DEPARTMENT OF AEROSPACE ENGINEERING

LIST OF COURSES OFFERED FOR MINOR PROGRAM (R20)

Course code	Course Title	Contact hours/week				Credits
		L	T	P	**Total**	
20AEM1	Introduction to Flight	4	0	0	4	4
20AEM2	Introduction to Aerodynamics	3	1	0	4	4
20AEM3	Introduction to Aerospace Structures	3	1	0	4	4
20AEM4	Introduction to Aerospace Propulsion	3	1	0	4	4

B.Tech. (IV Sem.) **Introduction to Flight**

L	T	P	Cr.
4	0	0	4

Course Educational Objectives: To learn the components of airplane and different types of flight vehicles, the basic aspects of aerodynamics and airfoils, the elements of propulsive systems, function of structural components in wing and fundamental aspects of flight vehicle in space.

Course Outcomes: At the end of the semester, the student will be able to

CO1: Describe functions of various external and internal components of an airplane [L2]
CO2: Describe the working principles of various aircraft engines systems **[L2]**
CO3: To analyze the performance of flight during manoeuvring **[L4]**
CO4: To apply the conditions of static stability in the aircraft design [L3]

UNIT - I
Basic Aspects: History-Early Planes, Components of Airplane and Their Functions, Types of Flight Vehicles, Classifications, Airfoils - Airfoil Nomenclature, Classifications of NACA Airfoils, Wing Geometry, Aerodynamic Forces, Lift, Drag and Moment Coefficients, Co-Efficient of Pressure, Centre of Pressure, Aerodynamics Centre, Pressure Distribution Over Aerofoil, Types of Drag.

UNIT - II
Propulsion and Flight Vehicle Structures
Air-breathing Engines - Engine Theory, Classification of Air-breathing Engine Propulsion system – Propeller, Jet propulsion – The thrust equation, Turbojet engine, Turbofan engine and Ramjet engine.

Flight Vehicles Structures and Materials - Physics of Solid materials – Stress and Strain. Elements of Aircraft structure. Materials

UNIT - III
Airplane Performance
Equations of Motion, Static Performance – Thrust required for level and unaccelerated flight, Thrust available and Maximum Velocity, Power required for level and unaccelerated flight, Power available and Maximum Velocity

UNIT - IV
Rate of Climb, Gliding Flight, Absolute and Service Ceilings, Time to Climb, Range and Endurance – Jet Airplane. Dynamic Performance – Take-off and Landing Performance, Turning flight and V- n diagram.

UNIT – V
Principles of Stability and Control
Definition of Airplane's axes, Concept of Stability and Control, Moments on the Airplane, Criteria for Static Longitudinal Stability – Quantitative Discussions. Static Longitudinal Control - Calculation of Elevator angle to trim, Directional Static Stability, Lateral Static Stability

TEXT BOOKS:

1. John D Anderson Jr., “Introduction to Flight”., McGraw-Hill Science/Engineering/Math; 7 editions, 2015

2. Robert C Nelson., “Flight Stability and Automatic Control”., TBS; Second 2nd Edition (2007)

REFERENCES:

1. Jan Roskam., “Airplane Flight Dynamics and Automatic Flight Controls”., Dar corporation (January 2003)

2. C. Kermode., “Mechanics of Flight”., Pearson Education Limited; III edition (December 4, 2012).

B.Tech. (V Sem.)

Introduction to Aerodynamics

L	T	P	Cr.
3	1	0	4

Course Educational Objective: To learn the theoretical methods solve for airfoil and the finite wing characteristics. To learn the basic concepts of compressible fluid flows, steady one-dimensional flow properties discharging from a reservoir, the supersonic flow properties.

Course Outcomes: At the end of the semester, the student will be able to
CO1: Apply potential flow theory to solve for airfoil characteristics. [L3]
CO2: Apply the Prandtl's lifting line theory to predict finite wing properties. [L3]
CO3: Apply the of compressible fluid flow equations to solve flow problems [L3]
CO4: Analyze the supersonic flow behaviour [L4]

UNIT – I
Basics of Aspects of Aerodynamic:

Thin Aerofoil Theory: Introduction, Aerofoil Characteristics, Vortex Sheet, Kutta Condition, Kelvin's Circulation Theorem, Starting Vortex, Thin Aerofoil Theory-Symmetrical Aerofoil and Cambered Aerofoil.

