Economics and business management [3204104]

Offerta didattica a.a. 2025/2026

Docenti: NICOLA GRECO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

The course aims to provide the essential knowledge of economics and management necessary to orient oneself in the world of projects, businesses and markets.

KNOWLEDGE AND ABILITY TO UNDERSTAND
The course is structured with the aim of familiarizing the student with the preparatory concepts and application knowledge necessary for understanding the industrial, economic and financial processes characteristic of the activity of industrial companies

APPLICATION CAPABILITIES
At the end of the course the student will have developed a holistic vision of the world of Business, will have learned the basic tools for comparing project alternatives, for Feasibility Studies, for understanding and drafting Industrial Plans, for knowing how to read and interpret the Corporate Communication Tools, Organizational Models, Financing, and will have learned the essential elements of Financial Mathematics, Financial Equivalence, Capital and Interest, Project Finance.

AUTONOMY OF JUDGMENT
The critical approach to problems and the understanding of the complex elements that supervise the work of the company that works "by order" (Project Based Enterprise) are implemented above all with the aim of strengthening the student's autonomy of judgment in dealing with contexts also problematic

COMMUNICATION SKILLS
A specific module is contained and addressed in the course relating to oral and written communication, the related principles and applications, the importance of "Public Speaking", the ability to deal with and communicate topics in clear and comprehensive terms.

LEARNING SKILLS
The multidisciplinary method of approaching problems is the basic element of a growing ability to learn the contents and processes proposed.

SDG's
SDG 5. Gender equality
SDG 8. Decent work and economic growth
SDG 10. Reduced inequalities
SDG 12. Responsible consumption and production

Prerequisiti

No prerequisites

Contenuti del corso

Basic notions of Business
- Enterprises, Market, Economic Balances
- Fixed and variable costs ; marginal costs and revenues ;
- Elasticity

Companies:
- Industrial companies ; "project based" companies; Stakeholders and tools of communication; Shareholders; Governance. Organization Principles and models.
- Elements of Financial Mathematics. Financial Equivalence. Internal Rate of Return (IRR) ; Net Present Value (NPV) ; Discounted Cash Flows (DCF) . Perpetual Income.

- Enterprise analysis: processes, products, market, organization; economic and financial analysis. Evaluation of enterprises: economic criteria, comparative criteria, financial criteria.
- Start up and Spin off . Acquisition, Merger and Demerger.
- Responsibility of the enterprises. Ethical code, Monitoring Authority, Social Responsibility. Sustainability. Structures of financing for projects and enterprises. Project Financing.
- Business plans
- International competition. National and International Contracting. Structures of the contracts. Risks, mitigations and recourse (guarantees).

Projects:
- Overview and basic concepts.
- Projects Risk analysis/assessment and Project risk management.
- Project Management. Project Control. Construction Management. Crisis Management.
- Preliminary evaluations, “information memorandum”, evaluation criteria for the cost of the projects, cost of materials, cost of construction, cost of products and utilities, cost of services, amortization, cash flow analysis, selection criteria. Planning and Scheduling.

The Chemical Engineer
- Main characteristics of the industrial scenarios, professional courses.
- “Experts” and “Managers”.
- The team work.
- Case study: analytic evaluation of the cost of a process plant.

Insights :
1. Economics

The figures of the Sustainability for the Chemical Engineer Paris 2015 and U.N. Sustainability Goals
ESG Funds
The Enterprise Acquisitions and the Private Equity

2. Companies

Porter : Value Chain ; “Five Forces” model ; “Three generic strategies” tool BCG Matrix ; Ansoff matrix
Internal Control and Risk Management Systems ; Internal Audit Corporate Governance
“FIDIC” Contracts

3. Projects

Schemes and Flows of the main activities :
• Process
• Engineering
• Procurement
• Construction
• Start-up

Metodi didattici

Lectures about the topics of the course and tutorials showing their applications (in particular, about the methods for estimating the cost of a Process Plant).

Modalità di verifica dell'apprendimento

The learning will be assessed via a written test followed by a discussion. The written test , for an overall length of about 2 hours, is represented by a numeric exercise based on a “Business case" involving calculations of Financial Mathematics + 10 questions, out of which a certain number are multiple answer quiz .
The oral test, for an overall length of about 30 – 45 ‘ involves 2 questions referred to the course program, out of which one on topics involving the themes of “Companies” and the other referred to “Projects”. One of the two questions is chosen by the student.

Criteria for measuring learning and attributing the final grade:
The mark, expressed in thirtieths, will be equal to the sum of the mark obtained in the written test, with a maximum of 20/30, and the oral test, with a maximum of 10/30. For the evaluation of the oral exam, the understanding of the concepts underlying the various topics will be considered prevalent with respect to the completeness of the discussion, to take into account the relative diversity of the teaching contents compared to the main educational path of the degree course, and to favor the maturation of a conscious thematic curiosity regarding rote learning.During the lectures the students are often requested to develop, even in groups, practical applications for the purpose of testing the knowledge obtained, and the ability to apply them.

Testi di riferimento

- Teacher’s Handouts
- -La Bella A., Battistoni E., Economia ed Organizzazione Aziendale, APOGEO.
- -Mankiw, Taylor, Ashwin PRINCIPI DI ECONOMIA PER L'IMPRESA, Ed. Zanichelli
- -Mintzberg H., Mintzberg on Management, The Free Press NY.
- -Imperatori G., Il Project Financing, Ed. Il Sole 24 Ore.
- -Balestri G., Il Bilancio di Esercizio, Ed. HOEPLI

Altre informazioni

At the end of the course the student will be able to identify the key factors of the Company's Value Creation, and understand the KPIs (Key Performance Indicators). They will be able to interpret the essential elements of the financial statements, and will be able to participate in teams responsible for drafting studies feasibility and industrial plans. You will know the elements of financing, with particular regard to Project Finance, and will be able to properly use the financial mathematics formulas necessary for this.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	comune	9	ING-IND/35

Stampa del 06/11/2025

Green chemistry and sustainability [3204103]

Offerta didattica a.a. 2025/2026

Docenti: MARCELLA TROMBETTA, MARTA BERTOLASO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

The course introduces the innovative themes of "Green Chemistry" which represents a modern scientific and technological platform through which to develop efficient chemical processes from both a chemical and environmental point of view. Specific learning objectives are the exploitation of biomass, waste minimization, energy and environmental efficiency of a chemical process.
The course aims to train a Professional who carries out his activities aiming to respond to the following Sustainable Development Goals of the 2030 Agenda for Sustainable Development of the United Nations:
Goal 6: Ensure access to water and sanitation for all
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy
Goal 8. Promote inclusive and sustainable economic growth, employment and decent work for all
Goal 12: Ensure sustainable consumption and production patterns

KNOWLEDGE AND UNDERSTANDING
Green Chemistry is a set of knowledge useful in designing the construction of products, materials, and plants with a minimal impact on human health and on the environment.
Examples of successful green chemistry developments will be highlighted. The Student will be able to knowledge and understand the emerging concepts useful for guiding green chemistry, environmental toxicology, substitution of solvents and toxic chemicals, energy sources, process intensification and intrinsically safe processes, chemistry of the recycle of water, products and materials.

APPLICATION CAPABILITIES
At the end of the course, the Student will be able to apply the principles of green chemistry for the innovation of industrial processes, for the use of alternative raw materials, for the treatment and recycling of waste, and for the treatment and recycling of water in order to reuse it. At the end of the course, the Student will be able to classify the hazard of chemical products by defining safer transport and usage conditions.

Module B: Sustainability
The module forms the theoretical and ethical foundation for the sustainability issues addressed in the other courses. It represents the basis on which to build subsequent knowledge for a critical evaluation of the processes that are implemented at various levels and on different scales (from the molecular to the (eco)systemic and social in the field of Ecological, Digital and Social or Organizational Transitions.

KNOWLEDGE AND UNDERSTANDING
The aim is to make the student learn and deepen the basic philosophical, epistemological and ethical knowledge essential for the critical analysis of the processes that are implemented to meet the Sustainable Development Goals, with a particular focus on technological applications in living systems.
The course aims to provide knowledge and understanding on the theoretical principles of Human Ecology and Sustainability.

APPLICATION CAPABILITIES
At the end of the course, the student is able to use critical knowledge of the ongoing Transitions (ecological, digital, social) for the planning and design of sustainable interventions also from a social and ethical point of view.

Prerequisiti

Module A: Green Chemistry
Notions of mathematics, physics, thermodynamics, inorganic and organic chemistry.

Module B: Sustainability
None.

Contenuti del corso

Module A: Green Chemistry

Sustainability of raw materials and energy sources: renewable and not renewable resources, the 12 Principles of Green Chemistry and Green Engineering, tools and methodologies for the assessment of chemical, toxicological and environmental risk, green design of chemicals, polymers, and materials.
Water for industry, food and pharmaceuticals: the properties of water. The water cycle. Classification and analysis. Requirements and uses of water for industry, for human consumption, and for the pharmaceutical industry. Major industrial water treatment.
REACh and the EU chemicals Law: toxicology, hazard and exposure, toxicity risk assessment, safety: types of hazard, risk evaluation, prevention, mitigation, clean production, substitution of toxic/dangerous chemicals.
HAZMAT the transport of dangerous materials: Kemler and, Kemler-ONU, directives and regulations.
Improvement of environmental performance of existing industrial processes: green metrics, greener production of chemical commodities, materials, and fine chemicals from industry, BAT technologies and their European directives.
Energy: sources, efficiency, safety: fuel types and their environmental impact
Bio-refinery: transformation of conventional raw materials into commodities, biocatalysis, energy crops, biofuels, biotechnological applications.
Alternative solvents for Green Chemistry: VOC, supercritical fluids, ionic/eutectic liquids, gas expanded liquids, polymeric liquids.
Mechanical, thermal, and chemical recycling: regulations, classification and waste treatment, main types of recycling, and the controlled landfill.

Module B: Sustainability
Environment and sustainability: an integrated vision. Evolution of the concept of environmental ethics and sustainable development. Definitions of sustainability.
Human Ecology and Sustainability: man's relationship with himself, with the natural environment and the use of resources. The objectives of environmental protection and damage to the environment: the goals for sustainable development (SDGs).
Ethics of innovation: the notion of the common good, discussion of the PNRR and other Italian or European Documents.
Human Factor in Digital Transitions: from Human Enhancement Technologies to Smart Cities.
Circular Economy and Bioeconomy: possibilities and impossibilities of the circular economy.
One Health epistemology: towards an integration of processes. The notion of interfaces.
Governance in Complexity and the 6 principles of experimentation, systems thinking, participation, precaution, anticipation, and care.

Metodi didattici
Face-to-face lectures explaining the contents of the course and exercises-tutorials carried out to show their applications on specific problems: 48 hours.

Module B: Sustainability
The course is divided into lectures and seminars with the support of PowerPoint presentations and two hours with tutorials and auto evaluation exercises: 24 hours.

Modalità di verifica dell'apprendimento
Module A: Green Chemistry
The knowledge and skills relating of green chemistry will be verified by means of a test with multiple choice questions (henceforth test) to be carried out on the course page on the University's elearning platform.
In the test, the Student will have to answer 15 multiple choice questions in 20 minutes in which to demonstrate that they have acquired the following specific learning outcomes:
1) to know how to apply the principles of the green chemistry
2) to produce water depending on industrial application
3) to know how to control of environmental impact of chemical processes and products
4) to know the legislation on toxicity and sustainability (REACh and EU laws)
5) to manage the transport and labelling of hazardous materials
6) to know how to apply biotransformation and biotechnology
7) to perform solvent and feedstock selection for green chemistry
8) to know and to apply catalysis for sustainable chemistry
9) to know mechanical, thermal and chemical recycling
The 15 multiple choice questions are evenly distributed among the 9 points of the specific learning outcomes.
The quiz will be taken in person in the classroom on your own PC or tablet on the elearning page of the course under the 'Exams' section. The quiz must be completed in the 'SMOWL' monitoring dashboard, which will allow the teacher to verify the absence of infractions by each Student during the quiz. Infractions include the use of artificial intelligence platforms or other websites to search for answers to the questions.
The student will receive the result of his/her quiz as a score expressed in thirtieths 24 hours after the quiz itself, as 24 hours is the time required to receive the report from 'SMOWL' on any infractions committed by each Student. The student who has committed infractions recorded by 'SMOWL' will receive an email from the teacher with the report of the infractions he/she committed, and the exam will be declared 'not passed'.

Module B: Sustainability
The exam consists of an oral test. The acquisition of the theoretical contents presented during the course will be

evaluated, as well as the ability to expose them in a linear and structured way with precision of language, as well as the ability to apply them to practical examples.

