DIDACTIC REGULATIONS OF THE DEGREE PROGRAM
MECHANICAL ENGINEERING FOR DESIGN AND MANUFACTURING

CLASS LM-33

School: Polytechnic and Basic Sciences

Department: Industrial Engineering

Regulations in force since the academic year 2025-2026

ACRONYMS

CCD	[Commissione di Coordinamento Didattico]	Didactic Coordination Commission
CdS	[Corso/i di Studio]	Degree Program
CFU	[Crediti Formativi Universitari = 1 ECTS]	University training credits
CPDS	[Commissione Paritetica Docenti-Studenti]	Joint Teachers-Students Committee
OFA	[Obblighi Formativi Aggiuntivi]	Additional Training Obligations
RDA	[Regolamento Didattico di Ateneo]	University Didactic Regulations
SSD	[Settore Scientifico Disciplinare]	Scientific Disciplinary Sector
SUA-CdS	[Scheda Unica Annuale del Corso di Studio]	Annual single form of the Degree Program
TAF	[Tipologia di Attività Formativa]	Type of Educational Activity

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Art. 1
Object

1. These Regulations govern the organizational aspects of the Master's Degree in Mechanical Engineering for Design and Manufacturing (class LM-33 Mechanical Engineering, SUA ID=1604844). The Master's Degree in Mechanical Engineering for Design and Manufacturing (Mechanical Engineering for Design and Manufacturing) is part of the Department of Industrial Engineering and is offered in both Italian and English. The didactic activity is carried out in modality of Type A: Conventional Study Course.
2. The CdS is governed by the Didactic Coordination Commission (CCD), pursuant to Art. 4 of the RDA.
3. The Didactic Regulations are issued in compliance with the relevant legislation in force, the Statute of the University of Naples Federico II, and the RDA.

Art. 2
Training objectives

The training of the Master's graduate in Mechanical Engineering for Design and Manufacturing is aimed at covering a wide range of roles typically filled by industrial engineers in companies that produce goods and/or services, particularly in relation to design and production issues using advanced tools and techniques.
The education that the Master's graduate in Mechanical Engineering for Design and Manufacturing acquires enables them to be successfully employed within Research and Development departments due to their ability to independently develop innovative projects in terms of both product and process. They can work autonomously or within teams, often multidisciplinary, and may also take on coordination responsibilities.

The Master's graduate in Mechanical Engineering for Design and Manufacturing is able to tackle unique and recurring problems related to:

- The innovation and development of industrial products through advanced numerical design techniques, structural optimization (FEM), and virtual prototyping (CAD).
- The study and development of mechanical and mechatronic systems in various production sectors, particularly in the mechanical, healthcare, and transport industries.
- The engineering and construction of artifacts, equipment, machinery, and production systems of various complexities.
- The development of new manufacturing technologies and methods using both traditional and innovative materials.
- The management of industrial production (materials, machinery, and human resources), safety, and industrial maintenance.

In all of these cases, they are capable of addressing advanced challenges posed by the use of new materials and manufacturing processes, and they play a crucial role in supporting teams of experts engaged in the design, production, and management of complex systems, including by providing necessary support in proposing and conducting advanced experimental activities.

They are also able to ensure compliance with standards in mechanical engineering, particularly concerning the manufacturing of products, and they can propose advancements in standards.

The training path includes three curricula, one of which is taught entirely in English.

The first curriculum is divided into five tracks, corresponding to the five main professional figures that the study course aims to train. The tracks students can choose are:

- Advanced and Smart Mechanical Design
- Advanced and Smart Production
- Vehicle Design
- Technological Processes
- Mechatronics

The focus areas of the first curriculum include mechatronics and complex mechanical systems, virtual modeling and prototyping, functional and structural design, manufacturing technologies, and production management. The common part of the five tracks includes some courses in the following disciplinary areas:

- Drawing and Methods of Industrial Engineering
- Applied Mechanics
- Mechanical Design and Machine Construction
- Manufacturing Technologies and Systems
- Mechanical Industrial Plants

The second curriculum, in railway mechanics, focuses on the design, manufacturing technologies, and management of complex mechanical systems in the railway vehicle sector (body, bogie, wheels and rails, overhead line, etc.). Although differently oriented, the railway mechanics curriculum aims to achieve the same specific educational objectives, through courses included in the same disciplinary areas as those of the first curriculum.

