BACHELOR IN CHEMISTRY AT PARMA UNIVERSITY

(3-year programme, 180 Credits)

The Bachelor in Chemistry at Parma University requires you to take 22 required subjects (144 credits), a subject at choice within a menu (6 credits) and two elective subjects within Parma University (12 credits). The study programme is completed with the English B1 course and a course on safety in chemical laboratories. You can go for an Internship Project (9 credits – 2 months) at a company in Italy or abroad or in a university research lab. You will conclude your Bachelor's programme with the Laurea exam (5 credits) where you will be entitled Junior Doctor in Chemistry. For detailed information on each subjects and curriculum check out the Chemistry Bachelor Syllabi for the academic year 2017/2018 (information provided may be subject to change, year by year).

This bachelor is linked to the Department of Chemistry, Life-Sciences and Environmental Sustainability that was awarded a special funding as Italian "Department of Excellence" for the 2018-2022 five-year period.

The bachelor is acquired in three years, with subjects distributed in two terms:

- first semester: October – February
- second semester: March - June.

All subjects are given in Italian. Book Exams are available for all subjects. The Internship work can be held in English.

Year 1			
I Term	**ECTS**	**II Term**	**ECTS**
GENERAL AND INORGANIC CHEMISTRY	9	ANALYTICAL CHEMISTRY AND LABORATORY	6
LABORATORY FOR GENERAL AND INORGANIC CHEMISTRY	6	PHYSICS I	6
MATHEMATICS I AND EXERCISES	9	ORGANIC CHEMISTRY I	6
SAFETY IN CHEMICAL LABORATORIES	1	LABORATORY OF ORGANIC CHEMISTRY I	6
ENGLISH B1	3	MATHEMATICS II AND EXERCISES	6

Year 2			
I Term	**ECTS**	**II Term**	**ECTS**
PHYSICS II	6	ANALYTICAL CHEMISTRY II AND CHEMOMETRICS	9
PHYSICAL CHEMISTRY I	6	PRINCIPLES OF INDUSTRIAL CHEMISTRY	6
LABORATORY OF PHYSICAL CHEMISTRY I	6	CHEMISTRY AND POLYMER TECHNOLOGY AND LABORATORY	6
INORGANIC CHEMISTRY	6	ORGANIC CHEMISTRY II	6
LABORATORY OF INORGANIC CHEMISTRY	6	LABORATORY OF ORGANIC CHEMISTRY II	6

Year 3			
I Term	**ECTS**	**II Term**	**ECTS**
PHYSICAL CHEMISTRY II	6	BIOCHEMISTRY	6
LABORATORY OF PHYSICAL CHEMISTRY II	6	INTERNSHIP	9
ANALYTICAL CHEMISTRY AND INSTRUMENTAL	9	FINAL EXAM	5
A SUBJECT FROM THE MENU			6
ELECTIVE SUBJECTS (other subjects from the menu or any other subject within Parma University)			12

MENU SUBJECT	ECTS
CHEMISTRY AND SUSTAINABLE TECHNOLOGIES OF INORGANIC MATERIALS	6
COMPLEMENTS OF INORGANIC CHEMISTRY	6
COMPLEMENTS OF ORGANIC CHEMISTRY	6
PROGRAMMING TOOLS AND COMPUTATIONAL METHOD IN CHEMISTRY	6

I YEAR SUBJECTS

ANALYTICAL CHEMISTRY AND LABORATORY OF ANALYTICAL CHEMISTRY

Analytical principles of thermodynamics of the chemical equilibria, homogeneous and heterogeneous equilibria, distribution functions, calculations about equilibrium concentrations. Activity and concentration. Solubility of ionic compounds, solubility product, effect of the common ion. Fractioned precipitation by pH control. Partitioning equilibria. Analytical principles of redox equilibria, potentials of the galvanic cells. Complex formation equilibria, chelates, distribution diagrams for complexation equilibria. Interaction between solubility, protonation, complexation, redox and partitioning equilibria. Applications in the recognition and separation of cations and anions, reactivity tests in the classical qualitative analysis. Principles of quantitative analysis. Principles and applications of volumetric analysis. Acid-base titrations, precipitation titrations, redox titrations, complexometric titrations. Principles and applications of gravimetric analysis. Laboratory practical activities.

