



ANNEX 2.1

COURSE REGULATIONS

SCIENCES AND TECHNOLOGY OF INDUSTRIAL CHEMISTRY

CLASS LM-71

School: Polytechnic School and of Basic Sciences

Department: Chemical Science

Regulations in force for the academic year 2025-2026

Characterizing Courses (TAF B) and Related or Supplementary Courses (TAF C)

Course: Complements of Inorganic Chemistry		Teaching Language: English/Italian
SSD (Subject Areas): CHEM-03/A		CREDITS: 6 CFU
Course year:II	Type of Educational Activity:B	
Modalità di svolgimento: Lectures In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: This course illustrates and discusses aspects of Inorganic Chemistry relevant to materials chemistry and industrial catalysis for fine chemicals. Specific topics are the chemical bond, structure and reactivity of organometallic and coordination compounds (with examples of application in industrial catalysis), characterization (NMR, IR) and molecular symmetry. These topics are in line with the declaratory of the SSD.		
Objectives: Students will learn to interpret the meaning of line drawings of complex structures in terms of bond types (coordination, covalent and dative bonds), which will allow them to read relevant research literature. They will acquire knowledge of basic reaction types of Main Group and Transition Metal chemistry, and use that knowledge to understand the effects of ligand and metal variation in homogeneous catalysis.		
Propaedeuticities: No prerequisites Is a propaedeuticity for: NONE		
Types of examinations and other tests: This course has a written exam (open book) The questions are open-answer		

Course: Organic Analysis and Synthesis		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-05/A		CREDITS: 5 credits for lectures, 1 credit for laboratory activity
Course year: I	Type of Educational Activity: B	
Teaching Methods: Lectures in presence and laboratory experiences		
Contenuti estratti dalla declaratoria del SSD coerenti con gli obiettivi formativi del corso: The course is fully consistent with the CHEM-05/A declaratory in the following items: - “The scientific disciplinary field is interested [...] in the study of carbon compounds, both of natural and synthetic origin, including biomolecules and mimetics thereof, and polymers. Topics under study are: development of efficient, sustainable and ecocompatible synthetic methodologies based on (stereo)selective and catalytic approaches (including bio-organic and enzymatic ones), elucidation of mechanisms related to the formation and modification of organic compounds either in the laboratory or in natural and environmental systems, [...] the structural characterization of the studied organic compounds and structure-reactivity relationship.” - “It’s also interested in the isolation of organic compounds [...], in their structural determination including stereochemistry as well as development of methods towards this goal and their synthesis. In addition, it is interested in the design and synthesis of biologically active compounds, organic materials, supramolecular systems, polymers and bio-polymers, the study of new catalysts also in relation to a development aimed at an application goal.”		
Objectives: The course is aimed at offering to students a survey of the most significant transformations of functional groups useful in Industrial Chemistry. In addition, the course illustrates the main spectroscopic and spectrometric approaches adopted for structural characterization of organic molecules, and their actual application to detect the progress of synthetic transformations. The course is also aimed at examining, through laboratory experiences, the experimental aspects related to the execution of synthetic transformations of organic molecules, including isolation and characterization of obtained products. At the end of the course, the student should be able to: a) predict the outcome of organic reactions in relation to their mechanism; b) interpret NMR (mono- and bidimensional) and mass spectra; c) predict the spectroscopic changes of organic molecules as they are submitted to synthetic modifications; d) acquire skill in the experimental execution of organic reactions in the laboratory.		
Propaedeuticities: none		
Is a propaedeuticity for: none		
Types of examinations and other tests: oral examination		

Course: Chemical Plants		Teaching language: Italian / English
SSD (Subject Area): ICHI-02/A		Credits: 8
Course year: I	Type of educational activity: B (characterising)	
Teaching methods: Lectures and numerical/laboratory exercises.		
Contents extracted from the SSD declaratory consistent with the training objectives of the Course: The disciplinary scientific sector includes the study of methodologies for the design, construction, verification and operation of industrial plants based on transformations [...] of matter. [...] The following are qualifying: plant design [...], the development of quantified process schemes [...], the selection, design, [...] and verification of the reactors [...]; economic evaluations [...].		
Objectives: The Student must demonstrate knowledge, ability to understand and ability to process even complex discussions concerning issues relating to chemical reactor systems, non-isothermal operations, non-ideal flow conditions and heterogeneous processes. This starts from the notions learned here and through the educational path of the Course, which intends to provide the Learner, in a specialised way, with the appropriate knowledge and methodological tools, also through applications to case studies, numerical and laboratory exercises. The Student must demonstrate the ability to solve conceptual and design problems relating to ideal and non-ideal chemical reactors, even in combination with each other and in the presence of multiple and/or non-isothermal and/or heterogeneous chemical reactions, with the ability to analyse the main basic economics aspects of a chemical process.		
Propaedeuticities: -		
Is a propaedeuticity for: -		
Types of examinations and other tests: Final written (optional) and oral test.		

