ANNEX 4

Syllabus of knowledge, skills and abilities required for admission to the Master's Degree Program in "Chemical and Process Engineering" at the University of Padova

Mathematics and numerical analysis

- Real-variable functions; limits; differential and integral calculus. Study of functions. Numerical series.
- Linear algebra and its geometric interpretation; vector spaces; linear functions; matrices and operations on matrices; eigenvalues, eigenvectors and their use; analytical solution of linear equations systems.
- Differential calculus for scalar and vector functions of several variables. Multiple, curvilinear and surface integrals. Optimization problems (with and without constraints). Linear differential equations.
- Numerical algorithms for systems of non-linear algebraic equations, approximation and quadrature problems, ordinary differential equations.
- Ability to apply all the above for the solution of exercises.

Chemistry

- Atomic structure of matter; periodic properties of elements; chemical bonds; chemical reactions; chemical, ionic and solubility equilibria; basic concepts of electrochemistry and chemical kinetics.
- Fundamentals of inorganic chemistry.
- Organic chemistry: nomenclature, structure, sources, properties and reactivity of the main organic functional groups.
- Ability to apply all the above for the solution of exercises.

Physics

- Physical quantities and units of measure. Classical mechanics (for point particle, systems of particles and rigid body). Thermodynamics and calorimetry.
- Fundamental laws of electromagnetism. Waves and vibrations of matter.
- Ability to apply all the above for the solution of exercises.

Chemical engineering

- Formulation and solution of macroscopic material and energy balances, for single equipment and entire processes, with and without chemical reaction and recycle streams. Determination of thermophysical properties from different sources (tables; graphs; empirical relations; computational codes).
- Units and dimensions. Definition of isolated/closed/open systems. Definition of specific heats. First and second principles of thermodynamics. Gibbs phase rule. Thermodynamic properties of pure fluids, pressure/temperature and pressure/specific volume diagrams; ideal gas law and equations of state; thermodynamic cycles. Solution thermodynamics: fugacity and activity, partial molar properties. Phase equilibria calculation: Raoult-Dalton and modified Raoult-Dalton models. Reaction equilibria.
- Mass, energy and momentum microscopic balances in homogeneous systems; microscopic balance equations for isothermal and non-isothermal systems, and for single-component and multicomponent systems. Main heat transfer mechanisms. Determination of heat transfer coefficient by dimensionless correlations.
- Selection of liquid and gas conveying equipment; hydraulic circuits.
- Sizing and rating of heat-transfer equipment, with and without phase change.
- Industrial chemical processes: relations between kinetics and thermodynamics; large-scale processes for the production of inorganic chemicals and intermediates.
- Ability to apply all the above for the solution of exercises.

General engineering

- Fundamentals on materials (metals, ceramics, glasses, polymers) and their production processes. Thermodynamic, mechano-physical properties, elastic-plastic behavior of materials. Synthesis, structure, morphology and properties of polymers.
- Fundamentals of mechanics of solids and structures.
- Organizational structures and business functions; financial statements and ratio analysis; cost classification; cost-benefit analysis.

Language

- Ability to read, listen to, and understand texts and technical discussions, including complex ones, in English.