DIDACTIC REGULATIONS FOR THE MASTER'S DEGREE COURSE IN CHEMICAL ENGINEERING CLASS LM-22

School: POLYTECHNIC AND BASIC SCIENCE SCHOOL

Department: CHEMICAL, MATERIALS, AND PRODUCTION ENGINEERING

Regulations in force from the academic year 2023 - 2024

ACRONYMS

CCD	[Commissione di Coordinamento Didattico]	Didactic Coordination Commission
CdS	[Corso/i di Studi]	Degree Course
CPDS	[Commissione Paritetica Docenti-Studenti]	Joint Teachers-Students Committee
OFA	[Obblighi Formativi Aggiuntivi]	Additional Educational Obligations
SUA-CdS	[Scheda Unica Annuale del Corso di Studi]	Annual Single Course Schedule
RDA	[Regolamento Didattico di Ateneo]	University Didactic Regulations

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Art. 1
Object

1. These Regulations govern the organisational aspects of the Degree Course in Chemical Engineering (class LM-22). The Degree Course in Chemical Engineering belongs to the Department of Chemical, Materials and Production Engineering.
2. The CdS is governed by the Didactic Coordination Commission (CCD), pursuant to Art. 4 of the RDA.
3. The Rules are issued in compliance with the relevant legislation in force, the Statute of the University of Naples Federico II and the University Didactic Regulations.

Art. 2
Learning objectives

The educational pathway of the Master's Degree in Chemical Engineering is intended to train a high-level professional figure responsible for the conception, research, design, planning, development, management and control of complex systems, processes and services in the area of chemical engineering and related areas. The course complements the Chemical Engineering bachelor's degree by aiming to establish a broader latitude of approach to problems, but at the same time a much higher level of professional insight and awareness. The student with a master's degree in Chemical Engineering becomes expert of the methodological aspects of process engineering, based on an advanced knowledge of chemical engineering subjects, and of the specific applications to the field of control techniques and safety analysis. The preparation, completed and supplemented by laboratory experiences and/or industrial internships, gives the graduate the ability to respond to the various specialised requirements that can be linked to the advanced analysis and design of transformation processes of industrial interest. In addition, the master's graduate acquires the knowledge, methodological tools and 'intellectual curiosity' necessary for the continuation of study and/or research activities at a more advanced level (second-level master's degree, PhD).
Master's degree graduates in the course of study must in particular
- be able to develop physical/mathematical models for the analysis of the characteristics and of the performance of equipment, plants and processes for the production of products and materials;
- be able to proceed to the design of plants and processes and to design and conduct research and development activities in the sector;
- be able to study and apply advanced methods for process regulation and control;
- be able to develop and apply technologies, including innovative ones, characterised by the required characteristics of safety and environmental compatibility.

The course aims to teach in-depth studies of general methods in advanced modelling techniques in a large part of the first year, while the second year is oriented towards industrial applications.
Students with the Master's Degree in Chemical Engineering must be able to use the English language correctly in written and oral form and possess adequate knowledge to enable the use of IT tools, necessary in the specific field of competence and for the exchange of general information.

Art. 3
Professional profile and work opportunities

Function in a working context:
The functions of master's degree graduates in Chemical Engineering relate to the management, operation, maintenance, and design of industrial plants; plants for the production of consumer goods, chemicals, pharmaceuticals, food textiles, cosmetics, detergents, plastics, energy production and management plants; mineral, gas, oil and water extraction systems; safety and environmental protection in the process industry, quality management and processing and processing.

Competences associated with the function:
The areas of activity and professional opportunities are:
-Chemical, pharmaceutical, food, production and energy management industries;
-Engineering companies that design, develop and implement processes and plants;
-Research centres and industrial laboratories;
-Technical structures of the public administration and consultancy firms for the environment and safety;
Employment opportunities:
A Master's degree in Chemical Engineering guarantees technical, scientific and managerial training suitable both for specialised studies (PhDs both in Italy and abroad; Level II Masters) and for professions with a high technical and managerial profile.
Approximately 10% of Chemical Engineering graduates undertake PhD studies in the numerous research fields of Chemical Engineering. PhD students are suitable for research activities on all scales from nano-materials (polymers, biomaterials, catalysts, foams, nano-particles and nano-composite materials) to industrial processes (sustainable energy production, combustion, biotechnology, safety, environment).
A relevant fact is the ability of Chemical Engineering graduates to integrate themselves within the international context by doing PhDs at the world's most important research laboratories.
With reference to the ISTAT-ATECO 2007 classification of productive activities, potential sectors of professional activity are those corresponding to a multiplicity of activities included in sections C (Manufacturing activities), D (Electricity, gas, steam and air conditioning supply), E (Water supply; sewerage, waste management and remediation activities) and P (Education) as well as in groups 71.12 (Activities of engineering offices and other technical offices), 71.20 (Technical testing and analysis), 72.19 (Other research and experimental development in the field of natural sciences and engineering), 84.13.1 (Regulation of the business of fuels and energy), 84.13.3 (Regulation of the business and services relating to mining and mineral resources - except fuels - manufacturing, construction and public works except roads and navigation works).
After passing the State Examination, graduates can become member of the Register of Engineers, with the title of Engineer.

Art. 4
Admission requirements and knowledge required for access to the Degree Course[1]

For enrolment in the Master's Degree Course in Chemical Engineering, specific access criteria are envisaged, in compliance with Article 6, paragraph 2 of Italian Ministerial Decree No. 270/04 and with the procedures defined in Article 5, concerning the possession of curricular requirements and the mandatory verification of the adequacy of the student's personal preparation. These requirements will include, inter alia, the documented ability to use correctly, in written and oral form, at least one European Union language other than Italian, with reference also to disciplinary lexicons.

[1] Artt. 7, 10, 11 of the University Didactic Regulations.

Art. 5
Procedures for access to the Degree Course

The Teaching Coordination Commission of the course normally regulates the admission criteria and any scheduling of enrolments, except in the case subject to different legal provisions[2]. Verification of personal readiness is compulsory in all cases, and only students meeting the curricular requirements may enter.

Pursuant to Art. 6 of the Ministerial Decree of 16 March 2007 (Decree of Institution of the Classes of Master's Degrees), admission to the Master's Degree Course in Chemical Engineering envisages the verification of the possession of curricular requirements, as well as the verification of the adequacy of the student's personal preparation. Specific provisions identify the Degree Courses that allow direct access to the Master's Degree Course, as well as the curricular integrations envisaged for students who do not meet these conditions. The Didactic Coordination Commission establishes the modality through which the student can make the curricular integration, to be selected according to the extent and nature of the integrations required.

The Didactic Coordination Commission shall also regulate, in accordance with guidelines established uniformly for all the Engineering Degree Courses of the Polytechnic and Basic Science School, the methods for verifying the adequacy of the student's personal preparation. Students for whom the average of the marks (in thirtieths) obtained in the profit examinations for the degree that gives access to the Master's Degree Course - weighted on the basis of the relative consistencies in CFUs - is not less than 24, are exempt from this verification. Specific provisions apply to students who are not in this condition.

In order to be admitted to the Master's Degree Course in Chemical Engineering, a documented ability to correctly use, in written and oral form, the English language, at least level B2, is required. Failing this, documentation must be acquired by the end of the Academic Year of enrolment and certified through the award of CFUs for 'additional language skills'. If the requirement is not met by the end of the first year, enrolment for the second year is still permitted, but no further examinations can be taken before the above-mentioned documentation has been acquired.

Furthermore, in order to be admitted to the Master's Degree Course in Chemical Engineering it is necessary to hold a degree, or another qualification obtained abroad that is recognised as suitable.

The curricular requirements for admission are automatically possessed by graduates of the degree course in Chemical Engineering established at the Federico II University, pursuant to Ministerial Decree 509/99 and Ministerial Decree 270/04, since the university credits of the active curriculum are declared fully recognisable for enrolment in the Master's Degree Course in Chemical Engineering.

Enrolment in the degree course for graduates other than those specified in the previous paragraph is not permitted in the absence of the minimum curricular requirements specified in the following table:

SSD	CFU minimi
MAT/**	24
FIS/01	8
CHIM/06-07	12
ING-INF/05	6
ING-IND/24-27	40
ING-IND/06, ING-IND/08, ING-IND/10, ING-IND/13, ING-IND/14, ING-IND/15, ING-IND/22, ING-IND/23, ING-IND/31-33, ICAR/08-09	18

The CCD, possibly with help of a special committee, assesses in this case the curricular requirements possessed by the candidate and recognises the credits in whole or in part. Any curricular integrations must be made by the student prior to enrolment, pursuant to Article 6, paragraph 1 of the Ministerial Decree of 16 March 2007 (Decree of Institution of the Classes of Master's Degrees). The integration may be carried out, depending on the case, by enrolling in individual courses of study activated at the Courses of Study of this University in accordance with Art. 16 paragraph 6 of the RDA, or by enrolling in the Bachelor Degree Course in Chemical Engineering at this University with an abbreviated course and assignment of a Study Plan that includes the curricular integrations required for enrolment in the Master of Science Degree Course.
The verification of the possession of the requirements relating to the student's personal preparation will be carried out, exclusively for students enrolled after 1 September 2011, on the basis of the average M average of the marks (in thirtieths) obtained in the profit examinations for the degree, weighted on the basis of the relative consistencies in CFUs, as well as the duration of studies D1 expressed in years of course, compared with the normal duration D2=3 years of the study path. The criterion for the student's automatic admission to the Master's Degree Course in Chemical Engineering is established according to the following table:

D1=D2	**D1=D2+1**	**D1≥D2+2**
M ≥ 21	M ≥ 22.5	M ≥ 24

In the presence of applications for the Master's Degree Course from students who do not meet the criteria for automatic admission, the Academic Coordination Board may examine the curriculum of the student, taking into consideration the marks obtained in exams that are in any case considered of particular relevance for the purposes of the successful completion of the Master's Degree course, and possibly imposing alignment courses, in accordance with Article 6, paragraph 3 of Ministerial Decree of 16 March 2007, without increasing the number of CFUs.

