systems	K2
CO2	Describe the working principles of control systems in an aircraft	K2
CO3	Illustrate and demonstrate the concepts of starting, ignition, fuel and lubricating systems of typical aircraft power plants and.	K3
CO4	Discuss the ideas of air cycle systems along with fire protection, deicing and anti-icing systems.	K2
CO5	Explain the technical aspects of aircraft instruments and their working principle	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**	**M**			**L**						
CO2	**H**	**H**	**M**			**L**						
CO3	**H**	**H**				**L**						
CO4	**H**	**M**	**M**			**L**						
CO5	**H**	**H**				**L**						

H- High; M-Medium; L-Low

g. Course Contents:

UNIT I -AIRPLANE CONTROL SYSTEMS L 3

Conventional Systems - fully powered flight controls - Power actuated systems – Auto pilot system - fly by wire systems - Digital Fly by wire system

UNIT II -AIRCRAFT PROTECTION SYSTEMS L 3

Fire protection system, Deicing and anti-icing systems - Working principles -Components - Advantages –Applications.

UNIT III -ENGINE SYSTEMS L 3

Lubricating systems for piston and jet engines,starting procedures for reciprocating and gas turbine engine aircrafts, Ignition system - components– working principle.

UNIT IV -HUMAN COMFORT SYSTEMS L 3

Basic Air cycle systems - Vapor compression and absorption cycle systems, Cabin air pressure system, and Evaporative vapor cycle systems - Evaporative air cycle systems.

UNIT V -AIRCRAFT INSTRUMENTS L 3

Flight Instruments and Navigation Instruments – Air speed Indicators: TAS, EAS, IAS, CAS, Vertical speed indicator- Mach Meters –Variometers- Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges - Pressure gauges - Operation and Principles- Gyroscope – Accelerometers, ILS.

Total hours: 15+ 15 = 30

LIST OF EXPERIMENTS:

1. Aircraft “Jacking Up” procedure
2. Aircraft “Levelling” procedure
3. Control System “Rigging check” procedure
4. Aircraft “Symmetry Check” procedure
5. Fuel systems for Gas turbine engine and Jet engine – An overview.
6. Study on the methods of Aircraft braking systems and “Brake Torque Load Test” on wheel brake unit.
7. Study on hydraulic systems and Pneumatic systems - maintenance and rectification of snags.
8. Study of Landing gear systems, classification and their components.

h. **Learning Resources**

i. Text Books:

1. McKinley, J.L., and Bent, R.D., “Aircraft Maintenance & Repair”, McGraw-Hill, 2013.
2. “General Hand Books of Airframe and Power Plant Mechanics”, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi 1995.

ii. References:

1. "Airframe and Power Plant Mechanics: Power plant Handbook" by Federal Aviation Administration, Aircraft Technical Book Company, 2012.
2. Mekinley, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw-Hill, 1993.
3. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993.
4. Treager, S., "Gas Turbine Technology", McGraw-Hill, 1997

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE215	AIRCRAFT STRUCTURAL MECHANICS	1	2	2	3

Course Category:
Programme core

a. Preamble:
Aircraft Structural mechanics deals with the linear and static analysis of determinate and indeterminate aircraft structural components. The course contents have been designed such that the students get familiar with the fundamental aspects of different types of beams and columns subjected to various types of loading and support conditions with particular emphasis on aircraft structural components. Also provide the design process using different failure theories.

b. Prerequisite Courses:
- Strength of Materials

c. Related Courses:
- Aircraft structural analysis
- Aircraft structures Laboratory
- Finite element Methods
- Theory of elasticity
- Theory of vibrations

d. Course Educational Objectives:
- To understand the structural behavior of different types of beams and columns subjected to various loading conditions with particular emphasis on aircraft structural components.
- To provide the knowledge of various failure theories

e. Course Outcomes:
Upon the successful completion of this course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Analyze the statically determinate structures.	K3, S3
CO2	Analyze the statically indeterminate structures.	K3, S3
CO3	Apply strain energy theorems on structural members	K3
CO4	Examine the columns with various end conditions.	K2, S3
CO5	Explain the design process using various theories of failure.	K2

f. CORRELATION OF COS WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L		H		L	H	H	L			
CO2	H	L		H		L	H	H	L			
CO3	H	L		H		L	H	H	L			