Criteria for measuring learning and defining the final grade:
The assessment of learning involves the attribution of a final grade expressed in thirtieths.
The final grade of "Green Chemistry and Sustainability" will be the weighted average of the credits between the marks obtained in the 2 Modules. The final grade will be recorded in the student's university electronic report.

Module A: Green Chemistry
In the test, the student will have to answer 15 multiple choice questions in 20 minutes, of which:
- each question will have 4 answers (A, B, C, D) of which only one is corrected;
- only one answer can be selected for each question;
- points are assigned as follows: 2 (two) points for each correct answer; 0 (zero) points for each incorrect or not given answer.
Each test will be different from the other and assigned randomly by the system. The correction of the test and, therefore, the score achieved corresponding to the grade, is made by the elearning system for comparison with the correct answers loaded on the platform itself. Each Student will receive only his results and, therefore, the grade achieved. Each student will not receive the grade of the other students.
24 hours after the end of the quiz, in addition to the score obtained, the student will be able to review their quiz by checking which questions they answered correctly and which they did not, and in this case, they will learn the correct answers.
The exam is deemed to be passed successfully if the grade is equal to or higher than 18/30. The maximum score achievable with the test equal to 30/30.
The Module A is deemed to be passed successfully if the grade is equal to or higher than 18/30. The maximum score achievable with the test is equal to 30/30. In the event of a full grade (30/30), the student will have the opportunity to try to grant honors (cum laude) through an oral test. The oral test will be carried out immediately after the test result. In the oral test, 1 question will be asked to the student. This question aims to evaluating the logic followed by the student in problem solving, the use of an appropriate language in the answer to the question and, also, the adequacy of the proposed solution in relation to the skills that the student it is assumed that he has acquired at the end of the course. The oral test is worth 3 points. The Module A final grade is calculated adding or subtracting the 3 points of the oral test to the grade 30/30 gained by the test.

Module B: Sustainability
The exam consists of an oral test with a mark expressed in thirtieths and Module B of the exam will be passed if and only if a grade greater than or equal to 18/30 is obtained The maximum final grade is full grade with grant honors (30/30 cum laude).

Testi di riferimento
Module A: Green Chemistry
Before each lesson, the teacher will make available to the students, on the course page on the university's e-learning platform https://elearning.unicampus.it/, handouts specifically prepared on the topics covered in the course program. During the lectures, the handouts will be further explored together using an electronic whiteboard that will allow saving any additions/observations. The student will thus be able to review and deepen the topics covered and transform what they have learned in class into knowledge and what they have done during the lessons into skills and competencies. All the necessary teaching materials will be uploaded to the course page on the university's e-learning platform: handouts and reference regulations.
Teaching materials recommended for independent study by the Student interested in learning more about the discipline:
Bashir Ahmad Dar, Fayaz Ahmad Butt, Green Chemistry: A Concise Course, Kindle Edition
P.T. Anastas, J.C. Warner, Green Chemistry: Theory and Practice, Editore: Oxford Un. Press
L. Constable, D. Constable,, Green Chemistry Metrics: Measuring and Monitoring Sustainable Processes, Editore: Wiley
M. Doble, A.Kumar, Green Chemistry and Engineering, Editore: Academic Press

Modulo B: Sustainability
Any slides by the teacher, seminar lessons and articles will be distributed during the course.
Recommended teaching material for independent study by students interested in deepening the discipline:
Bertolaso, M., Marcos, A., (2023). Umanesimo tecnologico. Carocci
Boschetto et al (2024) Lo spazio oltre lo spazio, Rubettino
Bertolaso M, Kovacic Z (2024) Narrative per una società consapevole, Rubettino
Valera L (2013), Ecologia Umana: le sfide etiche della relazione uomo-ambiente, Aracne
C. Giuliodori, P. Malavasi, Ecologia integrale, 2016
S. Jasanoff, A. Benessia, S. Funtowicz, L'innovazione fra utopia e storia, Codice Edizioni, 2010
Bertolaso M, Marinucci A (2024) Le questioni aperte della vita. Epistemologia della complessità. Rubettino.

Altre informazioni
Module A: Green Chemistry

- Knowledge and understanding of the major issues related to sustainability
- Understanding of the basics of green chemistry/green engineering and recognize green chemical processes and products
- Understanding of the fundamental considerations on alternative energy sources
- Understanding of the nature, reactivity, and environmental fates of toxic organic chemicals
- Understanding of the biochemical basis of biological organisms and the importance of biomass as source of chemicals and energy
- Understanding of the recent trends in industry issues related to sustainability and safety with emphasis on national and international regulations.
- Understanding of the societal implications of some environmental problems and the green chemistry proposed solutions.
- Application of the principles of the green chemistry
- Ability to apply the concept of Inherent Safety
- Ability to produce water depending on industrial application and to its reuse
- Ability to control of environmental impact of chemical processes and products
- Ability to manage the security, transport and labelling of hazardous materials
- Ability to perform solvent and feedstock selection for green chemistry
- Ability to use mechanical, thermal, and chemical recycling

Module B: Sustainability
- Knowledge and understanding of the concepts of "ecology" and "sustainability", for the benefit of the individual, society and the environment as well as the link between human beings and the environment, in its biological, philosophical, anthropological, historical-social and economic-legal aspects.
- Ability to integrate an ecological and sustainable perspective into life and professional choices.
- Awareness of autonomy in professional action, i.e. the ability to judge, prudence and decisiveness in action, applying the principles of "ecology" and "sustainability"
- Have acquired communication and relational skills necessary to interact in the world of work
- Have acquired critical thinking skills as a key element to operate professionally within the Sustainable Development Goals of the UN 2030 Agenda for Sustainable Development, with particular attention to the following:
Goal 8. To promote lasting, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 11. Making cities and human settlements inclusive, safe, durable and sustainable.
Goal 12. Ensuring sustainable production and consumption patterns.
Goal 13. Promoting action at all levels to combat climate change.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	comune	9	CHIM/07, M-FIL/02

Stampa del 06/11/2025

Chemical Plants [3204102]

Offerta didattica a.a. 2025/2026

Docenti: DIEGO BARBA

Periodo: Ciclo Annuale Unico

Obiettivi formativi
The final goal is to provide the necessary tools for the analysis and the design of the chemical processes. The course aims to provide the tools of design and the methodologies of process analysis focused on the industrial plants of several sectors (Energy, Environmental, Water, Oil & Gas, Chemical, Biotechnology, Pharmaceutical, Agro, Food, etc.) in which the chemical engineer habitually works. The course's peculiarity is to propose additional elements of knowledge to consider the concept of sustainability of industrial processes.

KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims to provide knowledge of the unit operations (distillation, absorption, stripping, etc.) from thermodynamics to transport phenomena.

APPLICATION ABILITY
At the end of the course the student will be able to:
- design unit operations
- create process schemes with heat and material balances
- design main equipment
- develop the basis design of industrial utilities
- develop the basic of mathematical models for process simulation;
- define the control philosophy
- develop process schemes.

SDGs
• Goal 6. Clean Water & Sanitation. Ensure availability and sustainable management of water and sanitation for all.
• Goal 7. Affordable & Clean Energy. Ensure access to affordable, reliable, sustainable and modern energy for all.
• Goal 12. Responsible consumption and production patterns. Ensure sustainable consumption and production patterns.
• Goal 13. Climate Action. Take urgent action to combat climate change and its impacts.

Prerequisiti
none

Contenuti del corso
TRANSFER OF MOMENTUM: Thermodynamics applied to machines.
Distributed and concentrated pressure drops. Characteristic curve of a circuit. Centrifugal pumps (head, NPSH, power, characteristic curves), the design point, the problem of pumping. Pumps in series and in parallel. Centrifugal and axial compressors (head, power, characteristic curve). Multistage centrifugal compressors intercooled. Schemes with regulation and control for the installation of pumps and compressors.

HEAT TRANSFER: heat exchangers.
Heat transfer between phases: cocurrent and countercurrent. Film coefficients: natural and forced convection, Nussel theory for condensing films, McAdams theory for boiling films. Resistances in series and in parallel, global exchange coefficient U and its variation along time: fouling factor. Differential equation of the heat transfer and conditions of integrability.
Tube heat exchanger (shell & tube). Design and validation of exchanger with sensible heat. Design and validation of boilers, condensers and evaporators. Caulking computation. Process schemes with regulation and control for exchangers, condensers and evaporators.

MASS TRANSFER: columns and process schemes
Survey: molecular diffusion models, mass transfer coefficients. Types of packed and stage columns. Liquid-liquid columns fluid dynamics. Computation of discrete and continuous mass transfer. Plate and tower yield.
Distillation: multicomponent liquid-vapor equilibrium. Equilibrium single stage: variance. Binary systems,

multicomponent systems: short-cut methods. Variance and choice of process parameters.
Sorption - gas/liquid equilibrium. Single component transfer: isothermal and non isothermal case study. Variance and choice of the process parameters.
Liquid/liquid extraction - Ternary equilibria: analytical and graphical representation. Single equilibrium stage: variance. Equilibrium stages in simple and reflux counter-current. Variance and choice of process parameters.

HEAT AND MATERIAL TRANSFER: Humidification and dehumidification; Psychometry. Thermodynamics of gas-vapor mixtures. Continuous operation in packed bed. Cooling tower. Process flow diagram of industrial cooling systems.

PROCESS FLOW DIAGRAM: Typical Industrial Process Scheme:
• Series of Distillation columns.
• Absorption and stripping.
• Extractive distillation and stripping.
• Azeotropic distillation (binary-ternary).
• Liquid-liquid Extraction with recirculation of the extract component.
• Chemical reactor and downstream processes.
• Thermal valorisation of solid waste.
• Vacuum system process.
PROCESS FLOW DIAGRAM: Utilities
• Thermal and electrical energy production process (steam turbine cycle)
• Industrial cooling water: Air cooling tower
• Industrial cooling water: Refrigeration cycle

Metodi didattici
The Process Chemical Engineering Course is structured into lectures and numerical exercises.

Modalità di verifica dell'apprendimento
The knowledge and skills acquired during Process Chemical Engineering are tested through:
- a written exam, consisting of one exercise, lasting four hours;
- an oral examination based on two topics assigned to the student four hours before the interview.

Criteria for measuring learning and defining the final grade:
The judgment of assessment for the two tests (written and oral) is expressed as a grade of out of 30 and the exam is passed successfully if the final grade is equal or higher than 18/30. The assigned grade will be registered on the student book and on electronic record book.

Testi di riferimento
• Green D.W., Perry R.H., Perry's Chemical Engineers' Handbook 8th Ed., Mc Graw-Hill.
• Treybal R.E.,Mass Transfer Operations, Mc Graw-Hill.
• Kern D.Q., Process Heat Transfer, Mc Graw-Hill.
• Bibliografia aggiuntiva:
• Hewitt G.F., Shires G.L., Bott T.R., Process Heat Transfer, CRC Press.
• Sinnot R., Tower G., Chemical Engineering Design 5th Ed., Butterworth-Heinemann.
• Couper J.R., Penney Q.R, Fair J.R., Walas S.M., Chemical Process Equipment, Elsevier.

Altre informazioni
The learning process is organized in a way that, at the end of the course, the student is able to apply the basis of thermodynamics and mass transfer to the design of unit operations (distillation, absorption, etc..), to design the processes instrumented schemes with material and energy balances, to design the individual devices and to develop the mathematical simulation for analysing the process response to the variation of main operating parameters. These application capabilities are extended to the thematic areas of: momentum transfer, heat transfer, mass transfer, industrial processes.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	comune	9	ING-IND/25

Stampa del 06/11/2025

General English [32041C1]

Offerta didattica a.a. 2025/2026

Docenti: ADAM JAMES MARTIN, DOCENTE_FITTIZIO DOCENTE_FITTIZIO

Periodo: Primo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	comune	3	L-LIN/12

Stampa del 06/11/2025

Basics of chemical engineering [3204101]

Offerta didattica a.a. 2025/2026

Docenti: VINCENZO PIEMONTE

Periodo: Ciclo Annuale Unico

Obiettivi formativi
The course represents the cultural basis for the chemical engineer. It represents the very basis on which further knowledge can be built on, in order to realize the process analysis and develop the design of technologies and production systems in the following engineering fields: Energy, Environment, Biotechnology, Drug Industry, Food and Agricultural Industry, Oil & Gas, Petrol Chemistry.

KNOWLEDGE AND ABILITY TO UNDERSTAND

The main goal is to provide the student the physico-chemical and the engineering tools required for the analysis of case studies typical of chemical engineering practice.
The course aims to provide knowledge and understanding ability on fundamentals of chemical engineering

APPLICATION CAPABILITIES

At the end of the course the student will be able to manage advances knowledge on transport phenomena and thermodynamics useful to design and optimize industrial processes. Furthermore, the use of process simulators normally used in engineering companies will allow the student to become familiar with tools typical of the business world.

