UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

dipartimento di farmacia-scienze del farmaco

General information	
Academic subject	**Analytical Chemistry and Complementary Chemistry** Two integrated modules: Analytical Chemistry (4 CFU/ECTS) and Complementary Chemistry (4 CFU/ECTS)
Degree course	**Pharmaceutical Chemistry and Technology**
Year of study	1st year
European Credit Transfer and Accumulation System (ECTS)	8
Language	Italian
Academic Year	2021/2022
Academic calendar (starting and ending date)	Annual course (November 2021 - May 2022)
Attendance	Compulsory attendance

Professor/ Lecturer	
Name and Surname	**Nicoletta Ditaranto (module Chimica Analitica)** **Nicola Margiotta (module Complementi di Chimica)**
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Department and address	**N.D.:** Dipartimento di Chimica, piano rialzato, stanza n.21 **N.M.**: Dipartimento di Chimica, c/o Palazzo Dip. Farmacia, 1st floor, room 207
Virtual headquarters	Microsoft Teams platform, virtual classroom code for lessons and tutoring: ***x04teli***
Tutoring (time and day)	**N.D.**: on Tuesday and Thursday, 3:00-5:00 pm, by email appointment **N.M.**: on Tuesday and Thursday, 3:30-5:30 pm or by email appointment

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Syllabus	
Learning Objectives	*Analytical Chemistry*: acquisition of the basic knowledge of Analytical Chemistry, with a particular focus on the understanding of simultaneous chemical equilibria in aqueous solution and to the qualitative and quantitative definition of the chemical species in equilibrium. *Complementary Chemistry*: acquisition of advanced skills relating to General and Inorganic Chemistry with insights into the properties of the elements and the aspects related to the chemistry of water and atmosphere.
Course prerequisites	Basics in Chemistry and Math
Contents	**Program of the Analytical Chemistry module** 1. Generalization of the acid/base concept and prediction of the direction of a reaction. 2. Methodological approach for the calculation of solution equilibria Charge balance, proton condition, mass balance, solving simultaneous equations, approximations, solving quadratic equations, logarithmic functions 3. Acid-base equilibria Strong acids and bases: pH calculation (exact solution). Weak acids and bases: ionization of weak acids and bases; general equation for calculating the pH of a weak monoprotic acid; approximations; graphical representations (distribution diagrams, logarithmic diagrams and their use). Analogies between weak acids and weak bases; ionization constants for bases and conjugated acids. Calculation of pH in salt solutions; salts of weak acids and weak bases; pH calculation; mixtures of acids; buffer solutions; buffering power. Polyprotic acids: stage dissociation; distribution diagrams; dissociation and formation curves; pH calculation for

	solutions containing salts of polyprotic acids; multiple buffers. 4. Precipitation equilibria: solubility product Solubility of simple ionic salts, effect of common ions. Solubility of salts of weak monoprotic acids. Solubility of hydroxides. **Program of Complementary Chemistry module** 1. COORDINATION COMPLEXES: symmetry operations, atomic and molecular orbitals. Naming and geometry of coordination compounds. Crystal field theory. Electron configuration of coordination compounds. Magnetic and spectroscopic properties. Coordination compounds with biological or pharmacological properties. Complexation equilibria. Formation and instability constants. Beta-fraction distribution as a function of ligand concentration: graphical and mathematical analyses. 2. CRYSTALLINE SOLIDS: Bravais lattice and primitive unit cells. Cubic crystal family. 3. KINETICS: rates of chemical reactions. Experimental and mathematical approach. Concentration and reaction rates: order of reaction. Rate laws and rate constants: zero- and first-order reactions. Half-life. Reaction rate and temperature. Arrhenius equation. Activation energy. Mechanisms of reaction. Activated complex and transition state. Catalysis (homogeneous, heterogeneous, and enzymatic). 4. NUCLEAR AND RADIOCHEMISTRY: particles that appear in nuclear decay. Medical/pharmaceutical applications of radioactivity. Nuclear reactions. Nuclear fission. Enriched and depleted Uranium. Nuclear fusion. Dating using ^{14}C. 5. PHASE DIAGRAMS: phase transitions. Analysis and interpretation of most common phase diagrams. Gibbs' phase rule. Ideal vs. real solutions. Dispersions. Colloids. Soaps and detergents. Partially miscible liquid systems. Freezing curves of pure compounds (water) and of solutions. Binary eutectic phase diagram. Frigorific mixtures. Vapour pressure vs. composition diagrams of salt-hydrates. 6. ELECTROCHEMISTRY: dependence of redox potential on pH. Pourbaix diagrams (potential/pH diagrams) obtainment and interpretation. 7. HETEROGENEOUS EQUILIBRIA: liquid-liquid and liquid-gas partition equilibria. Partitioning of a solute between two immiscible solvents. Extraction techniques. Partition coefficient. Unextracted fraction. Distribution ratio. 8. CHEMISTRY OF MAIN GROUPS ELEMENTS: in-depth study of general properties and chemistry of main elements. 9. INTRODUCTION TO ENVIRONMENTAL CHEMISTRY: development and chemistry of main pollutants and contaminants of water and earth atmosphere. COD and BOD. Temporary and permanent hardness of water. Limestone caves and surface karst phenomena.
Books and bibliography	1. Fondamenti di Chimica Analitica. Skoog, West, Holler, Chrouch - EdiSES; 2. Chimica Analitica. Trattazione algebrica e grafica degli equilibri chimici in soluzione acquosa. Di Marco, Pastore, Bombi - EdiSES; 3. Fondamenti di Chimica (V Edizione). Schiavello, Palmisano. EdiSES. 4. Gli equilibri ionici nella chimica analitica. Freiser, Fernando. PICCIN. 5. Chimica. VII Edizione. Kotz, Treichel, Townsend, Treichel. EdiSES.
Additional materials	Lecture notes