CO4	**H**	**L**		**H**		**L**	**H**	**H**	**L**			
CO5	**H**	**L**		**H**		**L**	**H**	**H**	**L**			

H- High; M-Medium; L-Low

g. Course Contents:

UNIT I -STATICALLY DETERMINATE STRUCTURES L-6T-6

Review of Basic Strength of materials - Analysis of plane truss – Method of joints – 3 D Truss - Plane frames - Composite beam

UNIT II STATICALLY INDETERMINATE STRUCTURES L-6T-6

Propped Cantilevers-- fixed- fixed beam- Clapeyron's Three Moment Equation - Moment Distribution Method.

UNIT III ENERGY METHODS L-6T-6

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 L-6T-6

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 L-6T-6

Ductile and Brittle Materials Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory and simple problems of shaft under combined loading.

Total Periods: 45+30=75

List of Experiments

1. Determination of Young's Modulus of steel using mechanical extensometers.
2. Determination of Young's Modulus of Aluminium using electrical strain gauges.
3. Deflection of beams with various end conditions.
4. Verification of Maxwell's Reciprocal theorem
5. Verification of principle of superposition.
6. Column – testing.
7. South – well's plot.

h. **Learning Resources**

i. Text Books:

1. James M. Gere, Timoshenko, "Mechanics of Materials" 2nd edition, CBS Publisher,2006
2. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. von Nostrand Co, 1990.

ii. References:

1. Donaldson, B.K., “Analysis of Aircraft Structures – An Introduction”, McGraw-Hill, 1993.
2. Bruhn.E.F.” Analysis and design of flight vehicle structures” Tri set of offset Company, USA, 1973.
3. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE216	AIRCRAFT STRUCTURAL ANALYSIS	1	2	2	3

Course Category:
Programme core

a. Preamble:
This course provides an introduction to the basic analysis of aircraft components such as ribs, bulk heads and stringers. It introduces the phenomenon of analysis of plate structure

b. Prerequisite Courses:
- Aircraft structural mechanics

c. Related Courses:
- Nil

d. Course Educational Objectives:
- To develop the analytical knowledge of the students in the area of aircraft structural components.
- To prepare students for designing structural elements of the wing and fuselage sections with minimum weight and to know the behaviour of various aircraft structural components under different types of loads.

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Analyze the bending stress in different section with various methods	K4,S3
CO2	Understand the importance of shear center and shear flow and analyze shear flow of various open section	K3,S3
CO3	Develop the concept of torsion and shear flow due to and analyze shear flow of various closed section	K3,S3
CO4	Analyze plates and sheets under buckling and find out the strength of stiffener panel	K4,S3
CO5	Analyze the aircraft wing components like ribs and calculate the properties structural elements of an aircraft and derive the effects various loads on the aircraft structural components	K5,S3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L		H			H	H	L			
CO2	H	L		H			H	H	L			
CO3	H	L		H			H	H	L			
CO4	H	L		H			H	H	L			
CO5	H	L		H			H	H	L			

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I UNSYMMETRICAL BENDING L-6 T-6

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized ‘k’ method, neutral axis method, and principal axis method.

UNIT-II SHEAR FLOW IN OPEN SECTIONS L-6 T-6

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, structural idealization, Shear flow variation in idealized sections.

UNIT-III SHEAR FLOW IN CLOSED SECTIONS L-6 T-6

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

UNIT-IV BUCKLING OF PLATES L-6 T-6

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 L-6 T-6

Loads on an aircraft – the V-n diagram – shear force and bending moment distribution over the aircraft wing and fuselage and other types of wings and fuselage, thin webbed beam. With parallel and non-parallel flanges, monocoque and Semi-monocoque aerospace structures Shear resistant web beams, Tension field web beams (Wagner’s).

