PhD Entrance Exam
Syllabus for Aerospace Engineering

Engineering Mathematics

Linear Algebra: Vector algebra, Matrix algebra, systems of linear equations, rank of a matrix, eigenvalues and eigenvectors.
Calculus: Functions of single variable, limits, continuity and differentiability, mean value theorem, chain rule, partial derivatives, maxima and minima.
Differential Equations: First order linear and nonlinear differential equations, higher order linear ODEs with constant coefficients. Partial differential equations and separation of variables methods.

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; 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;
Special Topics: Dynamic stability: Euler angles; Equations of motion; aerodynamic forces and moments.

Aerodynamics

Basic Fluid Mechanics: Conservation laws: Mass, momentum (Integral and differential form); Potential flow theory: sources, sinks, doublets, line vortex and their superposition; Viscosity, Reynold's 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.

Structures

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 strain; Maximum stress, Strain energy. Analysis of statically determinate 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.

Propulsion

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