SDGs

Goal 6: Clean Water and Sanitation

Goal 7: Affordable and Clean Energy

Goal 12: Responsible Consumption and Production

Goal 13: Climate Action

Prerequisiti
Notions of Transport Phenomena, Thermodynamics of Phase Equilibria

Contenuti del corso
1) Fluid Phase equilibria (L-V ; G-L ; L-L): γ-φ and φ -φ approaches.
Theory of regular solutions, models resulting from the expansion of Whol, models based on the local composition, UNIFAC model.
Selection criteria of thermodynamic models and their implementation in process simulators

2) Thermodynamics of surfaces.
Theory of adsorption, adsorption isotherms, multicomponent adsorption.
Thermodynamics of irreversible processes applied to the membranes

3) Material transfer.
Diffusivity and Fick's law, convection and diffusion, convection and reaction, reaction and diffusion, efficiency factor.
Dimensionless analysis and order of magnitude
Macroscopic Balances, global exchange coefficients, theory of film, boundary layer theory, penetration theory.
Transport in multicomponent systems (concentrated systems).
Transfer through adsorbent beds, breakthrough curves, adsorption kinetics for multicomponent systems.
Transfer through membranes. Model of solution and diffusion (dense membranes), hydraulic permeability (porous membranes).

4) Microscopic and macroscopic momentum balances, Navier-Stokes equations, fluid dynamics and non-Newtonian fluids. Notes on turbulence

5) Energy balances, viscous friction
6) Coupled balances. Matter and energy balances: laws of humidification and dehumidification. Energy and momentum balances: natural convection.

Metodi didattici
Lectures and numerical exercises using dedicated process simulators.

Modalità di verifica dell'apprendimento
The verification of the acquired contents will take place through a written and oral exam. The written test consists in carrying out 2 exercises in the two macro-areas of the course, thermodynamics and advanced transport phenomena, aimed at evaluating the student's practical skills in problem solving. During the written test, it will also be necessary to use a process simulator, in order to verify the ability to apply the solution to complex problems. The oral exam, on the other hand, aims at assessing the student's ability to analyse and simplify complex problems

The grade obtained is expressed out of thirty and the exam will be passed only if a grade greater than or equal to 18/30 will be achieved. For the written test, each exercise will contribute to the determination of the grade with a weight of 50%. The written test has a total duration of 4 hours. The oral exam, on the other hand, has an average duration of 60 'and contributes to the final determination of the exam grade at 50%.
The grade obtained will be recorded in an electronic report

Testi di riferimento
Lecture notes
R.B. Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena 2nd Ed., John Wiley & Sons.
S.I. Sandler, Chemical, Biochemical and Engineering Thermodynamics

Altre informazioni
At the end of the course, the student will be able to:

1) Analyze complex chemical-physical systems
2) Understand the thermodynamics of fluid-phase equilibria
3) Understand the thermodynamics of surfaces
4) Understand the transport phenomena on which industrial processes are based
5) Apply thermodynamic equilibrium equations for the analysis and optimization of unit operations such as distillation, absorption, stripping, extraction
6) Apply surface thermodynamics for the sizing of adsorption columns and membrane separation modules
7) Apply material, energy and momentum balances for the analysis and optimization of industrial equipment and processes
8) Apply the dimensionless analysis of chemical-physical phenomena to determine the limiting behaviors of a system and carry out industrial scale-up
9) Use a process simulator, normally used in design companies, to solve complex problems

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	comune	9	ING-IND/24

Stampa del 06/11/2025

Biotech Processes [3204105]

Offerta didattica a.a. 2025/2026

Docenti: VINCENZO PIEMONTE

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The purpose of the course is to provide students with the tools for the analysis and design of bioreactors and the up-stream and down-stream processes that characterize industrial biotechnologies. The course, developed through the integration of the typical approach of biochemical engineering principles with process analysis, will provide the student with quantitative tools for evaluating and analyzing bioreactors and biotech processes.

KNOWLEDGE AND ABILITY TO UNDERSTAND

The course aims to provide knowledge and understanding of biotechnological processes in the pharmaceutical, agro-food, biorefining and circular economy fields.

APPLICATION CAPABILITIES

At the end of the course, the student is able to use advanced knowledge on the design of bioreactors and on the analysis, optimization and innovation of industrial biotechnological processes. The student will also be able to use advanced process simulators that will allow him to model and analyze complex unconventional processes

SDGs

Goal 6: Clean Water and Sanitation

Goal 7: Affordable and Clean Energy

Goal 12: Responsible Consumption and Production

Goal 13: Climate Action

Prerequisiti
Notions of Transport Phenomena

Contenuti del corso
1) Enzymatic Kinetics: Michaelis-Menten kinetics, effect of temperature, pH, enzymatic inhibition, multi substrate and multi product reactions
2) Enzyme Bioreactors: Bioreactors with free enzymes (batch, ultrafiltration bioreactor, dialysis bioreactor). Immobilization and enzyme entrapment techniques, kinetics of immobilized enzymes, diffusion problems, enzymatic efficiency. Tubular bioreactors with immobilized enzymes.
3) Cell growth kinetics: Monod kinetics, series and parallel growth, yield factors, primary and secondary metabolites
4) Cellular bioreactors: batch bioreactors, fed-batch, fermenters. Stability of fermenters, wash-out problem. Continuous aerobic and anaerobic bioreactors. Bioreactors with cellular aggregates, the concept of limiting oxygen. Outline of structured models and mixed populations. Bioreactors with recombinant cells.
6) Case Studies: production of drugs, production of biofuels and bioplastics.
7) Notes on Life Cycle Assessment of Biotech processes
8) Process analysis and sizing criteria of a bioreactor / fermenter: material transfer, heat transfer, mechanical stirring and crop aeration.
9) Process parameters and control criteria of the bioreactor / fermenter.
10) Sterilization process: thermal deactivation of the microorganism, sterilization of culture media, sterile filtration systems, air sterilization
11) Processes for product recovery and purification: biomass separation (filtration and centrifugation), primary product isolation (solvent extraction, adsorption, precipitation, membrane chromatography separation, electrophoresis)

Metodi didattici
The lessons will take place through frontal teaching aimed at providing the elements for the analysis and design of

bioreactors, and more generally of biotechnological processes, and through exercises, even in groups, to develop the skills of working in teams and dealing with solving real problems. The exercises will make use of process simulators dedicated to biotech processes

Modalità di verifica dell'apprendimento

The acquired contents will be verified through the preparation of a paper/project developed in groups of up to 4 people which will be the starting point for the oral exam questions. The practical test (written project) is aimed at evaluating the student's practical skills in problem solving as well as evaluating the soft skills developed during the course, especially in terms of team building and team leader. The oral exam instead aims above all at evaluating the ability to analyze and optimize industrial biotechnological processes

The grade obtained is expressed in thirtieths and the exam will be passed if and only if a grade greater than or equal to 18/30 is obtained. The project will contribute to determining 1/3 of the final grade. The oral exam instead has an average duration of 60' and contributes to the final determination of the grade for the remaining 2/3.
The grade obtained will be recorded on an electronic report.

Testi di riferimento

Lecture notes
J. E. Bailey, D. F. Ollis, Biochemical engineering fundamentals, McGraw-Hill, 1986.
D.Barba, F.Giacobbe, V. Piemonte, Elementi di Ingegneria di Processo Biotech, Dispense Universitarie

Altre informazioni

At the end of the course, the student will be able to:

1) Understand the basics of enzyme and cellular kinetics
2) Design Batch, Fed-Batch and Continuous Bioreactors typical of the Biotech industry
3) Design ventilation systems for aerobic bioreactors
4) Analyze and optimize biotech processes for the production of drugs, biofuels, and biopolymers
5) Design the separation and purification systems for the products expressed in the bioreactors
6) Analyze and optimize downstream processes of the Pharma and Biotech industry
7) Use advanced process simulators to build custom models of complex and unconventional processes

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	comune	9	ING-IND/24

Stampa del 06/11/2025

Energy and Environment Processes [3204106]

Offerta didattica a.a. 2025/2026

Docenti: MAURO CAPOCELLI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The final goal is to provide the engineering tools for the analysis and the design of the chemical processes in the energy sector with a focus on environmental protection.

KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims to provide knowledge of the main industrial processes related to energy production, industrial utilities and some selected examples in the sector of environmental chemical engineering.

APPLICATION ABILITY
At the end of the course the student will be able to:
- design process schemes with heat and material balances for energy production
- develop the basis design of industrial utilities
- define the technical and environmental performances of industrial processes
- define the main strategies of pollutant removal

SDGs
• Goal 6. Clean Water & Sanitation. Ensure availability and sustainable management of water and sanitation for all.
• Goal 7. Affordable & Clean Energy. Ensure access to affordable, reliable, sustainable and modern energy for all.
• Goal 12. Responsible consumption and production patterns. Ensure sustainable consumption and production patterns.
• Goal 13. Climate Action. Take urgent action to combat climate change and its impacts

Prerequisiti
none

Contenuti del corso
1. INTRODUCTION: Natural resources, Climate Change and Sustainable Development, Fundamentals of Thermodynamics for Engineering.
2. ENERGY PRODUCTION: Process flow diagrams for the production of electrical and thermal energy (steam cycle and gas turbine, combined cycle), cogeneration and steam distribution networks, Renewable Energies (solar thermal, wind, photovoltaic, geothermal, etc.), economic criteria for the evaluation of the LCoE
3. TREATMENT OF GASEOUS EFFLUENTS & CCS: Process Scheme & main equipment, technologies for pollutant removal (DeNOx, DeSOx, Particulate abatement), Technologies of Carbon Capture & Storage (CCS).
4. GAS PROCESSING: NATURAL GAS & IDROGEN PRODUCTION Sweetening processes; Treatment of acid gases and sulphur recovery (Claus-Scott); NG transport, Case studies of using methane as a precursor: Process of steam reforming for the production of syngas and hydrogen; Cryogenic Technologies. Thermochemical conversion of biomasses; syngas, biogas and hydrogen.
5. WATER TECHNOLOGIES: Water Characterization and water scarcity; Water Treatment & Reuse; thermal & membrane processes for desalination & Water reuse; water/energy dual purpose plants and water/energy nexus.
6. INDUSTRIAL COOLING & other utilities: refrigerators cycles; air cooling, cooling tower; psychrometric and air conditioning systems

Metodi didattici
The course is structured into lectures and numerical exercises. Some projects are developed by groups of three or four candidates. The final reports are presented and discussed in the classroom by the working groups at the end of the year. The student is guided in the realization of a course handbook including tables, papers, process schemes as well as the own lecture notes.

Modalità di verifica dell'apprendimento
The knowledge and skills acquired in the course are tested through a written exam (4 hours approx.) and oral examination based on the written exam discussion and two additional topics assigned before the interview.

The judgment is expressed as a mark of out of 30 and the exam is passed successfully if the final grade is equal or higher than 18/30. The assigned evaluation will be registered on the student book as well as on electronic record book

Testi di riferimento

• The Course Book & Presentations by lecturers (printed as well as available on internet sharing platforms – elearning)
• Don W. Green; Robert H. Perry, Perry's Chemical Engineers' Handbook. 8th edition McGraw -Hill
• Scientific Publications by Lecturers
• Kirk-Othmer Encyclopedia of Chemical Technology
• Louis Theodore. Air Pollution Control Equipment Calculations 2008 by John Wiley & Sons, Inc.
• G.Tchobanoglous, F.L. Burton, H.D. Stensel. Wastewater Engineering - treatment and reuse (4th edition) 2004 Metcalf & Eddy, Inc.

Altre informazioni

The student develops his/her skills thanks to a teaching methodology that combines the constant attendance of lectures and exercises with an intense tutorial activity. Thanks to the learning process, at the end of the course, the student is able to realize processes schemes (with main instruments, material and energy balances). The student is able to realize heat & material balances to evaluate energetic and environmental performances of industrial processes.
Moreover, the student is able to set up the mathematical model of the process and to design some fundamental devices/equipment present in the process scheme with particular reference to:
• Energy production
• Flue gas treatment
• Waste energy recovery
• Water treatment and desalination
• Air separation
• Hydrogen production

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	Ambiente ed Energia	9	ING-IND/25

Stampa del 06/11/2025

Cosmetic & Pharmaceutical Industry product design [3204107]

Offerta didattica a.a. 2025/2026

Docenti: STEFANO SCIALLA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course has the key objective to provide students with a sound knowledge of modern technology innovation and product design methodologies, with focus on pharmaceutical and cosmetic applications. This includes a description of the various phases of the product development process, whose overall structure is relatively independent of the product nature, followed by a specific discussion of the most relevant technical aspects related to pharma and cosmetic products. These aspects comprise both the development and production of active ingredients, through chemical synthesis or biotechnology, and the design of liquid and solid formulations based on the knowledge of thermodynamic and kinetic laws that govern the behavior of such systems.
As a premise to the core topics of the course, some key concepts concerning the chemistry and applications of polymers are also reviewed and explained.

