

Ph.D. Entrance Examination Syllabus: Aerospace Engineering

Specialization Area 1: Aerodynamics

Basic Fluid Mechanics: Conservation laws: Mass, momentum and energy (Integral and differential form); Dimensional analysis and dynamic similarity; Elementary ideas of viscous flows including boundary layers.

Airfoils and Wings: Airfoil nomenclature; Aerodynamic coefficients: lift, drag and moment; Kutta-Joukowski 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, One-dimensional compressible flows, Isentropic flows, Fanno flow, Rayleigh flow; Normal and oblique shocks, Prandtl-Meyer flow; Flow through nozzles and diffusers.

Specialization Area 2: Flight Mechanics

Atmosphere: Properties, standard atmosphere. Classification of aircraft. Airplane (fixed wing aircraft) configuration and various parts. Pressure altitude; equivalent, calibrated, indicated air speeds. Aerodynamic forces and moments.

Airplane Performance: Drag polar; take-off and landing; steady climb and descent; absolute and service ceiling; range and endurance, load factor, turning flight, V-n diagram.

Static Stability: Stability and control derivatives; longitudinal stick fixed and free stability; horizontal tail position and size; directional stability, vertical tail position and size; lateral stability. Wing dihedral, sweep & position; hinge moments, stick forces.

Specialization Area 3: Structures

Strength of Materials: Stress and strain: Three-dimensional transformations, Mohr's circle, principal stresses, Three-dimensional Hooke's law, Plane stress and strain. Failure theories: Maximum stress, Tresca von Mises. Strain energy. Castigliano's principles. Statically determinate and indeterminate trusses and beams. Elastic flexural buckling of columns.

Flight Vehicle Structures: Characteristics of aircraft structures and materials. Torsion, bending and 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.

Specialization Area 4: Propulsion

Basics: Thermodynamics, boundary layers, heat transfer, combustion and thermo chemistry.

Aerothermodynamics of Aircraft Engines: Thrust, efficiency, range. Brayton cycle.

Engine Performance: ramjet, turbojet, turbofan, turboprop and turboshaft engines. After burners.

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

Centrifugal Compressor: Stage dynamics, inducer, impeller and diffuser.

Axial Turbines: Stage performance.

Rockets: Thrust equation and specific impulse, rocket performance. Multi-staging. Chemical rockets. Performance of solid and liquid propellant rockets.