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours

Hours			
200	60	20 (numerical exercises)	120
ECTS			
8	6	2	

Teaching strategy	Frontal lessons (6 CFU/ECTS) and numerical exercises (2 CFU/ECTS) Frontal lectures through PowerPoint presentations and numerical exercises on the blackboard. The slides of the Complementary Chemistry module can also be downloaded from the Google Drive link available from the teacher. The tests of both modules are available on the UniBa website.
	If necessary, the lessons will be done in Blended Learning
Expected learning outcomes	
Knowledge and understanding on:	○ *Analytical Chemistry*: acquisition of the basic knowledge of Analytical Chemistry, with a particular focus on the understanding of simultaneous chemical equilibria in aqueous solution and to the qualitative and quantitative definition of the chemical species in equilibrium; ○ *Complementary Chemistry*: acquisition of advanced skills relating to General and Inorganic Chemistry with insights into the properties of the elements and the aspects related to the chemistry of water and atmosphere.
Applying knowledge and understanding on:	○ The two modules include numerical exercises whose function is to get the student used to solve questions using a mathematical approach applied to chemical balances as well as through the use of graphic resolution.
Soft skills	*Making informed judgments and choices:* ○ The acquisition of basic and advanced concepts, as well as the correct technical-scientific terminology, will get the student able to independently evaluate chemical problems and choose the most appropriate approach for solving problems. *Communicating knowledge and understanding* ○ At the end of the course the student will be able to explain the topics learned in a clear and rigorous scientific manner. *Capacities to continue learning* ○ On the basis of the acquired cultural background the student will be able to face to successive chemical courses – as for their career plan.

Assessment and feedback	
Methods of assessment	Assessment of learning by means of a written test consisting of three exercises for the Analytical Chemistry module and four exercises/questions for the Complementary Chemistry module. The overall duration of the test is 2 hours; during the written test it is allowed to use the periodic table (provided by the lecturer) and a calculator. The result of the written test (and in case the access to the oral test) is communicated on ESSE3 platform. The past exam tests are available on the UniBa teaching website for both modules. The oral interview includes, for each module, a minimum of two questions on the topics covered, in addition to the discussion of the written test.
Evaluation criteria	• *Knowledge and understanding, Applying knowledge and understanding* ○ Ability to write ion balances, pH calculation of aqueous solutions and buffer systems, treatment of solubility balances, as well as reaction mechanisms concerning processes that occur in the solid state, in water and in atmosphere. • *Autonomy of judgment*

	○ Critical reasoning skills related to the topics studied • *Communication skills* ○ Quality of exposure and competence in the use of appropriate language, effectiveness and clarity during the oral exposure • *Capacities to continue learning* ○ Ability to organize and expose the acquired knowledge
Criteria for assessment and attribution of the final mark	The written test is assessed by averaging the mark obtained in the Analytical Chemistry module and the one obtained in the Complementary Chemistry module. The access to the oral interview is allowed with a mark greater than or equal to 15/30. The final grade is expressed after the oral interview, to be done in both modules, and takes into account the result of the written test. The exam is passed when the grade is greater than or equal to 18/30.
Additional information	