DAYANANDA SAGAR UNIVERSITY
SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU–560 111, KARNATAKA.

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS
FOR
BACHELOR OF TECHNOLOGY (B.Tech.) - 2021

AEROSPACE ENGINEERING

(ASE) - III & IV SEMESTER

2021-22 Onwards

SCHEME - B. TECH

III SEM - AEROSPACE ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101	21ME2301	COMPLEX VARIABLES & NUMERICAL METHODS	CR	04	--	--	--	04	*	***
2	101	21AS2301	INTRODUCTION TO AEROSPACE ENGINEERING	CR	03	--	--	--	03	*	***
3	101	21AS2302	THERMODYNAMICS	CR	03	--	--	--	03	*	***
4	101	21AS2303	FLUID MECHANICS	CR	03	--	--	--	03	*	***
5	101	21AS2304	MECHANICS OF SOLIDS	CR	03	--	--	--	03	*	***
6	101	21AS2305	AEROSPACE MATERIALS	CR	03	--	--	--	03	*	***
7	101	21AS2306	MATERIALS & MANUFACTURING LAB	CR	--	--	02	--	01	*	***
8	101	21AS2307	FLUID MECHANICS LAB	CR	--	--	02	--	01	*	***
9	101	21AS2308	MINI PROJECT – I	CR	--	--	--	02	01	*	***
					19	**--**	**04**	**02**	**22**		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,

SCHEME - B.TECH

IV SEM - AEROSPACE ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	101	21AS2401	AIRCRAFT PROPULSION	CR	03	--	--	--	03	*	***
2	101	21AS2402	AERODYNAMICS – I	CR	03	--	--	--	03	*	***
3	101	21AS2403	AEROSPACE STRUCTURAL MECHANICS	CR	03	--	--	--	03	*	***
4	101	21AS2404	MECHANISMS AND MACHINE THEORY	CR	03	--	--	--	03	*	***
5	101	21AS2405	MANUFACTURING PROCESSES	CR	03	--	--	--	03	*	***
6	101	21AS2406	PRODUCT DESIGN - 1	CR	02	--	02	--	03	*	***
7	101	21AS2407	AEROSPACE STRUCTURES LAB	CR	--	--	02	--	01	*	***
8	101	21AS2408	AEROSPACE PROPULSION LAB	CR	--	--	02	--	01	*	***
9	101	21AS2409	MINI PROJECT – II	CR	--	--	--	02	01	*	***
					17	**--**	**06**	**02**	**21**		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21ME2301
TITLE OF THE COURSE : Complex variables & Numerical Methods
L: T: P: C : 04:00:00: 04

MODULE 1 [8 hours]
3-D GEOMETRY
3-D Coordinate systems, Vectors, Dot and Cross products, Lines, planes and curves in space, Tangents to curves, Normal vectors of curve.

MODULE 2 [**14 Hours**]
MULTI VARIABLE CALCULUS
DIFFERENTIALCALCULUS:
Functions of two or more real variables, Partial derivatives of second and higher order, Euler'stheorem on homogenous function, Total derivatives, Jacobians, Maxima and minima,Lagrange's method of undetermined multipliers, Taylor's formula for two variables
INTEGRAL CALCULUS
Double integrals, Triple integrals, change of order of integration in a double integral, Changeof variables in double and triple integrals, Area as a double integral, Volume as a triple integral, Line integrals, Vector Fields and Line integrals.

MODULE 3 [12 hours]
GREEN'S, STOKE'S AND DIVERGENCE THEOREMS
Path independence, Green's theorem, Surfaces and area, Surface Integrals, Stoke's Theorem, Divergence Theorem.

MODULE 4 NUMERICAL METHODS - I [8 hours]
Introduction to Numerical methods, Initial and Boundary value problems, Numerical solution of ODE, Picard's method, Taylors series method, Euler's method, Modified Euler's method, Runge-Kutta method

MODULE 5 NUMERICAL METHODS - II [10 hours]
Introduction of PDE, Classification of PDE: parabolic, elliptic and hyperbolic. Boundary and initial conditions, Taylor series expansion, analysis of truncation error, Finite difference method: FD, BD & CD, Higher order approximation, Order of Approximation, Polynomial fitting, One-sided approximation.

Text Books:

1. Thomas's Calculus, G.B.Thomas, M.Weir, J. Hass, Pearson , 12th edition
2. Advanced Engineering Mathematics, E. Kreyzsig, Wiley, 10th Edition
3. Numerical Methods for Engineers, Chapra and Canale, Mc Graw Hill Education, 7 th edition.