The third curriculum, in Sustainable Development, is taught in English. Its objectives are focused on the design and creation of industrial products that meet new or evolving user needs. It also covers how innovation in materials and system architecture can improve performance while reducing environmental impact. Additionally, the Sustainable Development curriculum aims to define green technologies and lean production systems for manufacturing highly complex mechanical systems.

The study program is completed by additional training activities (further knowledge, internships inside or outside the university, and thesis work). These activities aim to give the graduate the ability to communicate effectively (also in English) in technical-scientific fields, to make good use of the relevant scientific literature, and to acquire new knowledge and methodologies (including IT) during their professional career.

The thesis work may involve design activities (product, process, plant) or original research activities to demonstrate not only the mastery of the subjects studied but also the ability to address new issues and work autonomously within an industrial or research structure.

To promote the training of engineering professionals with a strong interdisciplinary character, students enrolled in the Master's Degree Course are offered the opportunity to participate, in partial

overlap with the Master's Degree studies, in the Minor paths active at the University governed by specific regulations and associated with this and other Degree Courses. Pursuant to Art. 18, c. 2, of the University Teaching Regulations, admission to the Minor course gives rise to a career distinct from that of the Degree Course in which the student is enrolled. The activities expected in the Minor path may be recognized within the career of students enrolled in the Degree Course, in accordance with the Teaching Regulations; in any case, at least 6 CFU carried out in the Minor paths must be reserved for extracurricular activities in addition to the CFU of the statutory plan for obtaining the qualification (pursuant to Art. 18, c. 1, of the University Teaching Regulations).

Art. 3
Professional profile and work opportunities

Mechanical Engineer for the Design of Mechanical Elements and Systems

Function in a work context

The Mechanical Design Engineer carries out, often with coordination responsibilities, modeling, functional, and structural design activities using advanced digital techniques for highly complex mechanical elements and systems.

They participate, also with coordination responsibilities, in Research and Development activities, defining, organizing, and overseeing the activities necessary for the improvement and innovation of products.

Competencies associated with the role

Functional and structural design using advanced digital techniques (CAD, FEM) for mechanical elements and complex systems, both static and dynamic, in stationary or transient conditions, in linear and non-linear contexts.

Career opportunities

Technical and design offices of industrial companies and service companies.

Research and Development departments in industrial companies and service companies.

Mechanical Engineer for Production in Industrial Plants

Function in a work context

They choose and implement strategies for operating production plants, with a specific focus on highly automated processes like flexible production systems. They define optimal management strategies, considering economic and organizational aspects, and oversee industrial maintenance and safety activities.

They also participate, with coordination responsibilities, in Research and Development activities, defining, organizing, and overseeing the activities necessary for the improvement and innovation of products.

Competencies associated with the role

Collaboration, often with coordination responsibilities, in production planning and material management in manufacturing companies.

Identification of production systems based on the type of product and production volumes.

Technical and economic management of an industrial order.

Defining programming strategies for numerically controlled processing, assembly, and testing machines.

Career opportunities

Management and operation departments of production systems in industrial companies.

Research and Development departments in industrial companies and service companies.

Art. 4

Admission requirements and knowledge required for access to the Degree Program[1]

To enroll in a Master's Degree Course, a student must hold a Bachelor's Degree or a three-year university diploma, or another qualification obtained abroad and recognized as valid. Specific curricular requirements and a mandatory verification of the student's personal preparation are also required. This includes the possession of adequate language skills, which will be assessed according to criteria defined in the regulations of the Master's Degree Course.

