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

STUDY & EVALUATION SCHEME WITH SYLLABUS

FOR

B. TECH 4th YEAR
AERONAUTICAL ENGINEERING

ON

CHOICE BASED CREDIT SYSTEM

(EFFECTIVE FROM THE SESSION: 2019-20)

SEVENTH SEMESTER									
S.No.	Subject Code	Subject Name	Department	L-T-P	TH/Lab	Sessional		Total	Credit
					ESE	CT	TA		
1.		Open elective course-1	Other Deptt.	3-0-0	70	20	10	100	3
2.		Departmental Elective-3	Core Deptt.	3-0-0	70	20	10	100	3
3.		Departmental Elective-4	Core Deptt.	3-1-0	70	20	10	100	4
4.	RAE701	Aerodynamics-II	Core Deptt.	3-1-0	70	20	10	100	4
5.	RAE702	Flight Mechanics	Core Deptt.	3-0-0	70	20	10	100	3
6.	RAE751	Aircraft System Lab	Core Deptt.	0-0-2	50		50	100	1
7.	RAE752	Aerodynamic Design &Testing Lab	Core Deptt.	0-0-2	50		50	100	1
8.	RAE753	Industrial Training	Core Deptt.	0-0-3			100	100	2
9.	RAE754	Project-1	Core Deptt.	0-0-6			200	200	3
TOTAL					**450**	**100**	**450**	**1000**	**24**

DEPARTMENTAL ELECTIVE-3		
S.No.	**Subject Code**	**Subject Name**
1.	RAE070	Rocket and Missiles
2.	RAE071	Aircraft Structural Dynamics
3.	RAE072	Automatic Flight Control
4.	RAE073	Avionics-I

DEPARTMENTAL ELECTIVE-4		
S.No.	**Subject Code**	**Subject Name**
1.	RAE075	Introduction to FEM
2.	RAE076	Introduction to CFD
3.	RAE077	Helicopter Aerodynamics
4.	RAE078	Aircraft Systems

EIGHT SEMESTER									
S.No.	Subject Code	Subject Name	Department	L-T-P	TH/Lab	Sessional		Total	Credit
					ESE	CT	TA		
1.		Open Elective-2	Other Deptt.	3-0-0	70	20	10	100	3
2.		Departmental Elective-5	Core Deptt.	3-1-0	70	20	10	100	4
3.		Departmental Elective-6	Core Deptt.	3-0-0	70	20	10	100	3
4.	RAE851	Seminar	Core Deptt.	0-0-3			100	100	2
5.	RAE852	Project-2	Core Deptt.	0-0-12	350		250	600	12
TOTAL					**560**	**60**	**380**	**1000**	**24**

- **Students who was not-place in any company, it is mandatory to select any one subject from DE-5 & 6.**
- **Students who was place in any company, it is mandatory to select MOOC subject in both DE-5 & 6.**

DEPARTMENTAL ELECTIVE-5		
S.No.	**Subject Code**	**Subject Name**
1.	RAE080	Aircraft Rules and Regulation
2.	RAE081	Introduction to UAV System
3.	RAE082	Spacecraft Technology
4.	RAE083	Avionics-II

OR

Sub.Code	MOOC Subject Name
RAE084	Aircraft Propulsion.

DEPARTMENTAL ELECTIVE-6		
S.No.	**Subject Code**	**Subject Name**
1.	RAE085	Aircraft Engine Maintenance
2.	RAE086	Elements of Aero Elasticity
3.	RAE087	Aircraft Design & Testing
4.	RAE088	Ground Handling and Supporting Systems

OR

Sub.Code	MOOC Subject Name
RAE089	Design of Fixed Wing Unmanned Aerial Vehicles.

SEMESTER-VII

AERODYNAMICS-II

L-T-P
3-1-0

UNIT-I:

One dimensional compressible flow: Flow equations, Velocity of sound, Isentropicsubsonic and supersonic flows through converging and diverging passages, Supersonic flow through constant area ducts (Fanno flow), Rayleigh flow and flow through C-D nozzle. Area-velocity relations, Mach wave and Mach angle.Critical Mach number, critical pressure and drag divergent.Area rule for design.

UNIT-II:

Two-dimensional supersonic flow: Two-dimensional supersonic flow past wedges and concavecorners, Normal shock relations. Oblique shock relations, Hodograph shock polar. Strong, weak and detached shocks, Prandtl-Meyer expansion flow past two dimensional concave corners, Expansion hodograph, Reflection of shocks and expansion waves Method of characteristics.

UNIT-III:

Differential Equation of motion: Steady compressible flows. Small perturbation potential equations.solution for subsonic and supersonic flow. Prandtl-Glauert of transformation relation for subsonic flows.Linearized and exact 2-d linearized supersonic flows theory and its application for calculation of lift, drag and pitching moments centre of pressure. Method of characteristics Prandtl-Glauert correction. Compressibility effects on aerodynamic coefficients.

UNIT –IV:

Propellers momentum and blade theories: Aerofoil characteristics in forward flight. use of propeller charts, Effect of solidity, profile drag, compressibility etc. Blade area required, number of Blades, Blade form. Selection and performance of fixed and variable pitch propellers, configurations based on torque reaction-Jet rotors and flapping and feathering, Rotor controls and various types of rotor, Blade loading, Power losses and Rotor efficiency

Aerodynamics of Rotor Blade: Elementary concept of helicopter hovering and climbing, helicopters Methods of control collective and cyclic pitch changes - Lead - Lag and flapping hinges. Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.

UNIT-V

Aircraft Testing: Aerodynamic testing facilities for different speed regimes, low speed wind tunnels, closed and open circuit tunnels. Main features of Subsonic, supersonic and transonic tunnels, shock tunnels, Instrumentation and calibration of test section. Testing procedure, data reduction, blockage effects and boundary layer corrections, correction to lift and drag,

Measuring devices in test Section: Pitot static tube, yaw probes, five-hole probe, hot wire anemo-meters. Flow visualization techniques oil flow, tuft survey and smoke. Flow field pressure measurements, Schlieren, shadowgraph and interferometer technique, laser Doppler and PIV technique.

