

DR. A. P. J. ABDUL KALAM TECHNICAL UNIVERSITY

LUCKNOW, UTTAR PRADESH



COURSE STRUCURE / EVALUATION SCHEME

FOR

B.TECH. 4th YEAR

AERONAUTICAL ENGINEERING

[Effective from Session: 2025-26]

SEMESTER-VII														
S. No.	Code	Subject	Learning Mode	LTP			Evaluation Scheme						Total	Credit
				L	T	P	CT	TA	Total	PS	TE	PE		
1	BAE701	Flight Mechanics	Offline	3	0	0	20	10	30		70		100	3
2	BAE07*	Departmental Elective-IV	Offline	3	0	0	20	10	30		70		100	3
3	BOEM**	Open Elective-II	Offline / MOOCs	3	0	0	20	10	30		70		100	3
4	BAE751	Aircraft Systems and Maintenance Lab	Offline	0	0	2				50		50	100	1
5	BAE752	Mini Project or Internship Assessment *		0	0	4				100			100	2
6	BAE753	Project-I		0	0	10				150			150	5
7	BAE754	Startup and Entrepreneurial Activity Assessment #		0	0	4				100			100	2
TOTAL				9	0	20							750	19
* The Mini Project or Internship (5–6 weeks) is to be undertaken during the summer break following the VI semester and will be assessed in the VII semester. # The Startup and Entrepreneurial Activity will be assessed in the VII semester. Students are required to complete a minimum of 60 hours of startup or entrepreneurial engagement by the end of the VI semester.														

SEMESTER-VIII														
S. No.	Code	Subject	Learning Mode	LTP			Evaluation Scheme						Total	Credit
				L	T	P	CT	TA	Total	PS	TE	PE		
1	BOEM**	Open Elective-III	MOOCs	3	0	0	20	10	30		70		100	3
2	BOEM**	Open Elective-IV	MOOCs	3	0	0	20	10	30		70		100	3
3	BAE851	Project-II		0	0	18				100		350	450	10
TOTAL				6	0	18							650	16

The internal assessment of MOOCs will be conducted by the respective institute, and the external assessment (End Semester Examination) will be conducted by the University.

DEPARTMENTAL ELECTIVES

Semester ↓	Specialization →	Specialization-1	Specialization-2	Specialization-3	Specialization-4
		Aircraft Propulsion	Aerodynamics	Aircraft Legislation	Numerical Techniques
VII	Departmental Elective-IV	BAE071	BAE072	BAE073	BAE074
		Aircraft Maintenance	Helicopter Aerodynamics	Aircraft Rules and Regulations	Computational Fluid Mechanics

Subject Code: BAE701	FLIGHT MECHANICS	L-T-P : 3-0-0	Credits: 3
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Course Outcomes: After completion of this course, the students will be able to:		Bloom's Taxonomy
CO1	Understand atmospheric properties and fundamental flight principles.	K2
CO2	Analyze cruising and maneuvering flight performance parameters.	K4
CO3	Explain static longitudinal, lateral, and directional stability concepts.	K2
CO4	Describe dynamic stability modes and their effects on aircraft behavior.	K2
CO5	Apply stability and performance theories to evaluate aircraft flight characteristics.	K3

Unit-1: Atmospheric Properties and Flight Fundamentals

8 Hours

Standard atmosphere; types of altitude including geopotential, geometric, pressure, temperature, and density altitude; forces and moments acting on a flight vehicle; equations of motion of a rigid flight vehicle; types of drag and drag polar; types of airspeeds and instruments including airspeed indicator, altimeter, rate-of-climb indicator, and Mach meter; variation of thrust and power with velocity and altitude for air-breathing engines.

Unit-2: Cruising and Maneuvering Flight Performance

8 Hours

Performance of an airplane in level flight; power available and power required curves; maximum speed in level flight; conditions for minimum drag and minimum power required; range and endurance of aircraft; climbing and gliding flight including maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide; turning rate and turn radius, bank rate and bank angle; load factor and its limitations on turns; V-n diagram and gust envelope; take-off and landing performance.

Unit-3: Static Longitudinal Stability

8 Hours

Static stability fundamentals; purpose of controls in airplanes; static longitudinal stability including stick-fixed and stick-free concepts, basic equilibrium equation, stability criterion, effects of fuselage and tail, influence of center of gravity (CG) location, power effects, neutral points, and stick force gradients.

Unit-4: Static Lateral and Directional Stability

8 Hours

Dihedral effect; lateral control; coupling between rolling and yawing moments; roll stability and control including adverse yaw effects and aileron reversal; static directional stability and control including weathercock effect, rudder requirements, rudder lock, aerodynamic balancing; pedal-fixed and pedal-free stability; roll control reversal.