Course: Industrial Chemistry 1		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-04/A	Module: Industrial Chemistry 1; CFU: 5 Module: Industrial chemistry 1, exercises and laboratory; CFU: 5	
Course year: I	Type of Educational Activity: B	
Teaching Methods: Lectures (8 CFU) Laboratory (2 CFU) (in-person)		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course focuses on the development of chemical processes, through the study of thermodynamic, kinetic, catalytic, and technological aspects related to the synthesis of chemical products of industrial interest, industrial development, optimization and management of processes and related environmental impact and safety issues.		
Objectives: The program aims to transmit to students specialized notions from a theoretical and methodological/experimental point of view of the main elements of Industrial Chemistry. The program is constructed to teach to students specialized notions both from a theoretical and a methodological/experimental point of view in obtaining and processing kinetic and thermodynamic data useful for the design of a chemical plant.		
Propaedeuticities: None		
Is a propaedeuticity for:		
Types of examinations and other tests: Oral and written exam		

Course: Industrial Chemistry II		Teaching Language: Italian/English
SSD (Subject Areas): CHEM-04/A	Module: Industrial Chemistry II; Credits: 5 Module: Laboratory of Industrial Chemistry II; Credits: 5	
Course year: I		Type of Educational Activity: B
Teaching Methods: Lectures in presence and laboratory		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The disciplinary scientific area is interested in scientific and educational - training activities in the field of science and technology [...] of products, materials and chemical processes [...], through the definition of the principles and the study of the thermodynamic, kinetic, catalytic and technological aspects related to them. The disciplinary scientific area also deals with the synthesis, reactivity and modification of polymeric materials, functional polymers, hybrid materials and composite, with particular attention to the problems of circularity and valorization of resources and is also interested in the chemical and technological properties of polymeric materials, their characterization and structure-property relationships.		
Learning objectives: Acquisition of the fundamental notions on the molecular and crystalline structures of materials and on the physical and mechanical properties of inorganic metallic and ceramic materials and polymeric materials. The objective is to provide the concepts underlying the molecular approach in the study of the physical and mechanical properties of materials which allows to interpret and correlate the properties of use of a material to its molecular and crystalline structure. Acquisition with laboratory exercises of the main experimental techniques for the characterization of metallic, ceramic and polymeric materials. Numerical exercises and data analysis for the study of the relationships between properties measured in the laboratory and molecular and crystalline structures of materials.		
Pre-requisites: None		
It is a pre-requisite for: None		
Types of examinations and other tests: Oral exam and evaluation of the reports relating to the laboratory exercises.		

Course: Industrial Physical Chemistry		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-02/A Physical Chemistry	CREDITS: 6 CFU (5 LF + 1 LAB)	
Course year: I	Type of Educational Activity: C	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The teaching is consistent with the following points of the SSD CHEM-02/A declaratory: “The scientific disciplinary sector is concerned with the ... didactic-formative activity of the fundamental phenomena underlying chemical processes ... for the interpretation and prediction of the behavior of complex systems ... and their temporal evolution ... The study and use of knowledge considers levels, ranging from basic to applied-industrial research, in which there is data processing, evaluation of chemical processes, including those far from equilibrium, with their thermodynamic, kinetic and catalytic reaction models and their understanding in terms of molecular properties."		
Objectives: The course aims to develop in students the ability to analyze the behavior of real systems, closed or open, gaseous, liquid or solid, homogeneous or heterogeneous, in terms of their thermodynamic properties. The course includes a large number of numerical and laboratory exercises dealing with problems encountered in industrial practice, which allow students to test the skills acquired through the study of the theoretical topics presented.		
Propaedeuticities: none		
Is a propaedeuticity for: none		
Types of examinations and other tests: Written and Oral tests		

Educational Curriculum: Products, Processes and Environmental Protection (TAF: B or C)

Course: Development and control of the industrial chemical processes		Teaching Language: Italian
SSD (Subject Areas): CHEM-04/A		CREDITS: 6
Course year: I	Type of Educational Activity: B	
Teaching Methods: Lectures (4 CFU) Numerical laboratory (2 CFU)		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course focuses on the development of chemical processes, through the study of thermodynamic, kinetic, catalytic, and technological aspects related to the synthesis of chemical products of industrial interest, industrial development, optimization and management of processes and related environmental impact and safety issues.		
Objectives: The program is aimed at transmitting to students specialized notions both from a theoretical and methodological point of view in the simulation of both multiphase chemical reactors and unit operations, using suitable calculation tools (i.e., Matlab, CHEMCAD), and to the design of programs for the management of laboratory sensors and actuators.		
Propaedeuticities: None		
Is a propaedeuticity for:		
Types of examinations and other tests: Oral exam		

Course: Laboratory of Industrial Catalysis		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-04/A		CREDITS: 6
Course year: II	Type of Educational Activity: B	
Teaching Methods: Lectures and Laboratory exercises		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific group is concerned with scientific and educational-educational activity in the field of science and technology for the sustainable industrial development of chemical and energy products, materials, and processes, through the definition of principles and the study of [...] catalytic, and technological aspects [...].		
Objectives: The aim of the course is to provide the student, in a specialized way, with the knowledge and methodological tools also through the analysis of case studies, to address and solve conceptual and design problems concerning catalysis and its applications in the chemical industry, in environmental protection and in the energy sector. After a general overview of the current importance of industrial catalysis and the characteristics of industrial catalysts, aspects connected with the preparation and characterization of catalytic solids will be developed, the problems relating to deactivation will be analyzed, and it will end with an in-depth analysis of modern applications.		
Propedeuticities: None Is a propedeuticity for: None		
Types of examinations and other tests: Final oral exam.		