GENERAL AND INORGANIC CHEMISTRY

The foundations of the atomic and molecular theory; Structure of the atoms. Chemical bond; Nomenclature of the compounds; States of aggregation of the matter; Solutions; Chemical thermodynamics; Chemical equilibrium; Ionic equilibria; Chemical kinetics; Electrolytic and galvanic cells; Inorganic chemistry.

LABORATORY FOR GENERAL AND INORGANIC CHEMISTRY

The first part of the course will deal with the introduction on the chemical nomenclature, the chemical reactions, and the principal methods for stoichiometric calculations. The second part of the course will deal with numerical exercises on: gaseous systems, chemical equilibrium, theories of acids and bases. Lectures will be delivered on the description of the laboratory activities and on the safety procedures in the laboratory. These lectures will be followed, in the second part of the term, by practical activities in the chemical laboratory.

ORGANIC CHEMISTRY I

Classification, notational aspects and physical properties of mono-functional organic compounds. Basic concepts of stereochemistry. Methodological aspects for the comprehension of substitution, addition, elimination reactions of mono-functional organic compounds.

LABORATORY OF ORGANIC CHEMISTRY I

Introduction to the organic chemistry laboratory. Introduction to IR and UV-Vis spectroscopic techniques and to the most important separation techniques in the organic chemistry laboratory: theory and practice. Theoretical and practical approach to an organic synthesis reaction.

PHYSICS I

Kinematic, dynamic and static concept applied to point mass and extended objects. Mechanical waves and their interference. Statics and dynamics of fluids.

ENGLISH B1 (No vote, Threshold level)

Grammar and Vocabulary corresponding to the B1 level of English

MATHEMATICS 1 AND EXERCISES

The lectures aim at providing students with fundamental concepts of infinitesimal and integral calculus for functions of one variable, of numerical sequences and series, of Linear Algebra (paying particular attention to the theory of linear systems and to the problem of diagonalized matrices) and of the theory or ordinary differential equations which can be solved in a elementary way.

MATHEMATICS 2 AND EXERCISES

The subject of Mathematics II and Exercises is designed to provide tools and mathematical methods useful for several applications.

II YEAR SUBJECTS

CHEMISTRY AND POLYMER TECHNOLOGY AND LABORATORY

Definitions and nomenclature; average molecular weight; isomerism and stereoisomerism; main classes of polymers, thermodynamic conditions for polymerization. Polymer synthesis - Step-growth polymerization: statistical treatment, theory of gelation. - Free radical polymerization, anionic and coordination polymerization. - Polymerization processes - Copolymers - Structure of polymers - Conformations and configurations of polymer chains, polymer morphology. Crystallization, melting and glass transition. Polymer characterization - Methods for the determination of the average molecular weight: Spectroscopic methods for structural analysis: NMR. Mechanical and rheological properties - Introduction to viscoelasticity, mechanical and theoretical models of viscoelastic behaviour. Laboratory experiences: Polyesters, Nylon, Polystyrene, Emulsion polymerization of PMMA, Polyuretane, Epoxy resins, Silicones, Mechanical tests.

ANALYTICAL CHEMISTRY II AND CHEMOMETRICS

Types of scale and measurements; Normal distribution, other distributions; Comparisons between rates and probability; Alpha and beta errors; a priori and a posteriori power; Student t test; Analysis of variance (ANOVA); Analysis of variance with two or more criteria; Descriptive statistics for bivariate distributions; Sample treatment; Analytical Method selection; Voltammetry; Potentiometry; Amperometry

PHYSICAL CHEMISTRY I AND LABORATORY

The zero law of thermodynamics and the gas properties. The First law of Thermodynamics. The second law of Thermodynamics. The Gibbs energy and the chemical potentials. Physical transformations of pure substances. The solutions. Phase diagrams. Chemical equilibrium. Chemical kinetics.
The Lab course constitutes an adequate support and integration of the Physical Chemistry 1 course. The subjects developed in this ambit will be applied to the resolution of problems and to the laboratory practice.