Unit-5: Dynamic Stability

8 Hours

Degrees of freedom of rigid bodies in space; dynamic longitudinal and lateral-directional stability; Euler angles; velocities in three directions; decoupling of longitudinal and lateral-directional dynamics; dynamic stability modes including phugoid, short-period, spiral divergence, Dutch roll, autorotation, and spin; effects of freeing the stick; approximation of modes and factors affecting time period and damping.

Textbook and References:

- Anderson, J.D., Introduction to Flight, Tata McGraw-Hill.
- Perkins, C.D., and Hage, R.E., Airplane Performance, Stability and Control, John Wiley & Sons.
- Nelson, R.C., Flight Stability and Automatic Control, McGraw-Hill Book Company.
- McCormick, B.W., Aerodynamics, Aeronautics and Flight Mechanics, John Wiley & Sons.
- Babister, A.W., Aircraft Dynamic Stability and Response, Pergamon Press, Oxford.

Subject Code: BAE071	AIRCRAFT MAINTENANCE	L-T-P : 3-0-0	Credits: 3
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Course Outcomes: After completion of this course, the students will be able to:		Bloom's Taxonomy
CO1	Explain construction and operation of piston and gas turbine engines and their systems.	K2
CO2	Apply inspection methods to evaluate engine components using standard techniques.	K3
CO3	Perform testing, fault diagnosis, and rectification of aircraft engines.	K3
CO4	Describe procedures for engine storage, servicing, and documentation.	K2
CO5	Analyze propeller systems, auxiliary units, and related maintenance regulations.	K3

Unit-1: Introduction to Aircraft Powerplants and Engine Systems

8 Hours

Types of piston and gas turbine engines, their relative merits and demerits, and principles of operation. General constructional details and functions of each component. Principles, arrangement, and operation of fuel, lubrication, ignition, and starting systems. Accessories such as fuel pumps, oil pumps, barometric pressure controls, and air-fuel ratio controllers.

Unit-2: Engine Materials and Inspection Techniques

8 Hours

Materials used in piston and gas turbine engines. Methods for checking engine components during pre-assembly, subassembly, and final assembly for correct alignment. Use of gauges and precision instruments. Inspection procedures for crack and defect detection: dye penetrant, magnetic particle inspection, X-ray, ultrasonic, and eddy current techniques.

Unit-3: Engine Testing, Controls, and Troubleshooting

8 Hours

Engine controls and performance instruments: principles and functional checks. Testing procedures for piston and gas turbine engines using appropriate rigs and equipment. Fault diagnosis and rectification. Engine installation checks and procedures. Precautions before, during, and after ground running, including operating limitations, priming, bleeding, and troubleshooting.

Unit-4: Storage, Servicing, and Documentation

8 Hours

Procedures for short-term and long-term engine storage. Priming and inhibition of accessories. Periodic servicing, defect reporting, and inspections post-shock landing. Maintenance of inspection records and flight clearance procedures. Types of stores and documentation procedures for storing components.

Unit-5: Propeller Systems and Regulatory Aspects

8 Hours

Types of propellers and their mechanisms, including variable pitch and feathering systems, with associated control components. Lubricants, hydraulic fluids, and fuels used in piston and gas turbine engines. Maintenance objectives and legal requirements related to aircraft powerplants. Accident reporting and investigation procedures. Power augmentation systems, thrust reversers, and auxiliary power units (APUs).

Textbook and References:

- Kroes, M., Wild, T., & Delp, W., Aircraft Powerplants, McGraw-Hill Education.
- Treager, I.E., Gas Turbine Engine Technology, McGraw-Hill.
- Jeppesen, Aircraft Maintenance and Repair, McGraw-Hill Education.
- McKinley, J.L., & Bent, R.D., Aircraft Powerplants, McGraw-Hill.
- FAA (Federal Aviation Administration), AC 65-12A – Airframe and Powerplant Handbook.

Subject Code: BAE072	HELICOPTER AERODYNAMICS	L-T-P : 3-0-0	Credits: 3
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Course Outcomes: After completion of this course, the students will be able to:		Bloom's Taxonomy
CO1	Explain helicopter working principles and aerodynamic characteristics.	K2
CO2	Analyze aerodynamic effects on helicopter performance.	K3
CO3	Apply flight principles to blade forces, trim, and transmission systems.	K3
CO4	Describe structural requirements and airworthiness concepts.	K2
CO5	Evaluate rotor performance, balancing, and vibration control.	K3

Unit-1: Introduction to Helicopters and Flight Theory

8 Hours

Types, mechanisms, characteristics, and working principles of helicopters. Theory of rotary-wing flight. Key terminology. Effects of gyroscopic precession, torque reaction and directional control, dissymmetry of lift, blade tip stall, translating tendency and its correction, Coriolis effect and compensation, vortex ring state, and power settling.