Art. 6
Teaching activities and Credits

Each educational activity prescribed by the degree system is measured in Credits. Each Credit corresponds to 25 hours of work[3] per student and includes the hours of assisted teaching and the hours reserved for personal study or other individual training activities.
For the Degree Course covered by these Regulations, the hours of assisted teaching for each ECT, established in relation to the type of training activity, are as follows [4]:

- Lecture: 8 hours for ECT;
- Seminar: 8 hours for ECT;
- Guided teaching exercises: 8 hours per ECT;
- Laboratory activities: 8 hours per ECT;

[2] National programmed access is regulated by L. 264/1999 and subsequent amendments and supplements.
[3] According to Art. 5, c. 1 of Italian Ministerial Decree No 270/2004, "25 hours of total commitment per student correspond to university training credits; a ministerial decree may justifiably determine variations up or down the aforementioned hours for individual classes, within the limit of 20 per cent".
[4] The number of hours considers the instructions in Art. 6, c. 2 of the RDA: "of the total 25 hours, for each ECT, are reserved: a) 5 to 10 hours for lectures; b) 6 to 10 hours for seminars; c) 8 to 12 hours for laboratory activities, except in the case of training activities with a high experimental or practical content, and subject to different legal provisions or different determinations by DD.MM.".

- Internship: 25 hours for ECT [5].

The ECT corresponding to each learning activity is acquired by the student by satisfying the assessment procedures (examination, pass mark) indicated in the Schedule relating to the course/activity attached to these Regulations.

Art. 7
Description of teaching methods

Teaching is carried out at in modality A, standard Degree Course. If necessary, the CCD decides which subjects also include teaching activities offered online. Some lectures may also take place in seminar form and/or involve classroom exercises, language, and computer laboratories. Detailed information on how each course is conducted can be found on the course sheets.

Art. 8
Testing of learning activities[6]

1. The Didactic Coordination Commission, within the regulatory limits laid down[7], establishes the number of examinations and other means of assessment that determine the acquisition of credits. Examinations are individual and may consist of written, oral, practical, graphical tests, term papers, interviews or a combination of these modes.
2. The examination procedures published in the teaching schedules and the examination schedule will be made known to students before the start of classes on the Department's website.
3. Examinations are held subject to booking, which is made electronically. In the event that the student is unable to book an exam for reasons that the President of the Board considers justified, the student may still be admitted to the examination, following the other booked students.
4. Before the examination, the President of the Board of Examiners verifies the identity of the student, who must present a valid photo ID.
5. Examinations are marked out of 30. Examinations involving an assessment out of 30 shall be passed with a minimum mark of 18; a mark of 30 may be accompanied by honours by unanimous vote of the Board. Examinations are marked out of 30 or with a simple pass mark. Assessment following tests other than examinations are marked out with a simple pass mark.
6. Oral exams are open to the public. If written tests are scheduled, the candidate has the right to see his/her paper(s) after correction.
7. Examination Boards are governed by the University Didactic Regulations.

Art. 9
Course structure and syllabus

1. The legal duration of the Degree Course is 2 years. It is also possible to enrol on the basis of a contract in accordance with the rules laid down by the University (Art. 21 of the University Didactic Regulations).

[5] For Internship activities (Inter-ministerial Decree 142/1998), subject to further specific provisions, the number of working hours equal to 1 ECT may not be less than 25. [please indicate below in the note any different regulatory provisions, e.g., "LM-13: 1 ECT = 30 hours, Note MUR, Director Cuomo, Prot. 570/2011; LM-51, L-24: 1 CFU = 20 hours professional training activity + 5 hours of further supervised training activity, D.M. 654/2022 (Art. 2, practical-assessment Internship)"]

[6] Article 20 of the University Didactic Regulations.

[7] Pursuant to the DD.MM. 16.3.2007 in each Degree Course the examinations or profit tests envisaged may not be more than 20 (bachelor's degrees; Art. 4. c. 2), 12 (master's degrees; Art. 4, c. 2), 30 (five-year single-cycle degrees) or 36 (six-year single-cycle degrees; Art. 4, c. 3).

The student must acquire 120 ECTs[8] , attributable to the following Types of Educational Activities (TAF):
B) characterising,
C) related or complementary,
D) at the student's choice[9] ,
E) for the final exam,
F) further training activities.

2. The degree is awarded after having acquired 120 ECTs by passing examinations, not exceeding 12, including the final exam, and the performance of the other educational activities.
   Unless otherwise provided for by the legal system of university studies, examinations taken as part of basic, characterising and related or supplementary activities, as well as activities chosen autonomously by the student (TAF D, counted in the number of one[10]) are taken into consideration for counting purposes. Tests constituting an assessment of suitability for the activities referred to in Article 10, paragraph 5, letters c), d) and e) of Ministerial Decree 270/2004 are excluded from the count. Integrated courses comprising two or more modules are subject to a single examination.
3. In order to acquire the ECTs relating to independent choice activities, the student is free to choose from all the courses offered by the University, provided that they are consistent with the training project. This consistency is assessed by the Didactic Coordination Commission. Also for the acquisition of the ECTs relating to autonomous choice activities the "passing of the exam or other form of profit verification" is required (Art. 5, c. 4 of Ministerial Decree 270/2004[11]).
4. The study plan summarises the structure of the course, listing the envisaged teachings broken down by course year and, if necessary, by curriculum. At the end of the study plan table the propedeuticities envisaged by the course are listed. The plan of studies offered to students, with an indication of the scientific-disciplinary sectors and the area to which they belong, of the credits, of the type of teaching activity, is set out in Annex 1 to these Regulations.

[8] The total number of ECTs for the acquisition of the relevant degree must be understood as follows: six-year single-cycle degree, 360 ECTs; five-year single-cycle degree, 300 ECTs; three-year degree, 180 ECTs; master's degree, 120 ECTs.
[9] Corresponding to at least 12 ECTs for three-year degrees and at least 8 ECTs for master's degrees (Art. 4, c. 3 of Ministerial Decree 16.3.2007).
[10] Art. 4, c. 2 of Annex 1 to Ministerial Decree 386/2007.
[11] Art. 10, c. 5 of Ministerial Decree. 270/2004: "In addition to the qualifying educational activities, as provided for in paragraphs 1, 2 and 3, Degree Courses shall provide for: a) educational activities autonomously chosen by the student as long as they are consistent with the training project [TAF D]; b) educational activities in one or more disciplinary fields related or complementary to the basic and characterising ones, also with regard to context cultures and interdisciplinary training [TAF C]; c) educational activities related to the preparation of the final exam for the achievement of the degree and, with reference to the degree, to the verification of the knowledge of at least one foreign language in addition to Italian [TAF E]; d) training activities, not envisaged in the previous points, aimed at acquiring additional language knowledge, as well as computer and telematic skills, relational skills, or in any case useful for integration in the world of work, as well as training activities aimed at facilitating professional choices, through direct knowledge of the work sector to which the qualification may give access, including, in particular, training and guidance courses referred to in Decree no. 142 of 25 March 1998 of the Ministry of Labour [TAF F]; e) in the hypothesis referred to in Article 3, paragraph 5, training activities relating to internships and apprenticeships with companies, public administrations, public or private entities including those of the third sector, professional orders and colleges, on the basis of appropriate agreements".

Art. 10
Attendance requirements[12]

1. In general, attendance of lectures is strongly recommended but not compulsory.
   In the case of individual courses with compulsory attendance, this option is indicated in the relevant Teaching Schedule available in Annex 2.
2. If the lecturer envisages a different syllabus modulation for attending and non-attending students, this is indicated in the individual Teaching Schedule published on the course web page and on the teachers UniNA website.
3. Attendance at seminar activities that award training credits is compulsory. The relative modalities for the attribution of ECTs are the responsibility of the CCD.

Art. 11
Prerequisites and prior knowledge

1. The list of incoming prerequisites (necessary to sit a particular examination) and outgoing prerequisites can be found at the end of Annex 1 and in the Teaching Schedule (Annex 2).
2. Any prior knowledge deemed necessary is indicated in the individual Teaching Schedule published on the course webpage and on the UniNA teaching website.

Art. 12
Course Calendar

The course calendar is made available on the Department's website prior to the start of classes.

Art. 13
Guidelines for the recognition of credits earned in other Courses in the same Class[13]

For students coming from Courses in the same Class, or simultaneously enrolled in Degree Courses of the same Class, the Didactic Coordination Commission shall ensure the recognition of the highest possible number of credits acquired by the student at the Course of origin and/or simultaneously attended, according to the criteria set out in Article 14 below. Failure to recognise credits must be adequately justified. This is without prejudice to the fact that the number of credits relating to the same scientific-disciplinary sector directly recognised to the student may not be less than 50% of those already achieved.

Article 14
Guidelines for the recognition of credits acquired in Degree Courses of different classes, in university or university-level Degree Courses, through single courses, at online Universities and in international Degree Courses[14]; Guidelines for the recognition of credits acquired in extra-curricular activities

1. With regard to the criteria for the recognition of ECTs acquired in Degree Courses of different Class, in university or university-level Degree Courses, through single courses, at online Universities and in International Degree Courses, the credits acquired are recognised by the competent structure on the basis of the following criteria:
   - analysis of the programme carried out;

[12] Art. 20, c. 8 of the University Didactic Regulations.
[13] Art. 16 of the University Didactic Regulations.
[14] Art. 16 of the University Didactic Regulations.

- evaluation of the congruity of the disciplinary scientific sectors and of the contents of the training activities in which the student has earned credits with the specific training objectives of the Course of Studies and of the individual training activities to be recognised.

Recognition is carried out up to the amount of credits envisaged by the didactic system of the Degree Course. Failure to recognise credits must be adequately justified.

2. The possible recognition of ECTs relating to examinations passed as single courses may take place within the limit of 36 ECTs, upon request of the interested party and following the approval of the competent teaching structures. Recognition may not contribute to the reduction of the legal duration of the Degree Course, as determined by Art. 8, c. 2 of Ministerial Decree 270/2004, except for students who enrol while already in possession of a degree of the same level[15].
3. With regard to the criteria for the recognition of ECTs acquired in extra-curricular activities, within the limit of 12 CFU the following activities may be recognised:
   - Professional knowledges, skills and certified skills, taking into account the congruence of the activity carried out and/or of the certified skill with the aims and objectives of the Degree Course of enrolment as well as the hourly commitment of the duration of the activity.
   - Knowledges and skills acquired in post-secondary-level training activities, which the University contributed to develop and implement.

Art. 15
Guidelines for enrolment in individual Degree Courses

Enrolment in individual teaching courses, provided for by the University Didactic Regulations[16], is governed by the "University Regulations for enrolment in individual teaching courses activated as part of the Degree Courses "[17].