KNOWLEDGE AND UNDERSTANDING ABILITY
Students will acquire the chemical-physical and technology management knowledge that are the basis, respectively, of Formulation Science and Product Design, with particular reference to the pharmaceutical and cosmetic fields.

APPLICATION CAPABILITIES
At the end of the course, the student will use the acquired knowledge to develop a project work consisting in the conception of a completely new or significantly improved product and a preliminary strategy for its scale-up/market launch.

SDGs

Objective 3. Ensure healthy lives and promote well-being for all at all ages
Objective 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Objective 12. Ensure sustainable consumption and production patterns

Prerequisiti
None

Contenuti del corso
Part I – Polymer chemistry
- Definition, nomenclature, and physicochemical properties of polymers
- Main polymerization reactions and their mechanisms
- Analytical techniques for polymer characterization
- Polymer application examples to materials and formulations

Parte II – Product design management
- Product design management in the pharmaceutical and cosmetic industry
- Stages of product design:
a) Idea generation and screening;
b) The role of the consumer;
c) Concept development;
d) Product development / testing;
e) Scale-up and market launch.
- Financial feasibility assessment of a new product
- Intellectual property and patents
- Environmental sustainability and Life Cycle Assessment

Parte III – Product and formulation design in pharmaceutical and cosmetic applications
- Surfactants
- Emulsions. Kinetic and thermodynamic stability
- Rheology of disperse systems and rheology modifiers
- Cosmetic formulations

- Hydrogels and nanogels
- Development and formulation of pharmaceutical actives
- Particle size analysis techniques
- Quality in the cosmetic and pharma industry. Quality by Design

Lab sessions
Session 1) Examples of polymer synthesis
Session 2) Kinetics of ingredient adsorption/release
Session 3) In-lab making of cosmetic formulations

Metodi didattici
The course will be based on a mix of frontal teaching, in order to provide students with the fundamental knowledge needed to design an innovative product, and classroom/group exercises to develop problem solving skills applied to realistic case studies.
There will be seminars by external speakers from industry, to present concrete examples of new product development as well as the methodologies used.

Modalità di verifica dell'apprendimento
The assessment of acquired skills and knowledge will take place through an oral exam made of two consecutive parts.
Part 1: Powerpoint presentation (no more than 15 minutes long) of a project work carried out by a group of 2-3 students, concerning a case study of innovation and design of a pharmaceutical or cosmetic product. The case study will be autonomously chosen by the students and approved by the lecturer(s). In this project work students should demonstrate their understanding of the critical aspects of their case study, as well as their ability to discuss a product design proposal according to the following key points:
- Identify the unmet consumer/market needs;
- Propose an idea for the creation of a new product or the improvement of an existing one;
- Assess the technical feasibility of the product idea through data and a combination of qualitative and quantitative considerations, building a prototype where possible;
- Develop a preliminary (semiquantitative) assessment of the financial feasibility and environmental sustainability of the proposed product idea.
Part 2: Two questions on course topics.

The final grade is expressed in thirtieths and the exam will be passed if and only if the student achieves a grade of 18/30 or higher.
In Part 1, a maximum of 10 points will be assigned. In Part 2, a maximum of 20 points will be assigned, resulting from the sum of up to 10 points for the first question and up to 10 points for the second question.
Honors will be assigned to students who show a perfect knowledge of the topics presented in their project work and are able to perfectly answer the questions of Part 2, demonstrating an excellent ability to elaborate on the course contents. The final grade will be written on the student's record book and recorded in a digital report.

Testi di riferimento
Lecturer slides
V.B. Patravale, J.I. Disouza, M.T. Rustomjee – "Pharmaceutical Product Development" – CRC Press (2016)
U. Brockel, W. Meier, G. Wagner – "Product Design and Engineering: Formulation of Gels and Pastes" – Wiley (2013)
D.J. am Ende – "Chemical Engineering in the Pharmaceutical Industry: R&D to Manufacturing" – Wiley (2010)
C.E. Carraher – "Polymer Chemistry" - Marcel Dekker, Inc (2003)

Altre informazioni
- Knowledge and understanding of the main elements of innovative product design, from the initial idea generation phase up to engineering and industrial production.
- Ability to apply the main Product Design and Formulation Science methodologies to pharmaceutical and cosmetic product development.
- Awareness of financial feasibility and environmental sustainability criteria to be taken into account for the strategic assessment of a new product.
- Knowledge and understanding of key polymerization processes and polymer characterization techniques.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.

Corso di Laurea Magistrale	Ingegneria Chimica per lo Sviluppo Sostenibile (2025)	Industria Pharma e Biotech	9	ING-IND/24, ING-IND/24

Stampa del 06/11/2025

Biomateriali per l'Industria Pharma e Biotech [2202249]

Offerta didattica a.a. 2025/2026

Docenti: SARA MARIA GIANNITELLI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
Knowledge and understanding
At the end of the course the student will have acquired chemical, physical and engineering knowledge on a wide range of biomaterials from both non-renewable and renewable sources (or recycled matrices).
Applying knowledge and understanding
At the end of the course the student must be able to autonomously apply the acquired knowledge to assess the suitability of a material for real-life case studies.
The course aims to contribute to the achievement of the following Goals of the UN 2030 Agenda for Sustainable Development:
Goal 3. Ensure healthy lives and promote well-being for all at all ages.
Goal 12. Ensure sustainable consumption and production patterns.
Goal 13. Take urgent action to combat climate change and its impacts.
Goal 14: Life below water - Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Prerequisiti
Prerequisites:
Organic and inorganic chemistry.
Material science and technology.

Contenuti del corso
- Introduction to the Course (objectives, contents and methodologies). The course contents are organized in 3 main parts:

Part A:
- Definition and classification of biomaterials: metals and metal alloys, ceramics, polymers and composites. Mechanical and surface properties of biomaterials.
- Main techniques of synthesis/fabrication/characterization and surface modification of biomaterials.
- Polymeric hydrogels: properties and applications.
- Pharmaceutical nanotechnology and nanomedicines: micro- and nanoscale hydrogel systems. Formulation and characterization of micro/nanoparticles. Microfluidic approach for the synthesis of micro/nanomaterials. Principles of sterilization. Introduction to controlled drug delivery.
- Organ-on-a-chip: technological features and potential applications as a preclinical model for assessing drug efficacy and toxicity.

Part B:
- “Bio-based” products: bioplastics, bio-chemical and bioenergy.
- Bioplastics and biopolymers. State of the art and applications of biopolymers. Renewable raw materials: sources and types of biomass.
- EU policy framework on bioplastics.

Part C:
- Examples of industrial companies engaged in the valorisation of biomass: the landscape for biopolymers in packaging.
- Start-up and emerging Companies: case studies and pioneering researches of national and international significance.
- Innovative aspects: analysis of scientific literature.

Metodi didattici
Face-to-face lectures explaining the contents of the course and their application on specific problems (75%, approx. 36h), seminars (5%, approx. 2h) and laboratory experiences (20%, approx. 10h).

Modalità di verifica dell'apprendimento

Learning evaluation methods and criteria
The knowledge and skills will be verified by means of a test with multiple choice questions to be carried out on the University's elearning platform. Students will have to answer 10 multiple choice questions in 20 minutes to demonstrate that they have achieved the following specific learning outcomes:
1) knowledge and critical understanding of “standard” and next-generation biomaterials for Pharma and Biotech industry;
2) ability to choose the most suitable material for a specific application.
The test will be carried out in the classroom, on Student' PC or tablet. Students will receive the result of his test as a score expressed in thirtieths only when the latest Student of his group have completed the test.
The laboratory activity will be assessed based on the laboratory notebook, which the student will submit at the end of the course. The notebook must include: a description of the laboratory experience, the obtained results, and personal observations.

Criteria for measuring learning and awarding the final grade
The final grade will take into account both the laboratory activities and the written exam. In the test:
- each question will have 4 answers (A, B, C, D) of which only one is corrected;
- only one answer can be selected for each question;
- points are assigned as follows: 3 (three) points for each correct answer; 0 (zero) points for each incorrect or not given answer.
Each test will be different from the other and assigned randomly by the system. The score, i.e. maximum mark achievable in the test is 30/30. The correction of the test and, therefore, the score achieved corresponding to the final grade, is made by the elearning system for comparison with the correct answers loaded on the platform itself. At the end of the test, the Commission will be available to review together the incorrect answers.
The exam is deemed to be passed successfully if the grade is equal to or higher than 18/30. In this case, the final mark may be increased by up to 3 points, depending on the assessment of the laboratory notebook.

Testi di riferimento

Face-to-face lectures and exercises are carried out on an electronic whiteboard. The saved whiteboards will be uploaded on the e-learning platform at https://elearning.unicampus.it/. These whiteboards allow the student to review and deepen the topics covered and transform into knowledge what has been learned in class and into skills and competences what has been done during the exercises.
Teaching materials for independent study:
- Nanotechnology – An introduction. Jeremy J. Ramsden, 2nd Edition; Elsevier Editor.
- BioProducts: Green Materials for an Emerging Circular and Sustainable Economy. Edited by: Bhima R. Vijayendran.
- Aulton's Pharmaceutics: The Design and Manufacture of Medicines. Edited by: Michael E. Aulton, Kevin M. G. Taylor.
Additional material, in the form of reviews and scientific articles on specific topics, will be provided.

Altre informazioni

Learning outcomes
At the end of the course the student will be able to:
- understand and critically discuss the behavior of materials in different scenarios;
- demonstrate a comprehensive knowledge and understanding of bio-based materials and predict their impact on the environment;
- describe and analyse case studies and scientific papers;
- apply and integrate the acquired knowledge and understanding to support materials selection in new pharma and biotech applications.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Industria Pharma e Biotech	6	CHIM/07

Stampa del 06/11/2025

Industrial biotechnologies and biorefining [2202242]

Offerta didattica a.a. 2025/2026

Docenti: LUISA DI PAOLA

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The purpose of the course is to provide students with the fundamentals for the process and plant design of the food and pharmaceutical industry, from nanosystems to the global systems. The first part of the course will provide the basic computational methods to analyze biochemical systems, with a special focus to the elements of computational biochemistry of proteins in the framework of drug design & discovery. The second part of the course will focus on the integration of the fundamentals of Chemical Engineering to the analysis of applications in the food and pharmaceutical fields.
KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims at providing knowledge and consciousness about applications related to processes and plants for the food and pharmaceutical industry through a project-based approach.
APPLICATION ABILITY
The student will be stimulated to develop a critical approach to the elaboration and understanding of concepts through questions about the topics that are unclear; the student will be able to use the theoretical knowledge acquired during the course for the analysis and development of practical applications in the industrial biotechnology field.
SDGs
The course will also target the following United Nations Sustainable Development Goals;
Goal 3: Ensure healthy lives and promote well-being for all at all ages
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 12: Ensure sustainable consumption and production patterns
Goal 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Prerequisiti
None.

Contenuti del corso
Part I – Molecular Thermodynamics and Computational Biochemistry for Drug Discovery & Design
1. Elements of Statistical Thermodynamics: The principles of statistical thermodynamics (thermodynamic potentials, ensembles) for defining the interaction potentials of biomolecules.
2. Molecular Thermodynamics of Protein Structure and Function: Analysis of the relationship between structure and function considering molecular thermodynamics, providing quantitative methods to understand key features of protein molecular systems, such as stability and unfolding.
3. Protein Binding: The molecular thermodynamics of allostery and regulation for analyzing biological mechanisms and drug construction.
4. Protein-Protein Interactions: Definition of the most advanced computational analysis techniques for multi-protein complexes.
5. Computational Methods for Drug Discovery and Design: Computational applications (molecular dynamics, molecular docking) for drug design & discovery.
Part II - Principi dei Bioprocessi
6. Fundamentals of Membrane Separations: Definition of the chemical-physical fundamentals for designing membrane technological systems, with a particular focus on applications in the biotechnological field.
7. Principles and Applications of Solid-Liquid Separation: Definition of the chemical-physical fundamentals of liquid-solid separation (thermodynamics of liquid-solid equilibria, kinetic models), with particular attention to the world of biorefineries and nutraceuticals.
8. Purification via Preparative Chromatography: Chemical-physical fundamentals of chromatography technology for the purification of compounds in the pharmaceutical sector.
9. Elements of Biorefining: Integration of biomass valorization technologies, with particular attention to techniques for extracting high-value compounds and the energetic valorization of residual biomass.

