

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

SCHOOL OF ENGINEERING



SCHEME & SYLLABUS FOR
BACHELOR OF TECHNOLOGY (B.Tech.) – 2019 AEROSPACE ENGINEERING

(ASE)

2020-2024

SCHEME - B.TECH –ONWARDS

III

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	20ME2301	COMPLEX VARIABLES & NUMERICAL METHODS	CR	04	--	--	--	04	*	***
2	101	20AS2301	INTRODUCTION TO AEROSPACE ENGINEERING	CR	03	--	--	--	03	*	***
3	101	20AS2302	THERMODYNAMICS	CR	03	--	--	--	03	*	***
4	101	20AS2303	FLUID MECHANICS	CR	03	--	--	--	03	*	***
5	101	20AS2304	MECHANICS OF SOLIDS	CR	03	--	--	--	03	*	***
6	101	20AS2305	AEROSPACE MATERIALS	CR	03	--	--	--	03	*	***
7	101	20AS2306	COMPOSITES LAB	CR	--	--	02	--	01	*	***
8	101	20AS2307	FLUID MECHANICS LAB	CR	--	--	02	--	01	*	***
9	101	20AS2308	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

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	20AS2401	AIRCRAFT PROPULSION	CR	03	--	--	--	03	*	** *
2	101	20AS2402	AERODYNAMICS – I	CR	03	--	--	--	03	*	** *
3	101	20AS2403	AEROSPACE STRUCTURAL MECHANICS	CR	03	--	--	--	03	*	** *
4	101	20AS2404	MECHANISMS AND MACHINE THEORY	CR	03	--	--	--	03	*	** *
5	101	20AS2405	MANUFACTURING PROCESSES	CR	03	--	--	--	03	*	** *
6	101	20AS2406	PRODUCT DESIGN - 1	CR	02	--	02	--	03	*	** *
7	101	20AS2407	AEROSPACE STRUCTURES LAB	CR	--	--	02	--	01	*	** *
8	101	20AS2408	MANUFACTURING PROCESSES LAB	CR	--	--	02	--	01	*	** *
9	101	20AS2409	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,

VSEM - AEROSPACE ENGINEERING

SL	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION		Pre Requisite
				L	T	P	S/P	C	CIA	END EXAM	
1	20AS3501	Aerodynamics-II	CR	03	00	--	--	03	50	50	Aerodynamics-1
2	20AS3502	Introduction to Space Technology	CR	03	--	--	--	03	50	50	Introduction to Aerospace Engineering
3	20AS3503	Aircraft Performance	CR	03	00	--	--	03	50	50	
4	20AS3504	Avionics	CR	03	--	--	--	03	50	50	
5	20AS3508/ 20AS3509	Program Elective – 1	CR	03	--	--	--	03	50	50	
6	20OEXXX	Open Elective – 1	CR	03	--	--	--	03	50	50	
7	20AS3505	Avionics Lab	CR	--	--	02	--	1	50	50	
8	20AS3506	Flight Physics Lab	CR	--	--	02	--	1	50	50	
9	20AS3507	Mini Project – III	CR	--	--	--	02	1	50	50	
TOTAL				18	03	04	02	21	450	450	
L											

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

PROGRAM ELECTIVE –

1

Sl. No	Course Code	Course Name
1.	20AS3508	Wind tunnel model testing
2.	20AS3509	Finite elemental methods
3.	20AS3510	Air transportation system

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20ME2301
TITLE OF THE COURSE : COMPLEX VARIABLES & NUMERICAL METHODS
L: T: P: S/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

DIFFERENTIAL

CALCULUS:

Functions of two or more real variables, Partial derivatives of second and higher order, Euler's theorem 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, Change of 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, Taylor's 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:

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

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2301
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:

- Understand basic principles of aviation and the history of space vehicles
- Acquire the basic knowledge of aircraft structures, aerodynamics, propulsion, 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 fundamentals of flight, basics of aircraft structures, aircraft & rocket propulsion and aircraft materials during the development of an aircraft
- Understand the complexities involved during development of aerospace vehicles

Module -1: INTRODUCTION TO AEROSPACE ENGINEERING 8L hrs.

History of aviation, Atmosphere, space and its properties, Classification of aircraft and space 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 8L 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 8L 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

7L hrs.

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

Module -5: AIRCRAFT INSTRUMENT

8L 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 the airplane, 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 : 20AS2302
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 of thermodynamics

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 of Performance, Kelvin-Planck and Clausius statement of second law of thermodynamics,

Equivalence of the two statements, reversible and irreversible processes, , Carnot theorem and 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 : 20AS2303
TITLE OF THE COURSE : FLUID
MECHANICSL: 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 a point, 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, Uniform and 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 : 20AS2304
TITLE OF THE COURSE : MECHANICS OF
SOLIDSL: T/A: P: C : 03: 00: 00: 03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Understand the basic concepts of Engineering materials
- Understand center of gravity, centroid & Moment of Inertia under different loading
- Study of particle dynamics & Kinetics of rigid bodies.

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Recognize the concept of rigid body equilibrium and equation of equilibrium.
- Plot Free body diagram for trusses and moment of inertia of plate, prism, cylinder.
- Solve the problems on trusses and friction.

Module 1: INTRODUCTION TO ENGINEERING MECHANICS 7L hrs.

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

Module 2: FRICTION AND BASIC STRUCTURAL ANALYSIS 7L hrs.

Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction

Basic Structural Analysis: Equilibrium in three dimensions; Method of Sections; Method of Joints; Methods of analysis of truss; Simple Trusses; Zero force members; Beams & types of beams.

Module 3: CENTROID, CENTRE AND GRAVITY AND MOMENT OF INERTIA: 7L hrs.

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its 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:**9L hrs.**

Rectilinear motion: Plane curvilinear motion (rectangular path, and polar coordinates).
Curvilinear motion: Projectile motion, Relative and constrained motion; Newton's 2nd law.
Work - kinetic energy, power, potential energy. Impulse-momentum (linear, angular).