Article 16
Features and arrangements for the final examination

A student is admitted to the final examination if he/she has obtained all the credits envisaged by the Didactic Regulation for activities other than the final examination, distributed in the different types according to the indications of the Regulation. The final examination consists of the discussion of a Master's thesis written by the student on a subject agreed upon with a University lecturer and consistent with the educational objectives of the Course, in front of the Master's Degree Committee. The thesis and the discussion must be in English. The thesis must highlight a congruous activity carried out by the student both in the in-depth study of the subject and of the associated modelling and experimental tools, and in the identification of the possible applications.
The final exam is taken by the candidate in front of a Committee chaired by the Course Coordinator and consists of the presentation of the work carried out under the guidance of a lecturer and subsequent discussion with the members of the Committee.
The candidate is allowed to make use of an audio-visual support, to be projected publicly, or, alternatively, to draw up a summary booklet, to be delivered in copy to each member of the Commission.
At the end of the presentation, each lecturer may address remarks to the candidate relating to the topic of the thesis work.
The presentation normally lasts 15 minutes.

[15] R.D. No. 3241/2019.
[16] Art. 16, c. 6 of the University Didactic Regulations.
[17] R.D. No. 3241/2019.

Article 17
Guidelines for work internships and placements

1. Students enrolled in the degree course may decide to carry out internships or training periods with organisations or companies that have an agreement with the University. Internships and placements are/are not [delete one of the two options] compulsory, and contribute to the award of credits for the other educational activities chosen by the student and included in the study plan, as provided for by Art. 10, par. 5, letters d and e, of Ministerial Decree 270/2004[18].
2. The modalities and characteristics of internships and placements are regulated by the CCD with a specific regulation.
3. The University of Naples Federico II, through the Ufficio Tirocini di Ateneo and COINOR (www.coinor.unina.it), ensures constant contact with the world of work, in order to offer students and graduates of the University concrete opportunities for internships and work experience and to promote their professional integration.

Article 18
Disqualification of student status[19]

A student who has not taken any examinations for eight consecutive academic years incurs forfeiture, unless his contract stipulates otherwise. In any case, forfeiture shall be notified to the student by certified e-mail or other suitable means attesting to its receipt.

Article 19
Teaching tasks, including supplementary teaching, guidance and tutoring activities

1. Lecturers and researchers carry out the teaching load assigned to them in accordance with the provisions of the University Teaching Regulations and the Regulations on the teaching and student service duties of professors and researchers and on the procedures for self-certification and verification of actual performance[20].
2. Professors and researchers must guarantee at least two hours of reception every 15 days (or by appointment in any case granted no longer than 15 days) and in any case guarantee availability by e-mail.
3. The tutoring service has the task of guiding and assisting students throughout their studies and of removing the obstacles that prevent them from adequately benefiting from attending courses, also through initiatives tailored to the needs and aptitudes of individuals.
4. The University ensures guidance, tutoring and assistance services and activities to welcome and support students. These activities are organised by the POLYTECHNIC AND BASIC SCIENCE SCHOOL in collaboration with the individual Teaching Structures, as established by the RDA in Article 8.

Article 20
Evaluation of the quality of the activities performed

1. The Didactic Coordination Commission implements all the forms of quality assessment of teaching activities envisaged by the regulations in force according to the indications provided by the University Quality Presidium.

[18] Letter d traineeships can be both internal and external; letter d traineeships and placement can only be external.
[19] Art. 21 of the University Didactic Regulations.
[20] R.D No. 2482//2020.

2. In order to guarantee the quality of teaching to the students and to identify the needs of the students and all stakeholders, the University of Naples Federico II uses the Quality Assurance (QA)[21] system, developed in accordance with the document "Self-evaluation, Evaluation and Accreditation of the Italian University System" of ANVUR, using:
   - surveys on the degree of integration of graduates into the world of work and on post-graduate needs.
   - data extracted from the administration of the questionnaire to assess student satisfaction for each course in the curriculum, with questions relating to the way the course is conducted, teaching materials, teaching aids, organisation, facilities.

   The requirements deriving from the analysis of student satisfaction data, discussed and analysed by the Teaching Coordination Committee and the Joint Teachers' and Students' Committee (CPDS), are included among the input data in the service design process and/or among the quality objectives.
3. The QA organisation developed by the University implements a process of continuous improvement of the objectives and of the appropriate tools to achieve them, ensuring that planning, monitoring and self-assessment processes are activated in all the structures to allow the prompt detection of problems, their adequate investigation and the design of possible solutions.

Article 21
Final Rules

The Department Council, on the proposal of the Academic Coordination Committee, submits any proposals to amend and/or supplement these Rules for consideration by the Academic Senate.

Article 22
Publicity and Entry into Force

1. These Rules and Regulations shall enter into force on the day following their publication on the University's official notice board; they shall also be published on the University website. The same forms and methods of publicity shall be used for subsequent amendments and additions.
2. Annex 1 (CdS structure) and Annex 2 (Teaching/Activity schedule) are an integral part of these Regulations.

[21] The Quality Assurance System, based on a process approach and adequately documented, is designed in such a way as to identify the needs of the students and all stakeholders, and then translate them into requirements that the training offer must meet.

ANNEX 1

COURSE REGULATIONS FOR THE

MASTER'S DEGREE COURSE IN

CHEMICAL ENGINEERING

CLASS LM-22

School: POLYTECHNIC AND BASIC SCIENCE SCHOOL

Department: CHEMICAL, MATERIALS, AND PRODUCTION ENGINEERING

Regulations in force from the academic year 2023 - 2024

STUDY PLAN A.Y. 2023-2024

KEY

Type of Educational Activity (TAF):
B = Characterising
C = Related or Supplementary
D = Optional activities
E = Final examination and language skills
F = Further training activities

Curriculum "Ingegneria di Processo"

Year I - Term I									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type** ***(frontal lesson, laboratory etc.)***	**Course modalities** **(in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Complementi di Termodinamica e Fenomeni di Trasporto	ING-IND/24	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Sicurezza dei Processi Chimici	ING-IND/27	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Dinamica non Lineare dei Processi chimici	ING-IND/26	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional

Year I - Term II									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type** ***(frontal lesson,***	**Course modalities** **(in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**

					laboratory etc.)				
Sviluppo e Analisi del Rischio dei Processi Chimici	ING-IND/27	single	9	72	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Dinamica e Controllo dei Processi Chimici	ING-IND/26	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Reattori Chimici e Biochimici	ING-IND/25	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional
Additional language skills**			3				F	Other Type	Mandatory

Year II - Term I									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type** ***(frontal lesson, laboratory etc.)***	**Course modalities** **(in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Operazioni dell'Industria di Processo	ING-IND/25	single	9	72	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Economia ed organizzazione aziendale	ING-IND/35	single	9	72	Frontal lesson	In-person	C	Attività formative affini o integrative	Mandatory
Catalisi Industriale	ING-IND/27	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional

Year II - Term II									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type** ***(frontal lesson, laboratory etc.)***	**Course modalities** **(in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Fondamenti di Ingegneria Strutturale	ICAR/09	single	9	72	Frontal lesson	In-person	C	Attività formative affini o integrative	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional
Training and orientation traineeships***			6	48			F	Other Type	Mandatory
Final test			15	24			E		Mandatory

Curriculum "Product Engineering"

Year I - Term I

Title Teaching	SSD	Module	ECTS	Hours	Activity Type *(frontal lesson, laboratory etc.)*	Course modalities (in-person, remote)	TAF	Disciplinary area	Mandatory / optional
Advanced Thermodynamics and Transport Phenomena	ING-IND/24	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Safety in Chemical Processes	ING-IND/27	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Applied Physical Chemistry	ING-IND/23	single	9	72	Frontal lesson	In-person	C	Attività formative affini o integrative	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional

Year I - Term II									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type *(frontal lesson, laboratory etc.)***	**Course modalities (in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Rheology	ING-IND/24	single	9	72	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Process Dynamics and Control	ING-IND/26	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Chemical and Biochemical Reactors	ING-IND/25	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional
Additional language skills**			3				F	Other Type	Mandatory

Year II - Term I									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type *(frontal lesson, laboratory etc.)***	**Course modalities (in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Modeling and Numerical Simulation of Chemical Processes	ING-IND/26	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Soft Matter Engineering	ING-IND/26	single	9	72	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Unit Operations for Product Engineering	ING-IND/25	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional

Year II - Term II

Title Teaching	SSD	Module	ECTS	Hours	Activity Type *(frontal lesson, laboratory etc.)*	Course modalities (in-person, remote)	TAF	Disciplinary area	Mandatory / optional
Structure Engineering	ICAR /09	single	9	72	Frontal lesson	In-person	C	Attività formative affini o integrative	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional
Training and orientation traineeships***			6	48			F	Other Type	Mandatory
Final test			15	24			E		Mandatory

Curriculum "Sustainable Engineering"

Year I - Term I									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type *(frontal lesson, laboratory etc.)***	**Course modalities (in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Advanced Thermodynamics and Transport Phenomena	ING-IND/ 24	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Safety in Chemical Processes	ING-IND/ 27	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Fermentation Chemistry and Industrial Microbiology	CHIM /11	single	9	72	Frontal lesson	In-person	C	Attività formative affini o integrative	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional

Year I - Term II									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type *(frontal lesson, laboratory etc.)***	**Course modalities (in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Fundamentals of Bioprocess Engineering	ING-IND/ 24	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Process Dynamics and Control	ING-IND/ 26	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Chemical and Biochemical Reactors	ING-IND/ 25	single	8	64	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional
Additional language skills**			3				F	Other Type	Mandatory

Year II - Term I

Title Teaching	SSD	Module	ECTS	Hours	Activity Type *(frontal lesson, laboratory etc.)*	Course modalities (in-person, remote)	TAF	Disciplinary area	Mandatory / optional
Sustainable Process Design	ING-IND/25	single	9	72	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Environmental Chemical Engineering	ING-IND/25	single	6	48	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Industrial Chemistry from Renewable Feedstocks	ING-IND/27	single	9	72	Frontal lesson	In-person	B	Chemical Engineering	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional

Year II - Term II									
Title Teaching	**SSD**	**Module**	**ECTS**	**Hours**	**Activity Type *(frontal lesson, laboratory etc.)***	**Course modalities (in-person, remote)**	**TAF**	**Disciplinary area**	**Mandatory / optional**
Structure Engineering	ICAR/09	single	9	72	Frontal lesson	In-person	C	Attività formative affini o integrative	Mandatory
Optional exams*			0-18	0-144		In-person	D	Other Type	Optional
Training and orientation traineeships***			6	48			F	Other Type	Mandatory
Final test			15	24			E		Mandatory

