DEPARTMENT OF AEROSPACE ENGINEERING

LIST OF COURSES OFFERED FOR MINOR PROGRAM (R23)

Credits 18: Theory courses 3 X 3 Labs 2 X 1.5 NPTEL 2 X 3

Course code	Course Title	Contact hours/week				Credits
		L	T	P	Total	
23AEM1	Introduction to Flight and Aerodynamics	3	0	0	3	**3**
23AEM2	Aircraft Structures	3	0	0	3	**3**
23AEM3	Aircraft Systems	3	0	0	3	**3**
23AEM4	Helicopter Engineering	3	0	0	3	**3**
23AEM5	Space Technology	3	0	0	3	**3**
23AEM6	Aircraft Modeling Lab	0	0	3	3	**1.5**
23AEM7	Aerospace Engineering Lab	0	0	3	3	**1.5**
NPTEL						
	Introduction To Experiments in Flight					
	Introduction To Aircraft Design					
	Introduction To Aerospace Engineering					
	UAV Design					
	Introduction To Rocket Propulsion					
	Introduction to Launch Vehicle Analysis and Design					

B.Tech. (Minor)

23AEM1- INTRODUCTION TO FLIGHT AND AERODYNAMICS

L	T	P	Cr.
3	0	0	3

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

COs	Statements	Blooms Level
CO1	Describe functions of various external and internal components of an airplane	Understand
CO2	Classify the various forces and moments acting on an airfoil	Apply
CO3	Understand basics of high-speed flow	Understand
CO4	Differentiate the working principles of various aircraft engines systems	Apply
CO5	Understand the basic aspects of flight mechanics	Understand

UNIT - I

BASIC ASPECTS: History-Early Planes, Components of Airplane and Their Functions, Types of Flight Vehicles, Classifications, Standard Atmosphere, Altitude, Hydrostatic Equation, Geopotential and Geometric Altitudes

UNIT - II

BASIC AERODYNAMICS: Introduction – 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 – 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, Types of Nozzles, Applications of Nozzles, Shock and Expansion Waves

UNIT - IV

PROPULSION: 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, Rocket propulsion

UNIT – V

FLIGHT MECHANICS: Airplane Performance of steady level flight- Equations of Motion Thrust required, Power required, Climb performance, Range, Endurance, Turning flight, Takeoff and Landing performance, Aircraft stability and control

TEXT BOOKS:

Anderson. J. D, Introduction to Flight, Eighth Edition, McGraw-Hill Education, 2017.

REFERENCES:

1. Houghton. E. L., Carpenter P.W., Aerodynamics for Engineering Students, Seventh Edition, Butterworth-Heinemann, 2017.
2. Kermode. A. C, Mechanics of Flight, Eleventh Edition, Pearson Education, 2007.

B.Tech. (Minor) **23AEM2-AIRCRAFT STRUCTURES**

L	T	P	Cr.
3	0	0	3

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

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

COs	Statements	Blooms Level
CO1	Solve problems related to elastic members by applying stress-strain relations	Apply
CO2	Identify the Statically determinate and indeterminate structures	Understand
CO3	Calculate Bending and shear stress distributions over different cross sections	Apply
CO4	Apply the strain energy methods to analyze the structural members	Apply
CO5	Analyze the aircraft structural components subjected to loading	Analyze

UNIT – I

SIMPLE STRESSES AND STRAINS: Stresses and Strains Due to Axial Force, Hooke's Law, Factor of Safety, - Strain Energy Due to Axial Force - Relationship Between Elastic Constants. **Basic Elasticity**: Concept of Principal Planes-Principal Stresses-Determination of Normal and Tangential Stresses. Basic Elasticity Stresses and Strains, Equations of Equilibrium

UNIT - II

STATICALLY DETERMINATE AND INDETERMINATE BEAMS: Introduction**,** Types of determinate beams and Indeterminate Beams, Shear force and Bending Moment when Beams Carrying Point Load And Uniformly Distributed Load.