Books and References:

1. John D Anderson Jr., Fundamentals of Aerodynamics, 2nd Ed., Mc Graw Hill.
2. J JBertin and M L Smith, Aerodynamics for Engineers, 2nd Ed., Prentice Hall.
3. E. Rathakrishnan, Gas Dynamics, Prentice Hall of India.
4. R S Shevell, Fundamentals of Flight, 2nd Ed., Prentice Hall.
5. E L Houghton and N B Carruthers, Aerodynamics for Engineering Students, Arnold, 2nd Ed
6. John D Anderson Jr., Compressible flow, The basics with Applications, McGraw Hill.
7. E.L. Houghton and A, E, Brock, Aerodynamics for Engineering students, Edward Arnold.
8. W.F. Durand (Editor), Aerodynamic Theory, vol, I to VI, Dover Publication, 1963 A.H. Shapiro, Dynamics and Thermodynamics od Compressible Fluid Flow, vol, I & II Ronald Press.
9. A. Ferri, Elements of Aerodynamics of Supersonic Flow, McMillan, 1949.

FLIGHT MECHANICS

L-T-P
3-0-0

UNIT-I:

Introduction: Standard Atmosphere, variation of pressure with altitude, geo-potential and geometric altitude, pressure, temperature and density altitude. Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle, Different types of drag, parasite drag and Drag polar, Types of Airspeed, Airspeed indicator, altimeter, rate of climb indicator, machmeter. Variation of thrust and power with velocity and altitude for air breathing engines.

UNIT-II:

Cruising and Manoeuvring Flight Performance: Performance of airplane in level flight, power available and power required curves. Maximum speed in level flight, Conditions for minimum drag and power required. Range and endurance of aircraft, Climbing and gliding flight (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, limitations on turn, V-n diagram, load factor and Gust envelope, take-off and landing performance.

UNIT-III:

Static Longitudinal Stability: Static and dynamic stability - Purpose of controls in airplanes - Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and tail - Influence of CG location - Power effects - Stick fixed neutral point and static margin- Stick free stability-Hinge moment coefficient -Stick free neutral points-Symmetric manoeuvres - Stick force gradients – Stick force per 'g'.

UNIT-IV:

Lateral and Directional Stability: Dihedral effect - Lateral control - Coupling between rolling and yawing moments – Roll stability and control, Adverse yaw effects- Aileron reversal - Static directional stability and control, Weathercock effect - Rudder requirements, Rudder lock. Aerodynamic balancing, peddle fixed and peddle stability, roll control reversal.

UNIT-V:

Dynamic Stability : Degree of freedom of rigid bodies in space, Introduction to dynamic longitudinal stability: - Euler angles, velocities in 3- direction, Decoupling of longitudinal and lateral-directional dynamics; Modes of stability- longitudinal modes; lateral-directional modes, effect of freeing the stick – Brief description of lateral and directional Dynamic stability - Phugoid motion , short period motion, Spiral, divergence, Dutch roll, auto rotation and spin, approximation of longitudinal and lateral modes, Factors affecting time period and damping.

Book and References:

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley &Son:,
2. Nelson, R.C. “Flight Stability and Automatic Control”, McGraw-Hill Book Co., 2004.
3. Mc Cornick. W., “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, NY, 1979
4. Babister, A.W., “Aircraft Dynamic Stability and Response”, Pergamon Press, Oxford, 1980.

AIRCRAFT SYSTEM LAB

L-T-P
0-0-2

Minimum 10 out of following such Experiments (or such experiments)

1. Familiarization with various avionics systems such as High Frequency receiver. Very High Frequency receiver.
2. Functional Test of aircraft landing gear retraction system and its relevant indications in the cockpit.
3. Familiarization with pressure devices such as Pitot static system, Altimeters. Vertical speed indicator.
4. Familiarization with direct reading temperature indicating system.
5. Familiarization with Artificial horizons. Slip indicators and Direction gyros.
6. Familiarization with Magnetic compass and direct reading compass.
7. Familiarization with Fuel quantity indicating system.
8. Familiarization with Air speed indicator /Mach meter and Altitude reporting / alerting system.
9. Familiarization with Automatic Direction-finding system. VHF Omni Rang/Instrument Landing systems.
10. Functional Test of Aircraft Pressurization System on aircraft.
11. Identification of various components, pipelines with color coding on aircraft.
12. Study of hydraulic systems of various aircraft.
13. Study of pneumatic systems of various aircraft.
14. Study of brake systems of various aircraft.

AERODYNAMIC DESIGN AND TESING LAB

L-T-P
0-0-2

Minimum 10 out of following such Experiments (or such experiments)

1. Wind tunnel as a tool, their classification, uses and applications.
2. Flow visualization studies over airfoils /Cylinder in Smoke Tunnel.
3. Calibration of a subsonic Wind tunnel.
4. Measurement of pressure gradient along a wind tunnel.
5. Plot lift vs. angle of attack for the given airfoil at various speed.
6. Determination of flow velocity in Wind tunnel by Hot wire Anemometer.
7. Pressure distribution over a symmetric and cambered aero foil.
8. Measurement of velocity profile in favorable and adverse pressure gradient.
9. Estimation of forces and drag acting over a symmetrical airfoil with different angle of attack.
10. Estimation of forces and drag acting over an unsymmetrical airfoil with different angle of attack.
11. Pressure distribution over an airfoil and to find lift and drag.
12. Pressure distribution over a 2D cylinder and to find lift and drag.

DEPARTMENTAL ELECTIVE – 3

ROCKET & MISSILES

L-T-P
3-0-0

UNIT-I:

Rocket Propulsion Elements: Classification of propulsion systems, classification of rockets motors. Principles of chemical, electrical and nuclear rockets. General characteristics of solid and liquid propellant rockets.

Definitions and fundamentals: Total impulse, specific impulse and impulse to weight ratio. Thrust and thrust coefficient, thrust and use full power. Exhaust velocity and propulsive efficiency of a rocket motors. Mass ratio, power of the jet, combustion efficiency and internal efficiency of a rocket propulsion systems.

UNIT- II:

Chemical propellants: Propellant formula and mixture ratio, Effects of initial speed of reactants on the adiabatic flame temperature. Calculation of equilibriums compositions, systems containing only hydrogen and oxygen and system containing hydrogen, carbon, oxygen and nitrogen. Applicability of Dalton's law to chemical rocket motors,

Hybrids and electric propulsion: Applications of hybrid propellants. Electro thermal, electro static and electromagnetic propulsion systems.

UNIT-III:

Solid Propellants: Propellants characteristics, grain and grain configuration. Classifications of grains, fundamental properties of burning grain surface. Basic chemicals of solid propellants and oxidizers, fuels, binders, Propellants burning rate, burning rate modifiers and plasticizers. Manufacturing of solid propellants. Thrust time trace of solid propellants rockets. Strand burner method of temperature measurement and end burning. Elements of combustion instability. Auxiliary uses of solid propellants, gas generators.