Module5: KINETICS OF RIGID BODIES:**9L hrs.**

Basic terms, general principles in dynamics; Types of motion, Instantaneous center of rotation in plane motion and simple problems; D - Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.

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 : 20AS2305
TITLE OF THE COURSE : AEROSPACE
MATERIALSL: 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 aerospace engineering
- Understand different mechanical tests to study the strength of material
- Understand the material requirement for aircraft and space shuttle structures
- Study various metal based alloys, super alloys and high performance polymers for aerospace applications

COURSE OUTCOMES:

Upon successful completion of this course, the students:

- Demonstrate knowledge to select appropriate material for aerospace structures
- 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 shuttle structures

Module -1: INTRODUCTION TO AEROSPACE MATERIALS AND THEIR REQUIREMENTS **7L 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-wing aircraft structures, Helicopter structures, Space shuttle structures

Module -2: STRENGTH, DURABILITY AND TESTING OF AEROSPACE MATERIALS **8L 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**8L 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, Titanium aluminides, Shape memory titanium alloys

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

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

Module -5: STEELS & SUPER ALLOYS**8L 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 Wiley and 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 : **20AS2306**
TITLE OF THE COURSE : **COMPOSITES 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 composite material.
- Conduct testing on fabricated composites as per ASTM standards for composite materials.
- Basic understanding of Composite materials

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Understand different fabrication techniques for composite materials.
- Understand Non-destructive techniques on fabricated composites

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

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2307
TITLE OF THE COURSE : FLUID MECHANICS
LABL: 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 across various 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.

SEMESTER/YEAR : IV / II
COURSECODE : 20AS2401
TITLE OF THE COURSE : AIRCRAFT
PROPULSIONL: 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 THEORY AND 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 : 20AS2402
TITLE OF THE COURSE:
AERODYNAMICS-IL: T/A: P: C : 03:
01:00: 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, equipotential lines, 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, KuttaJoukowski 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 : 20AS2403
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:

Course Outcomes:

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

Upon successful completion of this course, the students:

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

Module -1: Engineering materials **7 Hrs**

Engineering materials, properties of materials, Stress and strain, types of stress and strain, Stress and strain relation, hook's law. Stress-strain relation, Plane stress and strain, Principle stresses, Mohr's circle of stress, Failure theories.

Module -2: Beam Analysis **8 Hrs**

Shear force and Bending moment, Stress in beam, shear stress in beam and deflection in beam, and thin walled sections. Strain energy due to stresses, Castigliano's theorems.

Module -3: Torsion, Buckling and Vibration **8 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 condition Structural Dynamics: Free and forced vibrations of undamped and damped SDOF systems.

Module -4: Flight vehicle structures **8 Hrs**

Analysis of aircraft structures, Principles of stressed skin construction: materials, Properties of material, Loads on structural components and its function, fabrication, construction.

Loads on aircraft: airworthiness, airframe loads, fatigue

Module -5: Simulation**8 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: 978-0078027673.

SEMESTER/YEAR : IV / II
COURSECODE : 20AS2404
TITLE OF THE COURSE: MECHANISMS AND MACHINE
THEORYL: 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 AND ACCELERATION 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 : 20AS2405
TITLE OF THE COURSE : MANUFACTURING PROCESSES
L: T/A: P: C : 3:0: 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.

Module 1: Metal casting and forging

10 Hours

Introduction, processes and applications of casting Light alloy casting, moulding 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 hrs

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.

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 : 20AS2406
TITLE OFTHECOURSE : PRODUCT
DESIGN- IL: T/A: P: C : 02:00: 02:00:03

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 GENERATION AND EVALUATION**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 (ONLY FOR INTERNALS)**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, McGraw Hill Basic Engineering Series and Tools, 1998.

SEMESTER/YEAR : IV / II
COURSECODE : 20AS2407
TITLE OF THE COURSE : AEROSPACE STRUCTURES LAB
L: T/A: P: C : 00: 00: 02: 1

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 : 20AS2408
TITLE OF THE COURSE : **MANUFACTURING PROCESSES LAB**
L: T/A: P: C : **00:00: 03: 1**

COURSE OBJECTIVES:

This course will enable students to:

1. To provide an insight to different machine tools, accessories and attachments
2. To train students into machining operations to enrich their practical skills
3. To inculcate team qualities and expose students to shop floor activities
4. To educate students about ethical, environmental and safety standards

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Perform turning, facing, knurling, thread cutting, eccentric turning and all other allied operations.
2. Understand surface milling/slot milling.

LIST OF EXPERIMENTS

1. Foundry practice: Preparation of a sand mould using single pattern
2. Preparation of sand mould using split piece pattern
3. Preparation of sand mould using match type pattern.
4. Preparation of three models on lathe involving Plain turning, Taper turning, Step turning.
5. Preparation of three models on lathe involving Thread cutting, Facing, Knurling.
6. Demonstration on gear cutting operation using milling machine.
7. Demonstration of various cutting operations by using of grinding machine, drilling machine & shaper machine
8. Design and development of a 3D printing part by using fused deposition modeling process (FDM)

SEMESTER/YEAR : V / III
COURSE CODE : 20AS3501
TITLE OF THE COURSE: AERODYNAMICS – II
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES

This course will enable students to:

1. To provide students with an overview of effects of Compressible flows.
2. Analyze how the aerodynamics affects the aircraft design and operation
3. To make students understand the characteristics of normal and oblique shock waves.
4. To make students learn about the effects of high-speed flows.

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Apply the essential facts, concepts and principles of compressible flows
2. Utilize the concepts of normal shock phenomenon
3. Analyze the concepts of oblique shock and expansion waves
4. Acquire the knowledge of differential equations of motion, governing Compressible flows.
5. Measure the parameters of high-speed flows.

Module -1

8Hours

One Dimensional Compressible Flow:

Mass, Momentum, Energy equations, velocity of sound, adiabatic steady state flow equations, Flow through convergent-divergent nozzle, Performance under various back pressures.