UNIT - II
Finite Wing Theory: Introduction, Down Wash, Induced Drag, Trailing Vortex, Vortex Filament, Biot-Savart Law and Helmholtz Theorems, Prandtl's Classical Lifting Line Theory-Elliptic Lift Distribution

UNIT - III

Basics of Compressible Flow: Introduction, Compressibility, Basic Equations of Compressible Flow- Energy Equation, Isentropic Flow Relations, Stagnation Properties, Speed of Sound, Mach Number, Mach Cone, Wave Propagation

UNIT - IV
Steady One-Dimensional Flow: Introduction, Fundamental Equations, Discharge from A Reservoir, Critical Values, Stream Tube Area-Velocity Relation, Types of Nozzles, Applications of Nozzles, Area-Mach Number Relation, Isentropic Flow Through Nozzles,

UNIT – V
Shock and Expansion Waves: Introduction, Types of Waves, Normal Shock-Equations of Motion, The Normal Shock Relations for Perfect Gas, Oblique Shocks- Relation Between β-θ-M, Detached Shocks, Expansion Waves, Prandtl-Meyer Flow, Flow with Shocks and Expansion Waves at the Exit of a Convergent- Divergent Nozzle, Mach Angle, Mach Wave.

TEXT BOOK

1. Anderson, J.D., “Fundamentals of Aerodynamics”, McGraw-Hill Book Co., New York, 1998
2. Rathakrishnan. E, Gas Dynamics, Seventh Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2021

REFERENCES

1. Ascher H. Shapiro, The dynamics and thermodynamics of compressible fluid flow Vol 1, The Ronald press Co. New York, 1953
2. Lipmann. H. W, Roshko. A, Elements of Gas Dynamics, John Wiley & Sons, New York
3. Thomson P.A., Compressible Fluid Dynamics, McGraw-Hill, New York, 1972
4. .

B.Tech. (VI Sem.) **Introduction to Aerospace Structures**

L	T	P	Cr.
3	1	0	4

Course Educational Objectives: To learn the basic aspects of elasticity, characteristics of statically determinate and indeterminate structures, energy methods and theorem applicable to beams and trusses, behavior of columns under loading conditions

Course Outcomes: At the end of the semester, the student will be able to
CO1: Solve problems related to elastic members by applying stress-strain relations [L3]
CO2: Analyze the statically indeterminate structures under various loading conditions [L4]
CO3: Evaluate the strain energy stored in the structural members [L4]
CO4: Analyze the buckling of columns and compressive member under various loading conditions [L4]

UNIT - I
Basic Elasticity: Concept of Principal Planes-Principal Stresses-Determination of Normal and Tangential Stresses-Mohr's Circle. Basic Elasticity Stresses and Strains, Equations of Equilibrium, Plane Stress and Plane Strain Problems, Compatibility Equations, Stress - Strain Relations

UNIT - II
Statically Indeterminate Structures: Introduction**,** Methods for Indeterminate Beams, Propped Cantilever- Fixed-Fixed Beams-Continuous Beams Carrying Point Load And Uniformly Distributed Load- Shear Force and Bending Moment Diagrams, Clapeyron's Three Moment Equation

UNIT - III
Energy Methods: Strain Energy Due to Axial Loading, Strain Energy Due to Bending– Strain Energy Stored by A Beam Subjected to Uniform Bending Moment-Castigliano's First Theorem- Castigliano's Second Theorem -Maxwell's Reciprocal Theorem

UNIT – IV
Columns: Introduction- Axially Loaded Compression Members-Crushing Load- Buckling Load-Euler's Theory-Effective Length of Column-Expressions for Buckling Load With Different Column End Conditions- Limitations-Euler's Formula- Rankine's Formula

UNIT – V
Stress Analysis in Wing and Fuselage: Study of Wing Spars and Box Beams, Shear Resistant Web Beams, Tension Field Web Beams (Wagner's) – Procedures to Find Shear and Bending Moment Distribution for Cantilever Beam.