UNIT – III

STRESS IN BEAMS : Introduction - Principal Axis and Neutral Axis Methods, Bending Stresses - Beams of Symmetric Sections with Symmetric Loads - Beams of Unsymmetrical Sections with Symmetric Loads, **SHEAR STRESSES:** Introduction, Derivation of Shear Stress Distribution Formula – Shear Stress Distribution Across Various Symmetric Cross Sectional beams.

UNIT – IV

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 Theorems - Maxwell's Reciprocal Theorem

UNIT – V

ANALYSIS OF AIRCRAFT STRUCTURES: Material, Structural components of aircraft, Loads on structural components, Function of structural components, Fabrication of structural components, Structural idealization, Study of Wing Spars and Box Beams, Tension Field Web Beams (Wagner's)

TEXT BOOKS:

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

REFERENCES:

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

B.Tech. (Minor) **23AEM3- AIRCRAFT SYSTEMS**

L	T	P	Cr.
3	0	0	3

Pre-requisites: Elements of Aerospace Engineering

Course Educational Objectives: To learn the conventional and modern control systems and working principle of different types of hydraulic and pneumatic systems, engine systems, auxiliary systems, and flight and navigation instruments used in an aircraft.

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

COs	Statements	Blooms Level
CO1	Identify the various types of controls in the airplane design	Understand
CO2	Understand the performance of hydraulic and pneumatic systems in the aircraft operation	Understand
CO3	Understand the performance of various engine systems of an aircraft	Understand
CO4	Employ necessary auxiliary systems in the operation of an aircraft	Understand
CO5	Employ various instruments necessary of the aircraft operation	Understand

UNIT - I

AIRPLANE CONTROL SYSTEMS: Conventional Control Surfaces – Power Assisted and Fully Powered Flight Controls – Power Actuated Systems, Engine Control Systems (FADEC), Push Pull Rod System – Operating Principles, Modern Control Systems – Digital Fly by Wire Systems – Auto Pilot System, Active Control Technology.

UNIT - II

AIRCRAFT SYSTEMS: Hydraulic and Pneumatic Systems - Study of Typical Workable System – Components – Advantages, Working Principles - Typical Air Pressure System – Brake System - Typical Pneumatic Power System - Components, Landing Gear Systems – Classifications (Air Oleo).

UNIT - III

ENGINE SYSTEMS: Fuel Systems for Piston and Jet Engines, Components of Multi Engines. Lubricating Systems for Piston and Jet Engines - Starting and Ignition Systems, Typical Examples for Piston and Jet Engines.

UNIT - IV

AUXILIARY SYSTEM: Basic Air Cycle Systems – Vapour Cycle Systems - Boot-Strap Air Cycle System –Evaporative Vapour Cycle Systems – Evaporation Air Cycle Systems, Oxygen Systems, Fire Protection Systems, De-icing and Anti-Icing System.

UNIT - V

AIRCRAFT INSTRUMENTS: Flight and Navigation Instruments Principles and Operation – Accelerometers, Air Speed Indicators – Mach Meters – Altimeters - Gyroscopic Instruments, Study of Various Types of Engine Instruments Operation and Principles – Tachometers – Temperature Gauges – Pressure Gauge

TEXT BOOKS

1. McKinley. J. L, Bent. R.D, Aircraft Maintenance and Repair, McGraw-Hill, 1993.
2. General Hand Books of Airframe and Power Plant Mechanics, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi1995.

REFERENCES:

1. Mekinley. J. L, Bent. R. D, Aircraft Power Plants, McGraw-Hill, 1993.
2. Pallet. E. H. J, Aircraft Instruments & Principles, Pitman & Co, 1993.
3. Treager. S, Gas Turbine Engine Technology, Third Edition, McGraw-Hill Education.

B.Tech. (Minor) **23AEM4-HELICOPTER ENGINEERING**

L	T	P	Cr.
3	0	0	3

Course Educational Objectives: To learn the function of various parts of helicopter, rotor theories and power requirements of helicopter motion, performance of helicopter in hovering and climbing, performance of horizontal and forward flight and control.