Reference Books:

1. Basic Multi Variable Calculus, Marsden, Tromba and Weinstein, W.H. Freeman, ThirdEdition
2. A First Course in Numerical Methods, Ascher and Grief, SIAM 2011
3. Higher Engineering mathematics, BS Grewal, 43rd Edition, Khanna publishers.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21AS2301
TITLE OF THE COURSE : INTRODUCTION TO AEROSPACE ENGINEERING
L: T/A: P: C : 03:00:00: 03

COURSE LEARNING OBJECTIVES

This course will enable students to:

1. Understand basic principles of aviation and the history of space vehicles
2. Acquire the basic knowledge of aircraft structures, aerodynamics, propulsion, materials, aircraft systems & instrumentation
3. Understand the basics of spacecraft and orbital mechanics

COURSE OUTCOMES

Upon successful completion of this course, the students:

1) Apply the basic knowledge & principles of aerospace vehicles and spacecraft
2) Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft & rocket propulsion and aircraft materials during the development of an aircraft
3) Understand the complexities involved during development of aerospace vehicles

Module -1: INTRODUCTION TO AEROSPACE ENGINEERING 8 hrs.

History of aviation, Atmosphere, space and its properties, Classification of aircraft andspace vehicle, Aircraft Nomenclature, Modern developments in Aviation.
Introduction to Space Flight: History of Space Flight & spacecraft technologies, Introduction to basic orbital mechanics, Kepler's Laws of planetary motion, Types of Orbits.

Module -2: FUNDAMENTALS OF AERODYNAMICS 8 hrs.

Aerodynamic forces and moments on an Airfoil, Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag, Centre of pressure and its significance, Aerodynamic center, Aspect ratio, Airfoil nomenclature, Basic characteristics of airfoils, Simple problems on lift and drag. Significance of speed of sound Propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows.

Module -3: AIRCRAFT and ROCKET PROPULSION 8 hrs.

Introduction, Classification, Piston Engine & its application, Brayton cycle, Principle of operation of Turboprop, turbojet and turbofan engines, Introduction to ramjets and scramjets; performance characteristics

Rocket Propulsion: Principles of operation of rocket, Classification of Rockets, Types of rockets and typical applications, Introduction to Space Exploration.

Module -4: AIRCRAFT STRUCTURES **7 hrs.**

Introduction, General types of construction, Truss, Monocoque, Semi-Monocoque andGeodesic structures, typical wing and fuselage structure. Introduction to aircraft materials.

Module -5: AIRCRAFT INSTRUMENT` **8 hrs.**

Instrument Displays, Introduction to Navigation Instruments, Basic Air data systems & Probes, Mach meter, Air speed indicator, Vertical speed indicator, Altimeter, Gyro based instruments.
Aircraft Systems: Introduction to Hydraulic and pneumatic systems, Air Conditioning and Cockpit pressurization system, Generation and distribution of Electricity on board theairplane, Aircraft Fuel System, Fire Protection, Ice and Rain Protection System.

Text Books:

1. John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673.
2. Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752

Reference Books:

1. Ian Moir, Allan Sea bridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206.
2. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition, 2016, ISBN: 9781118753910.
3. A.C. Kermode, "Flight without formulae", Pearson Education India, 5th edition, 1989, ISBN: 9788131713891.
4. Nelson R.C., "Flight stability and automatic control", McGraw-Hill, 2nd edition, 1998, ISBN: 9780071158381.
5. T.H.G Megson "Introduction to Aircraft Structural Analysis", Elsevier Exclusive Publications, 2nd edition, 2014, ISBN 13: 978-9351071860.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21AS2302
TITLE OF THE COURSE : THERMODYNAMICS
L: T/A: P: C : 03: 00: 00: 03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Understand the basic concepts of thermodynamics
- Understand the thermodynamics laws
- Develop an understanding of working principles of gas power cycles
- Understand the working principles aircraft propulsion systems

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Apply the concepts of thermodynamics to different processes
- Analyse the various gas power cycles
- Analyse different aero engine cycles and propulsion systems

Module -1: BASIC CONCEPTS OF THERMODYNAMICS 8L hrs.

Introduction- Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, Thermodynamic properties: definition and units. Intensive and extensive properties. Thermodynamic state, state point, path and process, quasi-static process, cyclic and non-cyclic processes, Energy and its forms, Work and heat (sign convention), irreversible process, causes of irreversibility

Module -2: ZEROTH LAW AND FIRST LAW THERMODYNAMICS 7L hrs.

Zeroth law of thermodynamics statement, Concept of Temperature and its measurement, Temperature scales.

First Law of Thermodynamics: First law of thermodynamics-application to closed and open system, Joules experiments, equivalence of heat and work, Internal energy and enthalpy, energy as a property, steady state, Steady Flow Energy Equation, extension of first law to control volume, Application of SFEE, Limitations of first law ofthermodynamics

Module -3: SECOND LAW OF THERMODYNAMICS AND PURE SUBSTANCE 8L hrs.

Thermal reservoirs, Efficiency, devices converting work to heat in a thermodynamic cycle,direct heat engine, reversed heat engine, Refrigerator and Heat Pump, Coefficient ofPerformance, Kelvin-Planck and Clausius statement of second law of thermodynamics,

Equivalence of the two statements, reversible and irreversible processes, , Carnot theoremand its corollaries. Second law, entropy and absolute temperature, third law and absolute entropy, Introduction to energy.