Metodi didattici
Teaching will be provided in the form of lectures thought to provide students with basic elements for the analysis

and design of biotechnology processes. Practical applications will be shown at the end of both parts and driving students to independently develop projects with innovative applications starting from provided theoretical knowledge.
The teaching methods and the verification of learning listed below, may undergo changes during the entire academic year in compliance with any legal provisions issued.

Modalità di verifica dell'apprendimento

Teaching will be provided in the form of lectures thought to provide students with basic elements for the analysis and design of biotechnology processes. Practical applications will be shown at the end of both parts and driving students to independently develop projects with innovative applications starting from provided theoretical knowledge.
The two projects, related to the development of topics regarding the two course's parts will contribute equally (15/30) to the final grade (maximum 30/30). The presentations will be given 30 minutes + 30 minutes for questions and additional discussion. The minimum grade is 18/30, the maximum is 30/30 with honours.
The teaching methods and the verification of learning listed below, may undergo changes during the entire academic year in compliance with any legal provisions issued.

Testi di riferimento

1. J. Bailey, D.F. Ollis (1986) "Biochemical Engineering Fundamentals", Ed. Mc Graw Hill;
2. L. Di Paola (2023) "Fundamentals of Molecular Bioengineering", Ed. SpringerNature;
3. P.M. Doran (2013) "Bioprocess engineering principles - 2nd Ed." Ed. Academic Press.

Altre informazioni

At the end of the course, the student will be able to use advanced knowledge of applications of biotechnology processes necessary to design and optimize innovative biotechnological industrial processes.
The student will need to learn how to expose the topics clearly and effectively. It will have to organize the exhibition in a consequential way from the basic knowledge required to develop the subject in a comprehensive way.
The course will pursue the following specific learning outcomes:
1. Comprehending the general framework of biotechnology, with a special regard on specific contributions of the chemical engineering;
2. Applying transport phenomena and thermodynamics elements for the development and management of biotechnological processes;
3. Acquiring novel methodologies and skills in the field of the computational biology for innovative applications of drug design & discovery;
4. Developing innovative applications in the biorefineries and pharma fields.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Industria Pharma e Biotech	9	ING-IND/24

Stampa del 06/11/2025

Biotecnologie per l'Industria Biotech [2202256]

Offerta didattica a.a. 2025/2026

Docenti: LAURA DE GARA

Periodo: Secondo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	BIO/04

Stampa del 06/11/2025

Dynamics and Control of Industrial Processes [2202238]

Offerta didattica a.a. 2025/2026

Docenti: MARCELLO DE FALCO, SIMONE GUARINO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The goal of the course is to provide students of Chemical Engineering for Sustainable Development the tools to study the dynamic behavior of industrial processes and to design the control systems of both single equipment and complete industrial plants.
Starting from the knowledge of mathematical and physical basic concepts such as Laplacian operators, energy and material balances, the concept of stability of open and closed loops, the student will apply these concepts to the dynamic study of the industrial equipment and to the analysis of feed-back and feed-forward control cycles.
After completing the course, the student will have all elements to analyze and design an industrial controller.

KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims to provide knowledge and understanding ability on dynamic modeling of industrial processes and on the development of process control systems.

APPLICATION ABILITY
At the end of the course the student will be able to:
- formulate dynamic models of industrial processes;
- define control strategies;
- set the tuning of feedback control parameters;
- develop process schemes.

AUTONOMY OF JUDGEMENT
The student will be encouraged to develop a critical approach on the processing and understanding of concepts through questions on topics which may prove confusing. Students will be encouraged to independently verify the plausibility of the proposed solutions of their problems.

COMMUNICATION SKILLS
The student will learn how to present the arguments clearly and effectively. It will organize the presentation in sequential order starting from the basic knowledge required to develop the argument in a comprehensive manner.

LEARNING SKILLS
The student will develop an increasing capacity to learn through a method of study that makes productive the attendance at lectures and exercises, through active participation to them.

Prerequisiti
none

Contenuti del corso
Module A
Dynamics of an industrial process: application of models of the first and second order, FOPTD and SOPTD.
Dynamic model of a distillation column: Matlab modeling.
Empirical models of industrial equipment.
Valves and actuators.
Feedback control loops: control algorithms and tuning of the parameters, ratio control, applicative examples.
Feedforward control loops: the concept of predictive model, control algorithms.
Control cycles modeling in Simulink environment.
Batch control systems.
Process schemes: graphics criteria and applications.
P&ID schemes

Module B
Process control concept and objectives. General information on control systems.
Dynamic systems - Dynamic response, Laplace transforms, Transfer functions, Bode diagram, State space and

Linearization.
Process feedback techniques with output feedback and state feedback.
The digital twin and elements of fault detection
Supervision, monitoring and control systems: architecture and operating principles of the Distributed Control System (DCS), Programmable Logic Controller (PLC), Supervisory Control And Data Acquisition (SCADA); notes on industrial protocols.
Elements of Cyber security for Operational Technology.
Laboratory activities

Metodi didattici
Lectures presenting the topics of the course, exercises to show their application to specific problems. Labs activities are planned.

Modalità di verifica dell'apprendimento
Knowledge assessment methods and criteria:
The knowledge acquired will be verified by a written exam and an oral test.
During the written exam, the knowledge and skills related to the study of dynamic systems and the design of industrial control systems are verified by the execution of two exercises related to the Module A.
The oral exam consists of two questions on the course program, and the discussion of a thesis related to the Module B. The oral test lasts about 20 minutes.
Criteria for measuring learning and defining the final grade:
The written exam evaluation is expressed as a grade of out of 30. The written exam is deemed to be passed successfully if the final grade is equal to or higher than 18/30.
The evaluation of the oral exam is expressed as a grade of out of 30. The oral test is deemed to be passed successfully if the final grade is equal to or higher than 18/30.
The final score is the average of the two votes.

Testi di riferimento
D.E. Seborg, T.F. Edgar, D.A. Mellichamp, “Process Dynamics and Control”, Wiley Ed.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	9	ING-IND/25, ING-INF/04

Stampa del 06/11/2025

HYDROGEN AND GREEN FUELS [2203210]

Offerta didattica a.a. 2025/2026

Docenti: ALBERTO GIACONIA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course will allow students to learn the fundamentals of hydrogen production processes and, in general, the production of synthetic fuels from renewable sources. The course will also cover other topics of the hydrogen value chain, such as hydrogen storage, distribution and use in different application sectors.

Prerequisiti
Basic knowledge of inorganic and organic chemistry.

Contenuti del corso
Part I: Hydrogen technologies (28 hours)
History of hydrogen technologies
Hydrogen production technologies: production from fossil sources, CO2 capture, production from biomass, electrolysis, thermochemical cycles, photo-electrolysis
Hydrogen storage and distribution
Green fuels: thermochemical conversion of CO2, methanation, Fischer-Tropsch processes, co-electrolysis
Hydrogen end-use: hard-to-abate sectors, refineries, electric grid services, power-to-gas applications, mobility
Part II: Analysis of hydrogen production processes (10 hours)
Renewable energy sources, balancing with end-users' needs, readiness level of processes and technology gaps, techno-economic evaluations, environmental impact assessment
Part III: Case studies and exercises (10 hours)
Development of project proposals, technical tours and visits to laboratories and plants.

Metodi didattici
Frontal lectures and laboratory visits
Frontal lectures: 42 hours
Laboratory visits: 6

Modalità di verifica dell'apprendimento
Oral test.
The examination of the course consists of an oral test (max. 45 minutes) divided in three parts:
Part 1. One question about the hydrogen technologies.
Part 2. One question about the analysis of hydrogen production technologies.
Part 3. Presentation (max. 15 minutes) of a study individually developed by the students about a case study or a project idea linked with the topics of the course.
The assessment aims at evaluating the students' skills to autonomously discuss about the acquired knowledge.

Testi di riferimento
Lecture notes and two recommended books.

Altre informazioni
- Knowledge and understanding of the main technologies for hydrogen production, storage, distribution and use.
- Knowledge and understanding of the different mechanisms for the conversion of renewable energy (solar, wind, biomass, etc.) to fuels.
- Ability to develop, analyse and compare processes of different kind (electrochemical, thermochemical, etc.) and to evaluate potentialities in different application cases.
- Ability to evaluate "solar fuels" production processes featured by different readiness levels, assessing potentials and burdens.
Ability to elaborate and present design solutions to real application cases and to expose the contents of the teaching with adequate technical language.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/25

Stampa del 06/11/2025

Advanced Process Engineering [2201239]

Offerta didattica a.a. 2025/2026

Docenti: DIEGO BARBA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims to provide basic knowledge and tools of process design of chemical plants with reference of separation processes, unit operations and chemical reactors. The first part of the course illustrates the mathematical structures of the algorithms at the basis of simulation software.
In the second phase, an industrial project is developed. This is carried out in collaboration with an engineering company that organizing all the activities to define the project documents (normally implemented by the company).

KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims to provide knowledge of the unit operations (distillation, absorption, stripping, etc.) from thermodynamics to transport phenomena.

APPLICATION ABILITY
At the end of the course the student will be able to:
- create mathematical models of unit operations
- develop algorithms for numerical simulations
- develop the basic of mathematical models for process simulation;
- utilize software packages for process simulations

Prerequisiti
none

Contenuti del corso
Numerical Methods in Process Simulators

• Biphasic equilibria of non-ideal multi-component systems addressed by iterative systems for the solution of nonlinear equations
• Multi-Stage operations (distillation, absorption and liquid-liquid extraction) for non-ideal multi-component systems and representation by means of matrix algebra
• Ideal reactors: the case of the "Gibbs reactor" and one-dimensional catalytic reactors analysed by integrating systems of ordinary differential equations
• Two-dimensional fixed bed catalytic reactor interpreted by partial differential equations of the parabolic type
• Mathematical regression methods for the definition of equilibrium data starting from experimental data and definition of the thermodynamic models

Chemical Engineering Software & Simulation Project

• Evaluation of the project specifications and safety criteria
• Thermodynamic and process analysis by means of a simulator accompanied by a sensitivity study
• Process Analysis & Simulation with software (Aspen Plus, Aspen Hysys, Matlab, Aveva Process Simulation)
• Case studies (cryogenic separation processes, thermochemical processes, liquefaction, CCS…)
• Definition of an instrumented process scheme accompanied by heat & material balance
• Design of selected equipment and drafting of process datasheets
• Drafting of the process report
• Presentation of the results to the teachers and the class

Metodi didattici
The course is structured into lectures and numerical exercises. The second stage (project-based) is developed by groups of four/five candidates with the approach of “learning-by-doing”. The final reports are presented and discussed in the classroom by the working groups at the end of the year. The student is guided in the realization of a course handbook including tables, papers, process schemes as well as the own lecture notes.

Modalità di verifica dell'apprendimento

The knowledge and skills acquired in the course are tested through and oral examination based on the discussion and two additional topics assigned before the interview and the evaluation of the “group project” activities.

Testi di riferimento

• The Course Book & Presentations by lecturers (printed as well as available on internet sharing platforms – elearning)
• Texts selected from the book “Calcolo Elettronico nell’Ingegneria Chimica” Prof Diego Barba Edizioni Siderea
• Texts extracted from the book “Separation Process Principles” di J.D. Seader; E.J. Henley

Altre informazioni

• Thanks to the learning process, at the end of the course, the student is able to understand how a process simulation software works and to draw up main documents of Process & Engineering.
• The students also acquire soft skills, improve teamwork and the ability to meet deadlines and responsibilities in a project-based learning programme.
• knowing the structures of the main process simulation algorithms and the characteristics of different types of simulators, the student acquires the ability to solve different types of problems on different simulation platforms (independently of the simulator and / or programming language).
• The course allows the students to work independently by simulating the typical work of the Process & Engineering Dept. and stimulating the critical approach and the self-assessment. By presenting the results to the class and the lecturers, the students are empowered to verify the plausibility of the provided solutions.
• Furthermore, the exam simulation tests, realized during the course, improve the process of self-assessment and trace the pathway to the final examination. The student develops his/her skills thanks to a teaching methodology that combines the constant attendance of lectures and exercises with an intense tutorial activity. This latter is based on projects developed by working groups (organized to push the contribution of each member to the result).
• The improvement of the communication skill is pursued by continuously encouraging the discussion and the public speaking, including the direct, active participation of the students in the presentation of several themes of the lectures. Basically, the exam has the characteristics of a job interview for an engineering company.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Ambiente ed Energia	6	ING-IND/25

Stampa del 06/11/2025

Artificial Organs Engineering [2201045]

Offerta didattica a.a. 2025/2026

Docenti:

Periodo: Secondo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/24

Stampa del 06/11/2025

Laboratorio di Modellistica e Simulazione di sistemi biologici [2202250]

Offerta didattica a.a. 2025/2026

Docenti: CHRISTIAN CHERUBINI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course has, as a major target, making the student acquire the knowledge and the methods of mathematical physics and of numerical simulation necessary to approach problems of relevance for the study of biological systems also based on transport phenomena.

