Aerospace Engineering

Code: AS

Engineering Mathematics

Linear Algebra: Vector algebra, Matrix algebra, Systems of Linear Equations, Eigen values and Eigen vectors, Rank of a matrix.

Calculus: Functions of Single Variable, Limit, Continuity and Differentiability, Mean Value Theorems, Chain rule, Partial Derivatives, Total Derivative, Maxima and Minima, Gradient, Divergence and Curl, Vector Identities, Directional Derivatives, Line, Surface and Volume Integrals. Stokes, Gauss and Green's Theorem's.

Differential Calculus: First Order Linear and Nonlinear Equations; Higher Order Linear ODEs with constant coefficients, Laplace Transforms. Partial Differential Equations and Separation of Variables Methods.

Numerical methods: Numerical Solution of Linear and Nonlinear Algebraic Equations, Integration by Trapezoidal and Simpson Rule, Single and Multistep Methods for Differential Equations.

Flight Mechanics

Atmosphere: Properties, Standard Atmosphere. Classification of Aircraft. Airplane (Fixed Wing Aircraft) Configuration and Various parts.

Airplane Performance: Pressure Altitude; Equivalent, Calibrated, Indicated Air Speeds; Primary Flight Instruments: Altimeter, ASI, VSI, Turn-Bank Indicator. Drag Polar; Take-off and Landing; Steady Climb & Descent, Absolute and Service Ceiling; Cruise, Cruise Climb, Endurance or Loiter; Load Factor, Turning Flight,

V-N Diagram; Winds: Head, Tail & Cross Winds.

Static Stability: Angle of Attack, Sideslip; Roll, Pitch & Yaw controls; Longitudinal Stick Fixed & Free Stability, Horizontal Tail Position and Size; Directional Stability, Vertical Tail Position and Size; Dihedral Stability. Wing Dihedral, Sweep & Position; Hinge Moments, Stick Forces.

Dynamic Stability: Euler Angles; Equations of Motion; Aerodynamic Forces and Moments, Stability & Control Derivatives; Decoupling of longitudinal and lateral Directional Dynamics and modes.

Space Dynamics

Central Force Motion, Determination of Trajectory and Orbital Period in Simple Cases. Orbit Transfer, In-Plane and Out-of-Plane.

Aerodynamics

Basic Fluid Mechanics: Incompressible Flows Irrotational Flow, Viscous flows, Boundary Layer on a Flat plate, Reynold's number Conservation of mass, momentum and energy, Potential flow theory, sources, sinks, doubles, line vertex and their super position, viscosity.

Airfoils and Wings: Classification of Airfoils, Aerodynamic Characteristics, High Lift Devices, Kutta Joukowski Theorem; Lift Generation; Thin Airfoil Theory; Finite Wing Theory; Induced Drag; Prandtl lifting line theory, Critical and drag, divergence Mach Number.

Compressible Flows: Basic concepts of compressibility, Conservation equations; One dimensional compressible flows, Isentropic flows, Fanno flow, Rayleigh flow; normal and oblique shocks, Prandtl-Meyer flow; Flow through nozzles and diffusers.

Elementary ideas of viscous flows including boundary layers; Wind Tunnel Testing:

Measurement and visualization techniques.

Strength of Materials: States of stress and strain. Stress and strain transformation. Mohr's Circle. Principal stresses. Three-dimensional Hooke's law. Plane stress and plane strain; Failure theories:

Rankine, Tresca and von Mises; Strain energy. Castigliano's principles. Analysis of statically determinate and indeterminate trusses and beams. Elastic flexural buckling of columns.

Flight vehicle structures: Characteristics of aircraft structures and materials. Torsion, bending and flexural shear of thin-walled sections. Loads on aircraft.

Structural Dynamics: Free and forced vibrations of undamped and damped SDOF systems. Free vibrations of undamped 2-DOF systems. Vibration of beams. Theory of elasticity: Equilibrium and compatibility equations, Airy's stress function.

Propulsion:

Basics: Thermodynamics, boundary layers and heat transfer and combustion thermochemistry.

Thermodynamics of aircraft engines: Thrust, efficiency and engine performance of turbojet, turboprop, turbo shaft, turbofan and ramjet engines, thrust augmentation of turbojets and turbofan engines. Aerothermodynamics of non-rotating propulsion components such as intakes, combustor and nozzle.

Axial compressors: Angular momentum, work and compression, characteristic performance of a single stage axial compressor, stage efficiency of the compressor and degree of reaction.

Axial turbines: Stage Performance.

Centrifugal compressor: Centrifugal compressor stage dynamics, inducer, impeller and diffuser.

Rocket propulsion: Elements of Rocket motor performance, thrust equation and specific impulse, vehicle acceleration, drag, gravity losses, multi-staging of rockets. Classification of chemical rockets, performance of solid and liquid propellant rockets.

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