Pure substance: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat), Dryness fraction (quality), T-S and H-S diagrams.

Module -4: THERMODYNAMIC GAS & VAPOUR CYCLES 8L hrs.

Otto cycle, Diesel cycle, dual cycle, Rankine cycle, Joule-Brayton cycle, ideal and real cycles. Numerical problems

Module -5: INTRODUCTION TO HEAT TRANSFER 8L hrs.

Thermodynamics and Heat Transfer, Applications, Historical background, Heat transfer modes, Conduction, Fourier law, Thermal conductivity, diffusivity, Convection; Newton's law of cooling, Radiation heat transfer, Simultaneous heat transfer mechanisms, Overall heat transfer coefficient.

Text Books:

1. Sonntag, R. E., Borgnakke ,C. and Van Wylen , G. J., "Fundamentals of Thermodynamics", 6th ed., Wiley, 2002
2. Cengel, Y., and Boles, M., "Thermodynamics: an Engineering Approach", 7th Ed., McGraw Hill, 2010
3. Rogers and Mayhew, "Engineering Thermodynamics: Work and Heat Transfer", 4th Ed, Longman Scientific, 1992.

Reference Books:

1. Nag, P. K., "Engineering Thermodynamics", 4th ed., Tata McGraw Hill, 2008
2. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition, 2016, ISBN: 9781118753910.
3. Cengel, Y., and Ghajar, "Heat transfer: A practical approach", McGraw Hill, 2nd Ed., 2002
4. Hill, P., and Peterson, C., "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2009
5. Farokhi, Saeed, "Aircraft Propulsion", Wiley-Blackwell 2nd Ed., 2014.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21AS2303
TITLE OF THE COURSE : FLUID MECHANICS
L: T/A: P: C : 03:00:00: 03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Understand the basics of incompressible fluid properties and flow regimes
- Study different types of fluid flows and governing laws
- Understand the concept of boundary layer theory

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Solve problems on incompressible fluid flow
- Analyse different flow regimes using governing laws of fluid flow
- Apply the concept of boundary layer in fluid flow
- Apply the principles of dimensional analysis for incompressible flow

Module -1: FLUID PROPERTIES AND FLUID STATICS 8L hrs.

Introduction, properties of fluids, viscosity, thermodynamics properties, surface tension and capillarity, vapor pressure. Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers.
Hydrostatic forces on plane inclined and curved surfaces, Fluid Statics: Fluid pressure at apoint, Pascal's law, and pressure variation in a static fluid.

Module -2: FLUID KINEMATICS 8 L hrs.

Lagrangian and Eulerian descriptions, Types of flows; Steady flow, Unsteady flow, Uniformand Non-Uniform flow, Rotational flow, Irrational flow, 1-D, 2-D, 3-D flows, Continuity equation, velocity and acceleration, velocity potential function, Stream function, lines of constant stream function and equipotential line, Streamline, Path line, and Streak line, Dilatation strain rate, Circulation, Vorticity.

Module -3: FLUID DYNAMICS AND FLOW MEASUREMENT 7L hrs.

Introduction, Euler's Equation of motion, Assumptions, Bernoulli's equation, Bernoulli's equation for real fluids and application, Measurement of flow, venturi meter, orifice meter,pitot tube.

Module -4: DIMENSIONAL ANALYSIS **8L hrs.**

Introduction, Dimensional homogeneity – Raleigh and Buckingham theorems Non - Dimensional numbers – Model laws and distorted Models-Unit Quantities-Specific Quantities.

Module -5: BOUNDARY LAYER THEORY **8L hrs.**

Equation of motion in differential form, Viscous flow, exact solutions, pipe flow. Laminar boundary layers. Boundary layer solution methods. Introduction to Turbulence, Reynolds averaging, Reynolds stress, turbulent boundary layer.

Text Books:

1. White, F. M., "Fluid Mechanics (SI Units)", 7th Ed., Special Indian Edition, McGraw Hill, 2011.
2. Panton, R. L., "Incompressible Flow", 3rd Ed., Wiley India Edition, 2006.
3. Cengel Y. A., Cimbala J.M., "Fluid Mechanics (Fundamentals and Applications)", 2nd Ed., Tata McGraw Hill, 2010.