SDGs:
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
Goal 12: ensure sustainable consumption and production patterns

Prerequisiti
Prior knowledge of Calculus and Physics is presupposed.

Contenuti del corso
-Dynamical systems: Generalities, one-dimensional flows.
-Two dimensional flows, stability, conservative and reversible systems.
-Limit cycles, Hopf bifurcations,
-Higher dimensional flows, deterministic chaos.
-Introduction to second order partial differential equations
-Diffusion equation and meaning of different boundary conditions.
-Wave equation.
-First order partial differential equations and systems of equations.
-Elements of Complex Analysis and Fourier and Laplace Transforms.
-Solution of relevant problems.
-Introduction to XPPAUT and Comsol Multiphysics software.
-Numerical applications with elements of theory: review of transport phenomena, Fermi-Pasta-Ulam experiment, stochastic differential equations and Brownian motion, enzyme kinetics,oscillating chemical reactions, reaction and diffusion problems; electrophysiological models, infectious disease modeling, tumor growth modeling.

(48 hours)

Metodi didattici
The teaching methodology consists of lectures performed in multimedia laboratory performed with slides and on the interactive whiteboard with applications and selected numerical simulations experiences (48 hours). If necessary, the lectures provides students of additional material through the course university web page .

Modalità di verifica dell'apprendimento
The learning verification consists in a one hour written exam on which the student must answer on paper to two selected questions formulated on the basis of the detailed online course program. The examiners study and correct the material written and assess to which extent the student has acquired the course content using as criteria the mastery of the necessary mathematical physics tools, the rigor in using them and the completeness and correctness of the exposition, in particular through the presence in the written test of all the necessary mathematical steps. The examiners view and comment together with the student the written exam and finally communicate him/her a vote out of thirty.
Each selected question receives a score ranging from 0 to 15. The total score is obtained by summing these two single scores. The total score can be confirmed of modified after the compulsory vision an comment phase with the student in the exam. The exam is passed if the student obtains a sufficient total score (18/30) or higher up to 30. In this case, the final score coincides with the exam's final grade, with laude given if the student obtains 30/30 and the exam has been performed in an exemplary way. The final exam's grade, if accepted by the student, is registered on the student's record book and on an electronic verbal. If the exam score is not sufficient, the student must come to another exam session answering two questions taken from the program again.

Testi di riferimento

-Teaching material available on the course page of the e-learning University website.

Additional material suggested for in-depth study:

-S. Strogatz, "Nonlinear dynamics and Chaos", Westview Press; 1 edition (2001).
-J.D. Murray,"Mathematical Biology, an introduction, vol.1 and 2", Springer (2001).
-S.J. Farlow, "Partial Differential Equations for Scientists and Engineers", Dover, (1993).
-M.R. Spiegel, "Schaum's Outline of Laplace Transforms", McGraw Hill (1965).
-N. F. Britton, "Essential Mathematical Biology", Springer (2003).
-D.S. Lemons, "An Introduction to Stochastic Processes in Physics", The John Hopkins University Press, (2002).
-J. Keener and J. Sneyd, Mathematical Physiology, Springer (1998).

Altre informazioni

-Knowledge and understanding
The course aims to provide knowledge and understanding of mathematical physics methodology in union also with numerical simulations tools applied to problems in the field of biological systems also based on transport phenomena. The target is to integrate the standard knowledge with advanced mathematical analytical and numerical modelling, viewed as a methodological tool allowing a quantitative interpretation of selected processes. At the end of the course, the student will be able to know with appropriate mathematical physics rigor several natural systems described by differential equations. A test is represented by the final exam. Specific examples in line with SDG goals will be addressed.

-Applying knowledge and understanding
The mathematical physics knowledge acquired will be consolidated through some analytical examples and selected numerical simulations of specific phenomena. These application abilities will have a central role in future in the study and design phases of processes dealing with food transformation, biotech and pharma industry, green energy production and environmental protection for instance, in order to plan experimental tests necessary for their validation and implementation. A test is represented by the final exam.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	MAT/07

Stampa del 06/11/2025

Materials Technology and Corrosion [2202241]

Offerta didattica a.a. 2025/2026

Docenti: FRANCESCO BASOLI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
Knowledge and understanding
The course aims to impart the basis for a correct choice of materials for engineering applications, specifically with regards to corrosion mechanisms. The course intends to provide students with the necessary knowledge for the understanding of fundamental processes concerning metal corrosion mechanisms. Moreover, the course intends to provide a basic knowledge on the different forms of corrosion as well as
methods to control prevent and protect from corrosion processes.

Applying knowledge and understanding
Upon completion of the course, students should be able to recognize the morphology of corrosion and to identify, based on its particular characteristics, the underlying factor that trigger its appearance. In addition, students should be able to understand the operating mechanisms within corrosive processes and to assess potential protection and preventions measure both at planning and maintenance stages.

SDGs
The module aims to contribute to the achievement of the following Sustainable Development Goals of the UN 2030 Agenda for Sustainable Development (SDGs):
Goal 6: Ensure access to water and sanitation for all
Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation
Goal 14: Conserve and sustainably use the oceans, seas and marine resources

Prerequisiti
Basic notions of inorganic and organic chemistry, mathematics and physics

Contenuti del corso
Generalities (3h):
Chemical physical and mechanical properties of materials. Classification of materials: metals, ceramics, polymers and composite. Chemical bonds and material crystal structures. Solidification of metals: polycrystalline materials. Diffusion.
Mechanical properties of materials (4h):
Stress–strain curves, effect of grain size, hardness, plastic deformation, creep, principle of fracture mechanics, fatigue.
Metals (11h):
Production of metallic materials, metallurgy of ferrous alloys, steels, stainless steels, cast irons, non-ferrous alloys (notes).
Corrosion and degradation of materials, materials protection (30h):
Electrochemical and thermodynamic principles of corrosion. Anodic and cathodic processes. Potential vs. pH curves. The measurement of the corrosion potential. Nernst equation. Reference electrodes. Corrosion kinetics: activation overpotential and polarization. Corrosion typologies. Evaluation of corrosion resistance. Anodic and chatodic protection. Materials selection for engineering design.

Metodi didattici
Lectures presenting the topics of the course (36h) and tutorials showing their application to specific problems (6h). Lab tutorials presenting electrochemical corrosion test methods (6h). As of resolution of the Academic Senate of the 26/04/2017, the course will be delivered in English.

Modalità di verifica dell'apprendimento
The verification of learning consists of an oral test aimed at promoting the ability of the student to sustain an autonomous discussion regarding the knowledge and competency acquired during the course.
The oral exam is structured in the following three consecutive phases:
Phase 1: Preparation of a paper on a case study concerning materials technology and corrosion, previously agreed with the teacher.

Phase 2: Presentation of the case study, lasting a maximum of 15 minutes, through a multimedia IT presentation.
Phase 3: Oral interview for the evaluation of how the student has acquired the theoretical bases of the course, which will consist of at least 2 questions of increasing complexity asked by the members of the examining commission. Questions will be based on the course syllabus.

Each of the phases described above will give the student a variable score between 0 and 10 points. The mark obtained is expressed out of thirty (up to 30/30 cum laude) and the exam will be passed if and only if a mark greater than or equal to 18/30 is obtained. The mark obtained will be recorded in the student electronic record-book.

Testi di riferimento

• William D. Callister Jr., David G. Rethwisch, Materials Science and Engineering: An Introduction, John Wiley & Sons
• Pietro Pedeferri, Corrosion Science and Engineering, Springer Nature
Additional Bibliography:
• Mars G.Fontana, Corrosion Engineering. McGraw-Hill
• Danny A. Jones, Principles and Prevention of Corrosion, Prentice Hall College Div
• Alberto Cigada, Tommaso Pastore, Struttura e proprietà dei materiali metallici, McGraw Hill;
• Walter Nicodemi, Metallurgia: Principi generali – Zanichelli
• Sinnott-Towler, Chemical Engineering Design, Butterworth-Heineman.
• Handouts provided by the teacher downloadable from the course page at https://elearning.unicampus.it/

Altre informazioni

At the end of the course, the student will be able to:
1) Know and understand the theory and fundamental principles of materials
2) Know the main metal alloys and the methods necessary for their production and characterization
3) Understand and predict the behavior of different materials in use
4) Understand and analyze the electrochemical mechanism of a corrosion process
5) Understand, based on the form of corrosion, the factors that control its onset
6) Understand the thermodynamic conditions underlying the wet corrosion process
7) Understand the kinetic principles that define the speed of progress of the corrosive process
8) Estimate the corrosion rate
9) Define the form and morphology of corrosion to which a metallic material can be subject in an aqueous environment
10) Know and apply the main corrosion prevention and protection systems
11) Evaluate the reduction of corrosion according to the prevention and protection system considered
12) Collect scientific information on a specific topic, critically identifying the data useful for the realization of a report, through an in-depth study of the state of the art
13) Effectively present a scientific report using appropriate language and tools (e.g. MS Powerpoint,)

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Ambiente ed Energia	6	ING-IND/22

Stampa del 06/11/2025

Mechanical Design of Plants [2202240]

Offerta didattica a.a. 2025/2026

Docenti: ANTONIO GERMANA'

Periodo: Primo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Ambiente ed Energia	9	ING-IND/25

Stampa del 06/11/2025

Final Examination [22022PF]

Offerta didattica a.a. 2025/2026

Docenti:

Periodo: Secondo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	12	PROFIN_S

Stampa del 06/11/2025

Chemical Reactors [2202114]

Offerta didattica a.a. 2025/2026

Docenti: VINCENZO PIEMONTE

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

he course represents one of the founding training bases of the chemical engineer and his ability to design complex reactors in all areas of industrial application.

KNOWLEDGE AND ABILITY TO UNDERSTAND

The purpose of the course is to provide students with the elements of chemical kinetics and transport phenomena that characterize the various types of industrial reactors so that the student is able to represent the behavior of reactors using mathematical models and to carry out their sizing.

APPLICATION CAPABILITIES

The course will provide the student with quantitative tools for evaluating and analyzing reactors and their applications in various industrial processes, in addition to the use of advanced simulators for the design of unconventional reactors.

SDGs

Goal 6: Clean Water and Sanitation

Goal 7: Affordable and Clean Energy

Goal 12: Responsible Consumption and Production

Goal 13: Climate Action

Prerequisiti

Notions of Transport Phenomena, Thermodynamics of Phase Equilibria

Contenuti del corso

1) Matter and energy balances for reacting systems. Definition of conversion and degree of advancement of a reaction. Stoichiometric constraints. Thermodynamics of chemical equilibrium. Calculation of the equilibrium composition of homogeneous and heterogeneous reagent systems.

2) Chemical kinetics: definition of the reaction rate. Kinetic expressions and reaction mechanisms. Effect of composition and temperature on the reaction rate. Kinetic data analysis.

3) Ideal reactors: Perfect mixing reactors and tubular reactor with piston flow. Relations balance for homogeneous isothermal reactors. Calculation of the reactor volume. Comparison of reactors a perfect mixing and tubular reactor. Variable density reagent systems: residence time effective and apparent. Thermal problems in ideal reactors: energy balances. Systems consisting of several reactors. Multiple reactions: yield and selectivity.

4) Non-ideal reactors: residence time distribution functions. Diagnosis of the causes of deviation from the ideal behavior; modeling of real reactors.

5) Heterogeneous reactors: chemical kinetics and diffusion in heterogeneous reactions. Fluid-solid reactions: model of the reacting core. Heterogeneous catalysis: kinetic models of reaction mechanisms. Efficiency factor.

6) Fluid-solid reactors - Sizing of fluid-solid reactors. Fixed bed, moving bed and a fluidized bed. Fluidization problems: minimum fluidization rate and terminal velocity. Transfer of matter and of heat in fluidized bed reactors. Models for calculating the conversion in fluidized bed reactors. Application to catalytic reactors.

7) Gas-liquid reactions - Slow, fast and infinitely fast reactions. Calculation of reactors and absorption equipment with reaction.

Metodi didattici
Lessons will take place through frontal teaching aimed at providing the elements for the analysis and design of reactors and through exercises, even in groups, to develop the skills of working in a team and dealing with the resolution of real problems. The exercises will make use of dedicated process simulators.

Modalità di verifica dell'apprendimento
The verification of the acquired contents will take place through a written and oral exam. The written test on paper consists in carrying out 2 exercises in the two macro-areas of the course, Ideal and non-ideal Reactors, aimed at evaluating the student's practical skills in problem solving.

The grade obtained is expressed out of thirty and the exam will be passed only if a grade greater than or equal to 18/30 is achieved. The candidate will be able to aspire to honors, answering the two questions perfectly and demonstrating a remarkable ability to rework the course contents. The grade obtained will be recorded in an electronic report.