Course: Safety in Industrial Chemical Processes		Teaching Language: Italian / English	
SSD (Subject Areas): CHEM-04/A		CREDITS: 6	
Course year: II	Type of Educational Activity: B (characterizing/related or supplementary)		
Teaching Methods: Lectures, in presence			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The scientific disciplinary group deals with the sustainable development, optimization and management of industrial processes with particular attention to the related problems of technologies for the reduction of the impact on the environment and the purification of emissions, the design of eco-compatible materials, the analysis and management of the safety of products and chemical processes.			
Objectives: The aim of the course is to provide an overview of the issues related to safety in the industrial plants and the analysis and assessment of plant risks. The topics covered in the course concern efflux models, elements of toxicology and industrial hygiene.			
Propaedeutcities: None Is a propaedeuticity for: None			
Types of examinations and other tests: Final oral exam.			

Course: Analytical methods for quality and process control		Teaching Language: Italian/English
SSD (Subject Areas): CHEM-01/A		CREDITS: 5 CFU frontal lessons 1 CFU Lab experiences
Course year: II	Type of Educational Activity: C	
Teaching Methods: The teaching method will be based on frontal lessons with the slide projection to support the student in learning the covered topics. Laboratory experiences will be carried out related to the extraction, separation and quantification of different classes of analytes in complex mixtures.		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: “Analytical chemistry deals with all processes related to the pre-analytical stages (sampling, separation, enrichment, matrix modifications) as well as the development and use of tools suitable for the quality of numerical information (for example chemometrics). The main goal is the qualitative and quantitative determination of the complex matrices of natural and artificial systems”.		
Objectives: The course aims to provide the student with theoretical and experimental knowledge of the main analytical methodologies from the pre-analytical phases of sampling, extraction and separation to instrumental analysis with the aim of determining the qualitative and quantitative composition of analytes in complex matrices. Particular emphasis will be given to understanding the principles underlying the functioning of some instrumental techniques and the use of bioinformatics software for the processing and interpretation of the obtained data. Furthermore, all the parameters for the validation of an analytical method will be discussed and the mathematical-statistical tools for the treatment of experimental data and the evaluation of the quality of the analytical result will be provided.		
Propaedeuticities: None Is a propaedeuticity for:		
Types of examinations and other tests: Oral examination		

Teaching Curriculum: Polymer Science (TAF B or C)

Course: Chemistry and technology of polymers		Teaching Language: Italian	
SSD (Subject Areas): CHEM-04/A		CREDITS: 6 (lectures)	
Course year: I	Type of Educational Activity: B		
Teaching Methods: Lectures in presence			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector is interested in scientific and educational-training activities in the field of science and technology for [...] industrial development of products, materials and chemical processes [...], through the definition of the principles and the study of [...] technological aspects related to them. The disciplinary scientific sector also deals with the [...] reactivity and modification of polymeric materials, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorization of resources and is also interested in chemical and technological properties of polymeric materials, their characterization and structure-property relationships.			
Objectives: The course aims at providing students with skills necessary to critically evaluate industrial issues related to the chemistry and technology of polymers. The main classes of industrial polymers as well as the ones with high added values will be discussed. For each class, the chemical mechanisms, the industrial processes, the chemical-physical properties and the applications will be reviewed. Examples of composite materials and the main concerns related to the recycling aspects will be also analyzed focusing on the industrial applications.			
Propaedeutcities: None Is a propaedeuticity for: None			
Types of examinations and other tests: Oral exam and evaluation of the reports prepared by the students at the end of the course.			

Course: Properties and Structure of Polymers		Teaching Language: Italian/English
SSD (Subject Areas): CHEM-04/A		CREDITS: 5 CFU Lectures+ 1 CFU Lab
Course year: II	Type of Educational Activity: B	
Teaching Methods: Lectures (in person) + Lab		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: “The sector also deals with the synthesis, reactivity and modification of polymeric, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorisation of resources and is also interested in the chemical and technological properties of polymeric materials, their characterization and structure-property relationships.”		
Objectives: The aim is to provide students with the theoretical and methodological tools for studying the relationships between properties and structure of polymeric materials in the condensed phase (mainly for semi-crystalline systems) by examining the influence of the structure of the polymer chains (constitution and configuration) and that of the morphology resulting from the thermo-mechanical history to which the material is subjected to. Numerical exercises are planned too in the Calculation Laboratory for the determination of molecular and structural parameters using appropriate models		
Propaedeutcities: None		
Is a propaedeuticity for: None		
Types of examinations and other tests: Written and/or oral tests in progress. Final written and/or oral exam. Possible computer exercises.		