Reference Books:

1. Dr. R.K. Bansal, (2000), "Fluid Mechanics and Hydraulic Machines", Laxmi Publication (P) Ltd., New Delhi.
2. P.N. Modi and S.M. Seth (1999), "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Naisarak, Delhi

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21AS2304
TITLE OF THE COURSE : MECHANICS OF SOLIDS
L: T/A: P: C : 03: 00: 00: 03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Understand the basic concepts of Engineering Mechanics
- Understand center of gravity, centroid & Moment of Inertia under different loading
- Study of particle equilibrium and its application.
- Understand the basics of strengths of materials
- Understand the concepts about thick and thin cylinders and beams

COURSE OUTCOMES

Upon successful completion of this course, the students:

- **Understand** the concept of rigid body equilibrium and equations of equilibrium.
- **Understand** center of gravity, centroid & Moment of Inertia under different loading
- **Relate** the use of free body diagram as applied to simple mechanisms, structures
- **Solve** problems involving trusses, friction and beams with different loads and boundary conditions
- **Apply** shear force and bending moment diagrams to visualise the states of loading and solve for
- Unknowns
- **Understand** the basic strength of material concepts including ductile and brittle materials, stress,
- strain, and their relationship, and temperature effects on material properties

Module 1: INTRODUCTION TO ENGINEERING MECHANICS (Statics) 9 hrs.

Force Systems - Basic concepts, Particle Equilibrium in 2-D & 3-D; Rigid Body equilibrium; Coplanar Concurrent Forces, Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Free body diagrams, Equilibrium of System of Forces

Module 2: FRICTION AND BASIC STRUCTURAL ANALYSIS 8 hrs.

Friction : Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction wedge Friction. Basic Structural Analysis: Equilibrium in three dimensions; Trusses, Method of Sections; Method of Joints; Methods of analysis of truss; Simple Trusses; Zero force members

Module 3: CENTROID, CENTRE AND GRAVITY AND MOMENT OF INERTIA: 8 hrs.

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and it implications; Area moment of inertia Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Prism.

Module 4: PARTICLE DYNAMICS: 7 hrs.

Engineering Materials: Engineering materials, properties of materials, Stress and strain, types of stress and strain, Stress and strain relation, Hooke's law. Extension or shorting of bar, Stress-strain relationship of ductile and brittle materials. Temperature affecting the material properties.

Module5: 8 hrs.

Shear Force and Bending Moment: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments.

Text Books:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall publications.
2. A Nelson (2009), Engineering Mechanics: Statics and dynamics, Tata McGraw Hill publications.

References:

1. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill publications.
2. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
3. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21AS2305
TITLE OF THE COURSE : AEROSPACE MATERIALS
L: T/A: P: C : 03: 00: 00: 03

COURSE LEARNING OBJECTIVES:

This course will enable students to:

- Develop an understanding of different materials used in aerospaceengineering
- Understand different mechanical tests to study the strength of material
- Understand the material requirement for aircraft and space shuttlestructures
- Study various metal-based alloys, super alloys and high-performancepolymers for aerospace applications

COURSE OUTCOMES:

Upon successful completion of this course, the students:

- Demonstrate knowledge to select appropriate material for aerospacestructures
- Comprehend the results of mechanical tests on materials
- Selecting the right materials for engineering process and application
- Characterize different aerospace materials of aircraft and space shuttlestructures

Module -1: INTRODUCTION TO AEROSPACE MATERIALS AND THEIR REQUIREMENTS 7 hrs.

Brief history of aerospace materials, Materials for the global aerospace industry, Types,Future advances in aerospace materials

Material requirements for aerospace structures and engines, Introduction to Fixed-wingaircraft structures, Helicopter structures, Space shuttle structures

Module -2: STRENGTH, DURABILITY AND TESTING OF AEROSPACE MATERIALS 8 hrs.

Strengthening of metal alloys: Introduction, Crystal structure of metals, Defects in crystal structures, strengthening of metal, Corrosion of aerospace metals

Introduction to Tension test, Compression test, Flexure test, Hardness test, Fracture test, Drop-weight impact test, Fatigue test, Creep test, Environmental durability testing, certification of aerospace materials, Non Destructive Testing (NDT).

Module -3: LIGHT METAL ALLOYS **8 hrs.**

Aluminum alloys for aircraft structures: Introduction, Aluminum alloy types, Heat treatment of aluminum alloys, High-temperature strength of aluminum,

Introduction to Titanium alloys and their applications, Types of titanium alloy, Titaniumaluminides, Shape memory titanium alloys

Introduction to Magnesium alloys and their applications, types, Metallurgy of magnesiumalloys

Module -4: COMPOSITE MATERIALS: **8 hrs.**

Applications of Composites, Fibers, Resins and other materials for composite manufacturing, manufacturing techniques of composites, Introduction to polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fiber composites, failures theory in composite materials

Module -5: STEELS & SUPER ALLOYS **8 hrs.**

Steels for aircraft structures: Introduction, Basic principles of steel metallurgy, Maraging steel, Medium-carbon low-alloy steel, Stainless steel

Super alloys for gas turbine engines: Introduction, Nickel-based super alloys, Iron–nickel super alloys, Cobalt super alloys, Thermal barrier coatings for jet engine alloys, advanced materials for jet engines

Text Books:

1. Adrian P. Mouritz, "Introduction to aerospace materials", Wood head Publishing Limited, 2012, ISBN 978-1-85573-946-8
2. George E. Dieter "Mechanical Metallurgy", McGraw Hill Publications
3. William D. Callister, "Materials Science and Engineering: an Introduction", John Wileyand sons