Testi di riferimento
Lecture notes
L.Marrelli, Reattori Chimici Vol.1 e Vol.2, Ed. Efesto,
O.Levenspiel, Ingegneria delle Reazioni Chimiche, Ed. Ambrosiana.
S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall.

Altre informazioni
At the end of the course, the student will be able to:

1) Understand the basics of chemical kinetics and transport phenomena essential for the design of chemical reactors
2) Understand the functioning of ideal reactors and distinguish them from non-ideal ones
3) Understand the mechanisms of heterogeneous catalysis
4) Understanding thermal and diffusional effects in heterogeneous catalysis
5) Apply chemical reactor engineering knowledge to design both ideal and non-ideal CSRT, BSTR, PFR reactors
6) Design L/G, L/S, G/S reactors in the most industrially used types
7) Optimize and scale-up of industrial reactors
8) Use advanced process simulators for unconventional reactor design

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	9	ING-IND/24

Stampa del 06/11/2025

Safety of chemical plants [2202258]

Offerta didattica a.a. 2025/2026

Docenti: GIORGIO ZERBONI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

Knowledge and understanding ability Thanks to the detailed analysis of the methods of implementation of a process plant, carried out in the first part of the course, the student will acquire not only the skills of the methods of analysis, prevention and mitigation of risks, but also the bases for the other possible specializations of the chemical engineer, in addition to that of safety, in the areas of project management, quality and energy saving.

Problem-solving skills
The analysis of hazard situations, extended to all phases of the construction and operation of a plant, will allow the student to identify risks and assess the relative probability of occurrence and severity of the consequences of a negative event in the entire life cycle of a plant, as well as to properly apply prevention and mitigation methods

Autonomy of judgements
Thanks to the knowledge of the most suitable risk analysis method for each specific circumstance, and of the prevention and mitigation techniques, the student will be stimulated to evaluate with his own judgment the conditions that can create the onset of dangerous situations, and evaluate how to face them.

Communication skills
The student is stimulated to discussion in relation to specific operational situations and therefore to put questions and formulate answers in a clear way

Learning skills
The characteristic of the course, based on the knowledge of the operating methods in the various phases of the life cycle of a plant, as well as of the most frequent causes of malfunction, will facilitate the student's framing of a potential hazard situation, even if not previously faced, and to propose an appropriate design or operational response.
At the conclusion of the course, the student will be able to know and apply the specific safety principles and safety standards (both European and International) through the various stages of the construction of an industrial plant or to verify their correct implementation. He will also be able to use the appropriate prevention and mitigation methodologies, to apply risk assessment techniques specific to process plant engineering, and to carry out an assessment of the solutions adopted or to be adopted to ensure an adequate level of safety in all phases of the implementation, from design to plant operation phase.

Prerequisiti

For a profitable learning of course contents, a good knowledge of the basis of design and operation of process equipment of chemical plants is mandatory.

Contenuti del corso

1.Phases of the execution of process plants : feasibility studies, meaning of know how in process plants; role of Process Licensors and meaning of basic design; process design and engineering, procurement and fabrication of equipment and materials, construction, hydrotests, start-up and test runs. Revamping of plants.
2.Safety during feasibility studies : the environmental impact study and the preliminary hazard analysis (PHA) ; authorization to operate a plant, European and international codes and standards related to environment and safety.
3. Safety during design phase: the concept of inherent safety; safety in plot plans (both general and area plot plans), instrumentation and control systems (DCS and SCADA) safety factors in the mechanical design of equipment: stresses due to internal pressure, external pressure, wind pressure and seismic loads; the electrical classification of the areas. Safety devices : safety valves: common, balanced and pilot type, rupture disks, breathing valves , flame arresters; blow-down and flare systems, packing and mechanical seals etc.; emergency diesel generators and UPS, Emergency Shut down Systems; 3D model and constructability review; emergency shut-down systems (ESD). Risk analysis methods during design , operation and maintenance phases (HazOp, LOPA, FTA, ETA, FMEA, QRA, Bow-tie, What if).
4. Safety during fabrication and transport of equipment and materials: fabrication schedule, quality plan, inspection and test plan; European Product Directives (PED, EN 13445, Machinery, ATEX). Welding procedures, qualifications

of welding procedures and of welders; inspections and tests, Non Destructive Tests. Transport from workshop to jobsite, Incoterms regulations.
5. Safety during construction : different aspects for grass- root plants and plant expansion or revamping projects; construction safety plan, geotechnical analysis, heavy lifting ; lifting plans and lifting devices, traceability : marking and identification of materials; work permits and hot works, tie-ins with existing facilities, as built drawings ; management of accidents and near miss ; safety assistance in field, training of construction personnel.
6. Safety during start-up: final inspections, utilities distribution, leakage tests, preparation of firefighting and alarm systems; inventory of chemicals and catalysts, purging of equipment; start-up safety review, training of operators: process simulators; emergency shut-down and evacuation plans.
7. Examples of risk analysis ; example of Plant Emergency Shutdown.

Metodi didattici
Lectures presenting in detail the topics of the course, with the aid of slides in power point as well as tutorials showing their application to specific problems.

Modalità di verifica dell'apprendimento
The attention of the students is kept alive with reference to specific cases while learning is verified by participating in the solution of design and operational problems.

Testi di riferimento
Giorgio Zerboni: Fasi della realizzazione degli impianti chimici (Phases of the implementation of Process Plant), Edizioni Efesto, new edition October 2020.
- Giorgio Zerboni: Sicurezza nella realizzazione degli impianti di processo (Safety in the implementation of Process Plants), Edizioni Efesto, new edition January 2021.
- Giorgio Zerboni: Esercizi di analisi di rischio tecnologico (Exercises of technological risk analysis), Edizioni Efesto, February 2022.

Furthermore, power point files , in the English language, shown during the lessons, are handed over to students once the lessons related to each section are completed.

Altre informazioni
Knowledge and capabilities concerning the "Safety of chemical plants" are assessed through an exam consisting of an oral test related to 3 different subjects, for an overall length of about 40'.
The exam involves an evaluation that is expressed as a grade of out of 30, duly registered on both the student's paper and an electronic record-book. An exam is deemed to be passed successfully if the final grade is equal to or higher than 18/30.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/25

Stampa del 06/11/2025

Security and safety of chemical plants [2202257]

Offerta didattica a.a. 2025/2026

Docenti: GIORGIO ZERBONI

Periodo: Secondo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/25

Stampa del 06/11/2025

Sensori chimici per l'Industria Pharma e Biotech [2202255]

Offerta didattica a.a. 2025/2026

Docenti: MARCO SANTONICO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
Provide an overview of the operating principles of sensors for chemical and biological quantities. Define the parameters that allow evaluating sensors' performance and the general criteria for the use of sensors in electronic circuits. Deepen the understanding of the operating mechanisms in specific application contexts of chemical and biosensors. Introduce the use of multivariate data analysis techniques and multisensory systems.

Prerequisiti
Basic mathematical, physical and chemistry knowledge acquired during the bachelor studies.

Contenuti del corso
Prof. Marco Santonico (32 hours)
Classification of sensors and fundamental parameters. Response curve; sensitivity; noise; resolution; selectivity; specificity; reproducibility. Principles of transduction. Introduction to interface electronics for sensors. Solid-gas and solid-liquid interactions, chemical sensors in the atmosphere and solutions. Biosensors. Analysis of basic transducers for chemical sensors and biosensors: chemFET, acoustic sensors, optical sensors, conductivity-based sensors. Characterization of solutions using voltammetric sensors. Multisensory systems. Introduction to multivariate data analysis. Analytical representation of data, calibration, and regression. A brief overview of statistics and statistical regression. Data matrices: Multiple Linear Regression, Principal Component Analysis, Principal Component Regression, Partial Least Squares.
Prof. Vincenzo Piemonte
Use of chemical sensors for monitoring industrial waste in the Red and Green Biotech sector; Biohazard assessment in biofuel production plants; determination of VOCs in gaseous effluents; sensor arrays for monitoring oxygenation in cellular bioreactors

Metodi didattici
The course includes theoretical lectures in the classroom. Additionally, laboratory activities are planned, where students can apply some of the sensors studied in specific cases.

Modalità di verifica dell'apprendimento
Knowledge assessment methods and criteria:
Oral examination. The student must demonstrate adequate knowledge and understanding of the theoretical and practical aspects underlying chemical sensors. The learning assessment will be based on three questions related to the analysis and study of topics on chemical sensors and their applications.

Criteria for measuring learning and defining the final grade:
The exam will be considered passed if the student's preparation is at least 18/30. The final grade will consider not only the student's mastery of the topics covered in the course program but also language proficiency and the ability to connect the examined topics with the broader themes of the study program. Honors will be awarded to students who achieve a grade higher than 30.

Testi di riferimento
Material provided by the teacher
Arnaldo D'Amico, Corrado Di Natale, Introduzione ai sensori, Ed. Aracne, 2008

Altre informazioni
Knowledge and Understanding
The course will provide students with internationally recognised knowledge of sensors for chemical, biological, and physical quantities, to foster a profound understanding of the mechanisms underlying their operation.

Applied Knowledge and Understanding

Students should grasp the theoretical and scientific aspects of the subject covered in the course and, through this understanding, be able to identify and solve problems related to real-life cases by providing original design contributions.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-INF/01

Stampa del 06/11/2025

Sensors and measurements in environmental monitoring [2202253]

Offerta didattica a.a. 2025/2026

Docenti: DANIELA LO PRESTI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims to provide basic knowledge regarding methodologies for the design of chemical sensors, techniques for their fabrication, and details regarding their principle of work and main characteristics. Furthermore, basic knowledge of the main applications of sensors in monitoring environmental parameters (e.g., air, soil, and water quality) will be provided.

KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims to provide knowledge and understanding of the working principle and development methodologies of chemical sensors used in environmental monitoring. Additionally, it aims to equip students with skills related to the techniques of the analysis of data collected by these sensors.
APPLICATION ABILITY
At the end of the course, the student will be able to:
- select the most suitable chemical sensors based on the specific field of application related to environmental monitoring
- analyze and investigate the metrological characteristics and performance of the chemical sensors under investigation
- design chemical sensors ad-hoc to analyze single or multiple environmental parameters
- analyze and interpret the data collected by the sensors under investigation

Prerequisiti
No prerequisites except those required for access to the Laurea programme.

Contenuti del corso
The contents of the course are reported below.

- Basic concepts of measurement methods with specific regard to the estimation of chemical parameters. Main elements (transducers, electronics, data transmission, and data analysis) and main characteristics of chemical sensors (e.g., sensitivity, selectivity, range of measurements, linearity, resolution, accuracy, response time, hysteresis, drift of sensitivity, and zero) (6 hours lecture, 6 h lab experience, 1.5 cfu).

- Environmental monitoring: basic concepts and applications. Main parameters and scenarios of interest. Health effects of pollution and how monitoring technologies may reduce emissions and pollution (8 hours lecture, 4 h lab experience, 1.5 cfu).

- Resistive and capacitive sensors. Most popular design and fabrication process. Resistive and capacitive gas sensors. Resistive and capacitive sensors for liquids. Applications of these sensors in environmental monitoring (4 hours lecture, 2 h lab experience, 0.75 cfu).
- Electrochemical sensors. Working principle of the most popular electrochemical sensors and their measurands. Applications of electrochemical sensors for environmental monitoring (4 hours lecture, 0.5 cfu).

- Optical sensors. Fiber optics. Working principle of the most popular optical and fiber optic-bases sensors. Optical and fiber optic sensors for environmental monitoring (4 hours lecture, 2 h lab experience, 0.75 cfu).

- Pressure, temperature, and flow sensors. Their main applications in environmental monitoring. Principle of work and main characteristics of the most popular sensors. Main applications of these sensors in environmental monitoring (4 hours lecture, 4 h lab experience, 1 cfu).

Metodi didattici
Lectures presenting the topics of the course and exercises to show their application to specific problems. Laboratory sessions allow students to learn the use of popular sensors used for monitoring chemical parameters. Theory and experiments on the measurement of parameters for environmental monitoring, including, for instance, quality of air, soil, and water and climatic conditions.

Modalità di verifica dell'apprendimento

Knowledge and skills acquired during the course will be assessed by 30-40 minutes of oral test. During the oral test, the student must demonstrate that she/he has a deep knowledge of specific topics reported in detail in the section “program”. The students will have to answer 2 questions focused on the course topic (30-40 minutes). This part will be considered as 20/30. In addition, knowledge and skills concerning the use and characterization of a specific sensor are assessed through an experiment performed in the laboratory (20 minutes). This part will be considered 10/30.