Total Periods: 45+30=75

List of Experiments

1. Unsymmetrical bending of beams
2. Shear center location for open sections
3. Shear center location for closed sections
4. Constant strength beam
5. Flexibility matrix for cantilever Plate
6. Beam with combined loading
7. Calibration of Photo- elastic materials
8. Stresses in circular discs and beams using photo elastic techniques
9. Wagner beam – Tension field beam

h. **Learning Resources**

i. Text Books:

1. T.H.G. Megson, “Aircraft Structures for Engineering Students”, 5th editionButterworth-Heinemann, 2012
2. Bruhn.E.F.” Analysis and design of flight vehicle structures” Tri set of offset Company, USA, 1973.

ii. References:

1. C. T. Sun, “Mechanics of Aircraft Structures”, Wiley, 2nd edition,2006
2. Donaldson, B.K., “Analysis of Aircraft Structures – An Introduction”, McGraw-Hill, 1993.
3. T.H.G. Megson, “Introduction to Aircraft structural analysis”, 2nd edition, Butterworth-Heinemann, 2013
4. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.
5. Howard D Curtis, „Fundamentals of Aircraft Structural Analysis‟, WCB-McGraw-Hill, 1997
6. David H. Allen, Walter Haisler, “Introduction to Aerospace Structural Analysis”, John wiley and sons, 1985
7. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE217	AVIONICS	2	0	2	3

Course Category:
Programme

a. Preamble:

This course Avionics provides an introduction to the basic concepts of electronics, working of communication and navigation systems in aircraft. It introduces the applications of digital electronic systems and flight control systems. This subject helps to understand basic Digital Avionics Architecture, GPS and modern Auto-pilot system. It introduces students to cognitive learning in applied electronics and develops problem solving skills with both theoretical and engineering oriented problems.

b. Prerequisite Courses:

- Aircraft Systems and Instruments

c. Related Courses:

- Navigation guidance and control

d. Course Educational Objectives:

- To introduce the basic concepts of ILS & Autopilot Systems.
- To introduce the basic concepts of cockpit digital instruments, digital avionic interfaces communication and navigation systems.

e. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Discuss the basic concepts of Avionics & subsystems.	K2
CO2	Describe the working principle of ILS & its subsystems and Demonstrate the programming skill in microprocessor and micro controller	K2, S3
CO3	Describe the principles of Avionics System architecture and Demonstrate MIL – STD – 1553 Avionics data buses	K2, S3
CO4	Describe the principles of Instruments in flight deck	K2
CO5	Illustrate the working principle navigation & communication systems.	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H				H		H			H		
CO2	H	H			H	H	H		H	H		
CO3	H	H		H	H		H			H		
CO4	H						H			H		

CO5	H			H			H		H	H		

H- High; M-Medium; L-Low

g. Course Content:

UNIT-IINTRODUCTION TO AVIONICS L-6

Need for Avionics in civil and military aircraft and space systems – Integrated Avionics and Weapon system – Typical avionics sub systems – Design and Technologies.

UNIT-II DIGITAL, RANGING AND LANDING SYSTEMS L-6

Digital Computers – Microprocessors – Memories – Aircraft communication systems, VHF Omni range – VOR receiver principles – distance maturity equipment – principles of operation – Instrument landing system – localizer and glide slope

UNIT-III DIGITAL AVIONICS ARCHITECTURE L-6

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

UNIT-IV FLIGHT DECK AND COCKPITS L-6

Control and display technologies CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) - Civil cockpit and military cockpit: MFDS, HUD, MFK, HOTAS.

UNIT-VINTRODUCTION TO AVIONICS SYSTEM L-6

Navigation systems - Flight control systems - Radar electronic warfare - Utility Systems Reliability and maintainability - Certification.