Reference Books:

1. Brian Cantor, Hazel Assender and Patrick Grant, "Aerospace Materials", Institute of Physics Publishing, ISBN: 0 7503 0742 0
2. Sam Zhang, Dongliang Zhao "Aerospace Materials Handbook" CRC Press Taylor & Francis Group, ISBN: 978-1-4398-7330-4

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21AS2306
TITLE OF THE COURSE : Materials & Manufacturing Lab
L: T/A: P: C : 00: 00: 02: 1

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Conduct experimentation on different Fabrication techniques for compositematerial.
- Conduct testing on fabricated composites as per ASTM standards for compositematerials.
- Basic understanding of Composite materials
- Basic Understanding of Manufacturing process including foundry, Lathe operations,3 D printing

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Understand different fabrication techniques for composite materials.
- Understand Non-destructive techniques on fabricated composites
- Understand Lathe operations,3 D printing

LIST OF EXPERIMENTS:

1) Fabrication of 200X200 mm- 4-layer laminate by hand lay-up set up
2) Fabrication of 200X200 mm- 4-layer laminate by Vacuum Bagging set up
3) Curing of 200X200 mm- 4-layer laminate by Auto clave set up
4) Fabrication of hollow shaft by filament winding
5) Non-destructive test (Ultrasonic test) to compare the quality of product manufacture by hand layup, vacuum bagging, and Auto clave setup.
6) Tensile test of composite material as per ASTM
7) Flexural testing of composite materials as per ASTM
8) Foundry & Lathe operations
9) Additive Manufacturing using Fused Deposition Modelling Technology.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 21AS2307
TITLE OF THE COURSE : FLUID MECHANICS LAB
L: T/A: P: C : 0: 0: 2: 1

COURSE LEARNING OBJECTIVES:

This course will enable students to:

- Conduct experiments on using flow measurement devices including Notch, Venturi meter, orifice meter and rotameter
- Conduct experiments to calculate major and minor losses in pipes
- Basic understanding of fluid machinery

COURSE OUTCOMES:

Upon successful completion of this course, the students:

- Understand major and minor losses in pipe flow
- Understand various methods to calculate discharge using different flow measurement devices including Notch, Venturi meter, orifice meter
- Determine Performance characteristics of pumps and turbines

LIST OF EXPERIMENTS:

1. Measurement of force and Centre of pressure on a plane surface
2. Study of potential flows
3. Verification of Bernoulli's theorem – Pressure measurement with pitot static tube
4. Performance test on air blower
5. Determination of friction factor for flow through pipes
6. Loss of Head on Pipe Fittings Apparatus-To determine and compare pressure drop acrossvarious pipe settings
7. Determination of the Coefficient of Discharge of the Given Orifice Meter**.**
8. Determination of the Coefficient of Discharge of the Given Venturimeter.

IV SEMESTER

SEMESTER/YEAR : IV / II
COURSECODE : 21AS2401
TITLE OFTHECOURSE : AIRCRAFT PROPULSION
L: T/A: P: C : 03: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the working principles of gas turbine and ramjet propulsion systems, the design principles of inlets, combustion chambers, nozzles used in them
2. Understand the operation of compressors and turbines in gas turbine propulsion systems
3. Understand rocket propulsion

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Analyze the engineering concepts of propulsion systems
2. Determine the performance characteristics of compressors and turbines
3. Choose the propellant based on the application.

Module -1: INTRODUCTION TO PROPULSION TECHNIQUES 7Hours

Introduction: Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power.

Gas turbine engine: Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet– Methods of Thrust augmentation.

Module -2: PROPELLER THEORYAND PERFORMANCE 7Hours

Propeller Blade Theory: Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses.

Propeller performance: prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts

Module -3: INLETS AND COMBUSTION 8 Hours

Nozzles: Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio, starting problem in supersonic inlets–Modes of inlet operation, jet nozzle– Efficiencies–Over expanded, under and optimum expansion in nozzles–Thrust reversal.

Combustion Chamber: Classification of Combustion chambers - Combustion chamber performance Flame tube cooling – Flame stabilization.

Module-4: COMPRESSORS **8 Hours**

Compressor types: Introduction to centrifugal compressors, Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps.

Module-5: TURBINES **8 Hours**

Axial and radial flow turbines: geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

Text Books:

1. Hill, P.G. and Peterson, C.R. "Mechanics and Thermodynamics of Propulsion", Pearson India, 2nd edition, 2009, ISBN-13:978-8131729519

2.Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H, "Gas Turbine Theory", DORLING KINDERSLEY,5th edition,2002, ISBN-13:978-8177589023

Reference Books:

1. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985, ISBN-13:978-0915928972.

2. G.P.Sutton, "Rocket Propulsion Elements", Wiley India Pvt Ltd, 7th Edition, 2010, ISBN-13:978-8126525775.

3.W.P. Gill, H.J.Smith & J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 4th revised edition,2007,ISBN-13:978-8120417106.

