General Information	BACELOR DEGREE IN BIOTECHONOLOGIES
Title of the subject	Analytical Chemistry
Degree Course (class)	Industrial and Agri-food Biotechnologies (L-2)
ECTS credits	8
Compulsory attendance	Yes
Language	Italian
Academic year	2020/2021

Subject Teacher		
Name and Surname	Tommaso Cataldi	
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Place and time of reception	Dipartimento di Chimica Monday-Tuesday-Friday: 12:00-13:00 pm	
Telephone Office	080-5442015	
ECTS credits details	Discipline sector (SSD)	Area
	CHIM/01	Analytical Chemistry

Study plan schedule	Year of study plan	Semester
	II	I

Time management	Lessons	Laboratory	Exercises	Total
CFU	**6**	**2**		**8**
Total hours	**150**	**50**		**200**
In-class study hours	**48**	**24**		**72**
Out-of-class study hours	**102**	**26**		**128**

Syllabus	
Prerequisites / Requirements	
Chemistry and Inorganic Chemistry, Mathematics, Physics, Organic Chemistry	
Expected learning outcomes (according to Dublin descriptors)	
Knowledge and understanding	Knowledge of methodological approaches for the systematic treatment of chemical equilibria in solution: acid-base, complex formation, precipitation, and redox equilibria. Knowledge of the theoretical and methodological bases to face classical and instrumental qualitative and quantitative problems of chemical analysis.
Applying knowledge	Ability to use simple calculation methods for: • the resolution of chemical equilibria in aqueous solutions; • understanding of the theoretical basis of qualitative / quantitative methods of analysis including volumetric, potentiometric, spectrophotometric and chromatographic ones.
Making informed judgments and choices	Ability to solve problems involving chemical equilibria, especially by resorting to adequate approximations. Ability to interpret titration

	curves, UV-vis absorption, emission and fluorescence spectra, and chromatographic separations.
Communicating knowledge	Ability to support, with appropriate scientific language and rigorous arguments, a combination of statements on the resolution of a qualitative / quantitative chemical analysis issues.
Capacities to continue learning	Ability to transfer the acquire basic knowledge to real world problems.
Study Program	
Content	Part I. Introduction to analytical chemistry. The chemical-analytical process. Mass and volume measurements. The laboratory notes. Laboratory and safety. Units of measure. How to report the results of chemical calculations. Errors in Analytical Chemistry: mean, median, accuracy and precision; random and systematic error; errors propagation. Evaluation of the analytical data: Student's t-distribution; confidence intervals; t test; test F. Calibration. The method of least squares. The use of electronic spreadsheets in analytical chemistry. Part II. Acid-base equilibria. Systematic treatment of equilibria: charge balance and mass balance. Acid-base equilibria: strong and weak acids and bases. Degree of dissociation and distribution function (a = f [pH]). Buffer solutions: Henderson-Hasselbalch equation. Approximations in the calculation of pH. Buffering capacity. Polyprotic systems, amino acids. Acid-base titrations: strong acid-strong base, weak acid strong base, acid-base indicators. Titrations and titration curves. Methods of analysis based on titration: general aspects, equivalent volume, final volume, titration error, primary and secondary standard. Part III. Equilibrium of precipitation. Factors affecting the solubility of electrolytes. Activity coefficients. Solubility products. Factors affecting the solubility. Effect of the common ion. Quantitative precipitation. Effect of pH on solubility. Formation of complexes and complexation equilibria. Titration with EDTA and titration curves. Indicators. Redox equilibria. Redox reactions in electrochemical cells. Electrode potentials. Standard potential (E °). Examples of calculation of Keq from E °. Effect of concentration: Nernst equation. The formal potential, calculation of the formal potential. Redox titrations; redox indicators. Part IV. Instrumental techniques of analysis. Determination of concentrations; instrumental measurements and calibrations. Processing and evaluation of results. Main quality parameters of an analytical method. Part V. Electrochemical Methods. Potentiometry: general principles. Liquid junction potential. Indicator electrodes, reference electrodes. Membrane potential and membrane electrodes. Nikolski-Eisenman equation; selectivity. Ion selective electrodes. Electrode for pH measurement. PH meter. Part VI. Spectroscopic methods. Properties of electromagnetic radiation, electromagnetic spectrum, absorption, emission and fluorescence of an electromagnetic radiation. Molecular absorption spectrophotometry in the visible and ultraviolet: transmittance and

	absorbance. Lambert-Beer law and its limitations. Instrumentation: sources, sample holders, wavelength selectors, detectors. Single and double beam spectrophotometers. Molecular fluorescence and phosphorescence. Relaxation processes. Quantum yield of fluorescence. Instrumentation. Part VII. Separative methods. General principles of chromatographic separations; chromatogram; fundamental quantities, equations and parameters. Classification of chromatographic methods. The chromatographic peak and its fundamental parameters. Qualitative and quantitative analysis. Retention time, retention factor, selectivity, efficiency, resolution. Factors determining peak widening: Van Deemter equation. Optimization of the analysis conditions of complex mixtures: isocratic or gradient elution in liquid chromatography. Gas chromatography: principles and instrumentation. Mode of injection. Types of columns and stationary phases. Detectors. Analytical applications. High performance liquid chromatography: principles and instrumentation. Mechanisms: adsorption, partition (direct phase and reverse phase), ion exchange, size exclusion. Types of columns and stationary phases. Choice of mobile phase. HPLC system, main features, block diagram, HPLC pumps, injection systems, chromatographic columns, detectors. The mass spectrometry detector. Analytical applications. Numerical exercises on the topics covered in the course. Laboratory and other practical work is a necessary part of the learning experience of analytical chemistry.
Bibliography and textbooks	D.C. Harris "Chimica analitica quantitativa" terza edizione italiana, 2017, Zanichelli (Bologna) D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch. Fondamenti di chimica analitica. 2^ edizione, 2005, Edises (Napoli).
Notes to textbooks	Slides of the lessons
Teaching methods	Lectures and numerical exercises.
Assessment methods (oral, written, ongoing assessment)	Oral interview and evaluation of the laboratory reports.
Evaluation criteria (describe criteria for each of the above expected outcomes)	The student must demonstrate: • ability in dealing with the calculation of concentrations of species involved in chemical equilibria; • knowledge of the theoretical bases of the classical volumetric methods of analysis; • knowledge of the theoretical bases of potentiometric, spectrophotometric and chromatographic methods.
Further information	--