Total: 30 Periods

h. LIST OF EXPERIMENTS

1. Programming in digital electronics training kit
2. Programming in microprocessor and micro controller
3. Simple programs using Arduino microcontroller
4. MIL-Std – 1553 Data Buses Configuration with Message transfer.
5. MIL-Std – 1553 Remote Terminal Configuration.

Total: 30 PeriodsPP

i. Learning Resources

i. Text Books:

1. Collinson R.P.G. “Introduction to Avionics”, Chapman and Hall, 1996.
2. Malcrno A.P. and Leach, D.P., “Digital Principles and Application”, Tata McGraw-Hill, 1990.
3. Gaonkar, R.S., “Microprocessors Architecture – Programming and Application”, Wiley and Sons Ltd., New Delhi, 1990.

ii. Reference:

1. Middleton, D.H., Ed., “Avionics Systems, Longman Scientific and Technical”, Longman Group UK Ltd., England, 1989.

2. Spitzer, C.R., “Digital Avionic Systems”, Prentice Hall, Englewood Cliffs, N.J., USA. 1987.

3. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000

4. Brain Kendal, “Manual of Avionics”, The English Book House, 3rd Edition, New Delhi, 1993

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE218	COMPUTATIONAL METHODS FOR AERONAUTICAL ENGINEERING	2	2	2	4

Course Category:
Programme core

a. Preamble:
The course introduces to theoretical basics and practical application of the finite element method as well as to related numerical modeling techniques. It is designed to solve practical engineering problems related to solid mechanics, heat transfer. It provides necessary tool for the analysis and solution of practical structures and processes.

b. Prerequisite Courses:
- Numerical Methods using MATLAB
- Compressible flow Aerodynamics
- Aircraft structural Mechanics

c. Related Courses:
- Nil

d. Course Educational Objectives:
- To equip the students with basic methodology of Finite Element Method.
- To formulate the structural analysis using FEM.
- To perform engineering simulations using Finite Element Method software packages

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe different types of computational methods	K2
CO2	Describe computational procedures	K2, S3
CO3	Solve one dimensional problems using numerical techniques	K4, S3
CO4	Solve the problems on plane elasticity	K4, S3
CO5	Solve heat transfer and torsion problems by application of FEM and compare with theoretical solutions	K4, S3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H			H	H	H	H		
CO2	H	H		H			H	H	H	H		
CO3	H			H			H	H	H	H		

CO4	**H**			**H**			**H**	**H**	**H**	**H**		
CO5	**H**	**H**		**H**			**H**	**H**	**H**	**H**		

H- High; M-Medium; L-Low

g. Course Content:

UNIT-I INTRODUCTION TO COMPUTATIONAL METHODS 12

Review of fluid mechanics, Types of fluid flow, governing equations of fluid flow- Continuity, Momentum, energy equations, Boundary conditions, Governing equations for incompressible and compressible flows- Introduction to FEA- Classical Techniques in FEA -Finite Element Method-Finite Volume Method-Finite difference method.

UNIT-II COMPUTATIONAL PROCEDURES 12

Process in CFD and FEA- preprocessing- mathematical modeling, Geometry and mesh creation, solver- Discretization method (Basics) and post processing- Contours, vectors, plots, streamlines, Residuals

UNIT III APPLICATIONS OF 1D ELEMENT 12

Stiffness matrix formulation of 1D element - Bar, Truss and Beam-Numerical applications of 1D element.

UNIT IV PLANE ELASTICITY PROBLEMS 12

Various types of 2-D-elements Application to plane stress, plane strain and Axisymmetric analysis.

UNIT V FIELD PROBLEMS 12

Applications to other field problems like heat transfer and fluid flow.