Course: Methods of Characterization of Polymeric Materials		Teaching Language: Italian/English
SSD (Subject Areas): CHEM-04/A		CREDITS: 6 (4 CFU lectures + 2 CFU LAB)
Course year: II	Type of Educational Activity: B	
Teaching Methods: Lectures (in person) + Lab (In person)		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The SSD is interested in scientific and educational - training activities in the field of science and technology for the sustainable industrial development of chemical and energy products, materials and processes, through the definition of principles and the study of thermodynamic aspects, kinetic, catalytic and technological related to them. [...] The sector also deals with the synthesis, reactivity and modification of polymeric, functional, hybrid and composite materials, with particular attention to the issues of circularity and valorisation of resources and is also interested in the chemical and technological properties of polymeric materials, their characterization and structure-property relationships.		
Objectives: Acquisition of the main methods for the characterization of the structure and chemical-physical properties of polymers		
Propaedeuticities: None		
Is a propaedeuticity for: None		
Types of examinations and other tests: Discussion of laboratory reports. Power point presentation (also for groups) relating to the exercises carried out (in Italian or English). Oral exam		

Course: Chemical technologies for the circular economy of polymers		Teaching Language: Italian/inglese	
SSD (Subject Areas): CHEM-04/A		CREDITS: 5 (lectures)+ 1 credit of labs	
Course year: I/II	Type of Educational Activity: C		
Teaching Methods: Lectures in presence and laboratory			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector is interested in scientific and educational-training activities in the field of science and technology for [...] industrial development of products, materials and chemical processes [...], through the definition of the principles and the study of [...] technological aspects related to them. The disciplinary scientific sector also deals with the [...] reactivity and modification of polymeric materials, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorization of resources and is also interested in chemical and technological properties of polymeric materials, their characterization and structure-property relationships.			
Objectives: The course aims at providing Students with skills necessary to understand the polymer properties to be used in a circular economy. The existing chemical processes combined with the new target design of materials from scratch will be analyzed. General rules for inserting polymeric materials in the circular economy will be reported. The main technologies for recycling polymeric materials will be critically reviewed with emphasis on the industrial targets.			
Propaedeutcities: None Is a propaedeuticity for: None			
Types of examinations and other tests: Oral exam and evaluation of the reports for the laboratory experience.			

Educational Curriculum: Industrial Formulations (B or C)

Course: Physical Chemistry of Materials		Teaching Language: Italian / English	
SSD (Subject Areas): CHEM-02/A		CREDITS: 6 CFU	
Course year: First		Type of Educational Activity: Elective	
Teaching Methods: In person			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The proposed teaching is fully consistent with the CHEM-02 declaration in the following points: educational and training activities related to the fundamental phenomena underlying chemical processes, the study and development of theoretical and computational models and methodologies for the interpretation and prediction of the behavior of complex systems, including molecular materials, in the fields where chemical sciences operate			
Objectives: The main objective of the course is to provide an exhaustive overview of the physico-chemical properties of condensed matter at both microscopic (periodic crystal and electronic structure, defects, ionic, covalent and metallic bonds) and macroscopic (optical, magnetic, catalytic, electric, thermal, mechanic) levels and of their assessment through experimental and theoretical/computational techniques			
Propaedeutcities: None			
Is a propaedeuticity for: None			
Types of examinations and other tests: Oral test			

Course: Formulation Industry		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-04/A		CREDITS: 6
Course year: II	Type of Educational Activity: B	
Teaching Methods: Lectures, in presence and laboratory		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The scientific disciplinary sector is interested in scientific and didactic-training activities in the field of science and technology for the sustainable industrial development of products, materials and chemical processes and for energy, through the definition of principles and the study of the thermodynamic, kinetic, catalytic and technological aspects related to them. He deals with the sustainable development, optimization and management of industrial processes with particular attention to the related problems of technologies for the reduction of environmental impact and the purification of emissions, the design of eco-compatible materials, the analysis and management of the safety of products and chemical processes, the structure and integration of industrial production in the chemical sector.		
Objectives: The aim of the course is to provide all the information necessary to develop and stabilize industrial formulations, i.e. all the industrial equipment useful for formulations. In particular, it will have to be able to develop heterogeneous and homogeneous sustainable formulations. At the end of the course, he/she must also have the ability to fill in the safety data sheet of a new formulation.		
Propaedeuticities: None Is a propaedeuticity for: None		
Types of examinations and other tests: Final oral exam and discussion of a project.		

Course: Polymer formulations		Teaching Language: Italian / English	
SSD (Subject Areas): CHEM-04/A		CREDITS: 5 (lectures) + 1 (laboratory activity)	
Course year: II	Type of Educational Activity: B		
Teaching Methods: Lectures in presence and laboratory			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector is interested in scientific and educational-training activities in the field of science and technology for [...] industrial development of products, materials and chemical processes [...], through the definition of the principles and the study of [...] technological aspects related to them. The disciplinary scientific sector also deals with the [...] reactivity and modification of polymeric materials, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorization of resources and is also interested in chemical and technological properties of polymeric materials, their characterization and structure-property relationships.			
Objectives: The course aims at providing Students with skills necessary to critically evaluate industrial issues related to preparation and characterization of formulations of polymers and their mixtures to obtain products with targeted properties by using different fabrication techniques. The Student needs to know recent advances in polymer blending technology and in type and role of additives in polymer-based formulations for applications involving materials with high resistance to impact, abrasion, fracture, surface coating and materials for special uses.			
Propaedeuticities: None Is a propaedeuticity for: None			
Types of examinations and other tests: Oral exam and evaluation of the reports relating to the laboratory exercises.			