(*) In order to personalise their educational pathway, students may choose, during both the first and the second year, courses up to the completion of the 18 credits. These optional exams must be indicated by submitting the study plan according to the procedures indicated in the student guide, available at the following link

www.scuolapsb.unina.it/downloads/materiale/curricula/LM-ICHI_guida.pdf

unless the student intends to choose subjects suggested by the CCD. The list of these courses is reported below:

Title Teaching	Semester	SSD	Prerequisites	Study course from which it is borrowed
Advanced numerical techniques for soft matter simulation	II	ING-IND/26	Modeling and numerical simulation of chemical processes	
Applied statistical thermodynamics	II	ING-IND/23		
Biomateriali	I	ING-IND/34		Laurea Magistrale in Ingegneria dei Materiali
Biotechnological processes	II	ING-IND/25		

Combustione e fluidodinamica di sistemi reagenti	I	ING-IND/25		
Environmental biotechnology	I	ING-IND/24		
Environmental Monitoring	II	ING-IND/24		
Food formulation engineering	II	ING-IND/25		
Formulation chemistry	I	CHIM/02		
Heterogeneous photocatalytic processes	II	ING-IND/27		
Industrial ecology and green engineering[(a)]	II	ING-IND/25		
Ingegneria dei materiali nanofasici per l'energia e la sensoristica	I	ING-IND/22		Laurea Magistrale in Ingegneria dei Materiali
Ingegneria dei sistemi elettrochimici e celle a combustibile	II	ING-IND/27		
Ingegneria Sanitaria Ambientale	II	ICAR/03		
Interfacial engineering	I	ING-IND/24		
Meccanica dei fluidi complessi[(b)]	II	ING-IND/24		
Reattori e apparecchiature multifase	II	ING-IND/25		
Regenerative chemistry	I	CHIM/07		
Rischi di esplosione nei luoghi di lavoro: prevenzione e protezione	II	ING-IND/27		
Sicurezza di materiali solidi e liquidi ed attività laboratoriali	I	ING-IND/27		
Sicurezza strutturale antiincendio di edifici per processi industriali	II	ICAR/09		
Simulazione molecolare di materiali	I	CHIM/04		Laurea Magistrale in Ingegneria dei Materiali
Sustainable technologies for pollution control	I	ING-IND/25		
Thermo-chemical conversion of biomass and waste	II	ING-IND/26		
Tossicologia e igiene industriale	II	MED/42		

(a) proposed within the Minor in Green Technologies but accessible to all students

(b) only for students of "Ingegneria di Processo" or of "Sustainable Engineering"

All the courses listed in the previous table have the following characteristics: single module, 6 credits, 48 hours, lectures and exercises, in presence.

With the aim of fostering the development of interdisciplinary skills and the ability to operate with a systemic vision in multi-sectoral contexts, the CCD will allow students to further customise their training pathway by taking part to a short thematic path known as Minor. The educational activities envisaged by the Minor correspond, typically, to between 24 and 32 CFU, and 18 of these CFU may be recognised as optional educational activities. Thus, at least 6 credits will be reserved for extracurricular activities in addition to the CFUs in the statutory plan for the degree. The Minors to which students may apply are indicated by the CCD, and listed in the student guide mentioned above, together with the corresponding regulations.

(**) The assessment of the Additional Language Skills is certified by the CCD Coordinator, by filling in a specific form, by exhibiting (at least) B2 English language certificates acquired at external "certified" centres (www.miur.gov.it/enti-certificatori-lingue-straniere), or by following procedures defined by the university language centre (www.cla.unina.it) and publicised at the beginning of each academic year on the CdS website (www.ingchim.unina.it). The corresponding 3 credits are not awarded a grade but only an aptitude.

(***) These credits may be acquired by participating in activities proposed by the Degree Course (possibly organised by other bodies), or by carrying out internship activities at research bodies, companies, or foreign universities within the framework of programmes such as Erasmus. The recognition of credits is certified by the CCD Coordinator, by filling in a specific form, on the basis of certificates issued by the persons in charge of the activities carried out. Those credits are not awarded a grade but only an aptitude.

ANNEX 2

COURSE REGULATIONS

MASTER'S DEGREE IN CHEMICAL ENGINEERING

CLASS LM-9

School: Polytechnic and Basic Sciences

Department: Chemical, Materials and Production Engineering

Regulations in force for the academic year 2023-2024

Curriculum "Ingegneria di Processo"

Course: Complementi di Fenomeni di Trasporto	**Teaching Language:** Italian	
SSD (Subject Areas): ING-IND/24		**CREDITS:** 8
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The course deals with an advanced approach to "the tools of thermodynamics, kinetics and transport phenomena". It develops skills of "transport phenomena (heat and mass transfer with or without chemical reactions… Newtonian fluid mechanics… chemical and process thermodynamics… chemical and physical equilibria".		
Learning objectives: The main objective is to give the students an advanced expertise in thermodynamics and fluid mechanics, i.e., in all phenomena involving equilibrium of non-ideal systems, and momentum transfer. Such an expertise includes a more theoretically based approach (derivation of Navier-Stokes equations, also in their average form for turbulence) and a more engineering-based approach (use of the one-dimensional energy balance equation).		
Pre-requisites: none **Is a pre-requisite for:** none		
Types of examinations and other tests: The exam is a written test where the student is asked to solve both numerical and conceptual problems. The written test can be integrated, at the student's wish, by a short oral test.		

Course: **Sicurezza dei Processi Chimici**		**Teaching Language:** **Italian**
SSD (Subject Areas): **ING-IND/27**		**CREDITS:** **6**
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: **The specific skills of the SSD are aimed at the engineering of new processes (including biological ones), catalysts and products, as well as the improvement of existing ones, with particular reference to chemical reactions, separation and purification operations and safety and of environmental impact involved, as well as the optimal choice of catalysts, reactor, equipment and materials**		
Learning objectives: **To give the students the knowledge related to the safety aspects for the storage, transportation and conversion of dangerous substances (unstable, flammable, toxic)**		
Pre-requisites: **none** **Is a pre-requisite for:** **none**		
Types of examinations and other tests: **oral exam**		

Course: Dinamica non Lineare dei Processi Chimici	**Teaching Language:** italian	
SSD (Subject Areas): ING-IND/26		**CREDITS:** 6
Course year: 1	**Type of Educational Activity: B**	

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:
The systems approach to the study of chemical and physical processes and phenomena of interest in chemical engineering is introduced. This approach is aimed at characterizing the dynamics of equipment and industrial processes also in relation to safety, with the introduction of non-linear mathematical analysis tools.

Learning objectives:
Aim of the course is to introduce the topic of stability analysis of equipment and processes of interest in chemical engineering at a detailed level with typical tools of non-linear dynamic analysis.

Pre-requisites:
None

Is a pre-requisite for:
None

Types of examinations and other tests:
Written exam plus oral discussion of a project work. The written exam consists of multiple-choice questions and numerical exercises

Course: Sviluppo e Analisi del Rischio dei Processi Chimici	**Teaching Language:** italian
SSD (Subject Areas): ING-IND/27	**CREDITS:** 9
Course year: 1	**Type of Educational Activity: B**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:
The specific skills required are oriented to engineering novel processes, catalysts and products focusing on chemical reactions, unit operations, safety issues and environmental issues....

Learning objectives:
The aim of the course is to introduce the subject of risk analysis starting from the fundamentals of the previous courses on transport phenomena, safety, combustion. The course aims at providing students with advanced notions related to risk analysis and more specifically to consequence analysis and frequency (probability) analysis of accidentals scenario. The final achievement of the students will be the ability of developing risk maps of industrial chemical processes.

Pre-requisites:
None

Is a pre-requisite for:
None

Types of examinations and other tests:
Intercourse evaluations are based on 1) project developed by a group of students on the consequence analysis of an accidental scenario; 2) project developed by a group of students on the risk analysis of a chemical processes 3) short individual interview. At the end of these steps, a final evaluation will be provided.
The exam consists on the development of a group project on risk analysis of a chemical industrial processes, the discussion of the project and an individual interview.

Course: Dinamica e Controllo dei Processi Chimici		**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/26		**CREDITS:** 8
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector is characterized by a system approach for the study of chemical and physical processes and phenomena involved. This approach is aimed at the optimisation, control and management of equipment and industrial processes. The qualifying topics of the sector concern the development and application of: mathematical models for the process development; methodologies for the study of dynamics, and for the analysis and synthesis of process control systems also in relation to safety.		
Learning objectives: The course provides the fundamentals of dynamics and control of chemical processes based on linear or linearized mathematical models		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: The type of exam, consisting of problem solution with comments, is written		

Course: Reattori Chimici e Biochimici	**Teaching Language:** Italiano	
SSD (Subject Areas): Impianti Chimici (ING-IND/25)		**CREDITS:** 8
Course year: 1	**Type of Educational Activity:** B	

Teaching Methods

In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The subject area aims at the study of methodologies for the construction and operation of industrial plants based on chemical-physical and biological transformations of matter aimed at the production of goods, the provision of services and the prevention or mitigation of habitat modifications induced by anthropic activities or settlements. The focus is on the functional design and choice of chemical and biochemical reactors and ancillary equipment with specific reference to the consideration of flow non-ideality, mixing/segregation, heterogeneous reactions.

Learning objectives:

The student must demonstrate:

- to know and understand the selection and design of chemical and biochemical reactors and the evaluation of their performance in relation to the optimal conversion of raw materials taking into account the effect of flow non-ideality, mixing/segregation, heterogeneous reactions.
- to be able to generate written reports on the topics of the course and to expand his/her knowledge through research and access to documents relevant to the topics of the course.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

The examination is based on written tests with numerical exercises.

Course: OPERAZIONI DELL'INDUSTRIA DI PROCESSO	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/25	**CREDITS:** 9
Course year: 2	**Type of Educational Activity: B**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The field includes the study of methodologies for the design of industrial plants based on chemical-physical processing of matter aimed at the manufacturing and supply of products and services, and the prevention or mitigation of habitat modifications induced by human activities. Chemical plant design also includes definition of plant scheme and process equipment, defining of related specifications, and development of functional diagrams.
For the process industry, the following elements are qualifying: the functional design and selection of equipment for unit operations and for specific separation processes; the overall view of the plant and the ability to recombine the many aspects into a design and functional scheme; and the environmental impact of the plants. The relevant fields are those related to chemical and energy technologies as well as environmental protection.