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

COs	Statements	Blooms Level
CO1	Understand the performance various components of helicopter.	Understand
CO2	Apply momentum theory in the design of propeller	Apply
CO3	Understand the performance of helicopter in various operating conditions	Understand
CO4	Describe the stability modes of helicopter	Understand

UNIT – I

BASICS OF HELICOPTER CONFIGURATION: Introduction, Configurations of Helicopter, Specifics of Helicopters, Articulated Rotor Systems, Effect of Cyclic Pitch Change, Swash Plate, Rotor Systems - Fully Articulated Rotor - Semi-Rigid rotor - Rigid Rotor - Coriolis effect, Methods of control.

UNIT – II

MOMENTUM THEORY: Introduction, Thrust Generation - Hovering - Figure of Merit, Blade Element Theory, General Expression for V_i - Local Solidity, Top Loss, Performance of ideally Twisted Constant Chord Blade, Rapid performance in Hover - Equivalent Chord.

UNIT – III

PERFORMANCE IN HOVERING AND CLIMBING: Introduction, Optimum Hovering Rotor, Induced Torque, Profile Drag Torque, Performance Equation - Optimum Rotor Design, Ground effect.

UNIT – IV

PERFORMANCE IN HORIZONTAL FLIGHT: Introduction, Flapping and lag Hinge, Steady Hover, Equilibrium in Horizontal Blade - Blade Hinge Motion, Blade Element Angle of Attack - Flapping Coefficient,

FORWARD FLIGHT: Introduction to Forward Flight, Performance equation, Drag-Lift Ratio, Profile Drag-Lift Ratio Charts, Profile Power, Parasite Power, Blade Stall - Introduction.

UNIT – V

STABILITY AND CONTROL: Introduction, Stability Terms - Trim - Static Stability - Dynamic Stability, Rotor Static Stability, Stability in Hover, Dynamic Stability, Dynamic Stability Reduction, Stability in Forward Flight,

TEXT BOOK:

1. E. Rathakrishnan., Helicopter Aerodynamics, PHI, 2018.

REFERENCES:

1. Gessow, A., Myers, Aerodynamics of Helicopter, G.C MacMillan & Co., N.Y. 1987.
2. B. W. McCormick, Aerodynamics of V/STOL Flight, Academic Press, 1987.
3. W. Johnson, Helicopter Theory, Princeton university Press, 1980.
4. B. W. McCormick, Aerodynamics, Aeronautics & Flight Mechanics, John Wiley, 1995.

B.Tech. (Minor) **23AEM5- SPACE TECHNOLOGY**

L	T	P	Cr.
3	0	0	3

Prerequisites: Basic Mathematics and Physics

Course Educational Objectives: This course is accessible to students from various engineering disciplines requires a curriculum that balances foundational aerospace concepts with interdisciplinary applications. This approach ensures that non-aerospace students can grasp the material while appreciating its relevance to their fields.

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

COs	Statements	Blooms Level
CO1	Understand the fundamentals of space exploration, space environment, and spacecraft system.	Understand
CO2	Understand different propulsion systems and launch vehicle mechanisms.	Understand
CO3	Explain satellite design, orbital mechanics, and applications in various fields.	Understand
CO4	Apply systems engineering principles in space mission planning and execution.	Apply
CO5	Understand emerging space technologies, sustainability, and ethical considerations.	Understand

UNIT – I

INTRODUCTION TO SPACE TECHNOLOGY & EXPLORATION

History and milestones of space exploration. Basics of space environment: microgravity, radiation, vacuum conditions. Space agencies (NASA, ISRO, ESA, CNSA) and major space programs. Spacecraft systems overview: structures, power, communication, attitude control.

UNIT – II

ROCKET PROPULSION & LAUNCH VEHICLES

Basics of rocket propulsion: Newton's laws in space flight. Chemical propulsion: solid, liquid, hybrid rockets. Electric and advanced propulsion systems. Launch vehicle design: staging, thrust-to-weight ratio, escape velocity. Case studies: Falcon 9 (SpaceX), PSLV (ISRO), SLS (NASA).

UNIT – III

SATELLITE TECHNOLOGY & APPLICATIONS

Types of satellites: communication, navigation, Earth observation, scientific. Satellite subsystems: power, thermal, communication, attitude control. Basics of orbital mechanics: Kepler's laws, orbital elements, satellite maneuvering. Applications in telecommunications, GPS, climate monitoring, and defense.