Course: Lab of Industrial Formulations		Teaching Language: Italian/English
SSD (Subject Areas): Mod. A: CHEM-02/A Physical Chemistry Mod. B: CHEM-04/A Industrial Chemistry		CREDITS: 6 CFU Mod. A: 3 CFU (1 LF + 2 LAB) Mod. B: 3 CFU (1 LF + 2 LAB)
Course year: II	Type of Educational Activity: C (caratterizzanti/affini o integrativi)	
Teaching Methods: In person and lab practices		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The teaching is consistent with the following points of the SSD CHEM-02/A declaratory: "[...] expertise covers the fields [...] of nanosystems, liquid and solid state including interfaces and surfaces, soft matter [...], and areas such as materials science, [...]. Thermodynamics [...] spectroscopy [...] and preparations enable the characterization and interpretation of the properties of complex systems and their temporal evolution [...]. The study and use of knowledge considers levels, ranging from basic to applied-industrial research, in which there is data processing [...] and their understanding in terms of molecular properties [...]." The teaching is consistent with the following points of the declaratory of SSD CHEM-04/A : "[...] scientific and educational activity in the field of science and technology for the sustainable industrial development of products [...] through the definition of principles and the study of thermodynamic, kinetic, catalytic and technological aspects related to them. It is also concerned with the techno-economic evaluation aspects of materials and processes. It deals with the sustainable development, optimization and management of industrial processes [...]. It deals with special attention to the related issues of technologies for [...] the analysis and management of the safety of chemical products and processes."		
Objectives: The training aims to develop specialized skills in the area of design, preparation and characterization of industrial formulations. In the field of aqueous-based formulations, using case studies of applicative interest, the student will learn how to exploit intermolecular interactions between components, with particular emphasis on self-aggregation of amphiphilic components, to achieve control of the structural, dynamic and functional properties of the product. In the field of nonaqueous formulations, the student will evaluate the influence of the use of additives on the technological properties of the final formulation of products of industrial interest. All characterizations will be carried out taking into account the industry reference standards. Case studies will be covered in both modules which concern the typical sectors of industrial formulations, from detergents to cosmetics, from cements to the addition of polymers in the process phase, from lubricants to paints, binders, surface coatings and many others.		
Propaedeuticities: None		
Is a propaedeuticity for: None		

Types of examinations and other tests:

Oral tests

Elective courses (TAF D).

Course: Solids Thermoconversion Processes for Energy Production		Teaching language: Italian / English
SSD (Subject Area): ICHI-02/A		Credits: 6
Course year: II	Type of educational activity: D (optional)	
Teaching methods: Lectures and numerical exercises.		
Contents extracted from the SSD declaratory consistent with the training objectives of the Course: The disciplinary scientific sector includes the study of methodologies for the design, construction, verification and operation of industrial plants based on transformations [...] of matter aimed at the production of goods [...] and the prevention or mitigation of modifications to environment [...]. The following are qualifying: plant design [...], the development of quantified process diagrams [...]; the assessments [...] of sustainability and environmental impact also examined in the context of industrial ecology. Reference sectors are [...] technologies to support environmental protection and the circular economy.		
Objectives: The Student must demonstrate knowledge, ability to understand and ability to develop even complex discussions concerning the problems relating to the use of alternative solid fuels, combustion and gasification processes with removal of gaseous pollutants (e.g.: SO ₂ , CO ₂), reuse of ashes and use of innovative technologies for reducing the environmental impact of chemical processes also with a view to the circular economy. This starts from the notions learned here and through the educational path of the Course, which intends to provide the Learner, in a specialised way, with the appropriate knowledge and methodological tools, also through case-study analysis, to solve conceptual and project problems relating to combustion and gasification processes of alternative solid fuels, with attention to gaseous and solid pollutants produced.		
Propaedeuticities: -		
Is a propaedeuticity for: -		
Types of examinations and other tests: Final oral exam consisting of a presentation on an assigned project paper.		

Course: Biopesticides for sustainable agriculture		Teaching Language: Italian / English	
SSD (Subject Areas): CHEM-05/A		CREDITS: 6 CFU	
Course year: II		Type of Educational Activity: D	
Teaching Methods: In-person			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The proposed course is fully consistent with the CHEM-05/A declaratory in the points: “The scientific disciplinary field is interested [...] in the study of carbon compounds, both of natural and synthetic origin.” “The following are the object of study: [...] structural characterization of organic substances and structure-reactivity relationships. It deals with the isolation of organic substances of animal, plant and marine origin, including those with biological activity, the determination of their structure including stereochemistry as well as the development of methods suitable for this purpose and their synthesis.” “The group also looks at the effect of organic molecules on the environment, and the circularity and sustainability of processes involving organic compounds.”			
Objectives: The course aims to provide knowledge on the structure-reactivity relationships of the most important classes of natural organic substances and their potential use for the development of environmentally sustainable biopesticides. In addition, the teaching aims to provide knowledge: a) on the structure and stereochemistry of organic compounds that can be used to increase production, defense and conservation of agricultural and forestry heritage; b) on the scale-up of promising biopesticides and their formulation aimed at application in the agri-food industry and for the protection of the environment and cultural heritage. Upon completion of the course, students must demonstrate that they have acquired the tools to independently solve problems concerning the structure, stereochemistry, nomenclature and biosynthesis of natural bioactive organic substances. Students must be able to predict the structure-function relationship of the major classes of organic compounds and the structural modifications necessary to increase and/or modulate their biological activity and specificity.			
Propaedeuticities: None			
Is a propaedeuticity for: None			
Types of examinations and other tests: Oral interview. Discussion of laboratory reports.			