Learning objectives:

Preparing the student on aspects of optimal design and operation of process equipment. Preparing the student in methodologies of systems analysis and principles of process economic optimization.

Pre-requisites: none

Is a pre-requisite for: none

Types of examinations and other tests:

Oral test and at the candidate's choice, a practical test.

Course: Economia e organizzazione aziendale	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/35	**CREDITS:** 9
Course year: 2	**Type of Educational Activity: C**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector brings together the skills for integrating design, economic, organizational, and managerial aspects in the engineering domain. In this context, one line is aimed at the integration of economic and managerial knowledge oriented towards design, highlighting the economic implications of projects, the relationships between design choices and company performance, the relationships between design and implementation of innovations, the methods of financing projects, the connection with the context in which the company operates.

Learning objectives:

The Economics and Business Organization course offers students the opportunity to approach the study of business, markets, and organizations. To this end, the training objectives provided aimed to:
- provide basic knowledge on the concept of business organization and its ecosystem
- provide helpful basic knowledge for drafting and analyzing the main accounting and financial statements (income statement, balance sheet, and explanatory notes)
- acquire the basic knowledge for the formulation of the Key Performance Indicators (KPI)
- transfer the concepts of competitiveness and strategic choices
- acquire the ability to analyze the resources (human, technical, economic, and financial) involved in the entrepreneurial development process
- transfer the necessary knowledge and essential elements for compiling company business plans.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and Project discussion

Course: Catalisi Industriale	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/27	**CREDITS:** 6
Course year: 2	**Type of Educational Activity: B**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The contents of the course are placed within the themes of Industrial Chemistry for Chemical Engineering. Specifically, the contents of the course are aimed at the study of catalytic reactions and at the industrial applications of catalysts in the most important processes for the chemical industry. In particular, the catalytic systems are described in relation to the specific chemical-physical properties required by the type of reactions and the characteristics of the processes for which they are intended

Learning objectives:

The main objectives of the course are to provide the student with the knowledge that allows him to identify the relevant aspects of the management of catalytic processes such as the stability and efficiency of the catalytic systems, the selectivity to the products of interest, the definition of the types and operating conditions of catalytic reactors and in general to identify criteria for choosing suitable catalytic systems and for defining the set of process conditions.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

The evaluation will be made on the basis of the discussion of the paper and the oral exam in a single session.

Course: **Fondamenti di Ingegneria Strutturale**	Teaching Language: Italian
SSD (Subject Areas): ICAR/09	**CREDITS:** 9
Course year: 2	**Type of Educational Activity: C**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The scientific-disciplinary contents consist of theories and techniques aimed at both the structural conception and the dimensioning of new buildings. They include the problems of actions on constructions and the behaviors that follow according to the types and morphologies, materials and technologies; the safety assessments; methods and tools for structural design.

Learning objectives:

The aim of the course is to provide the principles of statics and safety for continuous media and determine their fundamental application aspects. Starting from these notions, students will be able to develop analysis and critical thinking on real cases of research and field structural application, in a comparative perspective and multidisciplinary interaction. The final part of the course is dedicated to the verification of simple metal structures of interest to the Chemical Engineer.

Pre-requisites:

There are no prerequisites.

Is a pre-requisite for:

None

Types of examinations and other tests:

The exam is written and oral.

At the exam it is required to deliver a complete exercise (completed before the exam) concerning the design/verification of selected elements of a Tank

Curriculum "Product Engineering"

Course: Advanced Thermodynamics and Transport Phenomena	**Teaching Language:** English	
SSD (Subject Areas): ING-IND/24		**CREDITS:** 8
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The course deals with an advanced approach to "the tools of thermodynamics, kinetics and transport phenomena". It develops skills of "transport phenomena (heat and mass transfer with or without chemical reactions… Newtonian fluid mechanics… chemical and process thermodynamics… chemical and physical equilibria".		
Learning objectives: The main objective is to give the students an advanced expertise in thermodynamics and fluid mechanics, i.e., in all phenomena involving equilibrium of non-ideal systems, and momentum transfer. Such an expertise includes a more theoretically based approach (derivation of Navier-Stokes equations, also in their average form for turbulence) and a more engineering-based approach (use of the one-dimensional energy balance equation).		
Pre-requisites: none **Is a pre-requisite for:** none		
Types of examinations and other tests: The exam is a written test where the student is asked to solve both numerical and conceptual problems. The written test can be integrated, at the student's wish, by a short oral test.		

Course: **Safety in Chemical Processes**		**Teaching Language:** **English**
SSD (Subject Areas): **ING-IND/27**		**CREDITS:** **6**
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: **The specific skills of the SSD are aimed at the engineering of new processes (including biological ones), catalysts and products, as well as the improvement of existing ones, with particular reference to chemical reactions, separation and purification operations and safety and of environmental impact involved, as well as the optimal choice of catalysts, reactor, equipment and materials**		
Learning objectives: **To give the students the knowledge related to the safety aspects for the storage, transportation and conversion of dangerous substances (unstable, flammable, toxic)**		
Pre-requisites: **none** **Is a pre-requisite for:** **none**		
Types of examinations and other tests: **oral exam**		

Course: Applied Physical Chemistry	**Teaching Language:** English	
SSD (Subject Areas): ING-IND/23		**CREDITS:** 9
Course year: 1	**Type of Educational Activity: C**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: Connecting the structural and microstructural properties of materials and macroscopic properties of interest for engineering applications, with the goal of characterizing the behaviour of materials in given process conditions. A special focus is devoted to study the properties of solids and polymeric materials.		
Learning objectives: The course aims at providing students with advanced notions related to microscopic description, modeling and design of materials of interest for chemical engineers, including fluids, amorphous solids and soft matter systems.		
Pre-requisites: There are no prerequisites. **Is a pre-requisite for:** N.A.		
Types of examinations and other tests: Group project + Oral examination		

Course: Rheology	**Teaching Language:** English	
SSD (Subject Areas): ING/IND-24		**CREDITS:** 9
Course year: 1	**Type of Educational Activity: B**	

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The aim of SSD is the "Basic Process Design", i.e. the development of methodologies and technologies of the process industry (chemical, … , food, pharmaceutical, production and transformation of materials), on the basis of physical phenomena, chemical and biological principles that characterize the specific transformations. The study is based on a system perspective, by using the tools of thermodynamics, chemical kinetics, transport phenomena, to analyse the individual stages of processes and equipment, and recompose them in a unified vision. Characteristic skills include transport phenomena, specifically the Newtonian and non-Newtonian fluid mechanics and the rheology of complex fluids.

Learning objectives:

The aim of the course is to convey the fundamental principles underlying rheology, a science that studies the relationships between stress and strain, to teach the constitutive equations that regulate the flow behaviour of numerous non-Newtonian fluids, to deal with the empirical models for the characterization of specific rheological responses, and to guarantee, at the end of the course, an in-depth knowledge of the relationships between microstructure and macroscopic response for many viscoelastic systems.

Pre-requisites:

none

Is a pre-requisite for:

none

Types of examinations and other tests:

oral

Course: Process Dynamics and Control		**Teaching Language:** English
SSD (Subject Areas): ING-IND/26		**CREDITS:** 8
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector is characterized by a system approach for the study of chemical and physical processes and phenomena involved. This approach is aimed at the optimisation, control and management of equipment and industrial processes. The qualifying topics of the sector concern the development and application of: mathematical models for the process development; methodologies for the study of dynamics, and for the analysis and synthesis of process control systems also in relation to safety.		
Learning objectives: The course provides the fundamentals of dynamics and control of chemical processes based on linear or linearized mathematical models		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: The type of exam, consisting of problem solution with comments, is written		

Course: Chemical and Biochemical Reactors	**Teaching Language:** English
SSD (Subject Areas): Impianti Chimici (ING-IND/25)	**CREDITS:** 8
Course year: 1	**Type of Educational Activity:** B

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The subject area aims at the study of methodologies for the construction and operation of industrial plants based on chemical-physical and biological transformations of matter aimed at the production of goods, the provision of services and the prevention or mitigation of habitat modifications induced by anthropic activities or settlements. The focus is on the functional design and choice of chemical and biochemical reactors and ancillary equipment with specific reference to the consideration of flow non-ideality, mixing/segregation, heterogeneous reactions.

Learning objectives:

The student must demonstrate:

- to know and understand the selection and design of chemical and biochemical reactors and the evaluation of their performance in relation to the optimal conversion of raw materials taking into account the effect of flow non-ideality, mixing/segregation, heterogeneous reactions.
- to be able to generate written reports on the topics of the course and to expand his/her knowledge through research and access to documents relevant to the topics of the course.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

The examination is based on written tests with numerical exercises.

Course: Modeling and Numerical Simulation of Chemical Processes		**Teaching Language:** English
SSD (Subject Areas): ING-IND/26		**CREDITS:** 6
Course year: 2	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: Mathematical methods for the analysis, modeling, identification, and simulation, also with numerical methods, of process industry systems. Characterization and development of processes for the chemical, biotechnological, food, and pharmaceutical industries and for the production and transformation of materials.		
Learning objectives: The course aims at: (i) developing advanced mathematical models for fluid dynamics problems. (ii) providing the fundamental concepts on how to perform numerical simulations for fluid dynamics problems. (iii) teaching how to use computational fluid dynamics computer programs to solve complex fluid dynamics problems of interest in chemical engineering.		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: Written exam and project discussion		

Course: SOFT MATTER ENGINEERING	**Teaching Language:** Engish
SSD (Subject Areas): ING-IND/26	**CREDITS:** 9
Course year: 2	**Type of Educational Activity: B**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The modeling of processes and products based on complex microstructured liquids is introduced. This approach is aimed at the management of equipment and industrial processes. The course introduces deterministic and stochastic mathematical methods for the modeling and simulation with numerical methods of process industry systems. The contents are focused on the characterization and development of processes with attention to the aspects related to the production and transformation of materials.