Module -2

8 Hours

Normal Shock:

Prandtl Meyer equation and Rankine – Huguenot relation, Normal shock equations: Property ratios in terms of upstream Mach number, Moving Normal Shock wave, Numerical problems

Module -3

8 Hours

Oblique shocks and Expansion waves:

Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars,

flow past wedges and concave corners, strong, weak and detached shocks, Flow past convex corners, Prandtl –Meyer expansion function, Reflection and interaction of shocks and expansion waves, Pitot static tube, corrections for subsonic and supersonic flows.

Module -4

8 Hours

Steady State Compressible Flows:

Basic potential equations for compressible flow. Linearization of potential equation-small perturbation theory. Boundary conditions, Pressure coefficient expression, small perturbation equation for compressible flow -Ackert's supersonic airfoil theory, Lift, drag pitching moment and center of pressure of supersonic profiles.

Module -5

8Hours

Measurements in High speed Flow:

Types of subsonic wind tunnels - Balances and measurements - Interference effects- transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance - Shock tubes and shock tunnels - Free flight testing - Measurements of pressure, velocity and Mach number –Flow visualization methods of subsonic and supersonic flows

Text Books:

1. John D Anderson, “Modern Compressible Flow”, Mc Graw Hill, 3rd edition, 2012, ISBN-13: 978-1259027420.
2. Radhakrishnan, E., “Gas Dynamics”, Prentice Hall of India, 5th edition, 2014, ISBN-13: 978-8120348394

Reference Books:

1. Ascher. H. Sapiro, “Dynamics and Thermodynamics of Compressible fluid flow”, John Wiley & Sons, 1st edition, 1977, ISBN-13: 978-0471066910.
2. Yahya, S.M., “Fundamentals of Compressible flow”, NEW AGE, 2009, ISBN-13: 978-8122426687.
3. H.W. Liepmann and A. Roshko, “Elements of Gas Dynamics”, Dover Publications Inc, 2003, ISBN-13: 978-0486419633.
4. Hodge B. K, Koenig K, Compressible Fluid Dynamics with Computer Application, 1st edition, Prentice Hall, New York (1995).

SEMESTER/YEAR : V / III
COURSE CODE : 20AS3502
TITLE OF THE COURSE : INTRODUCTION TO SPACE TECHNOLOGY
L: T/A: P: C : 03:00: 00:03

COURSE OBJECTIVES

This course will enable students to:

1. Understand the harsh environment of space
2. Learn the governing laws of planetary motion
3. Know various launch systems and launching stages
4. Understand the function of spacecraft subsystems

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Apply orbital mechanics formula and tools to spacecraft mission design
2. Select appropriate launch systems and understand their effect on satellite and payload design and performance.
3. Select suitable payloads and sensors for various space missions

MODULE 1

8Hours

Space Environment

Earth's Atmosphere, Neutral atmosphere, Plasma, Solar Cycle, Solar Radiation, Radiation Belts, Earth's Magnetic field, Space Debris, Electro static charging, meteoroid impact, Effect of environment on Space craft, Aerodynamic drag

MODULE 2

Orbital Mechanics

8 Hours

Orbital velocity, escape velocity, Kepler's law of planetary motion, two body motion, linear and angular momentum, Kepler's second law, Equation of trajectory

MODULE 3

Space Propulsion

9 Hours

Space Missions, Principle of rocket launching, Rocket Propulsion, Staging, Solid propellant, liquid propellant and cryogenic Propulsion, Electric Propulsion, Electro Thermal Thrusters, Sounding rockets, PSLV, GSLV, Launch window

MODULE 4

Satellite & Subsystems

9Hours

Power Systems, Attitude Determination and Control, Guidance and Navigation, Avionics, Telemetry, tracking and command, Communication, Structure and Mechanisms, Thermal System

MODULE 5

Introduction to Test facility and Testing for space components and system **8 Hours**

Types of Tests; Test Facilities and Safeguards; Safety and Environmental Concerns; Monitoring and Control of Toxic Materials and Exhaust Gases; Instrumentation and Data Management; Reliability and Quality Control; Flight Testing. Assembly integration test, comprehensive test & test vacuum chamber and comprehensive test & test vibration facilities.

Text Books:

1. Wertz, J.R. and W.J. Larson, eds. Space Mission Analysis and Design (SMAD). 3rd ed. Microcosm Press, 1999. ISBN: 1881883108.
2. Pisacane, V.L. and R.C. Moore. Fundamentals of Space Systems. Oxford, 1994. ISBN: 0195074971.
3. Fortesque, P.W. and J.P.W. Stark. Space Systems Engineering. John Wiley and Sons, 1995.

Reference Books:

1. Griffin, M.D. and J.R. French. Space Vehicle Design. AIAA, 1991. ISBN: 0930403908.
2. Morgan, W.L. and G.D. Gordon. Communications Satellite Handbook. 1989. ISBN: 0471316032.

Other Sources:

1. <https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-851-satellite-engineering-fall-2003/lecture-notes/>

SEMESTER/YEAR : V / III
COURSE CODE : 20AS3503
TITLE OF THE COURSE: AIRCRAFT PERFORMANCE
L: T/A: P: C : 03: 00: 00: 00:03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the aircraft performance in steady unaccelerated and accelerated flight.
2. Understand the airplane performance parameters.
3. Acquire the knowledge on aircraft maneuver performance

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand Equations of motion for unaccelerated steady flight.
2. Develop the equation for the steady performance of level, climb and glide flight
3. Calculate the Range and Endurance of propeller driven and jet driven airplanes
4. Enumerate aircraft performance like takeoff, and landing of accelerated Flight
5. Understand the V-n diagram and calculate the Maneuver performance of the accelerated Flight
6. Understand the different phases of weight estimations required for designing of aircrafts

Module: 1

7 Hours

The Equations of Motion Steady Un accelerated Flight

Introduction, four forces of flight, General equation of motion, Power available and power-required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Module: 2

9 Hours

Steady Performance – Level Flight, Climb & Glide

Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach , climb performance graph (hodograph diagram), Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide.

Fundamental Airplane Performance Parameters

The fundamental Parameters: Thrust – to – weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity. Aerodynamic relations associated with lift-to-drag ratio.