Course: Processes and Plants for the Treatment of Gaseous Effluents		Teaching Language: Italian / English
SSD (Subject Areas): ICHI-02/A		CREDITS: 6
Course year: II	Type of Educational Activity: D (optional)	
Teaching Methods: Lectures and numerical exercises, in presence		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector includes the study of methodologies for the design, realisation, verification and operation of industrial plants based on transformations [...] of matter aimed at [...] mitigation of changes to the environment [...]. The following are qualifying: plant design [...], [...] sustainability and environmental impact assessments [...]. Reference sectors are [...] technologies supporting environmental protection [...].		
Objectives: The student must demonstrate knowledge, understanding and being able to elaborate even complex discussions concerning the problems relating to the removal of both particulate matter and gaseous pollutants from gaseous streams. This will be achieved starting from the notions learned here and through the training path of the Course that intends to provide, in advanced way, the Learner with the appropriate knowledge and methodological tools, also through applications to case studies. The student must demonstrate the ability to solve conceptual and design problems related to gaseous waste treatment processes for the removal of solid and gaseous pollutants.		
Propaedeutcities: None		
Is a propaedeuticity for: None		
Types of examinations and other tests: Final oral exam consisting of a report on an assigned project paper.		

Course: Design of Experiments for laboratory studies and formulations development		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-04/A		CREDITS: 6
Course year: II	Type of Educational Activity: D (optional)	
Teaching Methods: Lectures and numerical exercises		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector is focused on scientific and educational-training activities in the field of science and technology for the sustainable industrial development of chemical products, materials, and processes defining principles and studying of thermodynamic, kinetic, catalytic and technological aspects related to these areas. It is also interested in techno-economic evaluation of materials and processes. It deals with the sustainable development, optimization and management of industrial processes.		
Objectives: The course aims to provide students with the skills to design experiments in the field of a generic laboratory study, particularly focusing on industrial formulations, identifying the essential parameters needed to achieve specific final characteristics. Students are expected to demonstrate ability in basic statistical techniques for processing and interpreting data, and to be able to analyze real cases of experimental design for laboratory studies and formulations.		
Propaedeutcities: None Is a propaedeuticity for: None		
Types of examinations and other tests: Final oral exam and discussion of a project.		

Course: Polymerization catalysis		Teaching Language: Italian	
SSD (Subject Areas): CHEM-04/A		CREDITS: 5 (lectures) + 1 (laboratory activity)	
Course year: I/II	Type of Educational Activity: D		
Teaching Methods: Lectures in presence and laboratory			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector is interested in scientific and educational-training activities in the field of science and technology for [...] industrial development of products, materials and chemical processes [...], through the definition of the principles and the study of [...] technological aspects related to them. The disciplinary scientific sector also deals with the [...] reactivity and modification of polymeric materials, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorization of resources and is also interested in chemical and technological properties of polymeric materials, their characterization and structure-property relationships.			
Objectives: The course aims at providing Students with skills necessary to critically evaluate the enantioselective polymerization catalysis promoted by heterogeneous and homogeneous transition metal catalysts. The scope is to develop tools for understanding the enantioselective polymerization mechanisms combined with the relationships between catalyst structure/polymer properties. Examples of enantioselective ring open polymerization (ROP) will be also discussed stressing the peculiar difference with the traditional enantioselective catalysis.			
Propaedeuticities: None Is a propaedeuticity for: None			
Types of examinations and other tests: Oral exam and evaluation of the reports for the laboratory experience.			

Course: Physical Chemistry of Materials		Teaching Language: Italian/English	
SSD (Subject Areas): CHEM-02/A		CREDITS: 6 CFU	
Course year: First		Type of Educational Activity: D	
Teaching Methods: In person			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The proposed teaching is fully consistent with the CHEM-02 declaration in the following points: educational and training activities related to the fundamental phenomena underlying chemical processes, the study and development of theoretical and computational models and methodologies for the interpretation and prediction of the behavior of complex systems, including molecular materials, in the fields where chemical sciences operate			
Objectives: The main objective of the course is to provide an exhaustive overview of the physico-chemical properties of condensed matter at both microscopic (periodic crystal and electronic structure, defects, ionic, covalent and metallic bonds) and macroscopic (optical, magnetic, catalytic, electric, thermal, mechanic) levels and of their assessment through experimental and theoretical/computational techniques			
Propaedeuticities: None			
Is a propaedeuticity for: None			
Types of examinations and other tests: Oral test			

Course: Polymer crystallography		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-04/A		CREDITS: 6
Course year: II	Type of Educational Activity: D	
Teaching Methods: Lectures in presence		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The disciplinary scientific area is interested in scientific and educational - training activities in the field of science and technology [...] of products, materials [...], through the definition of the principles and the study of the thermodynamic, kinetic, catalytic and technological aspects related to them. The disciplinary scientific area also deals with the synthesis, reactivity and modification of polymeric materials [...] and is also interested in the chemical and technological properties of polymeric materials, their characterization and structure-property relationships.		
Learning objectives: Objective of the course is to provide students with a complete overview of the methods for the determination of the crystal structure of polymers by X-ray and electron diffraction and computational methods for the determination of the conformation and packing of macromolecules in polymer crystals and for the simulation of the diffraction patterns through calculations of the structure factors of models of the crystal structure.		
Pre-requisites: None		
It is a pre-requisite for: None		
Types of examinations and other tests: Oral exam		