Learning objectives:

Integration of the student's preparation with reference to specialized and in-depth knowledge of soft matter, the technologies used to process it, mathematical modeling techniques and numerical resolution of the models.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral exam plus oral discussion of a project work. Activities during the course will give you access to bonus points

Course: UNIT OPERATIONS FOR Product Engineering	**Teaching Language: English**	
SSD (Subject Areas): ING/IND-25		**CREDITS: 6**
Course year: 2	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector includes the study of methodologies for the design, construction, verification and operation of industrial plants based on chemical-physical and biological transformations of matter aimed at the production of goods, the provision of services and the prevention or mitigation of environmental modifications induced by anthropic activities. Qualifying items are: • plant design including simulation, • the elaboration of quantified process schemes: • the selection, the design and the verification of Reactors and Unit Operation Equipments used for specific applications. Sectors of reference are: chemical, pharmaceutical, food, energy, extraction, refining, transport and storage of raw materials, energy carriers, biotechnologies, and of the technologies that enable environmental protection and the circular economy.		
Learning objectives: The student must demonstrate knowledge of the main issues of handling and treatment of the main raw materials used for the formulation of products of interest to the food, pharmaceutical and cosmetic sectors and the possible physical, chemical, microbiological and organoleptic changes that may occur in the use of the equipment used in the different unit operations.		
Pre-requisites: NONE **Is a pre-requisite for: NONE**		
Types of examinations and other tests: Written (numerical exercises) + Oral		

Course: **Structure Engineering**	**Teaching Language:** English
SSD (Subject Areas): ICAR/09	**CREDITS:** 9
Course year: 2	**Type of Educational Activity: C**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The scientific-disciplinary contents consist of theories and techniques aimed at both the structural conception and the dimensioning of new buildings. They include the problems of actions on constructions and the behaviors that follow according to the types and morphologies, materials and technologies; the safety assessments; methods and tools for structural design.

Learning objectives:

The aim of the course is to provide the principles of statics and safety for continuous media and determine their fundamental application aspects. Starting from these notions, students will be able to develop analysis and critical thinking on real cases of research and field structural application, in a comparative perspective and multidisciplinary interaction. The final part of the course is dedicated to the verification of simple metal structures of interest to the Chemical Engineer.

Pre-requisites:

There are no prerequisites.

Is a pre-requisite for:

None

Types of examinations and other tests:

The exam is written and oral.

At the exam it is required to deliver a complete exercise (completed before the exam) concerning the design/verification of selected elements of a Tank

Curriculum "Sustainable Engineering"

Course: Advanced Thermodynamics and Transport Phenomena	**Teaching Language:** English	
SSD (Subject Areas): ING-IND/24		**CREDITS:** 8
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The course deals with an advanced approach to "the tools of thermodynamics, kinetics and transport phenomena". It develops skills of "transport phenomena (heat and mass transfer with or without chemical reactions… Newtonian fluid mechanics… chemical and process thermodynamics… chemical and physical equilibria".		
Learning objectives: The main objective is to give the students an advanced expertise in thermodynamics and fluid mechanics, i.e., in all phenomena involving equilibrium of non-ideal systems, and momentum transfer. Such an expertise includes a more theoretically based approach (derivation of Navier-Stokes equations, also in their average form for turbulence) and a more engineering-based approach (use of the one-dimensional energy balance equation).		
Pre-requisites: none **Is a pre-requisite for:** none		
Types of examinations and other tests: The exam is a written test where the student is asked to solve both numerical and conceptual problems. The written test can be integrated, at the student's wish, by a short oral test.		

Course: **Safety in Chemical Processes**		**Teaching Language:** **English**
SSD (Subject Areas): **ING-IND/27**		**CREDITS:** **6**
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: **The specific skills of the SSD are aimed at the engineering of new processes (including biological ones), catalysts and products, as well as the improvement of existing ones, with particular reference to chemical reactions, separation and purification operations and safety and of environmental impact involved, as well as the optimal choice of catalysts, reactor, equipment and materials**		
Learning objectives: **To give the students the knowledge related to the safety aspects for the storage, transportation and conversion of dangerous substances (unstable, flammable, toxic)**		
Pre-requisites: **none** **Is a pre-requisite for:** **none**		
Types of examinations and other tests: **oral exam**		

Course: **Fermentation chemistry and industrial microbiology**	**Teaching Language:** english	
SSD (Subject Areas): Chim/11		**CREDITS:** 9
Course year: 1	**Type of Educational Activity: C**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The disciplinary scientific sector collects the research topics that deepen the basic knowledge necessary for the design of industrial processes that use microorganisms, cell cultures, and immobilized enzymes. It includes the genetic improvement of microbial strains of industrial interest, metabolic engineering, control and validation of fermentation processes, and the products obtained, with reference to the biotechnological processes used in the pharmaceutical, chemical, food, and environmental remediation industries.		
Learning objectives: The course aims to provide the knowledge necessary to understand the different aspects of the biotechnological production of substances of industrial interest. In detail, it aims to provide the fundamental elements of industrial microbiology, microbial growth kinetics in the different fermentation modes (batch, fed-batch, and continuous), and fermentation chemistry. Furthermore, the course aims to deepen the microbial metabolism aimed at the development of industrial production processes and to introduce the main aspects of control of bioprocesses.		
Pre-requisites: There are no prerequisites **Is a pre-requisite for:** None		
Types of examinations and other tests: Written and oral		

Course: Process Dynamics and Control	**Teaching Language:** English	
SSD (Subject Areas): ING-IND/26		**CREDITS:** 8
Course year: 1	**Type of Educational Activity: B**	
Teaching Methods **In presence**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector is characterized by a system approach for the study of chemical and physical processes and phenomena involved. This approach is aimed at the optimisation, control and management of equipment and industrial processes. The qualifying topics of the sector concern the development and application of: mathematical models for the process development; methodologies for the study of dynamics, and for the analysis and synthesis of process control systems also in relation to safety.		
Learning objectives: The course provides the fundamentals of dynamics and control of chemical processes based on linear or linearized mathematical models		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: The type of exam, consisting of problem solution with comments, is written		

Course: Fundamentals of Bioprocess Engineering	**Teaching Language:** english	
SSD (Subject Areas): ING-IND 24		**CREDITS:** 6
Course year: 1	**Type of Educational Activity: B**	

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The course is aimed at providing the student with the tools for the development of methodologies and technologies of the biotechnology industry, taking into account the physical, chemical and biological phenomena related to the specific transformations.
The tools of thermodynamics, chemical kinetics and transport phenomena are used to analyse single stages of biotechnological processes and related equipment, that are eventually recomposed in a unified vision, functional for the identification and quantification of operational and design activities.
The applications are aimed at the development of new technologies that meet economic, energy and environmental compatibility requirement.
Characteristic skills include biochemical kinetics and reactor engineering, accompanied by elements of thermodynamics (energy analysis of processes, multi-component systems, chemical equilibria).

Learning objectives:

Students should get a deep knowledge of bioprocess options and of engineering constraints, to identify scientific problems with concrete industrial use, as well as to evaluate and optimize real biotechnological production processes.
They should get flexibility and creativity to give a synthetic and efficient description of problems. They should be able to deal with different professional figures (process engineers, chemists, biologists) involved in the development of biotechnological processes.
Once the course has been completed, the students should be able to gain autonomously insight about the topics covered in the course, to improve their personal knowledge on both engineering processes and biology fields

Pre-requisites:

none

Is a pre-requisite for:

none

Types of examinations and other tests:

The exam consists of an oral test, during which the student also discusses an exercise of simulation solved using Excel

Course: Chemical and Biochemical Reactors	**Teaching Language:** English	
SSD (Subject Areas): Impianti Chimici (ING-IND/25)		**CREDITS:** 8
Course year: 1	**Type of Educational Activity:** B	

Teaching Methods

In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The subject area aims at the study of methodologies for the construction and operation of industrial plants based on chemical-physical and biological transformations of matter aimed at the production of goods, the provision of services and the prevention or mitigation of habitat modifications induced by anthropic activities or settlements. The focus is on the functional design and choice of chemical and biochemical reactors and ancillary equipment with specific reference to the consideration of flow non-ideality, mixing/segregation, heterogeneous reactions.

Learning objectives:

The student must demonstrate:

- to know and understand the selection and design of chemical and biochemical reactors and the evaluation of their performance in relation to the optimal conversion of raw materials taking into account the effect of flow non-ideality, mixing/segregation, heterogeneous reactions.
- to be able to generate written reports on the topics of the course and to expand his/her knowledge through research and access to documents relevant to the topics of the course.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

The examination is based on written tests with numerical exercises.

Course: **Sustainable Process Design**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/25	**CREDITS:** 9
Course year: 2	**Type of Educational Activity: B**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

Chemical Plants design
Process design flowsheet
Equipment selection and design specifications for separation processes
Process design and economics, including safety, environmental and control systems

Learning objectives:
The course aims to train master students in: i) the advanced design of separation and purification equipment, either as stand-alone units or as part of a complex layout, and ii) the chemical process design and optimization. The course provides physical-mathematical models, numerical methods and technical guidelines for equipment and plant design, models for process economics and optimization, and guidelines and mathematical criteria for improving process sustainability, also thanks to their application to selected case studies.

Pre-requisites:
None

Is a pre-requisite for:
None

Types of examinations and other tests:
The examination includes intermediate group project(s) on specific case studies (presented as written reports) and an oral examination during which a final group project is discussed, and each student preparation is tested on selected course topics.

Course: Environmental Chemical Engineering		**Teaching Language:** English
SSD (Subject Areas): ING-IND/25		**CREDITS:** 6
Course year: 2	**Type of Educational Activity: B**	

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:
The subject area includes the study of methodologies for the building of industrial plants based on chemical-physical transformations of matter aimed at the production of goods, the provision of services and the prevention or mitigation of habitat modifications induced by anthropic activities or settlements. Plant design includes the lay-out of the process, the definition of the equipment included in the process, the relative specifications, the elaboration of functional diagrams including control instrumentation, risk analysis and environmental protection, costs evaluation.

Learning objectives:
The course aims to provide a detailed knowledge of the mechanisms of formation of polluted by anthropogenic activities to correctly understand environmental problems and the relationship between anthropogenic activities and effects on the living environment and human health. The goal is to provide tools and methodologies for the correct implementation of environmental policies.

Pre-requisites:
No preliminary courses required

Is a pre-requisite for:
No preliminary courses required

Types of examinations and other tests:
Examination is oral. The final mark is formulated based on the student's level of learning and on his or her ability to apply the knowledge acquired to problems other than those presented during the course. Attendance to the class is not mandatory.

