Aerospace Engineering

Flight Mechanics

Basics: 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; takeoff 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; longitudinal modes; lateral-directional 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: Conservation laws: Mass, momentum (Integral and differential form);Potential flow theory: sources, sinks, doublets, line vortex and their superposition; Viscosity, Reynolds number.

Airfoils and wings: Airfoil nomenclature; Aerodynamic coefficients: lift, drag and moment; Kutta-Joukoswki theorem; Thin airfoil theory, Kutta condition, starting vortex; 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, Fanno flow, Rayleigh flow; Isentropic flows, normal and oblique shocks, Prandtl-Meyer flow; Flow through nozzles and diffusers.

Boundary Layer: Elementary ideas of viscous flows including boundary layers; Wind Tunnel Testing**:** Measurement and visualization techniques.

Structure

Strength of Materials: States of stress and strain. S tress and strain transformation. Mohr's Circle. Principal stresses. Three-dimensional Hooke's law. Plane stress and strain; Failure theories: Maximum stress, 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 axial compressor stage, efficiency of the compressor and degree of reaction.

Axial turbines: Axial turbine stage efficiency

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

Rocket propulsion: 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.