Course: Dynamics and rheology of polymers		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-04/A		CREDITS: 6
Course year: II	Type of Educational Activity: D	
Teaching Methods: Lectures (in person)		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: “The sector also deals with the synthesis, reactivity and modification of polymeric, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorisation of resources and is also interested in the chemical and technological properties of polymeric materials, their characterization and structure-property relationships.”		
Objectives: Study of the dynamics of macromolecules in bulk and in solution: viscoelasticity, Rouse model, reptant chain model and relaxation times. Model of the chain in the tube. Scaling laws of the longest relaxation time as a function of the length of the chains. Mechanical tests on the theory of reptation. Spectroscopic techniques for analyzing the structure and dynamics of macromolecules in solution and in mass: NMR and scattering techniques.		
Propaedeuticies: None		
Is a propaedeuticity for: None		
Types of examinations and other tests: Written and/or oral tests in progress. Final written and/or oral exam. Possible computer exercises.		

Course: Introduction to Nuclear Magnetic Resonance of Solids		Teaching Language: Italian /English	
SSD (Subject Areas): CHEM-04/A		CREDITS: 6	
Course year: III		Type of Educational Activity: D	
Teaching Methods: Lectures (in person)			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: “The sector also deals with the synthesis, reactivity and modification of polymeric, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorisation of resources and is also interested in the chemical and technological properties of polymeric materials, their characterization and structure-property relationships.”			
Objectives: The course intends to provide the necessary foundations for those who intend to use NMR spectroscopy for the solid state to solve problems in Chemistry and Materials Science, from a structural point of view, but above all with regards to aspects relating to the segmental dynamics of macromolecules.			
Propaedeuticities: None			
Is a propaedeuticity for: None			
Types of examinations and other tests: Written and/or oral tests in progress. Final written and/or oral exam. Possible computer exercises.			

Course: Polymers for biomedical applications		Teaching Language: Italian / English	
SSD (Subject Areas): CHEM-04/A		CREDITS: 6	
Course year: II	Type of Educational Activity: D		
Teaching Methods: Lectures (in-person)			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector is interested in scientific and educational-training activities in the field of science and technology [...] of products, materials [...], through the definition of the principles and the study of [...] technological aspects related to them. The disciplinary scientific sector also deals with the synthesis, reactivity and modification of polymeric materials [...] and is also interested in chemical and technological properties of polymeric materials, their characterization and structure-property relationships.			
Objectives: The course aims at providing students with advanced notions related to the most used synthetic and natural polymeric materials for the fabrication of biomedical devices. The main objective is the study of the relationships between chemical composition, structure and properties of polymers and their final biomedical application. Departing from notions he/she has studied during the course, the Student needs to show ability to select and/or design biocompatible polymers having tailored properties for a specific biomedical application (such as fabrication of scaffolds for tissue engineering and drug delivery systems).			
Propaedeutcities: None Is a propaedeuticity for: None			
Types of examinations and other tests: Oral exam			

Course: Computational methods for reactions of industrial interest		Teaching Language: Italian
SSD (Subject Areas): CHEM-04/A		CREDITS: 6 (lectures)
Course year: I/II	Type of Educational Activity: D	
Teaching Methods: Lectures in presence		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The disciplinary scientific sector is interested in scientific and educational-training activities in the field of science and technology for [...] industrial development of products, materials and chemical processes [...], through the definition of the principles and the study of [...] technological aspects related to them. The disciplinary scientific sector also deals with the [...] reactivity and modification of polymeric materials, functional, hybrid and composite materials, with particular attention to the problems of circularity and valorization of resources and is also interested in chemical and technological properties of polymeric materials, their characterization and structure-property relationships.		
Objectives: The course aims at providing Students with skills necessary to use the computational methods for chemical reactions of industrial interest. The basic knowledge of the most common computational approach will be combined with the use of molecular descriptor and machine learning techniques. Several molecular descriptors will be explained focusing on the most reliable use for the (various) chemical reactions of industrial interest.		
Propaedeuticities: None Is a propaedeuticity for: None		
Types of examinations and other tests: Oral exam.		

Course: Exercises and Practices of Physical Chemistry of Formulations		Teaching Language: Italian / English
SSD (Subject Areas): CHEM-02/A Physical Chemistry	CREDITS: 6 CFU (3 LF + 3 LAB)	
Course year: II		Type of Educational Activity: D
Teaching Methods: Lectures + Lab (In person)		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The teaching is consistent with the following points of the SSD CHEM-02/A declaratory: "The sector is concerned with the study and development of [...] experimental models and methodologies, with applications to production and preparation technologies [...] of materials [...]. In particular, expertise covers the fields [...] of nanosystems, liquid and solid state including interfaces and surfaces, "soft" matter [...], and areas such as materials science [...]. Thermodynamics [...] spectroscopy [...] and preparations enable the characterization and interpretation of the properties of complex systems and their temporal evolution [...]. The study and use of knowledge considers levels, ranging from basic to applied-industrial research, in which there is data processing [...] and their understanding in terms of molecular properties [...]."		
Objectives: The course aims to develop specialized knowledge and skills in the area of preparation and structural/dynamic characterization of mono- and multiphase formulations. Through laboratory practice, the student learns how knowledge of the principles and characterization methodologies inherent in the physical chemistry of colloids and interphases enables understanding of the composition-structure-property relationship of formulations, forming the basis for their rational design.		
Propaedeuticities: none		
Is a propaedeuticity for: None		
Types of examinations and other tests: Oral tests		