Module: 3

9 Hours

Range and Endurance:

Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.

Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind.

Module: 4

9 Hours

Aircraft Performance in Accelerated Flight

Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length

Landing Performance and Accelerated Climb: Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.

Module: 5

8 Hours

Maneuver Performance

Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram.

Text Books:

1. John D. Anderson, Jr. "Aircraft Performance and Design", McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999.
2. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 2000.

Reference Books:

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.

SEMESTER /YEAR : V /III
COURSE CODE :20AS3504
TITLE OF THE COURSE : Avionics
L: T: P: S/P: C : 03:00: 00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. To understand analyze Avionics System Requirements
2. To understand evolution of Flight Deck Design
3. To understand Federated and Integrated Avionics System Architectures involving MAU, LRMs and various digital Data bus networks.
4. To understand system assessment methods

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. To apply System requirement analysis methods for decomposition of functions among systems and sub systems
2. To build message structures using data bus concepts and to evolve conceptual avionics system architectures
3. To evolve avionics test bench architecture
4. To appreciate importance of HFE in Flight Deck Design and automation

Module 1

8 Hours

Power Distribution System: Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilization-typical application to avionics. Need for Avionics in civil and military aircraft.

Module 2

8 Hours

Inertial Navigation System: Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing. Electronic Flight Control System: Fly-by-wire system:-basic concept and features. Pitch and Roll

rate:-command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis.

Module 3

8 Hours

Electronic Flight Instrument Systems: Display -units, presentation, failure, and annunciation. Display of air data. Introduction to Avionics Sub Systems and Electronic Circuits: Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

Module 4

8 Hours

Principles of Digital Systems: Digital Computers, Microprocessors, Memories. Flight Deck and Cockpits: 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, and HOTAS

Module 5

8 Hours

Avionics Systems Integration: Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control systems, Radar, Electronic Warfare, and fire control system. Avionics system architecture, Data buses, MIL-STD1553B.

Text Books:

1. Introduction to Avionics Systems R.P.G. Collinson Springer 3rd edition, 2011
2. Aircraft Systems: Mechanics, Electrical and Avionics Subsystems Integration Ian Moir, AllanSeabridge Wiley 3rd Edition, 2012

Reference Books:

1. Middleton, D.H., Ed., “Avionics Systems, Longman Scientific and Technical”, Longman GroupUK Ltd., England, 1989, ISBN-13: 978-0582018815.
2. Spitzer, C.R., “Digital Avionic Systems”, McGraw-Hill Inc., US, 2nd edition, 1992, ISBN-13:978-0070603332.
3. Mike Tooley and David Wyatt, Aircraft Communications and Navigation Systems, ButterworthHeinemann, 2007.

SEMESTER/YEAR : V / III
COURSE CODE : 20AS3505
TITLE OF THE COURSE : AVIONICS LAB
L: T/A: P: C : 0: 0: 3: 1

COURSE OBJECTIVES:

This course will enable students to:

1. Conduct experiments on logic gates
2. Conduct experiments on IOT kits

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand function of a satellite link
 2. Hands in experience on Raspberry pi and IoT kits
-
1. Studying and verifying the truth table of logic gates
 2. Establishing a direct communication link between Uplink Transmitter and Downlink Receiver using Tone Signal and Voice Signal
 3. Transmitting and receiving PC data, Function Generator Waveforms through Satellite link
 4. Sending tele-command and receiving Intensity of light and Temperature from satellite
 5. Familiarization of Raspberry pi and setting up ETS IoT Trainer Kit
 6. Interfacing LED/Buzzer with Raspberry pi to blink and control RGB LED with a specified time delay and verify the output on the ETS IoT Kit
 7. Associating OLED display and print a message and verify the output on the ETS IoT Kit
 8. Monitoring Temperature & Humidity, Acceleration using sensors using ETS IoT Trainer Kit
 9. Familiarization of digital storage oscilloscope for observing and measuring electronic signals
 10. Analysing wave shapes, measurement of frequency and voltage values at different ac. inputs.

SEMESTER/YEAR :V /III
COURSE CODE : 20AS3506
TITLE OF THE COURSE: FLIGHT PHYSICS LAB
L: T/A: P: C : 0: 0: 3: 1

COURSE OBJECTIVES:

This course will enable students to:

3. Conduct experiments on aerofoil, water flow channel.
4. Conduct experiments on pitot and static tubes.
5. Basic understanding of flow visualization.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand tubes and their flow performance.
2. Determine Performance and force measurement, pressure distribution in ae foil and bluntbody.

LIST OF EXPERIMENTS

1. Measurement of pressure distribution over an aero foil
2. Measurement of pressure distribution over a blunt body
3. Flow visualization in water flow channel
4. Force measurement
5. Flow over flat plate
6. Understanding pitot and static tubes

ELECTIVE SUBJECTS

1. Wind Tunnel Model Testing
2. Finite Elemental Methods
3. Air Transportation Systems

SEMESTER/YEAR : V / III

COURSE CODE : 20AS3508

TITLE OF THE COURSE : WIND TUNNEL MODEL TESTING

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

COURSE OBJECTIVES:

This course will enable students to:

1. To understand the need for experimental aerodynamics, types of wind tunnels and their application areas
2. To understand the design of wind tunnels, test section & drive system
3. To understand various types of test techniques & types of measurements and uncertainties
4. Acquire knowledge on design on models for wind tunnel testing
5. To carry out simple experiments in the DSU wind tunnel

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Design models for wind tunnel testing both for low speed and high speed wind tunnels
2. Having hands-on training on carrying out wind tunnel tests and analyze results
3. Ability to select proper measuring instruments based on need
4. Ability to analyze and present tested results

Module -1

9 Hours

Introduction to Wind Tunnels

Aerodynamics, Properties of Air and Water, Similarity Parameters, Incompressible Flow, Types of Wind Tunnels and their applications

Module -2

9 Hours

Components of Wind Tunnel Systems

Overall Objectives, Power Considerations, Energy Ratio of typical Wind Tunnels, Cooling, Test Section Flow Quality, Drive Systems, Wind Tunnel Construction, Test Section Inserts, Safety