Liquid propellants: Propellants characteristics specifications in view economic factors, performance of propellants, common physical hazards. Desirable physical and combustion properties. Various liquid propellants. Propellants feed systems, gas pressure feed system and turbo pump feed system.

UNIT-IV:

Thrust chambers: Thrust chamber for liquid propellants, injector, types of injectors. Combustion instabilities, cooling of thrust chambers, steady state methods and unsteady state method of cooling, regenerating of cooling, ablative cooling, and film cooling etc. ignition devices.

Nozzle theory and characteristics: Nozzle configurations, under and over expanded nozzles, mass flow through a nozzle. Theory of isentropic convergent divergent nozzles, Classification of nozzles used for solid propellants rockets motors.

UNIT –V:

Thrust vector controls and Engines controls: Thrust vector control with single nozzle and with multiple thrust chambers or nozzles. Testing of thrust vector control system. Control of engine starting and thrust build ups.

Introduction to Missiles: Classifications of missiles: Guidance phases during flight; Categories of Homing and command guidance. Classification of Missile Guidance laws; modern guidance law Pure Pursuit Guidance Law**.**Basic Results in Interception and Avoidance

Books and References:

1. Barrers, M, Jaumolte, A, De Vaubeke, B, F, and Vandenkerchove, J, Rocket Propulsion, Elsevier Publishing Company 1960,
2. Hill, P, G, and Peterson, C, R, Mechanics and Thermodynamics of Propulsion, Addison-Wesely Publishing Company 1965.
3. Penner, S, S, Chemistry Problem in Jet Propulsion, Macmillan Company, 1957.
4. Koelle, H, H, (Edr,) Handbook of Astronautically Engineering , McGraw – Hill Book .
5. Sulton, G, P, Rocket Propulsion Elements, John Wiley and Sons 1963.
6. Zucrow, M, J, Aircraft and Missile Propulsion – Vol, I and II, John Wiley and Sons, 1958.
7. Williams, FA, Barrere, M, and Huang, N, C, Fundamental Aspects of Solid Propellant Rockets.

AIRCRAFT STRUCTURAL DYNAMICS

L-T-P
3-0-0

UNIT-I:
Aerospace Structural Dynamics. Oscillatory motion. Oscillatory Motion. Free vibration of Undamped Single Degree of Freedom System (SDOF).Damped Single-degree of Freedom System Free Vibration of Damped 2nd Order System. Damped Single-degree of Freedom System Free Vibration of Damped System. Damped Single-degree of Freedom System Free Vibration of Damped System.

UNIT-II:
Characteristic of Harmonic Motion. Response Due to Harmonic Excitation Forces. Response Due to Harmonic Excitation Forces. Frequency response function. Rotating Unbalance. Support Motion. Energy dissipated by damping. Transient Loading. Response of single degree freedom with general type loading function (Forcing) Duhamel Integral, Convolution/Superposition Integral.

UNIT-III:
Laplace Transformation**.** Numerical solution of a dynamic system**.** The Newmark Method**.** System with two DOF**.** System with two DOF**.** Beat Phenomenon**.** Co-ordinate Coupling**.** Response of 2DOF System to Harmonic Excitation**.** Vibration Absorber.

UNIT-IV:
Steps of Modal Analysis**.** Steps of Modal Analysis**.** Steps of Modal Analysis**.** With viscous damping (under damped)**.**Distributed Parameter Systems or Continuous Systems**.** Vibration of Bars or rods**.** Vibration of Bars or rods.

UNIT-V:
Vibration of Bars or rods**.** Approximate Methods**.** Rayleigh Ritz Method**.** Gale kinds MethodGale kinds Method. Derivation of the element stiffness matrix for a bar**.** Derivation of the element stiffness matrix for a bar.

Books and References:

1. Megson T M G, 'Aircraft Structures for Engineering Students', Edward Arnold,1995.
2. Bruhn. E.H., 'Analysis and Design of Flight Vehicles Structures', Tri-state offset company.
3. Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCBMcGraw Hill.
4. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.
5. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.
6. E.E. Sechler& L, G, Dunn, Airplane Structural Analysis & Design, Wiley & Sons Ltd.
7. A.S. Niles & J, S, Newel, Airplane Structural Analysis and Design, Vol & II Wiley & Sons.
8. F.R. Shanley, Weight Strength Analysis of Aircraft Structures, Dover Publication.

AUTOMATIC FLIGHT CONTROL

L-T-P
3-0-0

UNIT-I:

Aircraft Navigation: Kinds of navigation - Position Fixing and Dead-reckoning systems. LORAN; DECCA; OMEGA. Very High Frequency Omni-Directional Range (VOR). Celestial navigation and GPS based navigation; Inertial Navigation Systems. Integrated navigation systems

UNIT-II:

Introduction to Radars: Radar equation. Block Diagram and Operation; Radar Frequencies. Application of Radars; Range performance of radars. Minimum detectable signal; Noise effects, Continuous wave and Frequency modulated radars; Doppler effect. CW-radar; Isolation between transmitter and receiver. Radial velocity; CW radar applications; Frequency modulated CW radars, MIT and Pulse Doppler radars; Description of operation.

UNIT-III:

Control Systems: Classical linear time invariant control systems. Transfer function representations; stability; time domain characteristics. proportional–integral–derivative controller design for aerospace systems, Proportional term, Steady-state error, Integral term, Derivative term, Transient Response via Gain Adjustment, Lag Compensation, Lead Compensation, Lag-Lead Compensation.

UNIT-IV:

Stability of Control Systems: Equations of motion, Stability derivatives, Routh's discriminant, solving the stability quartic Stability definitions, characteristic equation, location of roots in the s-plane for stability, Routh-Hurwitz criteria of stability, Root locus and Bode techniques and its application to controller design for aerospace systems., concept and construction, frequency response. Gain Margin and Phase Margin via the Nyquist Diagram, Stability, Gain Margin, and Phase Margin via Bode Plots, Relation Between Closed-Loop Transient and Closed-Loop Frequency Responses.

UNIT-V:

Guidance of Missiles: Classifications; Description of tactical missiles. Guidance phases during flight; Categories of Homing and command guidance. The kinematic equations, Missile Guidance laws; Classification of guidance laws; Classical guidance laws; Modern guidance laws. Basic Results in Interception and Avoidance**.** Engagement between Two Point Objects**.** Collision Condition and Collision Triangle**,**Pure Pursuit Guidance Law**.** Time of Interception; Miss-Distance**.**

Books and References:

1. Perkins C.D., &Hage, R.E. " Airplaneperformance, stability and control ", Wiley Toppan 1974.
2. Babister, A.W. " Aircraft stability and response ", Pergamum Press, 1980.
3. McCormic, B.W., " Aerodynamic, Aeronautics and Flight Mechanics ", John Wiely, 1995.
4. Nelson, R.C. " Fligh Stability & Automatic Control ", McGraw Hill, 1989.