Testi di riferimento

1. T. G. Beckwith, R. D. Marangoni, J. H. Lienhard. Mechanical Measurements Addison-Wesley Pub Company, Reading MA, USA.
2. Ernest O. Doebelin. Measurement System (2008). McGraw-Hill Education
3. Lecture notes which will be available vie the e-learning platform of the Università Campus Bio-Medico di Roma.

Altre informazioni

The student will be able to understand the main characteristics of chemical sensors and how to select the most feasible sensors according to the requirements of specific applications in environmental monitoring. The student will be stimulated to gain the ability to enrich his/her knowledge and analysis of the course contents. The student will have to develop the ability to communicate in a synthetic way and in general terms, as well as using the technical terms the aspects related to the course program. The student will also be able to analyze and interpret the data collected by chemical sensors for environmental monitoring (e.g., air quality, soil and water contamination temperature, and relative humidity of the environment). The learning capability of students will increase during the course since they will be continuously stimulated by an interactive teaching method.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/12

Stampa del 06/11/2025

Strategies for technological innovation [2202217]

Offerta didattica a.a. 2025/2026

Docenti: DOCENTE_FITTIZIO DOCENTE_FITTIZIO

Periodo: Secondo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/35

Stampa del 06/11/2025

Sustainable process development, modeling and optimization [2202243]

Offerta didattica a.a. 2025/2026

Docenti: GAETANO IAQUANIELLO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

Course Title: Sviluppo, Modellazione e Simulazione dei Processi Sostenibili

SSD: ING-IND/25

Year and Semester: 2nd year, first semester

Language: Italian

Credits (CFU): 6 CFU

Number of hours teaching activity : 48

Teachers/ lecturers: Gaetano Iaquaniello, Annarita Salladini e Emma Palo

Speficic Learning objectives

Knowledge and ability to understand.
The purpose of the course is to provide students with the fundamentals for the process analysis, simulation, and optimization, focusing in particularly on sustainable processes and/or at low CO2 emissions. The student will be stimulated to develop a critical approach to the elaboration of new process schemes and test the plausibility of the solutions through the simulation using non-conventional feedstocks, green hydrogen and CO2 through advanced process simulator tool as Aspen plus.

Application capabilities
At the end of the course, the student will be able to analyze and simulate process schemes, using non-conventional feedstocks, to evaluate through a techno-economic analysis the production' cost and the amount of CO2 emitted for ton of product. The development of specific project, based on a teamwork, will be part of the final examination.

Indipendence of judgement
The student will be able to present his work in a clear and efficient manner and will need to develop its abilities through active and productive participation at the lessons and at the training sessions with the process simulator tool.

Comunication skills
The student will be able to present his work in a clear and efficient manner and will need to develop its abilities through active and productive participation at the lessons and by proper exposition of his project work.

Ability to learn
Through the attendance at the lectures, active participation to the training session and development of the specific project work, the student should increase his ability to learn.

SDSs :

goal 8: Inclusive and sustainable economic growth
goal 12: Responsible Consumption and production
goal 13: Climate action

Prerequisiti

Chimica generale, Principi di ingegneria chimica e Progettazione degli Impianti Chimici

Contenuti del corso

Contents:

- Sustainability of the Chemical Processes, use of H2 and/or CO2 as feedstock
- Introduction of process simulation through specialized software, the Aspen Plus process simulator.
- Description of the major unity operations involved, their interconnection and optimization. Process analysis and simulation.
- Production costs through analysis of variables and fixed costs evaluation.
- Green and blue Hydrogen production and from un-conventional processes as methane cracking and wastes gasification.
- CO2 emissions per kg of H2 produced. Choice and optimization of main operational parameters, thermal integration.
-Thermal efficiency of a conventional boiler and in hybrid system heat pump/ boiler.
- Syngas production from municipal solid wastes (MSW), biomasses and other wastes. Analysis of different gasification reactors and simulation of the process.
- Selection Guide of thermodinamics models to be used for different unit operations.
- Scale-up criteria: definitions and models.
- CO2 recovery and re-use for methanol production and synthetic natural gas (SNG)
- Green ammonia and green methanol.
_- Ethanol of second generation: costs and relevant process issues
- Water desalination : simulation of thermal processes.
- Industrial Catalysis: simulation of catalytic reactors through process simulator.
- Introduction to the analysis of the critical aspects during start-up, shut-down and normal operation

Metodi didattici

Teaching will be provided in the form of monographic lectures, followed by simulation sessions using the process simulator. where the students, under the supervision of the teachers, will familiarize with the simulator tool. This approach will provide to the students the basic elements on resolving practical simulation cases and to consolidate the theoretical knowledge acquired during the lessons. At the training sessions it will be devoted about 50% of the course' time. To develop teamwork capability, it will be required to prepare a project study on a specific topic selected by a group of 4/5 students.

Modalità di verifica dell'apprendimento

The acquired learning level will be evaluated through a written and oral trial. The written test will consist of 2 simulation exercises and 2/3 questions related to the lectures and it will last 4 hours. The oral examination deals with the discussion of the written test and presentation of the teamwork' project study and is aimed at evaluating the ability of the student to analyze practical cases with a logical and consequential approach.

Testi di riferimento

- Lecture notes and scientific articles related to specific issues.
-Catalysis, Green Chemistry and Sustainable Energy, A. Basile, G. Centi, M. De Falco, G. Iaquaniello, Elsevier, BV 2019
-Plant Design and economics for chemical engineers, Max S. Peters, Klaus D. Timmerhaus, McGraw-Hill
-Fondamenti di Chimica Industriale – Zanichelli ISBN 978-88-08-32019-3

Altre informazioni

At the end of the course, the student will be able to:

1) Analyze and develop complex process schemes, based also with non-conventional feedstocks.
2) Modelling through simulation software tool the main unit operations and their interconnection.
3) Starting from heat and material balances, evaluate variable production costs.
4) Calculate the CO2 emissions per unit of product.
5) Evaluate production costs through analysis of variables (Opex) and fixed costs (Capex)
6) Understand the mechanism to optimize the production costs through process simulation.
7) Modelling of non-conventional feedstocks as municipal solid wastes (MSW), vegetable oils and CO2.
8) Modelling of thermal process for water desalination.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Industria Pharma e Biotech	6	ING-IND/25

Stampa del 06/11/2025

Technologies and Bioprocesses for the Food Industry [2202235]

Offerta didattica a.a. 2025/2026

Docenti: LUIGI NATALONI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The purpose of the course is to learn the basic principles of chemistry as applied to the food industry. Knowledge of plants and equipment found in the food and biochemical industry. Ability to apply the theoretical concepts of food processing chemistry, food safety to industrial realities while also considering economic and regulatory aspects. At the end of the course the student will be able to know the main categories of food and biochemical processing.

KNOWLEDGE AND UNDERSTANDING SKILLS
The objective is for the student to learn about the application of chemical engineering and the most common production units such as filtration, evaporation, separation in the food industry and to evaluate them through specific assessment through HACCP analysis and reasoning about circular economy and sustainability

APPLICATION SKILLS
Upon completion of the course, the student is able to develop and design a process to obtain a finished food product from both plant and animal raw materials.

Prerequisiti
Knowledge of principles of biochemical engineering, organic chemistry, and industrial plant engineering

Contenuti del corso
What the food industry is, what it is about, turnover data in Italy and the world. The most
important.
Example of some industrial processes for obtaining food, milk, fructose, sorbitol, chocolate, meat.
What a process technologist is involved in, what are the most important technologies in the food industry.
What is a process.
Explanation of PDP, the various stages of the project from exploring to execution. Block diagram, PFD, P&ID
Risk assessment, examples and case studies
Bachelor of Science in Food Science and Human Nutrition - Student Guide A. A. 2021/2022
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HACCP principles, some examples
Some food safety and food process de-risk solutions.
Development of a small process, such as mixing.
Enzymology
The importance of enzymology in food processes.
Fermentation and fermentation processes
Focus on alphaamylase, betaamylase, isomeraseetcc
Possible developments: sustainability via enzymes etcc
Some examples
Separation
Filtration, membrane separation, decantation and centrifugation, chromatography
Deashing, decolorization, desalting
Ion exchange resins, Electrodialysis, capacity deionization etc.
Industrial examples, sizing exercises etc
Evaporation and drying
Fluid viscosity fluid transport, mixing
packaging, transport and storage, shelf life
Mixing, bottling
Process control, automation
Visit to a plant
Study of a real and complete process: milk, sugar, pasta, cocoa, meat
Fermentation and fermentation processes, second generation biomasses
Exercises and case studies on previous topics
Sustainability, innovation on the food industry

Metodi didattici
Lectures and exercises explaining the contents of the course program, real examples of the processes, and seminars given by experts, possibly visit to a plant with food processes.

Modalità di verifica dell'apprendimento
The knowledge and skills acquired are tested by an oral test, which will include two questions on the course content. The choice of the two oral questions is intended to ascertain the actual degree of learning and the ability to independently rework the knowledge and skills described in the learning objectives.

Testi di riferimento
Lecturer's handouts.
Principles of food technology by R. Paul Singh, Dennis R. Heldman

Altre informazioni
The Student at the end of the course must demonstrate the following competencies:
1) what the food industry is and what it is about.
2) the project & process managemen
3) the principles of HACCP
4) use fermentation and fermentation processes
5) apply separation techniques
6) apply evaporation and drying.
7) refining and purification techniques.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/25

Stampa del 06/11/2025

Energy transition and technologies for the circular economy [2201240]

Offerta didattica a.a. 2025/2026

Docenti: AGOSTINO RE REBAUDENGO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course addresses the issue of climate change, by analysing its main causes and possible mitigation strategies, with a focus on the transition to a low-carbon energy system and the adoption of sustainable technologies and processes in line with the principles of the circular economy.

Particular attention will be given to the treatment of the organic fraction of municipal solid waste (OFMSW) for biomethane production, as well as to the main sources of renewable energy such as photovoltaics and wind power.

In addition to theoretical lessons, the course includes educational visits to an OFMSW treatment plant and photovoltaic and wind power production sites.

The course will also explore methodologies for the economic and financial evaluation of projects in the renewable energy sector, together with the fundamental principles of administrative law applied to the energy and environmental context.

Finally, specific attention will be given to analysing the state of the art in research on CO_2 capture and utilisation.

Prerequisiti
Knowledge of thermodynamics, general and organic chemistry.

Contenuti del corso
1. Introduction to climate change: causes, consequences and countermeasures
2. The anaerobic digestion process of biomass and waste: biological stages and process parameters
3. Overview of the national waste management system. Energy recovery from landfill biogas: predictive production models, plant structure and technologies
4. Energy scenario and national and supranational trends. Decarbonisation targets for 2030
5. Types of biodigesters and comparison of plant technologies, mass and energy balances, biomethane and compost production
6. Biogas treatments: thermal and electrical energy production via cogeneration
7. Comparison of processes and technologies for biomethane upgrading
8. Concepts of strategic planning, action plans, performance monitoring and project management
9. Economic and financial evaluation of new initiatives in the renewable energy sector.
Key economic and financial indicators: cost and revenue structure, income statement, cash flows, CAPEX
10. Advanced research in the circular economy. Focus on CO2 capture and utilisation: technologies, applications, research projects
11. Hydroelectric energy: design principles; Electrochemical storage systems (BEES): design principles
12. Solar photovoltaics: design principles
13. Wind energy: design principles
14. New initiatives in the biomethane sector: development models, authorisation procedures and incentive mechanisms.

Metodi didattici
The topics will be covered through lectures, enriched with case studies and practical applications. The course also includes educational visits to a biomethane and compost production plant, a photovoltaic plant and a wind farm.

To complement the lessons, seminars will be held by leading experts in the field, offering insights into specific and current issues.

Modalità di verifica dell'apprendimento
The knowledge and skills acquired will be assessed by means of a written test (multiple-choice test) or, alternatively, an oral test lasting at least 30 minutes.

Testi di riferimento
Handouts uploaded to the University's e-learning platform.

Altre informazioni
By the end of the course, students will be able to:
– understand and analyse the processes and technologies for the production of biogas, biomethane, electricity and compost from the anaerobic digestion of OFMSW;
– understand the authorisation, connection and incentive access procedures for biomethane production plants from OFMSW and other renewable sources;
– Apply key tools for economic and financial evaluation and project management;
– understand the industrial context of OFMSW and other renewable energy treatments;

Students will be expecyed to develop a critical approach to the elaboration and understanding of concepts.
During lessons, students will be encouraged to interact with the lecturer in order to improve their analytical skills on the topics covered.
Students will be required to engage in problem solving during activities during the educational visit to an industrial plant.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Scienze e Tecnologie per lo Sviluppo Sostenibile e One Health

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Corso di Laurea Magistrale	Master of Science in Chemical Engineering for the Sustainable Development (2017)	Common	6	ING-IND/24

Stampa del 06/11/2025