Module -3**9 Hours****Measurement Techniques & Calibration of Test Section**

Flow Visualization Techniques, Pressure, Force and Moment measurements, Boundary Layer measurements, External and Internal Balances, Balance requirements and Specifications, Installation in models, Calibration and use of transonic & supersonic wind tunnels, Design of models (Force models, pressure models and spin models) and instrumentation systems

Module -4**9 Hours****Special Test Techniques & Data Reduction**

Data Reduction from Wind Tunnel Tests, Scale Effects, Corrections to Wind Tunnel Data, Measurement Uncertainties

Module -5**4 Hours****Experiments in DSU Wind Tunnel**

Design and manufacturing of simple models for testing in DSU low speed wind tunnel, analyses of experimental findings and documentation

Text Books:

1. Jewel B. BARLOW, William H. RAE Jr., Alan POPE, "Low-Speed Wind Tunnel Testing", John Wiley & Sons, New York, Toronto, 1999, 3rd Edition, ISBN 978-0-471-55774-9
2. Alan Pope and Kenneth L Goin, "High-Speed Wind Tunnel Testing", John Wiley and Sons, New York, 1965

Reference Books:

1. Liepmann, H W and Roshko A, Elements of Gas Dynamics", Dover Publications, 2013. ISBN 9780486316857
2. John D Anderson Jr., "Fundamentals of Aerodynamics", 5th Edition, McGraw Hill Education (India) Pvt. Ltd., 2010

SEMESTER/YEAR : V / III

COURSE CODE : 20AS3509

TITLE OF THE COURSE: FINITE ELEMENTAL METHODS

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

COURSE OBJECTIVES

This course will enable students to:

1. To enable the students to appreciate the use of finite element methods to analyze structural and dynamic problems.
2. To enable the students to understand and perform finite element analysis of 1D and 2D structures.
3. To teach the procedure to perform finite element based steady-state and transient response analysis.

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Calculate element energy functions for 1-D and 2D finite elements.
2. Understand and apply Raleigh Ritz method and develop mathematical expressions for bars and beams.
3. Understand and appreciate the finite element method in solving simple problems of engineering significance.
4. Understand and appreciate the finite element method in solving steady state heat transfer problems.

Module 1

8 Hours

Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, and stress- strain relations for plane stress and plane strains. General description of finite element method, application and limitations, types of elements based on geometry. Node numbering, half band width.

Module 2

8 Hours

Basic Methods in FEM Euler - Lagrange equation for bar, beam (cantilever / simply supported fixed). Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach or stiffness matrix formulation of bar element and Galerkin's method.

Module 3**8 Hours**

Interpolation Models: Interpolation polynomials- linear, quadratic and cubic. Simplex complex and multiplex elements, 2D PASCAL's triangle, CST elements-shape functions and nodal load vector, strain displacement matrix and Jacobian for triangular and rectangular element. Higher Order Elements: Langrange's interpolation, one dimensional elements-quadratic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Isoparametric, sub parametric and super parametric elements.

Module 4**9 Hours**

1-D Bars & Trusses: Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by sing penalty approach and elimination approach. Guass-elimination technique. Trusses: Stiffness matrix of truss element. Numerical problems

Module 5**8 Hours**

Beams & Heat Transfer Beams: Hermite shape functions for beam element, derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads. Heat transfer: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction, Galerkin's approach for heat conduction, 1D heat transfer in thin fins.

Softwares used in FEM Analysis: Simulia and Ansys Structures

Text Books:

1. T.R. Chandrupatla and A.D Belegunde , Finite Elements in Engineering, 3rd Ed PHI.
2. S.S. Rao, Finite Element Method in Engineering, 4th Edition, Elsevier, 2006.

Reference Books:

1. R.D. Cook D.S Maltus, M.E Plesha and R.J.Witt, Concepts and applications of Finite Element Analysis, Wiley 4th Ed, 2009
2. J.N.Reddy, Finite Element Method, McGraw -Hill International Edition, 2009.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 20AS3510
TITLE OF THE COURSE : AIR TRANSPORTATION SYSTEM L: T:
P: C : 03: 00: 00:03

COURSE OBJECTIVES

This course will enable students to:

- Understand the air transport systems.
- Acquire the knowledge of aircraft characteristics, airlines and airport.
- Details the concepts of airspace infrastructure and its requirements for operation and services
- Understand the different concepts of navigation, Communication and environmental systems.
- Understand the Managerial concepts and its aspects behind the air transportation system

COURSE OUTCOMES:

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

- Understand the complete insight of Air transportation system.
- Explore the knowledge about basic aircraft characteristics, cabin design and manufacturers.
- Illustrate the detailed structure Airlines, Airports and its Infrastructure
- Understand the different air navigation and environmental systems used for improving the ATS
- List the Managerial aspects of Airlines

Module 1: AIR TRANSPORT SYSTEMS –INTRODUCTION 7 hrs.

Environment, transport and mobility. Systematic description and current challenges. Development of aircraft design driver-speed and range. Development of Airport, Airlines, ICAO, Regulatory Framework and Market Aspects.

Module 2: AIRCRAFT CHARACTERISTICS AND MANUFACTURERS 8 hrs.

Classification of flight vehicles, cabin design, basics of flight physics- structures, mass and balance. Flight performance and mission. Aircraft manufacturers, development process, production process, supply chain.

Module 3: AIRLINES, AIRPORT AND INFRASTRUCTUREL 8 hrs.

Airline types, Network management. Flight strategy and aircraft selection, flight operations, MRO. Role of Airport, Regulatory Issues, Airport operation and services. Airport planning - Infrastructure.

Module 4: AIR NAVIGATION SYSTEM & ENVIRONMENTAL SYSTEM L 8 hrs.

Principle of operation- Role of Air Navigation services. Air space structures, Airspace and Airport capacity, Aircraft separation. Flight guidance system. Communication system. Integrated air traffic management and working system. Environmental aspects-emission, noise, and sound.