SEMESTER/YEAR : IV / II
COURSECODE : 21AS2402
TITLE OFTHECOURSE : AERODYNAMICS–I
L: T/A: P: C : 03: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
2. To make the student understand the concept of vorticity, irrotationality, theory of airfoils and wing sections
3. Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
4. To introduce the basics of viscous flow.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Potential flows and Viscous flows
2. Understanding of flow past streamlined bodies and bluff bodies
3. Lift generation mechanisms, Lifting line theory and applications
4. Boundary layer theory: Laminar and turbulent flows

Module -1: INTRODUCTION TO LOWSPEEDFLOW 8 Hours

Potential flow analysis, Euler equation, incompressible Bernoulli's equation. Circulation and Vorticity, Green's lemma and Stoke's theorem, Barotropic flow, kelvin's theorem, stream line, stream function, irrotational flow, potential function, equipontentiallines, elementary flows and their combinations.

Module -2: TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW 9 Hours

Scalar and vector fields, velocity potential, line, surface and volume integrals, circulation and lift generation, Kutta-Joukovskii theorem, Source Flow, Sink flow, doublet flow, Ideal Flow over a circular cylinder, D'Alembert's paradox, magnus effect, Kutta-joukowski's theorem, starting vortex, kutta condition, real flow over smooth and rough cylinder.

Module -3: AIR FOIL THEORY **9 Hours**

Cauchy-Riemann relations, complex potential, methodology of conformal transformation, Kutta Joukowski transformation and its applications, Classical thin airfoil theory for symmetric and asymmetric airfoils and its applications.

Module -4: SUBSONIC WING THEORY **9 Hours**

Biot-Savartlaw and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory, Downwash and induced drag, Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl are lifting line theory. Extended lifting line theory- lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane. Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane.

Module -5: INTRODUCTION TO BOUNDARY LAYER THEORY **9 Hours**

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, shape parameter, boundary layer equations for a steady, two-dimensional incompressible flow, boundary layer growth over a flat plate, critical Reynolds number, Blasius solution, basics of turbulent flow.

Text Books:

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

2. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw Hill Book Co., 1999

Reference Books:

1. Milne Thomson, L.H., "Theoretical Aerodynamics", Macmillan, 1985

2. John J Bertin., "Aerodynamics for Engineers", Pearson Education Inc, 2002

3. Clancy L. J. "Aerodynamics", Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804

4.Kuethe, A.M and Chow, C.Y, "Foundations of Aerodynamics", Fifth Edition, John Wiley &Sons,2000.

5. Louis M. Milne-Thomson, "Theoretical Aerodynamics", Imported Edition, Dover Publications, USA (2011), ISBN9780486619804

SEMESTER/YEAR : IV SEM / II YEAR

COURSE CODE : 21AS2403

TITLE OF THE COURSE : AEROSPACE STRUCTURAL MECHANICS

L: T/A: P: C : 03: 00: 00:03

Course Learning Objectives:

This course will enable students to:

- Understand basic principles of aviation and the history of space vehicles
- Acquire the basic knowledge of aircraft structures, aerodynamics, materials, aircraft systems & instrumentation
- Understand the basics of spacecraft and orbital mechanics

Course Outcomes:

Upon successful completion of this course, the students:

- Apply the basic knowledge & principles of aerospace vehicles and spacecraft
- Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft & rocket propulsion and aircraft materials during the development ofan aircraft
- Understand the complexities involved during development of aerospace vehicles.

Module -1: Basic Stress Analysis 8 Hrs

1D, 2D and 3D stresses and strains. Symmetric stress tensor, Hooke' Law in 2 Dimensions, Stress strain relations, Plane stress and Plane strain, Principal stresses, Mohr's circle of stress, Failure theories.

Module -2: Beam Analysis 8 Hrs

Asymmetric bending, Bending of thin-walled sections, shear flow and shear Centre. Strain energy due to stresses, deflection and rotations in beam, Castigliano's theorems.

Module -3: Torsion, Buckling and Vibration 9 Hrs

Torsion of a solid section, hollow sections and thin- walled sections. Buckling and stability of columns, critical load, Euler's column theory, types of end conditions Structural Dynamics: Basics of rotational motion, Free and forced vibrations of undamped and damped SDOF systems

Module -4: Flight vehicle structures 8 Hrs

Analysis of aircraft structures, Loads on structural components and its function, fabrication, construction. Principles of stressed skin construction : Loads on aircraft : airworthiness, airframe loads, fatigue

Module -5: Simulation **6 Hrs**

Simulation software's. Simulation problems: pre-processing, processing post processing. Simulation of simple problems of beams, truss.