Course: Chemistry of Advanced Materials		Teaching Language: Italian / English	
SSD (Subject Areas): CHEM-03/A		CREDITS: 6	
Course year:	Type of Educational Activity: D		
Teaching Methods: Lectures			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Development of synthesis methodologies [...]the structural, spectroscopic, electrochemical and functional characterization of [...]inorganic,[...] supramolecular and nanostructured materials. Furthermore, through experimental and theoretical-computational methods, structure-property relationships are studied [...]. The study, the general area of interest[...]consider levels ranging from basic research to applications in all sectors of chemistry, including energy.			
Objectives: Synthetic, structural, chemical-physical aspects and the potential applications of some classes of advanced materials will be illustrated, with particular regard to those for applications in electronics and photonics.			
Propaedeutcities: none Is a propaedeuticity for: none			
Types of examinations and other tests: oral exam			

Course Environmental Chemistry and Sustainability		Teaching Language: Italian / English
SSD (Subject Areas): CHIM/12-CHIM/01		CREDITS: 6
Course year: II	Type of Educational Activity: D	
Teaching Methods: Lectures (in-person)		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: "The sector studies chemical substances and their transformations in the context [...] of environmental recovery [...] with a systemic vision through experimental and modeling approaches. It is interested in the development and application of diagnostic methods for the characterization of environmental matrices."		
Learning objectives: The aim of the course is to provide knowledge of the chemistry of the environment and the natural and anthropic processes that can modify it; moreover, hints are given on the methodologies applied to optimize the use of natural resources and reducing the consumption of energy and raw materials.		
Pre-requisites: None Is a pre-requisite for: None		
Types of examinations and other tests: Discussion of student report, power point presentation and oral exam.		

Course: Principles of protein engineering for cell factories		Teaching Language: Italian
SSD (Subject Areas): BIOS-07/A		CREDITS: 6 CFU
Course year: I	Type of Educational Activity: D (optional)	
Teaching Methods: Lectures in presence		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The proposed course is fully consistent with the BIOS-07/A declaration in the points: [...] Biochemistry investigates the molecular mechanisms of the functions of cells, tissues and organs; [...] Biochemistry studies all biological processes at the molecular level, the structure, properties, intracellular localizations and functions of biomolecules [...], peptides and protein macromolecules, nucleic acids [...]; Biochemical knowledge is crucial for the construction of in vitro and in vivo models, for the engineering of biological systems and synthetic biology.		
Objectives: The course aims to give students a different approach to the study and acquisition of the basics of the molecular organization of the cell, of bioinformatic strategies for the design, of molecular biology for the construction and industrial use, of proteins engineered with new characteristics (stability, reaction specificity, etc.). Some model cases selected from the most recent literature will be proposed. Starting from the discussions during the lectures on all the topics covered: 1) on the molecular and cellular organization of prokaryotic and eukaryotic organisms, 2) on the different types of microscopes that can be used, 3) on the production of recombinant proteins for industrial application purposes, the student will have at their disposal all the tools to be able to independently proceed with subsequent in-depth studies, drawing mainly from the recent scientific literature available online (scientific articles, reviews, etc.).		
Propaedeuticities: None		
Is a propaedeuticity for: None		
Types of examinations and other tests: oral exam Oral exam		

Course: Process Intensification		Teaching Language: English/Italian	
SSD (Subject Areas): CHEM-04/A		CREDITS: 6	
Course year: II		Type of Educational Activity: Lectures (6 CFU)	
Teaching Methods: In-person			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course focuses on the development of chemical processes, through the study of thermodynamic, kinetic, catalytic, and technological aspects related to the synthesis of chemical products of industrial interest, industrial development, optimization and management of processes and related environmental impact and safety issues.			
Objectives: To provide students with the elements for a design of heterogeneous catalysts, structured and optimized, which allow the abatement of diffusive phenomena inside and outside the catalyst itself. The student will be able to design of innovative reactors and reactive equipment, which also involve separation processes.			
Propaedeuticities: None			
Is a propaedeuticity for:			
Types of examinations and other tests: Oral exam			

Course: Rheology		Teaching Language: Italian	
GSD (Subject Areas): ICHI-01/B		CREDITS: 6	
Course year:	Type of Educational Activity: D		
Teaching Methods: In-person			
Contents extracted from the SSD declaratory consistent with the training objectives of the course: “The study, by using thermodynamics, chemical kinetics, reactions engineering, transport phenomena, rheology and energetic analysis of processes and products life cycle, and artificial intelligence, focuses on single process operations and unit operations at multiscale level, and their reorganization within a unifying vision of process intensification”			
Objectives: The course aims to: 1) illustrate the phenomenology related to the rheological behavior of Newtonian and non-Newtonian fluids, 2) provide useful tools for the rheological characterization of such fluids, 3) provide tools for the quantitative treatment of flow problems of interest in processes.			
Propaedeutcities: None			
Is a propaedeuticity for: None			
Types of examinations and other tests: Discussion of laboratory reports. Oral exam			