Module 5: MANAGERIAL ASPECTS OF AIRLINEL 8 hrs.

Airline passenger marketing, forecasting methods, pricing and demand. Air cargo-market for air freight. Principles of airline scheduling. Fleet planning.

Text Books:

- 1) Dieter Shmitt, and Valker Gollnick, Air Transport System, Springer, 2016.
- 2) John G Wensveen, Air Transportation-A Management Prospective, Ashgate Publishing Ltd,
- 3) 2011.

Reference Books:

- 1) Mike Hirst, The Air Transportation System, Wood head publishing Ltd, England, 2008

OPEN ELECTIVE – I (V Sem)

SEMESTER/YEAR : V SEM / III YEAR

COURSE CODE : 20OE0023

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:

- Understand basic principles of aviation and the history of space vehicles
- Acquire the basic knowledge of aircraft structures, aerodynamics, propulsion, 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 fundamentals of flight, basics of aircraft structures, aircraft & rocket propulsion and aircraft materials during the development of an aircraft
- 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 and space 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

7hrs.

Introduction, General types of construction, Truss, Monocoque, Semi-Monocoque and Geodesic 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 the airplane, 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 AvionicsSubsystems 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.

SEMESTER/YEAR : VI / III
COURSE CODE : 20 A S 3 6 0 1
TITLE OF THE COURSE : CONTROL THEORY
L: T: P: S/P: C : 03:00: 00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the concepts of open loop, closed loop systems and types of controllers.
2. Construct signal flow diagram from the Blocks and signal flow graphs.
3. Know about the Bode plot, Nyquist plot, polar plot and Root locus method.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Apply the concepts of open loop, closed loop systems and types of controllers.
2. Develop signal flow diagram from the Blocks and signal flow graphs.
3. Interpret the Bode plot, Nyquist plot, polar plot and Root locus method

Module -1

8 Hours

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.

Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, Analogous systems: Force voltage, Force current

Module -2

8 Hours

Block Diagrams and Signal Flow Graphs: Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula

Module -3**8 Hours**

Transient and Steady State Response Analysis: Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's- Hurwitz Criterion

Module -4**8 Hours**

Root Locus Plots: Definition of root loci, General rules for constructing root loci, Analysis using root locus plots. Frequency Response Analysis: Polar plots, Nyquist stability criterion, Stability analysis, Gain margin and phase margin.

Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams.

Module -5**8 Hours**

System Compensation and State Variable Characteristics of Linear Systems: Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and Observability, Kalman and Gilberts test

Text Books:

1. Katsuhiko Ogatta, Modern Control Engineering, Pearson Education, 5th edition, 2015, ISBN13: 978-9332550162.
2. M.Gopal, Control Systems Principles and Design, TMH, 4th edition, 2012, ISBN-13: 978-0071333269.

Reference Books:

1. Richard.C.Dorf and Robert.H.Bishop, Modern Control Systems, Pearson Education India, 12th edition, 2013, ISBN-13: 978-9332518629
2. Eronini-Umez, System dynamics & control, Thomson Asia pvt Ltd. Singapore, 2002.
3. Schaum's series, Feedback Control System, 2001.

SEMESTER/YEAR : **VII / I V**
COURSE CODE : **20AS3602**
TITLE OF THE COURSE : **Aircraft Design**
L: T: P: S/P : C : **03 :00 : 00 :00 : 03**

COURSE OBJECTIVES

This course will enable students to

1. This course deals with Conceptual designs of aerospace vehicles, components, missions, or systems that incorporate realistic constraints/applicable engineering standards.
2. Students who successfully complete the course will demonstrate the outcomes by accomplishing the conceptual design of an aircraft

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Develop the ability to synthesize basic engineering science to accomplish a mission-driven design of an aircraft, including:
2. Perform conceptual airplane and propulsion sizing estimates to meet specified operational and performance requirements
3. Develop proficiency in and an appreciation for performing trade studies to optimize aircraft conceptual design.

Module 1

8 Hours

Overview of Design Process:

Introduction, Typical requirements for a civil transport and a military fighter aircraft, Phases of design, Aircraft conceptual design process, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take-off weight calculation, Trade studies.

Airfoil Selection: Airfoil geometry, Airfoil lift and drag, Airfoil families, Airfoil design, Airfoil lift coefficient, Airfoil thickness, Camber, Stall, Reynolds number effects

Module 2

9 Hours

Geometry: Wing geometry, Aspect ratio, Sweep, Taper ratio, Twist, Incidence, Dihedral, Wing vertical location of wings, Wing tips, Biplane wings, Tail geometry and arrangement

Thrust to Weight Ratio & Wing Loading Thrust to weight definitions, Power loading,

Statistical estimate of T/W. Thrust matching, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance.

Module 3

8 Hours

Initial Sizing: Rubber engine sizing, Fixed engine sizing, Geometry sizing – Fuselage, Wing, Tailvolume coefficient and Control surface sizing,

Configuration Layout & loft: Conic lofting, Conic fuselage development, Conic shape parameter, Wing-tail layout & Loft. Aerofoil linear interpolation. Aerofoil flat-wrap interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in configuration layout: Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements

Module 4

8 Hours

Aerodynamics & Propulsion: A brief overview of aerodynamic coefficients and forces, Types of propulsion systems, Jet engine thrust considerations, Thrust-drag book keeping, Installed thrust methodology, Piston engine performance – propeller performance and piston-prop thrust correction, Turboprop performance

MODULE 5

7 Hours

Sizing calculation using spread sheet, Design using CAD software. Software available for aircraft design (OpenVSP)

Text Books:

1. Daniel P. Raymer, Aircraft Design - A Conceptual Approach- AIAA Education Series, IVEdition © 2006.
2. Thomas C Corke, Design of Aircraft- Pearson Edition. Inc. © 2003.

