COMMON TOPICS

These topics are mandatory to all candidates.

MATHEMATICS AND NUMERICAL METHODS
Trigonometry: trigonometric functions, Pythagorean identities, angle transformation formulae, Euler's formula. Complex number and analytic functions.

Analytical Geometry: coordinates, equations and curves, distance and angle, intersection of geometric objects, tangent and normal, coordinate transformation.

Calculus: limits and continuity; differential calculus; integral calculus, series, partial and directional derivatives; vector-valued functions; definite and improper integrals; line integrals; surface integrals; multidimensional integrals; differential operators: gradient, divergence and curl, vector identities. theorems of Stokes, Gauss and Green.

Linear algebra: matrix algebra, linear systems of equations, eigenvalues and eigenvectors.

Ordinary differential equations: first order linear and nonlinear equations; systems of linear differential equations; higher order linear ODEs with constant coefficients, Cauchy and Euler equations, initial and boundary value problems.

Numerical methods: root finding of linear and nonlinear algebraic equations, numerical quadrature; unconstrained optimization methods.

PHYSICS AND ANALYTICAL MECHANICS
Physical quantities, units, and scientific method.
Measurement, probability, errors.
Dynamics of point particles, systems, and rigid bodies.
Newton’s laws of motion, cardinal equations, conservation laws.
Macroscopic systems and the laws of thermodynamics: Temperature and heat, First and Second Law of Thermodynamics.
Gravitational and electrostatic fields.
Waves and vibrations: Oscillations, wave propagation.

PROGRAMMING LANGUAGE: ForTran, C Programming, C++ Programming, Mathematica, MATLAB, Python

SPECIFIC TOPICS

Each candidate should select two topics for the oral test among those in the following lists.

AERODYNAMICS
Laminar and turbulent flows
Compressible flows: fluid compressibility, sound speed, Mach number.
One-Dimensional Compressible Flow with Area Change, Friction, and Heat
Normal and Oblique Shock Waves
Airfoils and wings: Classification of airfoils, aerodynamic characteristics, Kutta Joukowski theorem; lift generation; wing theory; induced drag.

AEROSPACE STRUCTURES
Aeronautical and Space mechanical and thermal environments.
Mechanical constitutive laws of isotropic and anisotropic materials.
Beam (1D), plates, and shells (2D) theories.
Semi-monocoque structures.
Theoretical foundation and numerical issues on Finite Element analysis.
Structural dynamics of continuous and discretized systems

FLIGHT DYNAMICS
Prediction of aircraft performances
Aircraft modelling
Static stability and control
Dynamics of aircraft motion and response to controls
Basic methods for aircraft closed-loop control

PROPULSION
Thermodynamics and Principles of Combustion Physics
Thrust and Performance Parameters of aerospace engines
Inlets and Nozzles in aerospace engines
Cycle Analysis in aerospace engines
General classification of aeronautical and space engines and propellants
Combustion Chamber phenomenology and design
Principles of flight and orbital mechanics

SPACE SYSTEMS
Space missions design
Spacecraft architecture: system and subsystems
Orbit and attitude determination and control system
Space environments and their interactions with space vehicles