Unit-2: Rotor Blade Aerodynamics and Forward Flight

8 Hours

Blade forces and motion in forward flight. Force, torque, and flapping coefficients. Helicopter trim and performance analysis in forward flight. Transmission systems: gearboxes, main and tail rotors, clutches, freewheeling units, rotor brakes, tail rotor drive shafts, flexible couplings, bearings, vibration dampers, and bearing hangers.

Unit-3: Helicopter Structures and Airworthiness

8 Hours

Airworthiness requirements for structural strength. Structural classification: primary, secondary, and tertiary structures. Fail-safe, safe-life, and damage-tolerance concepts. Zonal and station identification systems. Basic structural loads: stress, strain, bending, compression, shear, torsion, tension, hoop stress, and fatigue. Provisions for drainage and ventilation.

Unit-4: Rotor Blade Theory and Performance Parameters

8 Hours

Momentum and blade element theories. Blade advance ratio, figure of merit, profile and induced power estimation. Constant chord and ideal twist rotors, over-pitching, autorotation, and ground effect. Tip loss factor and Prandtl's tip loss correction. Effects of compressibility on rotor blades. Aerodynamic interference between main rotor and tail rotor. Effect of blade aspect ratio and blade solidity on performance. Power required in different flight conditions (hover, forward flight, climb).

Unit-5: Rotor Dynamics and Vibration Control

8 Hours

Rotor alignment, main and tail rotor tracking. Static and dynamic balancing. Types of vibrations and vibration reduction methods. Ground resonance, helicopter spin, and stall behavior. Flapping, lead-lag, and feathering motions of rotor blades. Dynamic inflow effects on rotor loads. Active and passive vibration control techniques. Blade root moments and load distributions. Flutter and aeroelastic stability considerations in rotor blades.

Textbook and References:

- Stepniewski, W.Z., & Keys, C.N., Rotary-Wing Aerodynamics, Dover Publications.
- Leishman, J.G., Principles of Helicopter Aerodynamics, Cambridge University Press.
- Prouty, R.W., Helicopter Performance, Stability, and Control, Krieger Publishing.
- FAA (Federal Aviation Administration), Helicopter Flying Handbook (FAA-H-8083-21).

Subject Code: BAE073	AIRCRAFT RULES AND REGULATIONS	L-T-P : 3-0-0	Credits: 3
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Course Outcomes: After completion of this course, the students will be able to:		Bloom's Taxonomy
CO1	Explain the Aircraft Act, Rules, and DGCA regulations.	K2
CO2	Interpret operator responsibilities and CAR procedures.	K2
CO3	Apply defect recording and airworthiness procedures.	K3
CO4	Demonstrate certification and maintenance documentation.	K3
CO5	Analyze regulatory requirements for equipment, fuel, and testing.	K3

Unit-1: Regulatory Framework and Operator Responsibilities

8 Hours

Need for rules and regulations concerning aircraft registration in India. Overview of the Aircraft Act 1934, Aircraft Rules 1937, and Aircraft Manual. Airworthiness Advisory Circulars (AAC) and Civil Aviation Requirements (CAR) issued by DGCA. Responsibilities of operators/owners. Procedures for approval and use of cockpit checklists, Minimum Equipment List (MEL), and Configuration Deviation List (CDL).

Unit-2: Defect Management and Organizational Approval

8 Hours

Procedures for defect recording, reporting, investigation, rectification, and analysis. Requirements for approval, renewal, and scope extension of maintenance organizations. Layout and contents of quality control systems, maintenance procedures, quality assurance, and related manuals.

Unit-3: Airworthiness Documentation and Maintenance Practices

8 Hours

Requirements for maintenance and certification of aircraft, including gliders, microlights, and balloons. Key airworthiness documents: Certificate of Registration, Certificate of Airworthiness, Type Certificate, Flight Release, and Maintenance Certificates. Issuance, renewal, suspension, and restoration procedures. Documentation for inspection schedules, TBO/COSL, maintenance planning, and manufacturer's literature. Maintenance of aging aircraft and procedures for special flight permits.

Unit-4: Fuel Handling and Equipment Maintenance

8 Hours

Aircraft refuelling procedures, calibration of fuel gauges, and fuel quality control at airports. Requirements for installation and maintenance of aircraft instruments, systems, and mandatory equipment such as CVR, DFDR, ACAS, and GPWS/EGPWS. Use and maintenance of test equipment. Environmental and cleanliness requirements for aircraft system shops.

Unit-5: Avionics, Storage, and Special Procedures

8 Hours

Installation and maintenance of communication, navigation, and radar systems including Mode A, C, and S transponders. EMI control procedures. Storage conditions and life limits for rubber-based components. Calendar-based overhaul life for engines. Flight testing for airworthiness validation. Weight and balance control, medical supplies, logbook maintenance, onboard documentation, and taxi permit issuance.