UNIT – IV

SPACE MISSION DESIGN & SYSTEMS ENGINEERING

Mission planning: defining objectives, cost, and feasibility analysis. Spacecraft design: structural considerations, thermal management, power distribution. Systems engineering approach: integration of subsystems, risk assessment. Case study: Mars Rover Missions, Artemis program.

UNIT – V

EMERGING TRENDS, SPACE SUSTAINABILITY & ETHICS

Small satellites, CubeSats, and satellite constellations. Commercial space industries: SpaceX, Blue Origin, Virgin Galactic. Space debris and mitigation strategies. Space law and treaties: Outer Space Treaty, Moon Agreement. Ethical issues: Militarization of space, resource exploitation, planetary protection**.**

TEXT BOOK:

1. Sellers, J. J., Astore, W. J., Giffen, R. B., & Larson, W. J. – *Understanding Space: An Introduction to Astronautics* (McGraw-Hill).
2. Chaisson, E., & McMillan, S. – *Astronomy Today* (Pearson).

REFERENCES

1. Sutton, G. P., & Biblarz, O. – *Rocket Propulsion Elements* (Wiley).
2. Elbert, B. R. – *Introduction to Satellite Communication* (Artech House).
3. Kaplan, M. H. – *Modern Spacecraft Dynamics and Control* (Wiley).

B.Tech. (Minor.) **23AEM6-AIRCRAFT MODELING LAB**

L	T	P	Cr.
0	0	3	1.5

Course Educational Objectives: To learn surface modeling package (CATIA) to draw 2D sketches, 3D parts, various aircraft components and assembly drawing, and finite element package (ANSYS) to analyze the behavior of simple structural elements under static loading system.

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

COs	Statements	Blooms Level
CO1	Draw aircraft components in 2D and 3D geometric modeling	Apply
CO2	Solve and analyze the structural components of aircraft for deformations and stresses using a numerical tool	Analyze

Any ten experiments are to be performed:

1. Design of basic aircraft component elements
2. Design of aircraft wing and nose
3. Design and drafting of aircraft wing structural elements
4. Design and drafting of aircraft fuselage structural elements
5. Design and drafting of landing gear
6. Design and drafting of rotary engine
7. Assembly of landing gear
8. Modal analysis of beam with different end conditions
9. Modal analysis of nose cone
10. Modal analysis of wing
11. Modal analysis of fuselage-Monocoque
12. Static analysis of cantilever beam.
13. Static analysis of bending of curved beam
14. Analysis of thermal stresses in bar

B.Tech. (Minor) **23AEM7-AEROSPACE ENGINEERING LAB**

L	T	P	Cr.
0	0	3	1.5

Course Educational Objectives:

1. To learn the basic experiments in open jet facility and wind tunnel
2. To learn the basic flow visualization techniques
3. To understand various principles and theorems involved in the theory of aircraft structures
4. To learn the various basic experiments related to components of jet engines and piston engines.

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

COs	Statements	Blooms Level
CO1	Analyze the flow characteristics over aerodynamic bodies	Analyze
CO2	Analyze beam structures subjected to different loading conditions	Analyze
CO3	Analyze the performance of various jet engines components	Analyze

Any of the 10 Experiments are required to be conducted

1. Determination of lift and drag for the symmetrical aerofoil.
2. Generation of potential flow pattern over objects using Hele-Shaw Apparatus.
3. Visualization of flow field around a flat plate using open channel.
4. Pressure Distribution over a cambered aerofoil.
5. Flow thorough Convergent Nozzle
6. Flow through Convergent- Divergent Nozzle
7. Verification of Maxwell's Reciprocal Theorem.
8. Non Destructive Test- Dye Penetration Test
9. Determination of Beam Deflection
10. Compression Test of Columns.
11. Wagner Beam-Tension Field Beam.
12. Free jet characteristics
13. Wall jet characteristics
14. Cascade testing of compressor blade row
15. Cascade testing of turbine blade row
16. Flow through subsonic inlet