Course: INDUSTRIAL CHEMISTRY FROM RENEWABLE FEEDSTOCKS	**Teaching Language:** English	
SSD (Subject Areas): ING-IND/27		**CREDITS:** 9
Course year: 2	**Type of Educational Activity: B**	

Teaching Methods

In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

Methods for the definition and implementation of chemical processes, from raw materials to finished products and production waste, with the aim of providing, also through material and energy balances, tools and criteria for the quantitative evaluation of processes, both from an economic, environmental, safety and quality control point of view. Study of processes starting from the evaluation of the thermodynamic, kinetic and transport aspects that underlie them. The specific skills of the sector are aimed at the engineering of new catalyst processes and products, as well as the improvement of existing ones, with particular reference to the chemical reactions and the safety and environmental impact problems involved, as well as the optimal choice of catalysts and reactor

Learning objectives:

The course aims at providing students with advanced notions and methodological tools necessary to provide an integrated view of the main industrial organic processes in particular between chemical fundamentals and engineering principles for the exploitation of renewable and not renewable feedstocks.

Pre-requisites: no prerequisites

Is a pre-requisite for: no prerequisites

Types of examinations and other tests: Oral exam or discussion of project

Course: **Structure Engineering**	**Teaching Language:** English
SSD (Subject Areas): ICAR/09	**CREDITS:** 9
Course year: 2	**Type of Educational Activity: C**

Teaching Methods
In presence

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The scientific-disciplinary contents consist of theories and techniques aimed at both the structural conception and the dimensioning of new buildings. They include the problems of actions on constructions and the behaviors that follow according to the types and morphologies, materials and technologies; the safety assessments; methods and tools for structural design.

Learning objectives:

The aim of the course is to provide the principles of statics and safety for continuous media and determine their fundamental application aspects. Starting from these notions, students will be able to develop analysis and critical thinking on real cases of research and field structural application, in a comparative perspective and multidisciplinary interaction. The final part of the course is dedicated to the verification of simple metal structures of interest to the Chemical Engineer.

Pre-requisites:

There are no prerequisites.

Is a pre-requisite for:

None

Types of examinations and other tests:

The exam is written and oral.

At the exam it is required to deliver a complete exercise (completed before the exam) concerning the design/verification of selected elements of a Tank

Suggested optional exams

Course: Advanced Numerical Techniques for Soft Matter Simulation	**Teaching Language:** English
SSD (Subject Areas): ING-IND/26	**CREDITS:** 6
Course year: II	**Type of Educational Activity: D**
Teaching Methods: in-person	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: Mathematical methods for the analysis, modeling, identification, and simulation, also with numerical methods, of process industry systems. Characterization and development of processes for the chemical, biotechnological, food, and pharmaceutical industries and for the production and transformation of materials.	
Learning objectives: The course aims at presenting advanced numerical techniques for the simulation of the mechanical and fluid dynamic behaviour of systems of interest in soft matter science and technology, e.g., suspensions, emulsions, foams, and granular media.	
Pre-requisites: Modeling and Numerical Simulation of Chemical Processes **Is a pre-requisite for:** None	
Types of examinations and other tests: Project discussion	

Course: Applied Statistical Thermodynamics	**Teaching Language:** English
SSD (Subject Areas): ING-IND/23	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: in-person	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: Connecting the structural and microstructural properties of materials and macroscopic properties of interest for engineering applications, with the goal of characterizing the behaviour of materials in given process conditions. A special focus is devoted to study the properties of solids and polymeric materials.	
Learning objectives:	

The course aims at providing students with advanced notions related to microscopic description and particle simulations (LAMMPS) of materials and systems of soft matter of interest for chemical engineers.

Pre-requisites:
There are no prerequisites.

Is a pre-requisite for:
N.A.

Types of examinations and other tests:
Project + Oral examination

Course: Biotechnological Processes	**Teaching Language:** English
SSD (Subject Areas): ING-IND/25	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity:** D

Teaching Methods: in-person

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:
Biorefinery concept. Recovery, yield, selectivity, pureness – concepts for operation units dedicated to biotechnological processes. Downstream processes in biotechnological industries - Removal of insolubles (filtration and centrifugation), isolation of product, purification and polishing. Liquid-liquid extraction. Membrane filtration. Adsorption. Chromatography. Precipitation/Crystallization. Flowsheet development. Techno-economic analysis in biorefinery processes - CAPEX and OPEX. Case studies - Energy from Biomass and Waste, Bioproducts from biomass and waste and examples of biorefinery concepts

Learning objectives:
The student must be able to select unit operations to exploit renewable resources and to design selected units

Pre-requisites:
None

Is a pre-requisite for:
None

Types of examinations and other tests:
Written exam with numerical exercises. The final exam evaluation is expressed as a grade from 18/30 to 30/30 cum laude

Course: **COMBUSTION AND REACTIVE FLUID DYNAMICS**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/25	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D

Teaching Methods: in-person

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

Chemical kinetics fundamentals. 0D and 1D flame models. Turbulence and flame-turbulence interaction. Aerodynamics of combustion processes. CFD of combustion chambers in prototypal configurations. Spray Atomization of liquid fuels.

Learning objectives:

The course aims to provide the methodological tools and knowledge to frame combustion processes in the context of propulsion and power generation applications to evaluate their potential development under the constraints of new energy carriers, zero-emission limits, and high performances. In addition, the course defines in the most relevant prototype configurations the equations that describe combustion processes evolving under fixed boundary/initial conditions, analyzing their most significant parameters and most sensitive variations. Such a systematic framing of combustion processes makes it possible to enucleate the most significant sub-processes that can be addressed by established computational methods of a single-disciplinary nature. Finally, the course analyzes specific categories of combustion processes with the aim of exercising the acquired methodological tools, familiarizing with basics of simple process design, and developing critical paths that allow considering new configurations in their potentialities and similarities with established configurations.

Pre-requisites: None

Is a pre-requisite for: None

Types of examinations and other tests:

Oral and group project

Course: **Environmental Biotechnology**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/24	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D

Teaching Methods: in-person

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

Applications are focused on environmental engineering and are aimed at the development of new technologies that address economic, energy, and environmental concerns. Characterizing competencies include transport phenomena (exchange of matter between phases in the presence of chemical reactions, and related equipment; control of pollutant dispersion in the environment); biochemical kinetics and bioreactor design.

Learning objectives:

The course provides an advanced discussion of biological wastewater treatment methods and bioremediation techniques for contaminated soil and groundwater based on the application of biochemical engineering principles and environmental microbiology.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests: Written

Course: **ENVIRONMENTAL MONITORING**	**Teaching Language:** English
SSD (Subject Areas): **ING/IND 24**	**CREDITS:** 6
Course year: 2022-23	**Type of Educational Activity:** D
Teaching Methods: in-person	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: Development of the technologies and methods of the process industry with application to environmental engineering and fulfilling environmental sustainability requests	
Learning objectives: The course aims at providing students with advanced notions for a specialistic study of the impact of anthropogenic emissions on the environment. In particular the course deals with: environmental legislation, analytical techniques of pollutants, the organization of a monitoring campaign and the study of dispersion of pollutants in the environment with a special focus on atmospheric dispersion.	
Pre-requisites: Not provided **Is a pre-requisite for:** Not provided	
Types of examinations and other tests: Oral	

Course: **Food Formulation Engineering**	**Teaching Language:** **English**
SSD (Subject Areas): ING/IND-25	**CREDITS:6**
Course year: I-II	**Type of Educational Activity: D**
Teaching Methods: in-person, lectures, exercises, case studies	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector includes the study of methodologies for the design, construction, verification and operation of industrial plants based on chemical-physical and biological transformations of matter aimed at the production of goods, the provision of services and the prevention or mitigation of environmental modifications induced by anthropic activities. Qualifying items are: • plant design including simulation, • the elaboration of quantified process schemes including the protection and control instrumentation, and cost evaluation:	

- the selection, the design and the verification of Reactors and Unit Operation Equipments used for specific applications.

Sectors of reference are: chemical, pharmaceutical, food, energy, extraction, refining, transport and storage of raw materials, energy carriers, biotechnologies, and of the technologies that enable environmental protection and the circular economy

Learning objectives:

The student is expected to acquire knowledge and comprehension skills of advanced concepts of food formulation and processing with special emphasis on:

- technical, commercial, marketing and sustainability guidelines in food design and formulation;
- project management in food design and production;
- definition, selection and characterization of raw materials, packaging and processes used in food production.

Pre-requisites: None

Is a pre-requisite for: None

Types of examinations and other tests:
Written (test with multiple choice) + Oral (Project Report Discussion)

Course: **Formulation Chemistry**	**Teaching Language:** english
SSD (Subject Areas): CHIM/02 Physical Chemistry	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D

Teaching Methods: in-person

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The course aims to describe, both at the macroscopic and at the atomic-molecular level, the structure, properties, and transformations of matter, with particular regard to chemical formulations. Based on the development of experimental methodologies, it aims at the construction of models for the interpretation and prediction of experimental parameters and at the solution of problems related to complex systems of chemical, physical and environmental interest.

Learning objectives:

The student will acquire the basic concepts of colloid and interface science and of design and engineering of chemical formulations, with particular attention to the relationship between the microscopic structure/dynamics of the formulations and their functional behavior and to the methods used for their production and characterization.
The student will become able to design, produce and characterize common industrial formulations. The course includes a laboratory activity presented as a "case study", in which the student will have the opportunity to apply the acquired knowledge to a real industrial problem.

Pre-requisites: None

Is a pre-requisite for: None

Types of examinations and other tests: Project discussion and oral

Course: HETEROGENEOUS PHOTOCATALYTIC PROCESSES	**Teaching Language:** english	
SSD (Subject Areas): ING-IND/27		**CREDITS:** 6
Course year: 2023/24	**Type of Educational Activity: D**	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: **Methods for the definition and implementation of chemical processes, from raw materials to finished products and production waste, with the aim of providing, also through material and energy balances, tools and criteria for the quantitative evaluation of processes, both from an economic, environmental, safety and quality control point of view. Study of processes starting from the evaluation of the thermodynamic, kinetic and transport aspects that underlie them. The specific skills of the sector are aimed at the engineering of new catalyst processes and products, as well as the improvement of existing ones, with particular reference to the chemical reactions and the safety and environmental impact problems involved, as well as the optimal choice of catalysts and reactor**		
Learning objectives: **The course aims at providing students with advanced notions necessary to provide an integrated overview of the heterogeneous photocatalysis and its main applications, with a look at the future developments**		
Pre-requisites: no prerequisites **Is a pre-requisite for:** no prerequisites		
Types of examinations and other tests: Oral evaluation		

Course: Industrial Ecology and Green Engineering	**Teaching Language:** English	
SSD (Subject Areas): Impianti Chimici (ING-IND/25)		**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The subject area aims at the study of methodologies for the construction and operation of industrial plants based on chemical-physical and biological transformations of matter aimed at the production of goods, the provision of services and the prevention or mitigation of habitat modifications induced by anthropic activities or settlements. The focus is on becoming familiar with and applying fundamental tools of Industrial Ecology, including Mass Flow Analysis and Life Cycle Assessment, to the evaluation of the sustainable use of resources and of industrial process and product development.		
Learning objectives: The student must demonstrate: • to be familiar with and to be able to apply fundamental tools of Industrial Ecology, including Mass Flow Analysis and Life Cycle Assessment, to the evaluation of the sustainable use of resources and of industrial process and product development.		