AVIONICS-I

L T P
3-0-0

UNIT-I:

Information: Communication system, signals, analogue, digital and coded forms, time and frequency representation signal spectra, types of distortion.

Information: Nature and measure, influence of band width and signal /noise ratio on channel capacity, elements of Shannon's theorem and its implication. Problem of communication in presence of noise.

Modulation: Amplitude, angle and phase modulation single and vestigial sideband forms demodulation, Super heterodyne principle automatic gain and frequency control typical circuit arrangements.

Pulse modulation: Sampling principle sampling criterion, quantization and quantization noise selection of number and distribution of quantization levels, bandwidth requirements, examples of coding and decoding circuits.

UNIT-II:

Transmission: Transmission lines and their circuit representation, characteristic impedance, complex propagation constant, standing wave radio matching and impedance charts

Channel Performance: Amplitude and phase distortion, phase and group delay distortion caused by multiple effects, Noise, origin measurements, noise figure and noise temperature effect on channel performance, Frequency and time division multiplexing.

Circuits: Circuits for Communication transmitters and receivers, block diagrams and examples of typical circuits, television receivers, Camera and display tubes.

UNIT-III:

Radiation: Principle: application of basic formulae for unipolar and dipolar aerials, effective height directional, properties, gain impedance, linear arrays traveling –wave aerials rhombic as parasitic elements.

Propagation: Principles: influence of ionosphere and troposphere reflection from earth's surface, field strength calculation, fading diversity reception

Television Wave forms: Scanning, Interlacing, Horizontal and vertical resolution, bandwidth requirements, Colour television principles, chrominance and luminance singles, basic definitions of photometry and colorimetric dichromatic systems.

UNIT-IV:

Systems: Description of typical point-to-point and broadcast radio systems, choice of typical parameters (e.g., operating frequency, type of modulation, transmitter power level, bandwidth. Special Systems (Principles): V.H.F., D.H.F. Satellite communication and related equipment, electronic counter measure, low- level TV and Head down display, CRT displays, Direction finding Air borne Telemetry Systems, Laser and infrared systems, Air data and flight recording systems.

UNIT-V:

Operating Cost: Direct operating cost-Depreciation of airframes and engine Insurance (Hull Insurance, passenger liability third party liability etc.) Housing and Parking Charges.

Indirect. Operating cost-their breakdown and criteria for estimation of payload, range and Block speed, Characteristics of aircraft and their effect on operating cost.

Unit operation costs: Cost per ton kilometre and cost per seat kilometre- Break- even load factor both in terms of passengers as well as total available payload.

Other Costs: Introductory Costs, (Crew training, Technical personnel training, ferry flights, additional building and workshop facilities costs, route, proving etc,) Financing Charges, Aircraft suitability for Traffic and Route system.

Books and Reference:

1. Communication Systems by B.P. Lathi (John Wiley and Sons 1968),
2. Communication System and Techniques by Schwartz, M.W.R. Benett and S. Stein (McGraw Hill, New York, 1966)
3. Systems – An introduction to Signals and Noise in Electrical Communication by Carlson
4. A.N.(McGrawHill, New York 1968).

DEPARTMENTAL ELECTIVE – 4

INTRODUCTION TO FEM

L-T-P
3-1-0

UNIT-I:
Introduction to Finite Element Method**.** Element Calculations**.** Global Assembly**.** Application of Boundary Conditions and Higher Order Approximation. Review of various approximate methods variational approach and weighted residual approach application to structural mechanics problems. finite difference methods- governing equation and convergence criteria of finite element method.

UNIT-II:
Finite Element Method for Higher Order Approximation**.** Natural Coordinate**.** Numerical Integration**.** Programming of Element Calculation1-D Finite Element Code**.** Bar elements, uniform section, mechanical and thermal loading, varying section, 2D and 3D truss element. Beam element - problems for various loadings and boundary conditions.

UNIT-III:
Pre-Processor**.** Processor and Post -Processor**.** Testing of 1-D FE Code**.** Integral Formulations for Beam Problem**.** Finite Element Formulation for Beam Problem: Shape Functions**.** Evaluation of Element Quantities and Assembly Procedure. Plane stress, plane strain and axisymmetric problems. Derivation of element matrices for constant and linear strain triangular elements and axisymmetric element.

UNIT-IV:
Integral Formulations of Two-Dimensional Problems**.** Finite Element Formulation of 2-D Problems: FE Equations**.** Evaluation of Element Quantities, Assembly and Application of Dirichlet Boundary condition**.** Evaluation of Element Right Side Vectors, Assembly and Application of Dirichlet Boundary condition. stiffness matrix and consistent load vector, evaluation of element matrices using numerical integration.

UNIT-V:
Lagrangian Triangular Elements**.** Simplest Rectangular Element**.** Axisymmetric Problems. Heat transfer problems, steady state fin problems, derivation of element matrices for two dimensional problems, torsion problems. method of factorization for solving simultaneous algebraic equations – Features of software packages, sources of error. 3D Frame elements - longitudinal and lateral vibration. Use of local and natural coordinates.

Books and Reference:
1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Printice Hall India, Third Edition, 2003.
2. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001
3. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, 2000.
4. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.
5. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis",
6. Larry J Segerlind, "Applied Finite Element Analysis", Second Edition, John Wiley and Sons.

INTRODUCTION TO CFD

L-T-P
3-1-0

UNIT-I:

Introduction to CFD: Principles of Conservation-Continuity Equation, Naiver Stokes Equation, Energy Equation and General Structure of Conservation Equations, Classification of Partial Differential Equations and Physical Behaviour, Approximate Solutions of Differential Equations-Error Minimization Principles, Variation Principles and Weighted Residual Approach.

UNIT-II:

Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems, Boundary Condition Implementation and discretization of unsteady state Problems**.** Equations of fluid dynamics and their classification. Boundary conditions.Finite difference schemes- Projection and truncation error, Stability, consistency, accuracy and convergence of numerical schemes.