List of Experiments 30

1. Flow analysis over a flat plate
2. Flow analysis over a cylinder
3. Fluid flow over typical airfoil
4. Structural analysis using 1D element
5. Structural analysis using 2D plane elasticity element
6. Stress analysis of plate with hole using 3D element
7. Thermal analysis of a rod using 1D heat conduction element
8. Thermal analysis of a plate using 2D heat transfer element

Total Periods: 90

h. Learning Resources

i. Text Books:

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, “Introduction to Finite Elements in Engineering”, Third Edition,Prentice Hall India, 2003
2. Rao. S.S., " The Finite Element Methods in Engineering," 5th edition, Butterworth and Heinemann, 2010
3. Reddy J.N., "An Introduction to Finite Element Method", 3rdedition, McGraw Hill, 2005

ii. Reference:

1. Daryl L. Logan, “A First Course in the Finite Element Method”, 5th edition, Cengage Learning, 2012
2. Krishnamurthy, C.S., "Finite Element Analysis", 2nd edition, Tata McGraw Hill, 2001.
3. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
4. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley and Sons, Inc., 2003.
5. Larry J Segerlind, "Applied Finite Element Analysis", Second Edition, John Wiley and Sons, Inc.1984.

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE319	**Strength of Materials Laboratory**	**0**	**0**	**2**	**1**

Course Category:
Programme core

a. Preamble:
Strength of Materials Lab demonstrates the basic principles of strength and mechanics of materials through a series of experiments using Universal Testing Machines to calculate tensile strength of steel and aluminum samples and experiments to measure hardness of steels. Students will also test steel samples in single shear, double shear and impact loading, followed by experiments on the torsion testing machine to calculate torsional strength of aluminum samples and the strut apparatus to analyze different modes of buckling in a slender aluminum column.

b. Pre-requisites:

- Engineering Mathematics II

c. Link to Other Courses

- Nil

d. Course Educational Objectives

Students undergoing this course are expected:

- To enhance knowledge in testing of various structural components using different structural testing machines.
- To calculate material properties like tensile, compressive, impact and shear strength.

e. Course outcomes:

On successful completion of this course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Estimate hardness of various materials using Brinell and Rockwell hardness tests.	K4,S3
CO2	Determine the deflection of the beams with various loading conditions.	K4,S3
CO3	Operate UTM and calculate tensile strength of various materials.	K4,S3
CO4	Estimate the impact strength of materials using Izod and Charpy testing machines.	K4,S3
CO5	Calculate the linear and torsion stiffness of springs.	K4,S3

(S1-Factual, S2-Conceptual, S3-Procedural, S4-Metacognitive)

f. CORRELATION OF COS WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H		H	L	H	H	H	L			
CO2	H	H		H	L	H	H	H	L			
CO3	H	H		H	L	H	H	H	L			
CO4	H	H		H	L	H	H	H	L			
CO5	H	H		H	L	H	H	H	L			

H- High; M-Medium; L-Low

g. LIST OF EXPERIMENTS

1. Brinell Hardness test
2. Rockwell Hardness test
3. Deflection of Beams
4. Tension test
5. Torsion test
6. Izod Impact test
7. Charpy Impact test
8. Testing of helical springs
9. Block Compression Test
10. Shear Test

Total Periods: 30

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE320	**THERMODYNAMICS LABORATORY**	**0**	**0**	**2**	**1**

Course Category:
Programme core

a. Preamble:
This course indulges with experimental techniques for the understanding of basic thermodynamics concepts.

b. Pre- requisites:
- Basic mechanical engineering

c. Link to Other Courses
- Nil

d. Course Educational Objectives
Students undergoing this course are expected:

- To study energy transformations and thermodynamic relationships applied to flow and non-flow processes in refrigeration cycles using experiments.
- To introduce the concept of IC engines operation and also estimate the heat transfer properties of solid material.

e. Course outcomes:
On successful completion of this course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Estimate performance of IC engines using experiments	K2,S3
CO2	Estimate properties of simple heat engines	K2,S3
CO3	Estimate flash and power point of the fuel	K3,S3
CO4	Understand the thermal conductivity and thermal resistances	K2,S3