Textbook and References:

- Aircraft Manual (India) – Directorate General of Civil Aviation (DGCA), Govt. of India
- Aircraft Act, 1934 and Aircraft Rules, 1937 – Latest Amendments
- Civil Aviation Requirements (CAR) – Published by DGCA
- Airworthiness Advisory Circulars – Issued by DGCA
- Airworthiness Notices and ICAO Documents – International Civil Aviation Organization

Subject Code: BAE074	COMPUTATIONAL FLUID DYNAMICS	L-T-P : 3-0-0	Credits: 3
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Course Outcomes: After completion of this course, the students will be able to:		Bloom's Taxonomy
CO-1	Understand the governing equations of fluid flow and their mathematical classification.	K2
CO-2	Apply numerical methods to discretize and solve fluid dynamics problems.	K3
CO-3	Analyze the stability, consistency, and convergence of finite difference schemes.	K3
CO-4	Understand finite volume methods and grid generation techniques for CFD applications.	K2
CO-5	Implement iterative solvers and algorithms like SIMPLE for fluid flow simulations.	K3

Unit-1: Introduction to CFD and Governing Equations

8 Hours

Principles of conservation: Continuity, Navier-Stokes, and Energy equations. Structure of conservation equations. Classification of partial differential equations and their physical interpretation. Approximate solutions: error minimization, variational principles, and weighted residual methods.

Unit-2: Numerical Methods and Discretization

8 Hours

Principles of conservation: Continuity, Navier-Stokes, and Energy equations. Structure of conservation equations. Classification of partial differential equations and their physical interpretation. Approximate solutions: error minimization, variational principles, and weighted residual methods.

Unit-3: Finite Volume Methods and Grid Techniques

8 Hours

Integral form equations, numerical fluxes at cell faces, upwind methods, flux vector and flux difference splitting, shock capturing methods. Role of CFD in design. Explicit and implicit methods. Grid types and stability analysis in time-dependent problems.

Unit-4: Stability Analysis and Discretization Schemes

8 Hours

LAX equivalence theorem. Stability analysis of parabolic and hyperbolic equations using FTCS, CTCS, FTFS, FTBS, and Leapfrog schemes. Finite volume discretization of 2-D unsteady diffusion problems.

Unit-5: Solvers and Advanced Topics

8 Hours

Solving linear algebraic systems: elimination, iterative and gradient-based methods. Finite volume discretization of convection-diffusion equations. Navier-Stokes equation approaches: stream function-vorticity and primitive variable. SIMPLE and SIMPLER algorithms. Unstructured grid formulation.

Textbook and References:

- H. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson Education.
- John D. Anderson Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw Hill.
- T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
- Charles Hirsch, Numerical Computation of Internal and External Flows, Vol. I & II, Wiley.
- P. Niyogi, S. K. Chakraborty, and M. K. Laha, Introduction to Computational Fluid Dynamics, Pearson Education.

Subject Code: BAE751	AIRCRAFT SYSTEMS AND MAINTENANCE LAB	L-T-P : 0-0-2	Credits: 1
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Course Outcomes: After completion of this course, the students will be able to:		Bloom's Taxonomy
CO1	Identify and explain key avionics and navigation systems.	K2
CO2	Test landing gear and pressurization systems; interpret cockpit indicators.	K3
CO3	Understand the working principle of key flight instruments.	K2
CO4	Identify aircraft components; describe hydraulic, pneumatic, and brake systems.	K2
CO5	Apply practical skills to maintain and troubleshoot aircraft systems ensuring airworthiness.	K3

Minimum 10 experiments to be performed from the following list:

1. Familiarization with various avionics systems such as High Frequency (HF) receiver and Very High Frequency (VHF) receiver.
2. Functional test of aircraft landing gear retraction system and verification of relevant cockpit indications.
3. Familiarization with pressure devices including Pitot-static system, altimeters, and vertical speed indicator.
4. Familiarization with direct-reading temperature indicating systems.
5. Familiarization with artificial horizons, slip indicators, and directional gyros.
6. Familiarization with magnetic compass and direct-reading compass.
7. Familiarization with fuel quantity indicating system.
8. Familiarization with airspeed indicator, Machmeter, and altitude reporting/alerting systems.
9. Familiarization with Automatic Direction Finding (ADF) system, VHF Omni Range (VOR), and Instrument Landing Systems (ILS).
10. Functional test of aircraft pressurization system.
11. Identification of various aircraft components and pipelines with color coding.
12. Study of hydraulic systems of various aircraft.
13. Study of pneumatic systems of various aircraft.
14. Study of brake systems of various aircraft.