Reference Books:

1. J Roskam, Aeroplane Design –Vol: 1 to 9
2. John Fielding, Introduction to Aircraft Design - Cambridge University Press, 2009
3. Standard Handbook for Aeronautical & Astronautical Engineers, Editor Mark Davies , TataMcGraw Hill, 2010

SEMESTER/YEAR : VI / III
COURSE CODE : 20 A S 3 6 0 3
TITLE OF THE COURSE : AIRCRAFT STABILITY & CONTROL
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the basics of aircraft stability and control.
2. Understand the static longitudinal and static directional stability.
3. Acquire the knowledge on dynamic lateral and directional stability.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand the contribution of various airframe components on longitudinal static stability in stick fixed condition and responses required from control surfaces to overcome sudden aerodynamic unbalancing.
2. Evaluate stick force required at stick free condition and understand the basic concepts of static directional stability.
3. Predict aileron control forces and flying modes such as Dutch roll, spiral roll, phugoid, longperiod oscillation with the help of Routh's criterion, for a given stability equation.
4. Estimate the dynamic derivatives for forward speed, pitching velocity, time rate of change of angle of attack, rolling rate and yawing rate.
5. Develop various inter-coupling effects with the motion of aircraft and Examine the response of an aircraft

Module -1: Static Longitudinal Stability and Control-Stick Fixed

8Hours.

Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects Introduction, Trim condition. Static margin, Stick fixed neutral points. Longitudinal control,

Module -2: Elevator Control and Stick free**8Hours**

Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range. Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, the trim tabs, Stick-free Neutral point, Restriction on aft C.G.

Module -3: Static directional stability and control**8 Hours**

Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin, one engine inoperative condition, Weather cocking effect.

Module -4: Static Lateral stability and control**8 Hours**

Introduction, definition of roll stability, estimation of dihedral effect. Effect of wing sweep, flaps, and power, Lateral control, Estimation of lateral control power, Aileron control forces, balancing the aileron. Coupling between rolling and yawing moments. Adverse yaw effects, Aileron reversal.

Module -5: Dynamic Lateral and Directional Stability**8Hours.**

Types of modes of motion: long or phugoid motion, short period motion, Airplane Equations of longitudinal motion. Factors affecting period and damping of oscillations. Effect of wind shear, sideslip excursion. Dutch roll and Spiral instability. Auto-rotation and spin.

Text Books:

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.

Reference Books:

1. Bandu N. Pamadi, "Performance, Stability, Dynamics and Control of Airplanes", AIAA 2nd Edition Series, 2004.
2. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill, International Editions, Aerospace Science Technology Editions, 2000.

SEMESTER/YEAR : VI / III
COURSE CODE : 20 AS 3604
TITLE OF THE COURSE : ORBITAL MECHANICS
L: T: P: S/P: C : 03:00: 00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the basic concepts of space mechanics and the general N- body.
2. Study satellite injection and satellite orbit perturbations.
3. Acquire the knowledge of interplanetary and ballistic missile trajectories

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Apply the basic concepts of space mechanics and the general N- body.
2. Explain satellite injection and satellite orbit perturbations.
3. Distinguish between interplanetary and ballistic missile trajectories

Module -1

8 Hours

Basic knowledge of Space: Overview of major contents of universe, Black body radiation, specific intensity, flux density, luminosity, Basics of radiative transfer (Emission/absorption coefficients, source functions) formation of the solar system, stars, and planets physical processes in the solar system; dynamics of the solar system; physics of planetary atmospheres; individual planets; comets, asteroids, and other constituents of the solar system; extra-solar planets.

Module-2

8 Hours

Fundamentals of Orbit Mechanics, Orbit Maneuvers: Coordinate Systems, Classical Orbital Elements, Determining the Orbital Elements, the Gauss Problem - General Methods of Solution. Ground trace In-Plane Orbit changes, Hohmann Transfer, Bielliptical Transfer, Plane Changes, Combined Maneuvers and Propulsion for Maneuvers.

Module -3

8 Hours

Interplanetary Trajectories: Two-dimensional interplanetary trajectories, fast interplanetary trajectories, three dimensional interplanetary trajectories, launch of interplanetary spacecraft,

trajectory estimation about the target planet, concept of sphere of influence, Lambert's theorem.

Module-4

8 Hours

Satellite Injection and Satellite Perturbations: General aspects of satellite injection, satellite orbit transfer, various cases, orbit deviations due to injection errors, special and general perturbations, Cowell's method and Encke's method, method of variations of orbital elements, general perturbations approach.

Ballistic Missile Trajectories: Introduction to ballistic missile trajectories, boost phase, the ballistic phase, trajectory geometry, optimal flights, time of flight, re-entry phase, the position of impact point, influence coefficients.

Module- 5

8 Hours

Launch Vehicle Dynamics: Tsiolkovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Reusable launch vehicles, future launchers, launch assist technologies. Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques.

Text Books:

1. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, W.H. Freeman & co, 1984.
2. Thomson, Introduction to Space Dynamics, Dover Publications, Revised edition, 2012

Reference Books:

1. Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979
2. William E. Wiesel, Space Flight Dynamics, Create Space Independent Publishing Platform, 3rd Edition, 2010, ISBN-13: 978-1452879598
3. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, Wiley India Pvt Ltd,

SEMESTER/YEAR : VI / III
COURSE CODE 20 A S 3 6 X X
TITLE OF THE COURSE : INTRODUCTION TO COMPUTATION FLUID DYNAMICS
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES

This course will enable students to:

1. Introduce Governing Equations of viscous fluid flows
2. Introduce numerical modeling and its role in the field of fluid flow and heat transfer
3. Enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
4. Create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. After completion of the course student would be able to
2. Create numerical modelling and its role in the field of fluid flow and heat transfer.
3. Use the various discretization methods, solution procedures and turbulence modelling to solve flow and heat transfer problems.

Module 1:

Governing equations and boundary conditions

8Hours

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations– Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

Module 2:

Finite difference and finite volume methods for diffusion

9Hours

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three – dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes –Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

Module 3:

Finite volume method for convection diffusion

10Hours

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness,Hybrid, Power-law, QUICK Schemes.

Module 4:

Flow field analysis

9 Hours

Finite volume methods -Representation of the pressure gradient term and continuity equation– Staggered grid – Momentum equations – Pressure and Velocity corrections – PressureCorrection equation, SIMPLE algorithm and its variants – PISO Algorithms.