(S1-Factual, S2-Conceptual, S3-Procedural, S4-Metacognitive)

f. CORRELATION OF COS WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H		H	L	H	H	H	L			
CO2	H	H		H	L	H	H	H	L			
CO3	H	H		H	L	H	H	H	L			
CO4	H	H		H	L	H	H	H	L			

. H- High; M-Medium; L-Low

g. List of experiments

1. Performance test on a 4-stroke diesel engine
2. Valve timing of a 4 – stroke diesel engine
3. Port timing of a 2-stroke petrol engine
4. Determination of effectiveness of a parallel flow heat exchanger
5. Determination of effectiveness of a counter flow heat exchanger
6. Determination of flash point and fire point of a fuel
7. COP test on a vapour compression refrigeration test rig
8. COP test on a vapour compression air-conditioning test rig
9. Determination of thermal conductivity of solid.
10. Determination of thermal resistance of a composite wall.
11. Determination of emissivity of solid.
12. Determination of viscosity of a fuel.

Total Periods: 30

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE321	**FLUID MECHANICS LABORATORY**	**0**	**0**	**2**	**1**

Course Category:
Programme core

a. Preamble:

The lab is designed to provide the student with a physical understanding of the fundamental principles and basic equations of fluid mechanics. This understanding is gained through the application of "text book" concepts and equations to real problems

b. Pre- Requisites

- Engineering Mathematics II

c. Link To Other Courses

- Nil

d. Course Educational Objectives

Students undergoing this course are expected:

- To manipulate the pressure gauges and pressure measurements in fluid systems.
- To calibrate the basic instruments in fluid mechanics.

e. Course outcomes:

On successful completion of this course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate the calibration of various fluid mechanics instruments.	K2,S3
CO2	Carry out an experiment to show the effect of Bernoulli's principle using a Venturi tube.	K2,S3
CO3	Measure the pressure using Pitot static tube	K3,S3
CO4	Demonstrate practical understanding of friction losses in internal flows	K2,S3

(S1-Factual, S2-Conceptual, S3-Procedural, S4-Metacognitive)

f. CORRELATION OF COS WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**			

CO2	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**			
CO3	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**			
CO4	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**			

. H- High; M-Medium; L-Low

g. LIST OF EXPERIMENTS

1. Verification of Bernoulli's theorem
2. Pressure measurement with pitot static tube
3. Calibration of venturimeter
4. Calibration of Orifice meter
5. Determination of pipe flow major losses.
6. Determination of pipe flow minor losses.

Total Periods: 30

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE322	AERODYNAMICS LABORATORY	0	0	2	1

Course Category:
Programme core

a. Preamble:
This lab aids the students to learn about the requirement of wind tunnel in the field of Aeronautical Engineering. Students get hands on experience about speed calibration Flow visualization, Force and pressure measurements over slender and bluff bodies.

b. Pre- Requisites:
- Fluid Mechanics

c. Link to Other Courses:
- Nil

d. COURSE EDUCATIONAL OBJECTIVES:
Students undergoing this course are expected:
- To understand the flow pattern over different aerodynamic profiles.
- To have hands on experience on pressure and force measurement over aerodynamic profiles.
- To estimate aerodynamic response of different objects

e. COURSE OUTCOMES:
On successful completion of this course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the different types of wind tunnel	K2,S3
CO2	Calibrate the test section speed of the wind tunnel	K3,S3
CO3	Illustrate the stream patterns over bluff and slender bodies.	K2,S3
CO4	Investigate the variation of surface pressure over bluff and slender bodies	K4,S3
CO5	Compute the lift and drag co efficient over an airplane model	K3,S3

(S1-Factual, S2-Conceptual, S3-Procedural, S4-Metacognitive)

f. CORRELATION OF COS WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H		H		H	H	H	L			
CO2	H	H		H		H	H	H	L			