UNIT-III:

Basics of Finite Volume Method: Equations in integral form, numerical flux at cell faces, upwind methods, flux - vector splitting, flux- difference splitting, shock capturing methods. Introduction to CFD as a design tool; explicit and implicit methods; O.C.H types of grids. Important Consequences of discretization of time dependent diffusion type problems and stability analysis.

UNIT-IV:

LAX Equivalence theorem, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): FTCS (Forward time central space) scheme, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (Leap frog scheme), Dunford-Frankel scheme, Stability analysis of hyperbolic equations: FTCS, FTFS, FTBS and CTCS Schemes, Finite Volume Discretization of 2-D unsteady State Diffusion type Problems.

UNIT-V:

Solution of Systems of Linear Algebraic Equations: Elimination Methods, Iterative Methods, Gradient Search Methods, Discretization of Convection-Diffusion Equations: A Finite Volume Approach, Discretization of Naiver Stokes Equations- Stream Function Vorticity approach and Primitive variable approach, SIMPLE Algorithm, SIMPLER Algorithm, Unstructured Grid Formulation.

Books and References:

1. T J R Hughes, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis,
2. O C Zicnkievicz and RL Taylor, The Finite Element Method, Vol I&II, McGraw Hill, Indian Ed.
3. John D Anderson Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw Hill.
4. Charles Hirsch, Numerical Computation of Internal and External Flows, Wiley Series I Numerical Methods in Engineering.

HELICOPTER AERODYNAMICS

L T P
3-1-0

UNIT-I:

Theory of Flight—Rotary Wing Aerodynamics: 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, power settling, over pitching. Auto rotation and Ground effect.

UNIT-II:

Flight Control Systems: Cyclic control; Collective control; Swashplate; Yaw control: Anti-Torque Control, Tail rotor, bleed air; Main Rotor Head: Design and Operation features; Blade Dampers: Function and construction; Rotor Blades: Main and tail rotor blade construction and attachment; Trim control, fixed and adjustable stabilizers Hovering performance - Momentum and simple blade element theories Figure of merit - Profile and induced power estimation Constant chord and ideal twist rotors.

UNIT-III:

Blade Tracking and Vibration Analysis: Rotor alignment; Main and tail rotor tracking; Static and dynamic balancing; Vibration types, vibration reduction methods; Ground resonance. Blade forces and motion in forward flight, Force, torque and flapping coefficient, Helicopter trim. analysis, Performance in forward flight. Transmissions: Gear boxes, main and tail rotors; Clutches, free wheel units and rotor brake. Tail rotor driveshafts, flexible couplings, bearings, vibration dampers and bearing hangers.

UNIT-IV:

Helicopter Structures: Airworthiness requirements for structural strength; Structural classification, primary, secondary and tertiary, fail safe, safe life, damage tolerance concepts; Zonal and station identification systems; Stress, strain, bending, compression, shear, torsion, tension, hoop stress, fatigue; Drain sand ventilation provisions.

UNIT-V:

System installation provisions; Lightning strike protection provision. Construction methods of: stressed skin fuselage, formers, stringers, longerons, bulkheads, frames, doublers, struts, ties, beams, floor structures, reinforcement, methods of skinning and anticorrosive protection. Pylon, stabiliser and undercarriage attachments.

Books and Reference:

1. Automatic Flight Control – E.H.J. – Pallet.
2. Aviation Maintenance Technician Handbook (General) 9A – FAA.
3. Helicopter Theory by Wayne Johnson.
4. Helicopter Calculation & Design Vol. I, II, & III by M.L. MIL, A.V. Nekrasov, A.S.Braverman.

AIRCRAFT SYSTEMS

L-T-P
3-1-0

UNIT-I:

Flight Control Systems: Principles of flight control, flight control surfaces, control surface actuation, flight control linkage systems, trim and feel. Power control, mechanical, direct drive, electromechanical, electro-hydrostatic actuation, multiple redundancy. The fly by wire system. Airbus and Boeing implementations. Inter-relationship of flight control, guidance and vehicle management systems.

Air conditioning and Cabin pressurization: Air Supply – Sources including engine bleed, APU and ground Cart - Air-conditioning System component layout, functioning of individual components & routine checks on the system - Distribution System - Flow temperature and humidity control.

UNIT-II:

Fire protection system: Fire and smoke detection and warning system, Fire Extinguishers system, Portable fire extinguisher type of Fire detectors, standard operating procedures for fire on ground.

Fuel System:Characteristics of aircraft fuel systems, System layout, checks during routine servicing, and common problems in the system components. fuel system components, fuel transfer pumps, fuel booster pumps, fuel transfer valves, non-return valves. Fuel quantity measurement systems, level sensors, fuel gauging probes. Fuel system operation, fuel pressurization, engine feed, fuel transfer, use of fuel as heat sink, external fuel tanks, fuel jettison, in-flight refuelling. Integrated civil aircraft fuel systems.

UNIT-III:

Hydraulic and Pneumatic System: System layout, hydraulic reservoirs and accumulators, pressure Generation, pressure control, indication and warning system functioning of hydraulic pump. Checks on hydraulic oil. Pneumatic layout System. Pneumatic reservoirs and accumulators, pressure Generation, pressure control, indication and warning system functioning of Air Pump of Pneumatic Systems. Use of pneumatic power in aircraft. Sources of pneumatic power, the engine bleed air, engine bleed air control. Users of pneumatic power.

UNIT-IV:

Ice protection system: Ice formation classification and detection, anti-icing system, de-icing system, and working of system in general. Effect of ice formation on functioning on various systems. **Oxygen system:**System layout, supply regulation, sources, storage charging and distribution. Indications and warning Engine oxygen system, procedures for carrying out oxygen leak check, precaution while working on oxygen system.

UNIT-V:

Electrical Systems: Aircraft electrical system characteristics, power (AC and DC) generation. Power generation control, voltage regulation, parallel operation, supervisory and protection functions.

Modern electrical power generation types, constant frequency, variable frequency, variable speed constant frequency types. Primary power distribution, power conversion and energy storage. Secondary power distribution, power switching, load protection. Electrical loads, motors and actuators, lighting, heating, subsystem controllers, ground power. Emergency power generation. Electrical load management system.