In particular, for enrollment in the Master's Degree in Mechanical Engineering for Design and Manufacturing, the curricular requirements include having a degree in the class of degrees in Industrial Engineering (Class 10 of DM 509/99 and L-9 of Ministerial Decree 270/04) or an equivalent qualification, or having earned at least 90 CFU in specific scientific-disciplinary sectors, as follows:

At least 40 CFU in the sectors:

MATH-02/A (ex MAT/02) - Algebra
MATH-02/B (ex MAT/03) - Geometry
MATH-03/A (ex MAT/05) - Mathematical Analysis
MATH-03/B (ex MAT/06) - Probability and Mathematical Statistics
MATH-04/A (ex MAT/07) - Mathematical Physics
MATH-05/A (ex MAT/08) - Numerical Analysis
MATH-06/A (ex MAT/09) - Operations Research
STAT-01/A (ex SECS-S/01) - Statistics
STAT-01/B (ex SECS-S/02) - Statistics for Experimental and Technological Research
IINF-05/A (ex ING-INF/05) - Information Processing Systems
PHYS-03/A (ex FIS/01 + FIS/03) - Experimental Physics + Physics of Matter
CHEM-03/A (ex CHIM/03) - General and Inorganic Chemistry
CHEM-04/A (ex CHIM/05) - Science and Technology of Polymeric Materials
CHEM-06/A (ex CHIM/07) - Principles of Chemistry for Applied Technologies

At least 50 CFU in the sectors:

CEAR-06/A (ex ICAR/08) – Structural Mechanics
IIND-01/D (ex ING-IND/04) - Aerospace Structures and Constructions
IIND-06/A (ex ING-IND/08) - Fluid Machinery
IIND-06/B (ex ING-IND/09) - Energy Systems And Power Generation
IIND-07/A (ex ING-IND/10) - Thermal Engineering And Industrial Energy Systems
IIND-07/B (ex ING-IND/11) - Building Physics And Building Energy Systems
IMIS-01/A (ex ING-IND/12) - Mechanical And Thermal Measurements
IIND-02/A (ex ING-IND/13) - Applied Mechanics
IIND-03/A (ex ING-IND/14) - Mechanical Design And Machine Construction
IIND-03/B (ex ING-IND/15) - Design Methods For Industrial Engineering
IIND-04/A (ex ING-IND/16) - Manufacturing Technology And Systems
IIND-05/A (ex ING-IND/17) - Industrial Mechanical Systems Engineering
IIND-03/C (ex ING-IND/21) - Metallurgy
IMAT-01/A (ex ING-IND/22) - Materials Science And Technology
IIET-01/A (ex ING-IND/31) - Electrical Engineering
IIND-08/A (ex ING-IND/32) - Power Electronic Converters, Electrical Machines And Drives
IEGE-01/A (ex ING-IND/35) - Business And Management Engineering

[1] Artt. 7, 13, 14 of the University Didactic Regulations.

At least 24 CFU in the sectors:

IIND-02/A (ex ING-IND/13) - Applied Mechanics
IIND-03/A (ex ING-IND/14) - Mechanical Design And Machine Construction
IIND-03/B (ex ING-IND/15) - Design Methods For Industrial Engineering
IIND-04/A (ex ING-IND/16) - Manufacturing Technology And Systems
IIND-05/A (ex ING-IND/17) - Industrial Mechanical Systems Engineering

Art. 5
Procedures for access to the Degree Program (CdS)

1. The CCD of the Degree Program normally regulates the admission criteria and any scheduling of enrolments, except in cases subject to different provisions of law[2].
2. Verification of personal preparation is always mandatory, and only students who meet the curricular requirements can access it.
3. The verification of curricular requirements is conducted by the CCD through the analysis of the student's previous academic records. Enrollment in the Master's Degree in Mechanical Engineering for Design and Manufacturing is not allowed if the minimum curricular requirements are not met. If the minimum requirements are not satisfied, the CCD assists the student by prescribing enrollment in individual courses offered by the University and passing the relevant exams before registration.