- to be able to generate written reports on the topics of the course and to expand his/her knowledge through research and access to documents relevant to the topics of the course.

Pre-requisites:
None

Is a pre-requisite for:
None

Types of examinations and other tests:
The examination is based on the oral discussion starting from the analysis of a project work.

Course: **ELECTROCHEMICAL SYSTEMS ENGINEERING AND FUEL CELLS**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/27	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D

Teaching Methods: in-person

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:
The contents of the course are placed within the themes of Industrial Chemistry for Chemical Engineering. Specifically, the contents of the course are aimed at the study of electrochemical systems which are the basis for the development of energy production technologies with high efficiency and low environmental impact.
The characteristic aspects of the electrocatalytic reactions that occur in systems such as fuel cells and electrolysis cells are specifically treated]

Learning objectives:
The main objectives of the course are to provide the student with the knowledge that allows to evaluate the benefits of applying electrochemical technologies in terms of efficiency, sustainability and environmental impact. A further objective is to enable the student to critically evaluate the prospects for the application of the various technologies and the sectors of use with the greatest potential

Pre-requisites: None

Is a pre-requisite for: None

Types of examinations and other tests:
The evaluation will be made on the basis of the discussion of the paper and the oral exam in a single session

Course: Interfacial Engineering	**Teaching Language:** English
SSD (Subject Areas): ING-IND/24	**CREDITS:** 6
Course year: First or Second Year	**Type of Educational Activity: D**

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The course is meant to develop advanced “tools of thermodynamics, kinetics” and “transport phenomena” occurring at the interface between different phases, with applications "aimed not only at the process industry, but also at environmental and biomedical engineering".

Teaching Methods: in-person
Learning objectives: Knowledge: Provide the basic concepts relating to phase equilibria and transport phenomena in interfacial processes relevant for chemical engineering. Skills: Solving problems of mass and energy balance, and of phase and chemical equilibria at the interface between different phases.
Pre-requisites: None **Is a pre-requisite for:** None
Types of examinations and other tests: The exam is composed of a written test and of an oral presentation. For the latter, students are divided into small groups.

Course: **Mechanics of complex fluids**		**Teaching Language:** italian
SSD (Subject Areas): Ing-Ind/24		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector has as its object the "Basic Process Design", i.e. the development of methodologies and technologies of the process industry on the basis of the physical, chemical and biological phenomena that characterize the specific transformations. Characteristic skills include the mechanics of Newtonian, non-Newtonian fluids and polyphasic systems. The applications are addressed not only to the process industry, but also to environmental and biomedical engineering and are aimed at the development of new technologies that respond to economic, energy and environmental compatibility needs.		
Learning objectives: The course aims to provide students with specialized notions concerning the behavior of complex fluids in flow, with particular attention to the link between the microstructure and macroscopic properties of the fluids under examination. Complex fluids of interest for chemical and materials engineering, in the industrial, biomedical and pharmaceutical fields and new technologies for their characterization will be presented.		
Pre-requisites: none **Is a pre-requisite for:**		
Types of examinations and other tests: Oral examination		

Course: MULTIPHASE DEVICES AND REACTORS		**Teaching Language:** Italian
SSD (Subject Areas): IND-ING/25		**CREDITS:** 6
Course year: I-II	**Type of Educational Activity: D**	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The course deals with the study of the methodologies for the design of industrial plants based on chemical-physical transformations of matter. The plant design includes the process schemes and the definition of the equipment constituting the process, particularly concerning the functional design and the choice of reactors and equipment for unitary operations and for specific exchange and separation applications. The reference sectors are those relating to chemical, pharmaceutical, food, energy and environmental protection technologies.		
Learning objectives: The aim of the course is to provide advanced elements for understanding the concepts of multiphase fluid-dynamics and reactor design, with particular attention to granular systems and fluidization. The course aims to present a reasoned review of the main multiphase equipment for unitary operations and for chemical reactions in the process industry, to describe the equipment with reference to the functional aspects, to address the design aspects and the criteria for their sizing.		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: Oral examination		

Course: **Regenerative Chemistry**		**Teaching Language:** English
SSD (Subject Areas): CHIM07		**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: CHIM07 is involved in the study chemical and physico-chemical principles of technologies, in particular deep interest is focused on the investigation of properties of materials and their interaction with environment.		
Learning objectives: (i) Learning the basic principles of green and circular chemistry (ii) Learning about renewable feedstocks for the chemical industry, present and under development (iii) Gaining fundamental skills to recognize and design green and sustainable (regenerative) chemical processes and products (iv) Studying waste managing and recycling strategies: urban mining, organic and inorganic end-life products recovery, bio-waste valorization		

Pre-requisites: None **Is a pre-requisite for:** None
Types of examinations and other tests: Oral Test and project discussion

Course: **Risk of explosions: prevention and protection**		**Teaching Language:** Italian
SSD (Subject Areas): **ING-IND/27**		**CREDITS:** **6**
Course year: I/II	**Type of Educational Activity: D**	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: **The specific skills of the SSD are aimed at the engineering of new processes (including biological ones), catalysts and products, as well as the improvement of existing ones, with particular reference to chemical reactions, separation and purification operations and safety and of environmental impact involved, as well as the optimal choice of catalysts, reactor, equipment and materials**		
Learning objectives: **To give the students the knowledge for the evaluation of the risks of explosion for the storage, trasportation and conversion of dangerous substances (unstable, flammable) and for the adoption of most suitable preventive and protective measures**		
Pre-requisites: **none** **Is a pre-requisite for:** **none**		
Types of examinations and other tests: **oral exam**		

Course: **SAFETY OF SOLID AND LIQUID MATERIALS AND LABORATORY ACTIVITIES**		**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/27		**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D	

Teaching Methods: Lectures and experimental activities

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The specific skills required are oriented to engineering novel processes, catalysts and products focusing on chemical reactions, unit operations, safety issues and environmental issues

Learning objectives:

(i) Skills and ability to understand the hazard associated with the use/storage of dangerous substances, (ii) Identification and development of the experimental/calculation plan for the classification of the danger of liquid, solid and gaseous flammable substances, (iii) Ability to identify the flammability/explosivity parameters and the indices necessary for quantifying the degree of danger.

Pre-requisites: None

Is a pre-requisite for: None

Types of examinations and other tests:

oral test

Course: **Structural fire safety of buildings for industrial processes**	**Teaching Language:** Italian
SSD (Subject Areas): ICAR/09 – Tecnica delle Costruzioni (Structural Engineering)	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity:** D

Teaching Methods: in-person

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

Problems of the actions on constructions and the behaviours that follow according to the typologies and morphologies, materials and technologies, with particular reference to the accidental "fire" action. Assessment of vulnerability, reliability, comfort, safety and durability. Methods and tools for structural design and construction of structures.

Learning objectives:

The course will provide the basic elements for the design, calculation and safety checks of structures exposed to fire, with particular reference to the structural typologies for buildings for industrial use. The course will allow students to acquire the main tools for the application of fire prevention strategies starting from the definition of fire risk and fire action through the prescriptive approach and the innovative approach named Fire Safety Engineering. The main tools to be able to operate with some applicative software will also be provided.

Pre-requisites: None

Is a pre-requisite for: None

Types of examinations and other tests:

Oral exam and discussion of a project work.

Course: **Sustainable Technologies for Pollution Control**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/25	**CREDITS:** 6
Course year: II	**Type of Educational Activity:** D
Teaching Methods: in-person	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: Chemical Plants design Process design flowsheet Equipment selection and design specifications for separation processes Process design and economics Application to Environmental protection problems	
Learning objectives: The course aims to present the chemical-physical principles, the main features and the key performance indicators of technologies for the downstream and upstream purification of gas and water streams, aimed to minimize the environmental impacts and increase the sustainability indicators of process industries, power plants and internal combustion engines, including applications to fuel cells and carbon capture and storage/utilization processes. The course describes state-of-the-art separation and catalytic processes as well as innovative plasma chemistry and electrohydrodynamic-based processes.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: The evaluation criteria is based on a group project discussion.	

Course: Thermo-Chemical Conversion of Biomass and Waste	**Teaching Language:** Inglese
SSD (Subject Areas): ING-IND/26	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: in-person	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: Le competenze del settore sono finalizzate alla caratterizzazione ed allo sviluppo di processi con attenzione agli aspetti energetici, economici e di interazione con l'ambiente per le industrie chimiche, biotecnologiche, alimentari, farmaceutiche e per la produzione e trasformazione dei materiali.	
Learning objectives:	

Il corso fornisce le informazioni di base relative ai processi e alle tecnologie per la conversione termo-chimica di biomasse e rifiuti in bio-prodotti
Pre-requisites: nessuno **Is a pre-requisite for:** nessuno
Types of examinations and other tests: Il tipo di esame, che consiste nella preparazione e discussione di un elaborato, è scritto e orale

Course: **Tossicologia e Igiene Industriale**	**Teaching Language:** Italian	
SSD (Subject Areas): Igiene Generale e Applicata (MED-42)		**CREDITS:** 6
Course year: I	**Type of Educational Activity:** D	
Teaching Methods: in-person		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: In accordance with the declaratory of MED/42, the teaching activity has specific expertise in the field of Applied Hygiene in Environment and Workplaces.		
Learning objectives: The course aims to provide specialised knowledge on industrial hygiene and occupational toxicology. Specifically, general knowledge and skills will be acquired on the main diseases of occupational interest also in their preventive and social aspects, on the role of the competent physician and the entire company prevention system. Students will be able to know, understand and apply the procedures on prevention and health protection against specific risks of occupational origin, through a complete overview of the legislative elements on the subject.		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: Written Exam with multiple choice questions.		