Books and References:

1. Airframe and Power plant mechanics – Airframe hand book Civil Aircraft Injection Procedure.

2. Aircraft repair manual – LaryRethmaier.

3. Light Aircraft Inspection – J E Heywrod.

4. J V Casamassa and RD Bent, Jet Aircraft Power Systems, McGraw Hill.

5. E H J Pallet, Automatic Flight Control, BSP Profession Books.1993.

6. Civil Aircraft Inspection Procedures (CAP 459), Himalayan Books.

7. W Thomson, Thrust for Flight, Sir Issac Pitman.1992.

SEMESTER-VIII

DEPARTMENTAL ELECTIVE – 5

AIRCRAFT RULES AND REGULATION

L-T-P
3-1-0

UNIT-I:

Rules and Regulation of Aircrafts:

Need for Rules and Regulations as they relate to registration of aircraft in India.
Aircraft Manual, The Aircraft Act 1934, The Aircraft Rules 1937.
Airworthiness Advisory Circulars issued by DGCA.

CAR Series A- Procedure for issue of CAR and Responsibility of operator:

Responsibility of operator/owners.
Procedure for CAR issues.

CAR Series B- Approval of cockpit check list, MEL & CDL:

Minimum Equipment List Configuration Deviation List etc, Use of such documents.
Preparation and use of cockpit and emergency check list.

UNIT-II:

CAR Series C-Defect Recording, Monitoring, Investigation and Reporting:

Defect recording, reporting, investigation, rectification and analysis.

CAR Series E- Approval of Organization:

Requirements and procedure for issue/ extension in scope/renewal of organization in various categories: Layouts, Contents and requirements for quality control/ maintenance system/Quality Assurance/ Procedures Manuals.

UNIT-III:

CAR Series F- Airworthiness and Continued Airworthiness:

General requirements for maintenance and certification of aircraft including gliders, micro-light aircraft, hot air balloons and Rebuilding of Aircraft.

Documents associated with continued airworthiness of aircraft such as certificate of airworthiness, issue Revalidation and Suspension certificate of airworthiness, certificate of registration, Type certificate, certificate of maintenance, flight release, etc Procedures and requirements for issuance, renewal and restoration of validity of such documents, Conditions for suspension/cancellation of C of R, C of A, etc.

Documents related with maintenance of aircraft and its components such as inspection schedules, special inspection schedules, TBO/COSL, Maintenance Planning Documents, manufacturers Literatures, Procedures for preparation and approval of such documents.
Requirements for maintenance of aging aircraft, procedures and conditions for issuance of Special flight permits.

UNIT-IV:

CAR Series H-Requirement of Aircraft fuel, Refuelling of Aircraft and calibration of aircraft fuels:

Aircraft fuelling procedures.Unusable fuel supply-calibration of fuel quantity gauge of aircraft.
Aviation fuel at airport Storage, Handling and quality controls.

CAR Series I – Aircraft instrument, equipment and accessories:
General requirement for installation and maintenance of various instruments and systems installed on aircraft.Minimum instrument required and additional equipment as per requirement.
Requirements for installation and maintenance of various mandatory equipment's on aircraft such as CVR, DFDR, ACAS, GPWS/ EGPWS etc.Requirements for maintenance of test equipment's.Airworthiness procedure for cleaned room and environment for aircraft system/ accessories shop.

UNIT-V:
CAR Series R- Airborne communication, navigation & Radar Equipment:
Installation of communication, Navigation and Radar equipment.Maintenance of Airborne Communication, Navigation and RadarEquipment. Installation of mode 'a', 'c' and mode 's'transponders.Control of electromagnetic interference of aircraft.
CAR Series S- Storage of Aircraft parts:
Storage condition and storage/ service life of rubber part and aircraft components containing rubber parts.Fixation of Calendar period, for determining overhaul life of reciprocating engines.
CAR Series T-Flight Testing of aircraft:
Flight Testing of aircraft for which a Certificate of Airworthiness haspreviously been issued.
CAR Series X-Miscellaneous requirements:
Weight and Balance Control of Aircraft.
Provision of medical supplies in aircraft, Use of furniture material in aircraft, Aircraft Log Books.Documents to be carried on board by Indian Registered Aircraft.Procedure for issue of taxi permit.

Books and References:
1. Aircraft Act. 1934 & Aircraft rules 1937 by DGCA.
2. Civil Aviation Requirement Section-2 by DGCA.
3. www.dgca.nic.in

INTRODUCTION TO UAV SYSTEM

L-T-P
3-1-0

UNIT-I:

Introduction to UAV: History of UAV –classification – Introduction to Unmanned Aircraft Systems models and prototypes System Composition-applications.

UNIT-II:

Design of UAV Systems: Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and EuropeDesign for Stealth--control surfaces-specifications.

UNIT-III:

Avionics Hardware: Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing.

UNIT-IV:

Communication Payloads and Controls: Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency rangemodems-memory system-simulation-ground test-analysis-trouble shooting.

UNIT-V:

Development of UAV Systems: Waypoints navigation-ground control software- System Ground Testing- System In-flight TestingFuture Prospects and Challenges-Case Studies – Mini and Micro UAVs.

Books and References:

1. Reg Austin “Unmanned Aircraft Systems UAV design, development”, Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
3. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road toAutonomy”, Springer, 2007.
4. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 1998.
5. Dr. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin AeronauticsCompany, 2001.

SPACECRAFT TECHNOLOGY

L-T-P
3-1-0

UNIT-I:

Basic concepts: The Solar System – References Frames and Coordinate Systems – The celestial Sphere, The Ecliptic Motion of Vernal Equinox – Sidereal Time – Solar Time –Standard Time – The Earth's Atmosphere.Study the basic concepts of orbital Mechanics with particular emphasis on interplanetary trajectories.

UNIT-II:

The general n-body problem: The many body Problem – Langrange, Jacobian identity The Circular Restricted Three Body Problem – Liberation Points – Relative Motion in the N-body Problem – Two – Body Problem – Satellite Orbits – Relations Between Position and Time – Orbital Elements.

UNIT-III:

Satellite injection and satellite orbit perturbations: General Aspects of satellite Injections – Satellite Orbit Transfer – Various Cases – Orbit Deviations Due to Injection – Errors – Special and General Perturbations – Cowell's Method – Encke's Method – Method of vibrations of Orbital Elements – General Perturbations Approach.

UNIT-IV:

Interplanetary trajectories: Two Dimensional Interplanetary Trajectories – Fast Interplanetary Trajectories – Three Dimensional Interplanetary Trajectories – 3-Dimensional Interplanetary Trajectories – Launch if Interplanetary Spacecraft – Trajectory about the Target Planet.

UNIT-V:

Ballistic missile trajectories and materials: The Boost Phase – The Ballistic Phase – Trajectory Geometry – Optimal Flights – Time of Flight – Re-entry Phase – The Position of the Impact Point – Influence Coefficients. Space Environment - Peculiarities - Effect of Space Environment, the Selection of Spacecraft Material.