CO3	**H**	**H**		**H**		**H**	**H**	**H**	**L**			
CO4	**H**	**H**		**H**		**H**	**H**	**H**	**L**			
CO5	**H**	**H**		**H**		**H**	**H**	**H**	**L**			

H- High; M-Medium; L-Low

g. List of Experiments:

1. Introduction to wind tunnel layout.
2. Flow visualization over different profile in water flow channel.
3. Flow visualization over wing using oil flow/ribbon method.
4. Smoke Flow visualization over streamline and bluff bodies.
5. Subsonic wind tunnel test section speed calibration using Pitot static tube.
6. Pressure distribution over cylinder.
7. Pressure distribution over rough cylinder.
8. Pressure distribution over aerodynamics profiles.
9. Estimation of aerodynamic forces and moments of aerodynamic profiles
10. Calibration of Wind tunnel in vertical/horizontal direction.

Total Periods: 30

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE323	PROPULSION LABORATORY	0	0	2	1

Course Category:
Programmed core

a. **Preamble:**
This course Propulsion Lab provides an introduction to the basic concepts of assembly and dismantling of piston and gas turbine engines, heat transfer, evaluation of Calorific value of fuels and Velocity evaluation for free and wall jet setup.

b. **Prerequisites:**
- Thermodynamics Laboratory

c. **Links to other courses:**
- Nil

d. **Course educational objectives:**
Students undergoing this course are expected:
- To develop the basic knowledge of the students in gas turbine engine and its assembly and dismantling.
- To develop the basic knowledge of the students in piston engine and its assembly and dismantling.
- To evaluate calorific value of the fuels.
- To characterize the fixed pitch propeller.

e. **Course outcomes:**
On the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
C01	Illustrate the concept of piston engine and gas turbine engine.	K3,S3
C02	Exhibit the concept of jet characteristics.	K4,S3
C03	Estimate heat transfer coefficient the free and forced convection heat transfer.	K4,S3
C04	Perceive the calorific value of a various fuels.	K4,S3
C05	Manipulate the performance of propeller.	K4,S3

(S1-Factual, S2-Conceptual, S3-Procedural, S4-Metacognitive)

f. **Correlation of COs with POs:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**L**	**L**	**M**					**M**	**M**		
CO2	**H**	**L**	**L**	**M**		**L**			**M**	**M**		
CO3	**H**	**L**	**L**	**M**		**L**			**M**	**M**		
CO4	**H**	**L**	**L**	**M**					**M**	**M**		
CO5	**H**	**L**	**L**	**M**		**L**			**M**	**M**		

H- High; M-Medium; L-Low

g. **Course contents:**

1. Study of an aircraft piston engine (includes study of assembly of sub systems, various components, their functions and operating principles).

2. Study of an aircraft jet engine (includes study of assembly of sub systems, various components, their functions and operating principles).

3. Forced convective heat transfer over a flat plate.

4. Free convective heat transfers over a flat plate

5. Cascade testing of a model of axial compressor blade row.

6. Study of performance of a propeller.

7. Determination of heat of combustion of aviation fuel.

8. Combustion performance studies in a jet engine combustion chamber.

9. Determination of characteristics of free jet.

10. Determination of characteristics of wall jet.

Total Periods: 30

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE324	Aero Engine Maintenance and Structures Repair Laboratory	0	0	2	1

Course Category:
Programmed core

a. **Preamble:**

This course engages the students towards the inspection and repair works in piston and jet engines using modern methods like NDT, preparation of manuals. The course introduces the fundamental skills on engine stripping and assembly. This also explains about the advanced knowledge on aircraft structural components and its repair techniques. It gives Hands on experience with experiments of the on wood gluing, welding, riveting, sheet metal forming and also do repair on composites, sandwich panels etc.

b. **Prerequisites:**

- Aircraft Structural Mechanics

c. **Links to other courses:**

- Nil

d. **Course educational objectives:**

Students undergoing this course are expected:

- To experimentally study the repair techniques on Aircraft structural and engine components.
- To experimentally know the various repair techniques like welding, gluing, etc.,
- To experimentally study the control cable inspection and sheet metal forming.
- To experimentally study the NDT and other inspection techniques.
- To prepare the troubleshoot manuals.

e. **Course outcomes:**

On successful completion of this course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Identify the parts of the engine and airframe	K3,S3
C02	Demonstrate the NDT and fuel pipe line repair works.	K4,S3
C03	Demonstrate the Welding techniques	K4,S3

C04	Understand troubleshoot and prepare the manuals for engine maintenance.	K4,S3
C05	Demonstrate panel patch works.	K4,S3

(S1-Factual, S2-Conceptual, S3-Procedural, S4-Metacognitive)

f. **CORRELATION OF COS WITH PROGRAMME OUTCOMES:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**L**	**L**	**M**					**M**	**M**	**H**	**L**
CO2	**H**	**L**	**L**	**M**		**L**			**M**	**M**	**H**	**L**
CO3	**H**	**L**	**L**	**M**		**L**			M	**M**	**H**	**L**
CO4	**H**	**L**	**L**	**M**					M	M	**H**	**L**
CO5	**H**	**L**	**L**	**M**		L			M	**M**	**H**	**L**

H- High; M-Medium; L-Low

g. **List of experiments:**

1. Welded patch repair by TIG, MIG, PLASMA ARC.
2. Riveted patch repairs.
3. Preparation and repair of Sandwich panels.
4. Sheet metal forming.
5. Control cable inspection and repair.
6. Stripping and Reassembly of a piston engine and Jet engine
7. Engine (Piston Engine) - cleaning, visual inspection, NDT checks.
8. Piston Engine Components - dimensional checks.
9. Engine (Jet Engine) - cleaning, visual inspection, NDT checks.
10. Fuel lines inspection and repair.
11. Engine starting procedures and Troubleshooting - Jet and Piston Engine.

Total Periods: 30

COURSE CODE	COURSE TITLE	L	T	P	C
1151AE325	FLIGHT MECHANICS AND CONTROL LABORATORY	0	0	2	1

Course Category:
Programme core

a. Preamble:
This course teaches the student about how a system behaves for an external input and how the system could be controlled to obtain a desired response. This course also gives the students to understand the how the Aircraft behaviour changes depending on change in the aircraft's derivatives. Students get a chance to learn about and design flight control system and get hands on experience of the hardware used in flight testing.

b. Pre-requisites:
- Linear system Analysis and Control
- Airplane Performance

c. Links to other courses:
- Nil

d. Course educational Objectives:
Students undergoing this course are expected:
- To understand the system behaviour and the control techniques
- To familiarize aircraft behaviour with respect to the aerodynamic control and stability derivatives

e. Course Outcomes:
On successful completion of this course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Estimate the system response	K4,S3
CO2	Forecast the actual flight behavior from the numerical parameters	K4,S3
CO3	Estimate the flight parameters	K4,S3
CO4	Design flight control law	K4,S3
CO5	Calibrate and read sensor data	K3,S3

(S1-Factual,S2-Conceptual,S3-Procedural,S4-Metacognitive)

f. CORRELATION OF COS WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**	**H**		
CO2	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**	**H**		
CO3	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**	**H**		
CO4	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**	**H**		
CO5	**H**	**H**		**H**	**L**	**H**	**H**	**H**	**L**	**H**		

H- High; M-Medium; L-Low

g. List of experiments:

1. Determine the Closed loop time response for the given transfer function by Root locus technique
2. Design a PID control for the given transfer function and performance requirements
3. Simulate the longitudinal flight dynamics for the given Aircraft parameters
4. Design a Simple Altitude-hold Autopilot system for the given flight model
5. Calibrate the given Load cell.
6. Lab Project

Total Periods: 30