Module 5:

Hands on Simulia/Ansys

Text books

1. Versteeg, H.K., and Malalasekera, W., “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Second Edition Pearson Education Ltd. 2007.
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.

Reference Books

1. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow, Hemisphere" Publishing Corporation, 2004.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.

3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005

SEMESTER/YEAR : VI / III
COURSE CODE : 20A S 3 6 X X
TITLE OF THE COURSE : FATIGUE & FRACTURE MECHANICS
L: T: P: S/P: C : 03:00: 00: 03

COURSE OBJECTIVES :

- Understand the basic concepts of failure mechanisms of fatigue and fracture and the various dependencies and linkages
- Know the application of suitable theories to use in different situations - fail-safe, safe-life and damage tolerant design situations
- Evaluate the key loads, parameters and estimate the fatigue life and crack propagation
- Learn the use of practical handbooks, data sheets and standards for meeting airworthiness requirements around fatigue and damage tolerance

COURSE OUTCOMES :

- **Understand** the concept of cyclic loading - low cycle and high cycle and the impact on the life
- **Know** the factors that influence the fatigue life - the design factors, the environment, loads and correlation to test data
- **Understand** the concept of damage due to cracks, the stress intensity factor, fracture toughness and apply it to solve various problems
- **Solve** problems involving fatigue life and damage tolerant life
- **Apply** the available experimental and empirical data, formulae, handbooks to evaluate fatigue life

MODULE 1

8Hrs

Introduction to fatigue.

Historical evolution of fatigue considerations. Review of static and dynamic loading, concepts of cyclic loading. S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Notched S.N. curves.

MODULE 2

8Hrs

Statistical aspects of fatigue lifing.

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques - Cumulative damage - Miner's theory - Use of handbooks and empirical relations

MODULE 3

9Hrs

Physical aspects of fatigue

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces. Prevention and control methods. Linkages to other failure mechanisms like corrosion.

MODULE 4

10Hrs

Fracture Mechanics

Introduction to fracture Mechanics, Types and Characteristics of Brittle & Ductile Fractures, Brittle-Ductile transition, LEFM - Linear Elastic fracture mechanics Energy approach, Fracture Toughness, Griffith's criterion-Potential energy and surface energy, Stress Intensity approach (SIF), Stability Time dependent crack growth & damage tolerance, Paris Law. Introduction to Elastic-Plastic fracture mechanics, J-Integral,

MODULE 5

8Hrs

Fatigue design, testing and airworthiness

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures, aging aircraft and continued airworthiness, linkages to structural health monitoring, inspection and testing

TEXT BOOKS :

- 1 Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, Henry o. Fuchs “Metal Fatigue in engineering” John wiley Newyork, Second edition. 2001.

- 2 Matej Billy, “Cyclic Deformation and Fatigue of Metals”, Elsevier Science Ltd., 1993. (Units 1 to 3)

- 3 Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009. (Unit 4)

REFERENCES:

- 1 K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001
- 2 D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.
- 3 T.L. Anderson, Fracture Mechanics - Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005

SEMESTER/YEAR : VI / III
COURSE CODE : 20AS3605
TITLE OF THE COURSE : SIMULATION LAB
L: T/A: P: C : 03:00: 00:00: 1

COURSE OBJECTIVE:

This course will enable students to:

1. To know fundamental skills and knowledge required to use MATLAB for the simulation of Engineering systems
2. To introduce concepts of numerical methods and introduce Matlab in an Engineering Framework.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Students can be able to understand the use of software tools for modelling and analysis of Mathematical concepts for engineering applications
2. Students will be able to model and analyze simple engineering concepts and, its importance in engineering applications

LIST OF EXPERIMENTS:

1. Introduction to MATLAB:

Familiarization with MATLAB and MATLAB control system toolbox. Representation of scalars, vectors and matrices in MATLAB. Basic 2D and 3D plot using MATLAB. Locating the roots of equations using various methods..

2. Frequency response for a spring-mass system; simulation of the oscillations
3. Stability analysis using Root locus, Bode plot, Nyquist plot and Polar plot techniques.
4. Simulate a bomb drop from an aircraft on a moving tank in pure pursuit motion.
5. Develop a straight and level flight simulation program using MATLAB
6. Simulate aircraft Take-off and Landing with trajectory tracing
7. Simulation of Hoffmann transfer
8. Simulation of velocity calculations for orbit maneuvering
9. Simulation of time period calculations for orbital motion

SEMESTER/YEAR : VI / III
COURSE CODE : 20AS3606
TITLE OF THE COURSE : MODEL BASED SYSTEM
ENGINEERING L: T/A: P: C : 01 :00 : 03 :00: 2

COURSE OBJECTIVES:

This course will enable students to:

1. Student uses the knowledge and information gained in the course to expand and improve the application of model-based systems engineering in their field.
2. Student implements model-based systems engineering practices in their field that result in higher levels of value and satisfaction with engineered systems.
3. Student pursues further in-depth education and training in systems engineering

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Demonstrate analysis of systems using model-based systems engineering approaches that lead to better and increased performance of systems.
2. Describe the processes, methods, and practices of model-based systems engineering.

Model based system Engineering sessions:

3Hour

What is Landing Gear & its function, Types of Landing Gear, Different parts of a Modern Landing Gear, Different parts of a Modern Landing Gear Shock Strut.

Assessment 1

4 Hours

Steering System, Brakes, Uplock & Downlock, Retraction & Extension, Emergency lowering of Landing Gear

Assessment 2

4 Hours

Introduction to MBSE Process LG Design Process Requirement Management Theory, Requirement Management Lab, Functional Architecture, Mapping Requirements and Functional Components, practice sessions.

Assessment 3

18 Hours

Introduction to Mathematical modeling & Design of a DC motor, LG Detail Design Process Practice session, Logical Architecture Definition, Physical CAD Integration, Mapping Functional and Logical Components, Test Case Validation and Impact Analysis

Assessment 4

8 Hours

Final Practice session, End Examination (theory & lab).