Books and References:

1. Cornelisse, J.W. "Rocket Propulsion and Space Dynamic", W.H. Freeman & Co., 1984.
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 1993.
3. Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979.
4. Parker E.R., "Material for Missiles and Spacecraft", McGraw – Hill Book Co., Inc., 1982.

AVIONCS-II

L-T-P
3-1-0

UNIT-I:
Radar Engineering: Radar definition, Radar range equation, pulsed, CW and Doppler Radars, MTI, Noise Figure Consideration, various types of radar displays, Detection of radar signals in Noise. **Microwave Engineering:** Various types of radar transmission Lines, Rectangular and circular waveguides, coaxial lines, field patterns, modes (high order and evanescent), passive components.

UNIT-II:
Guided Transmission: Rectangular and Circular waveguides, coaxial lines, field patterns, high order and evanescent modes, passive components (e.g. directional couplers, filters, isolators, circulators).
Devices and Generators: Characteristics of magnetron, klystron, back ward wave oscillator, solid – state sources, Amplifiers, characteristics of traveling wave tubes and parametric amplifiers, Diode detectors and mixers. Diode detectors and mixers. Aerials and Propagation: Antenna theory, various types of antenna for medium wave, short wave, VHF and UHF frequencies, propagation at microwave frequencies, atmospheric at temptation.

UNIT-III:
Aerials & Propagation: Antenna theory, Medium wave, short wave, VHF and UHF antennas Microwave antennas, Waveguide techniques, Properties of open-ended wave guides, horns reflectors and slotted arrays, Propagation at microwave frequencies, atmospheric attenuation, effects of precipitation, effects of diffraction by hills – and buildings, clutter signals.

UNIT- IV
Systems: Description and relevant theory for point –to –point and satellite links, pulse, Doppler and frequency modulated radars, block diagrams of transmitters and receivers.
Special Systems (Principles): Analog and Digital Computers for aeronautical application, Head –up displays.

UNIT- V
Electronic Navigation: Maps and charts, classification of navigation systems, pilot age, viz dead rocking celestial and radio navigation, Radio direction finding at medium, high and very high frequencies, The radio compass and automatic direction finders, Radio ranges-medium frequency and VHF Omni directional ranges, Hyperbolic navigation systems, Loran and Decca, TACAN, Aids to approach and landing, The standard ILS and Ground Control Approach Systems, Dead reckoning navigation systems, Doppler navigational and inertial navigation, The technology of navigational instruments.

Books and References:
1. M.I. SkoInik: Introduction to Radar Systems, (McGrawHill).
2. G.J. Sonnenberg: Radar and Electronic Navigation.
3. B.S. Walker: Introduction to Computer Engineering.
4. M. Kayton and W, Fried: Avionic Navigation Systems (Wiley, New York).

5. PovessilRayen and Waterman: Airborne Radar (Van Nostrand 1961).

DEPARTMENTAL ELECTIVE – 6

AIRCRAFT ENGINE MAINTENANCE

L-T-P
3-0-0

UNIT-I:
Types of piston and gas turbine engines and their relative merits and demerits, principle of operation of piston and gas turbine engines, general constructional details and functions of each part, Principles, arrangement, operation and inspection of complete fuel, lubrication, ignition and staring system as applicable to piston and gas turbine engines, Principles and operation of accessories such as fuel pump, oil pump, barometric pressure control and air fuel ratio control etc. As applicable to gas turbine and piston engines.

UNIT-II:
Knowledge of material used in piston and gas turbine engines. Methods of checking of components prior to and during subassembly and subsequent assembly of the engine of both piston and gas turbine type for correct alignment, Weight and balance Knowledge of various gauges and precision instruments used. Inspection procedures for crack detection Such as die-penitent, magnetic particle Inspection, X- Ray, ultra-sonic and eddy Current etc.

UNIT-III:
Engine controls and performance instruments, General principles of operation and methods of checking for correct functioning. Testing of piston and gas turbine engines, various test rigs/instruments and equipment used. Fault diagnosis and rectification during testing. Engine installation checks of aircraft engines, precautions and procedures prior to, during and after ground running checks with particular reference to operating limitation, priming bleeding, etc, Trouble shooting and rectification.

UNIT-IV:
Procedure for short term and long-term storage of engines.Accessories priming and inhibition procedures.Periodical servicing, procedures, reporting and rectification of defects and inspection after shock landings.Maintenance of inspection records and clearance procedure for flights.Types of stores, maintenance of stores.Inspection of documents and procedures for storage of components.

UNIT-V:
Types of propellers and their mechanisms, variable pitch, feathering propellers and associated control system components. Knowledge of lubricants, hydraulic fluids and fuels used in piston and gas turbine engines. Maintenance objectives & legal requirements as related to power plants & systems. Accident reporting & investigation. Power augmentation devices, thrust reversers & auxiliary power unit.

Books and References:
1. Jet Engine Manual by E. Mangham and A Peace.
2. Fundamentals of Internal Combustion Engines by P.W. Gill, J.H. Smith & E.J. Ziurys.
3. Gas Turbine for Aircraft by A.W. Judge.

4. Gas Turbine Materials by G, Lueas and J.F. Pollock.

ELEMENTS OF AEROELASTICITY

L-T-P
3-0-0

UNIT-I:

Rectilinear motion of a particle: Differential equation of motion in resisting medium, Free vibrations with viscous damping, forced ration with harmonic disturbing force and general disturbing force, plane harmonic motion, Motion of a projectile with and without damp, motion of a particle subjected to a central force: planetary motion.

UNIT-II:

Dynamics of a System of Particles: Principle of Linear momentum and regular momentum, Rectilinear motion of a variable mass: Rockets, Kinetic energy and work, Law of conservation of energy.

Dynamics of a System with Constraints: Equations of constraints, generalized coordinates, generalized forces, Equations of equilibrium, Generalized co-ordinates, Application of generalized coordinates in bending of beams, D' Alembert's principle, Lagrange's equation and applications, Hamilton's principle and application.

UNIT-III:

Small Oscillations of Conservative Systems: Free vibrations of derivative systems, Linear oscillations of two coupled masses, Free variation of system with two degrees of freedom and system with several degrees of freedom, Principal modes and their orthogonal property, Normal modes static coupling and dynamic coupling, Approximate methods of calculating principal frequencies.

UNIT-IV:

Dynamics of Elastic Bodies: Vibration of a string under tension, Free vibration of beams with various end condition and the determination of the various modes of vibrations and their natural frequencies, variation of beams with concentrated masses, Critical speed of a rotating Forced vibration of beams, Tensional vibration of a shaft and –shaft combination, Approximate methods of calculating natural frequencies.