INORGANIC CHEMISTRY AND LABORATORY

Inorganic Chemistry Laboratory: safety rules, synthesis of coordination compounds and their characterization by means of spectroscopic techniques. Theory: coordination compounds, infrared spectroscopy, heteronuclear NMR spectroscopy, UV-vis spectroscopy, VSEPR theory and molecular geometries. Periodic system and chemical properties of the elements; block s and p elements; d-transition elements, coordination compounds.

ORGANIC CHEMISTRY II

Heteroaromatic compounds; Aldehydes and ketones properties and reactivity; Conjugated α,β-unsaturated systems. Michael addition. Carboxylic acids and derivatives. Electrophilic rearrangements towards C, N and O electron deficient atoms. Alkylation of enolates; Condensation reactions of carbonyl compounds. Condensations in biological field. Amines: Synthesis and reactivity. Amino acids, peptides, proteins; Carbohydrates; Lipids; Nucleic Acids. Synthesis of mono-and polyfunctional molecules will be discussed according to the retrosynthetic approach.

LABORATORY FOR ORGANIC CHEMISTRY II

The course will provide the students the theoretical knowledge and the practical ability to perform an organic reaction in the lab and to determine the molecular structure of a simple compound from spectroscopic (NMR, IR, Mass) data.

PHYSICS II

Theory and applications in Electromagnetism and Optics. The electric charge, the Coulomb law and the description of electrostatic phenomena using the electric field and the electrostatic potential. Gauss' law. The potential generated by charge distributions. Dipoles. Electrical properties of matter, conductors and dielectrics. Currents and resistance, current density and Ohm's laws. DC Circuits. Electric phenomena associated to moving charge and the magnetic field. Magnetic fields generated by moving charges and the phenomena of Faraday's induced electrical potential. Magnetic properties of matter. Electric circuit with continuum and alternate current and their study. The unification of electric and magnetic phenomena and Maxwell's equations for the Electro-Magnetism. Geometric optics: reflection, refraction, dispersion, lenses, mirrors. Wave optics: interference, diffraction, polarization, diffraction lattices.

PRINCIPLES OF INDUSTRIAL CHEMISTRY

Elements of thermodynamics and kinetics: finding the right operating conditions (pressure, temperature, contact time) in conducting a chemical reaction in some examples of industrial processes. Concepts of yield, conversion and selectivity. Parallel and consecutive reactions. Mass and energy balances applied to chemical industry. Multiphase reactions. Use of homogeneous and heterogeneous catalysts in industrial field (examples from petroleum industry). From laboratory to industry: problems associated with the scale-up. Raw materials, sustainability and safety of a chemical plant. Considerations on the overall costs of a process. Illustration of some important industrial processes (separation of air gases; syngas; methanol production; Fischer-Tropsch Process; ammonia, hydrazine, nitric acid; sulfuric acid; Claus process; chlorine and sodium hydroxide, hydrochloric acid, sodium carbonate; Acetylene).

III YEAR SUBJECTS

BIOCHEMISTRY

Properties of biomolecules: nucleotides and nucleic acids, carbohydrates, lipids, amino acids and proteins. Structure and function of proteins. Biological membranes. Enzyme catalysis and kinetics. Introduction to the metabolism: coenzymes, high energy bonds, redox potentials. Catabolism of glucose. Metabolism of glycogen. Gluconeogenesis. Tricarboxylic acids cycle and related reactions. Electron transport, oxidative phosphorylation and respiratory control. Photosynthesis. Lipid metabolism: Fatty acids oxidation, ketone bodies, fatty acids biosynthesis, cholesterol. Metabolism of amino acids: transamination reactions, urea cycle, PLP-dependent reactions. Nucleotides metabolism: ex-novo purines and pyrimidine biosynthesis.