TEXT BOOKS
1. Timoshenko. S, Strength of Materials, Vol. I and II, Princeton D. Vonostrand Co, 1990.
2. Megson. T. M. G, Aircraft Structures for Engineering Students, Sixth Edition, Elsevier, 2007.

REFERENCES

1. Donaldson. B. K, Analysis of Aircraft Structures-An Introduction, McGraw-Hill, 1993.
2. Bruhn. E. F, Analysis and design of flight vehicle structures, Tri set of offset Company, USA, 1973
3. Punmia. B. C, Theory of Structures, Laxmi Publication.
4. Ramamrutham. S, Narayanan. R, Theory of Structures, Dhanpat Rai Publishing Co, 2003.

B.Tech. (VII Sem.) **Introduction to Aerospace Propulsion**

L	T	P	Cr.
3	1	0	4

Course Educational Objectives: To learn engineering concepts of jet engines, principle of operation of aircraft jet engines. To learn the basic aspects of rocket propulsion, working principle of liquid, and solid propellant rocket systems, and advance propulsion techniques.

Course Outcomes: At the end of the semester, the student will be able,
CO1: To analyze the performance characteristics of various jet engines.[L4]
CO2: To analyze the performance characteristics of aircraft compressor. [L4]
CO3: To analyze the performance of turbines of jet engines. [L4]
CO4: To analyze the performance of solid and liquid propellant rocket systems [L4]

UNIT - I
FUNDAMENTALS OF GAS TURBINE ENGINE: Working of Gas Turbine Engine, Characteristics of Turboprop, Turbofan, And Turbojet Cycle Analysis, Performance Characteristics, Thrust Equation - Factors Affecting Thrust — Methods of Thrust Augmentation.

UNIT - II
SUBSONIC AND SUPERSONIC INLETS: Introduction, Subsonic Inlets - Internal Flows - External Flow, Supersonic Inlets
COMPRESSORS: Principle of Operation of Centrifugal Compressor – Work Done and Pressure Rise – Velocity Diagrams – Elementary Theory of Axial Flow Compressor – Velocity Triangles – Degree of Reaction,

UNIT - III
COMBUSTION CHAMBERS: Classification of Combustion Chambers, Combustion Process
TURBINES: Elementary Theory of Turbines - Impulse and Reaction Turbines, Axial Flow Turbine, Radial Flow Turbine, Velocity Triangles and Power Output, Estimation of Stage Performance, Methods of Blade Cooling

UNIT - IV
ROCKET PROPULSION: Operating principle, Effective Exhaust Velocity, Thrust equation, Specific impulse, Rocket Propulsion Requirements, Equations of Motion for an Accelerating Rocket, Multistage Rocket

UNIT – V
LIQUID PROPELLANT ROCKET: Introduction, Liquid Propellants, Types of Fuels and Oxidizers, Propellant Tanks, Tank pressurization, Turbo pump Feed Systems, Gas pressure feed systems, injector configurations

SOLID PROPELLANT ROCKET: Solid propellant rockets, double base and composite propellants, Propellant grain and its configuration, Propellant Grain Stress and Strain, Hybrid Rockets.

Advanced Propulsion systems

TEXT BOOK

1. Ganesan. V, Gas Turbines, Third Edition, Tata McGraw-Hill, New Delhi, 2018
2. Sutton. G.P, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York,5th Edn.,1993.

REFERENCES

1. Saravanamuttoo. H.I.H, Rogers. G. F. C, Cohen. H, Straznicky. P. V, Nix. A. C, Gas Turbine Theory, Seventh Edition Pearson Education, 2018.
2. Hill, P.G., Peterson, C.R. Mechanics & Thermodynamics of Propulsion, Addison – Wesley. Longman INC, 1999.
3. Mattingly. J. D, Elements of propulsion: Gas Turbines and Rockets, AIAA Educational Series
4. Rolls Royce Jet Engine, Third Edition, 1983.