Text Books:

1. T.H.G.Megson, Aircraft Structures for Engineering students, Elsevier. 5th edition, 2007.
2. Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books.2006, ISBN: 9788170020752

Reference Books:

1. J.B.K.Das and Dr. P.L.Srinivas Murthy , "Mechanics of Materials", Sapna, 2016.
2. John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-007802767

SEMESTER/YEAR : IV / II
COURSECODE : 21AS2404
TITLE OFTHECOURSE : MECHANISMS AND MACHINE THEORY
L: T/A:P: C : 03: 00: 00:03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand different types of mechanisms and kinematic pairs
2. Understand the techniques for studying the dynamics of machines and its components
3. Study the effect of gyroscopic couple on aircrafts

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Analyze different types of mechanisms using analytical and graphical methods
2. Determine the terminologies gear and gear trains.
3. Solve problems on balancing of reciprocating and rotating masses
4. Determine the performance characteristics of Gyroscope

Module -1: BASICS OF MECHANISMS 7 Hours

Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. Kinematic Chains and Inversions: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.

Straight line motion mechanisms. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph

Module -2: VELOCITY ANDACCELERATION ANALYSIS 8 Hours

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Freudenstein’s equation for four bar mechanism and slider crank mechanism. Function Generation for four bar mechanism. Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's Theorem.

Module -3: GEARS TERMINOLOGY 8Hours

Gear nomenclature, types, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference.

Gear Trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains.

Module 4: BALANCING OF ROTATING & RECIPROCATING MASSES 8Hours

Balancing of Rotating Masses: Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes. Inertia effect of crank and connecting rod, numerical problems.

Module -5: GYROSCOPES 8Hours

Gyroscope: Vectorial representation of angular motion. Gyroscopic couple, effect of gyroscopic couple on ship, plane disc, aero plane, stability of aircrafts.

Text Books:

1. Sadhu Singh, Theory of Machines, Pearson Education. 2nd Edition, 2007.

2.Rattan S.S. Theory of Machines, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition,2009

Reference Books:

1. J.J. Uicker, G.R. Pennock, J.E. Shigley, “Theory of Machines & Mechanisms”, Oxford 3rd Ed.2009

2. A.G.Ambekar, “Mechanism and Machine Theory”, PHI, 2007

SEM/YEAR : IV/II
COURSE CODE : 21AS2405
TITLE OFTHECOURSE : MANUFACTURING PROCESSES
L: T/A: P: C : 3:0: 0:3

COURSE OBJECTIVES:

This course will enable students to:

1. To introduce the concepts of manufacturing processes.
2. To understand the fundamentals and principles of different processes like forging, rolling.
3. To understand fundamentals of Rapid prototyping.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand and gain knowledge on casting processes.
2. Understand the extrusion & sheet metal forming.
3. Understand the principles of lathe machines and rapid prototyping.
4.

Module 1: Metal casting and forging 10 Hours

Introduction, processes and applications of casting Light alloy casting, mounding practice, melting practice, precision investment casting, effect of casting parameters on properties titanium casting, directional solidification, powder metallurgy technique and forging equipment, press, recent trends, quality control aspects of thermo mechanical processing,

Module 2: Metal cutting and joining Process 10 Hours

Alloy requirements, sheet materials, steels, titanium alloys, high temperature super alloys, heat treatment and de-scaling, forming, chemical machining, electron beam welding, brazing of super alloys, ultrasonic machining, water jet cutting, electrochemical processing, laser cutting for rotating machinery components, joining technologies like plasma technique, laser welding

Module 3: Sheet Metal Working 10 hours

Shearing mechanisms, Processes like blanking, piercing, punching. Metal Forming processes like bending, cup drawing, coining, embossing. High energy rate forming-superplastic forming-principles & process parameters. Applications of sheet formed products in aerospace.Riveted joints, desirable properties of rivets, basic terminologies, and advantages of riveted joints.

Module 4: **Additive Manufacturing** **10 Hours**

Basic Principles of Additive Manufacturing and Processes, Designing for Additive Manufacturing, Multiple Materials, Hybrids, Composite Materials, current and future directions, Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Powder-based AM processes. Printing processes, extrusion based fused deposition modeling object, Stereo lithography Micro- and nano-additive, Advantages and application, smart manufacturing concepts based on industrial 4.0,Metal metal 3d Printing,

Module 5: Aerospace components and protective measures **10 Hours**

Major engine components, material trends, component operating environments and material requirements, compressor and turbine discs, blades. Combustion chambers, shafts, bearings Corrosion behavior, coatings and surface treatments, erosion behaviour of compressor components, surface degradation and protection of combustor and turbine components

Text books:

1. "Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2009.
2"Manufacturing & Technology: Foundry Forming and Welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
3. Workshop Technology- Hazara Choudhry, Vol-II, Media Promoters & Publishers Pvt. Ltd. 2004
4. Production Technology-R. K. Jain, Khanna Publications, 2003.
5. Production Technology- HMT, Tata MacGraw Hill, 2001.
6. Paul F. Jacobs: "Stereo lithography and other RP & M Technologies", SME, NY 1996.
7.Flham D. T & Dinjoy S.S "Rapid Manufacturing" Verlog London 2001.

