Evaluation criteria – PhD cycle XL

Oral examination (max 60 points)

Candidates who have obtained a vote of at least 32/60 in the overall assessment of qualifications and the project are admitted to the oral test.
During the oral exam, the basic knowledge and two disciplinary sectors chosen by the candidate among the five proposed (see syllabus) (max 40 points) will be verified.
The Commission will also evaluate the motivations, interests and aptitude for research, through discussion of previous activity and presentation of up to 3 illustrative slides relating to the research project (max 20 points).
The oral test is considered passed if the candidate has obtained the vote of 42/60.
The minimum overall score for admission to the research doctorate is 74/120.

SYLLABUS (Cycle 40)

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 electromagnetic fields.
Waves and vibrations: Oscillations, wave propagation.

PROGRAMMING LANGUAGE
The candidate should have a working experience with at least one of the following programming languages: 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 performance
Aircraft modeling
Static stability and control
Dynamics of aircraft motion and response to controls
Basic methods for aircraft closed-loop control

AERONAUTICAL PROPULSION
Thermodynamic cycle analysis in aeronautical engines
Thrust and performance parameters of aeronautical engines
Air intakes in aeronautical engines
Combustion chambers of aeronautical engines
Nozzles in aeronautical engines
Elementary theory of turbomachinery

SPACE PROPULSION
Thermodynamic cycle analysis in space engines
Thrust and performance parameters of space engines
Thrust chambers of space engines
Nozzles in space engines
Elementary theory of turbomachinery

ORBITAL MECHANICS
Newtonian mechanics
Two-body orbital mechanics
Classical Orbital Elements

Rigid body kinematics and dynamics

AIRCRAFT SYSTEMS
Aircraft systems (flight control, avionics, fuel, engine control, electrical, hydraulic, environmental control, emergency)
Aircraft instruments
System and subsystem design and development

SPACE SYSTEMS
Space missions analysis and design (space mission life cycle, mission objectives, requirements and constraints, mission architectures and mission budget)
Space environment and survivability
Spacecraft design
Spacecraft systems (electrical power, thermal control, telecommunications, telemetry and command, attitude and orbital determination, ground control)