UNIT-V:

Aero elasticity: Elements of aero elasticity , General nature of acrostic problems, Nature of static aero elastic phenomenon , Wing diver, Gene and control system reversal for an idealized tow dimensional wing and approximate solution for a finite wing , Flutter phenomena and flutter analysis Difference between flutter instability and resonance , Simplified expressions for aerodynamic forced and moments for an oscillating air foil, Determination of flutter speed and frequency for an idealized two dimensional wing as well as for a finite wing, Methods of flutter control and prevention, Elementary theory of buffeting.

Books and References:

1. S. Timoshenko, Vibration Problems in Engineering, Van No strand 1959.
2. W.T. Thomson, Vibration Theory and Application, Allen and Unwind 1966.
3. S. Timoshenko and D,H, Young, Advanced Dynamics , McGraw Hill , 1948.

4. Y.C. Fung, Introduction to the Theory of Aero elasticity, Addison Wesley, 1965.

AIRCRAFT DESIGN AND TESTING

L-T-P
3-0-0

UNIT-I:

Introduction: Wing Loading and Thrust Loading**.** Basic Design - Lift and Drag**.**Range and Endurance**.**Mission Requirements.Range and Endurance: Propeller-driven Aircraft. Fuel Consumption: Cruise Flight. L/D for Maximum Range and Endurance.Range and endurance for Jet-driven Aircraft.Estimation of Fuel for a Mission.Design Considerations: Power Plant, Gross Weight. Design Considerations: Air foil Selection.

UNIT-II:

Design Considerations: Wing. Wing Design: Air foil. Wing Design: t/c, Camber and Leading-Edge Radius.

Wing Design: Aspect Ratio. Wing Design: Sweep, Twist and Taper Ratio. Wing Arrangements.Tail Arrangements.Aircraft Structure.Wing Loading and Power Loading.Thrust Loading and Wing Loading.Thrust Loading. Wing Loading.Wing Loading: Manoeuvre, Climb and glide. Take-off: Wing Loading and Thrust Loading. Take-off and landing distance. Stall and High Life Devices.

UNIT-III:

Wing Loading: Take-off and Landing.Revision (Wing Loading and Thrust Loading).Numerical: Wing Loading. Wing Loading: Designers Approach.Wing Loading: Designers Approach. Stability Considerations.Static Stability Basics.Wing and tail contribution to Longitudinal Static Stability.Conceptual Design.Conceptual design Elevator Effectiveness.Elevator Effectiveness.Numerical - pitching moment. Numerical - Elevator Effectiveness.Aircraft Maintenance Guidelines.Inspection for Aircraft.Numerical of Weight Fraction

UNIT-IV:

Introduction to Wind Tunnel: Low speed wind tunnels, main features of supersonic, transonic and hypersonic tunnels, shock tunnels, closed and open circuit tunnels. Design of contraction and diffuser and other components of wind tunnel.Instrumentation and calibration of test section, blockage effects and boundary layer corrections, correction to lift drag, moment coefficient due to wind tunnel wall interference.

UNIT-V:

Measuring devices in Test Section: Pitot tube static tube, yaw probes, five-hole probe, hot wire anemo-meters. Flow visualization techniques oil flow and smock flow. Flow field pressure measurements, Schlieren, shadowgraph and interferometer technique, laser Doppler, hot wire PIV technique, Wind tunnel balances, mechanical and strain gauge balances and their design. Scale effects. Non - aeronautical use of wind tunnels.

Books and References:

1. Daniel P Raymer, Aircraft Design: A conceptual approach, AIAA Series, 1992.
2. D Stanton, The Design of Airplane, GRANADA, UK 1983.

3. John D Anderson (Jr.), Airplane Performance and Design, McGraw Hill 1999.
4. E Torenbeek, Synthesis of Airplane Design.

GROUND HANDLING AND SUPPORTING SYSTEMS

L-T-P
3-0-0

UNIT-I:
General knowledge of ground handling of Aircraft, Aircraft Safety; Mooring, Jacking, Levelling, hoisting of aircraft, Towing, Mooring of an a/c during adverse conditions.Aircraft cleaning and maintaining.Ground signalling/marshalling of aircraft in day & night time, Brief knowledge of the signals given by the control tower.

UNIT-II:
Knowledge of Airfield lighting system, Aircraft Rescue & Fire Fighting.Maintenance and handling of ground equipment's used in maintenance of aircraft. Compressors, Portable hydraulic test stands, Electrical power supply equipment, charging trolley. Air-conditioning and Heating unit, Ground support air start unit. Pressure oil unit, Fire extinguishers, jacks, Hoisting cranes/gantry, Ladders, Platforms, Trestles, Chocks.

UNIT-III:
Knowledge of safety and fire precautions to be observed duringrefuelling, defueling. Maintenance including refuelling, defueling & engine start.Maintenance of hydraulic accumulators, reservoirs and filters: Maintenance of landing gear (L/G), Shock strut charging and bleeding, Maintenance of L/G brakes i.e., Dragging, Grabbing, Fading, Brakes and excessive brake pedal travel.

UNIT-IV:
Maintenance on wheels, tires and tubes i.e. dismantling, inspection, assembling, inflating, inspection and installation Rigging of flight control surfaces and duplicate inspection; Rigging Checks-Angular alignment checks and symmetry checks, Knowledge and use of Tension meters, Protractors etc. Storage of rateable.

UNIT-V:
Definition Probabilistic nature of failures - Mean failure rate - Meantime between failures - Hazard rate - Hazard models, Waybill model - System reliability improvement - Redundancy - Series - Parallel and Mixed configurations.
Introduction - Choice of maintenance strategy - Mean time- to repair (MTTR) - Factors contributing to Mean Down Time (MDT) - Fault diagnosis, and routine testing for unrevealed faults - Factors contributing to Mean Maintenance Time - (MMT) on condition maintenance - Periodic condition monitoring – Continuous condition monitoring - Economics of maintenance.

Books and References.
1. Airframe &Power plant Mechanics, General Handbook AC65-9A by FAA.
2. Airframe &Power plant Mechanics, Airframe Handbook AC 65-15A by FAA.
3. Michacl J Kroes and William. A Watkins, Aircraft Maintenance and Repair, McGraw Hill.
4. Civil Aviation Requirement - Section - 2- Airworthiness Series H for Safety & Fire Precautions in Fuelling& Defueling issued by DGCA.