Reference books:

1. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed. Pearson Edu. 2006.
2. "Manufacturing Technology", Serope Kalpakjian, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006.
3. Manufacturing Science- Amitabh Ghosh and Mallik, affiliated East West Press, 2003.
4. Rapid prototyping materials by Gurumurthi, IISc Bangalore

SEMESTER/YEAR : IV / II
COURSECODE : 21AS2406
TITLE OFTHECOURSE : PRODUCT DESIGN- I
L: T/A: P: C : 02:00: 02: 03

COURSE OBJECTIVES:

This course will enable students to:

1.Acquire practical knowledge regarding conceptualization, design and development of a new product.

2. Understanding costing and economic decision making

3. Familiarization with design software on 3D modeling, section of solids, orthographic view and dimensioning

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Understand the need of a new product, the product life cycle and the product design process.

2.Get awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).

3. Get competence with a set of tools and methods for product design and development.

4. Generate detailed 3Ddrawing

Module1: INTRODUCTION 8 Hours

Importance of product design, life cycle of a product, steps involved in the design process, communication during the design process, team behavior and tools, design review, delta design exercise.

Module 2: IDENTIFICATION AND UNDERSTANDING OF CUSTOMER NEEDS 8 Hours

Voice of customer, gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Requirements capture, development of product design specifications, quality function deployment (QFD) technique, case studies in QFD.

Module 3: CONCEPT GENERATIONANDEVALUATION 8 Hours

Generating engineering specifications, functional analysis and design, concept generation methods, creativity and problem solving, creativity method, creative idea evaluation, TRIZ, axiomatic design. Concept evaluation: Information representation, concept evaluation overview, evaluation techniques based on 1) feasibility judgment, 2) GO-NO-GO screening,3) technological readiness, 4) basic decision matrix (Pugh's Method). Time value of money, cost comparison, profitability of investment, sensitivity and break-even analysis.

Module 4: PRODUCT ARCHITECTURE AND PROTOTYPING 8 Hours

Product Architecture- What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Prototyping- Prototyping basics, principles of prototyping, technologies, planning for prototypes

Module 5: SOFTWARE BASICS AND 3D MODELING 8 Hours

Introduction to software (CATIA), CAD Basics, solid modeling, surface modeling (Theory on Bezier curves), sectioning, views, dimensioning, 2D drawing preparation, bill of materials Product design of own choice – part drawing, exploded view and assembly and simulation of the model using simulia.

Text books

1. Dieter, G.E., Engineering Design: A materials and process in approach, McGraw-Hill International Series, 2000.

2. Ullman, D. G., Mechanical Design Process, McGraw Hill, 2004.

Reference books

1. Ulrich, K. T. and Eppinger, S. D., Product Design and Development, Irwin McGraw Hill, 2000.

2.Eide,R., Jenison, R. D., Marshaw , L. H., and Northup L. R., Introduction to Engineering Design,McGrawHillBasicEngineeringSeriesandTools,1998.

SEMESTER/YEAR : IV / II
COURSECODE : 21AS2407
TITLE OFTHECOURSE : AEROSPACE STRUCTURES LAB
L: T/A: P: C : 00: 00: 02:01

COURSE OBJECTIVES:

This course will enable students to:

1) Conduct experiments on various structural elements like beams, columns, frames and pressure Vessels.
2) Conduct experiments on different testing machines like universal testing machine, fatigue testing machine, creep testing machine
3) Calculate tensile strength, fatigue strength and creep strength of different materials

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1.To understand the basic concepts of material science and real experience getting to determine different strength properties.
2. To understand the application of Aircraft material science
3. To understand various aerospace structural components like longerons, stringers, bulk head and ribs
4. To understand different instrumentation and different industry standards

LIST OF EXPERIMENTS:

1. Deflection of beams using Beam testing set-up
2. Deflection of columns using Column testing set-up
3. Determination of stress in thin wall pressure vessel
4. Pin jointed frame analysis
5. Determination of bending stress in beam
6. Determination of Fatigue strength
7. Vibration testing
8. Creep testing

SEMESTER/YEAR : IV / II
COURSE CODE : 21AS2408
TITLE OF THE COURSE : AEROSPACE PROPULSION LAB
L: T/A: P: C : 00:00: 03:1

COURSE OBJECTIVES:

This course will enable students to:

1. Conduct experiments on using devices including bomb calorimeter, viscometers and gasturbine engines.
2. Conduct experiments to viscosity and efficiency of engines.
3. Basic understanding of performance of engines.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand propellers and their performance.
2. Determine Performance characteristics of Gas turbine engines.

LIST OF EXPERIMENTS:

1. Flash and Fire point of fuel
2. Redwood viscometer
3. Saybolt Viscometer
4. Bomb Calorimeter
5. Performance of Two stroke engine
6. Performance of Four stroke engine
7. Performance of propeller
8. Description of Gas Turbine Engine