ANALYTICAL CHEMISTRY AND INSTRUMENTAL

Introduction to instrumental analytical methods - Classification of analytical techniques - Criteria for the choice of analytical methods. Method performance characteristics: linearity, sensitivity, limit of detection, limit of quantitation, accuracy (trueness and precision), selectivity. Calibration methods. Spectroscopic techniques: Molecular Absorption and Fluorescence UV-vis Spectrophotometry; Molecular Absorption IR Spectrophotometry; Atomic Absorption Spectrophotometry; Atomic Emission Spectrophotometry; X-ray Fluorescence Spectroscopy; Mass Spectrometry; X-ray Diffraction. Theory and application of chromatography.

PHYSICAL CHEMISTRY II

Quantum Mechanics: an introduction. A few exact solutions of the Schrödinger equation. Methods of approximation. Symmetry in Quantum Mechanics. Atoms and molecules: some basic concepts. Atomic structure. Molecular structure.

LABORATORY OF PHYSICAL CHEMISTRY II

Particle-in-box model: application to organic dyes. Introduction to Fourier transform. FT-IR spectrophotometer. Roto-vibrational spectra of diatomic molecules. Group theory: definition of a group, symmetry elements, symmetry groups, reducible and irreducible representations. Reduction of the representations. Connection to quantum mechanics. Definition of the vibrational normal modes and their symmetry (with examples). Use of group theory for the evaluation of integrals of interest in quantum mechanics. Selection rules for IR spectroscopy. Raman spectroscopy and its selection rules. Prediction of IR and Raman activity for molecules of different symmetry. Adiabatic approximation. Huckel method: approximations, resolution of the problem and calculation of atomic charges, bond orders, dipole moments.

SUBJECTS FROM THE MENU'

CHEMISTRY AND SUSTAINABLE TECHNOLOGIES OF INORGANIC MATERIALS

Crystalline and amorphous materials. Engineering materials: metals, ceramic materials, polymeric and composite materials. Mechanical, thermal and electrical properties of materials and tests for their characterization. Connection between microstructure and properties. Heterogeneous equilibria. Binary phase diagrams. Burnt and hydrated lime. Fine and coarse aggregates. Ceramic materials for buildings. Composite materials. Metallic materials. Electrochemical corrosion of metals. Galvanic cells. Intergranular corrosion. Stress corrosion. Corrosion control and prevention. Environmental sustainability of inorganic materials.

COMPLEMENTS OF INORGANIC CHEMISTRY

Constitution of the metal complexes. Electronic spectra of atoms. Russell-Saunders coupling. The ligand field theory. Structures and coordination numbers. The Tanabe-Sugano diagrams. The electronic spectra of complexes. Magnetic properties of complexes. Correlation between theory and experiment: spectroscopic measurements, magnetic measurements, measurements of optical activity, electron paramagnetic resonance. Polymetallic complexes and mixed-valence. Kinetics and mechanisms in the reactions of coordination compounds. Thermodynamic and kinetic stability. The chemistry of the metals of the first transition series. The chemistry of transition metals heavier. The elements of the lanthanides and actinides. Metal clusters. Organometallic compounds.

COMPLEMENTS OF ORGANIC CHEMISTRY

Organic stereochemistry and methods for the resolution of mixtures of enantiomers. Oxidation and reduction reagents in organic chemistry. Aromatic nucleophilic substitution. Diazonium salts: synthesis and reactivity. Synthesis of heterocycles. Special reactions on phenols. Organometallic reagents in organic chemistry. Thermodynamics and kinetics in organic chemistry reactions. The kinetic isotope effect. Introduction to the retrosynthetic approach. New synthetic methodologies for drug-discovery (Combinatorial libraries, High-throughput-screening, parallel synthesis, split&mix synthesis).

COMPUTATIONAL METHODS IN CHEMISTRY

Numerical methods: Numerical differentiation; Quadrature methods; Methods for the search of roots; Ordinary differential equations; Resolution of chemical kinetics equations; Numerical analysis of UV/Vis spectra. van der Waals equation of state.