   With reference to the requirement of having at least 24 CFU in the sectors IIND-02/A, IIND-03/A, IIND-03/B, IIND-04/A, IIND-05/A, the CCD may identify equivalencies for credits earned in different scientific-disciplinary sectors, based on the content of specific courses from the student's previous academic career, provided these are closely related to the topics of the aforementioned sectors.

   Students holding an L-9 degree or equivalent but with fewer than 24 CFU in the sectors IIND-02/A, IIND-03/A, IIND-03/B, IIND-04/A, IIND-05/A, will be admitted to the Master's Degree program with the recommendation of an Individual Study Plan that includes a specific alignment path, without an increase in the total number of CFU.

   After verifying the curricular requirements, the adequacy of the student's personal preparation, including their language proficiency, must also be verified. This verification is governed by the CCD according to guidelines established uniformly for all Master's Degree Programs within the Polytechnic School and Basic Sciences.

   For this purpose, the weighted average (**M**) is calculated based on the CFU and the grades (in thirtieths) obtained in the exams required to earn the degree that grants access to the Master's Degree program. A student's personal preparation is considered adequate if **M ≥ 24.** Students who do not meet the weighted average requirement (M) will have to take a specific admission test. Information regarding the scheduling, procedures, and requirements for passing the test is provided on the Study Course website (http://meccanica.dii.unina.it/it/orientamento-lm).

   Regarding the verification of language skills, students who do not hold a qualification obtained by attending a study program delivered in Italian or English, and who do not have certifications or language qualifications attesting to their knowledge of Italian or English at least at level B1 of the Common European Framework of Reference (CEFR), must demonstrate adequate comprehension and conversation skills in either Italian or English through a proficiency test.

   Specifically, since to obtain the Master's Degree the student must be able to use a European Union language fluently, in addition to Italian, the study plan includes a sufficient number of CFU (at least 3) to acquire 'Additional language knowledge,' particularly in English. The attainment of this knowledge, at least at level B2, will be certified in accordance with the methods defined by the University's Language Center (www.cla.unina.it). Students already in possession of an English

[2] National programmed access is regulated by L. 264/1999 and subsequent amendments and supplements.

certificate at least at the B2 level upon registration may request its recognition for the purposes of Additional Language Knowledge, following procedures established by the Language Center.

Art. 6
Teaching activities and university training credit (Teaching activities and CFU)

Each training activity, prescribed by the CdS detail sheet, is measured in CFU. Each CFU corresponds to 25 hours of overall training commitment[3] per student and includes the hours of teaching activities specified in the curriculum as well as the hours reserved for personal study or other individual training activities.

For the Degree Program covered by this Didactic Regulations, the hours of teaching specified in the curriculum for each CFU, established in relation to the type of training activity, are as follows [4]:

- Lecture or guided teaching exercises: 8 hours per CFU;
- Seminar: 8 hours per CFU;
- Laboratory activities or fieldwork: 8 hours per CFU;

For internship activities, each credit corresponds to 25 hours of overall training commitment [5].

The CFU corresponding to each training activity acquired by the student is awarded by satisfying the assessment procedures (examination, pass mark) indicated in the Course sheet relating to the course/activity attached to these Didactic Regulations.

Art. 7
Description of teaching methods

The didactic activity is carried out in modality of Type A: Conventional Study Course

If necessary, the CCD decides which courses also include teaching activities offered online.

Some courses 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 in the course sheets.

Art. 8
Testing of training activities[6]

1. The CCD, within the prescribed regulatory limits[7], establishes the number of examinations and other means of assessment that determine the acquisition of credits. Examinations are individual

[3] According to Art. 5, par. 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 above or below the aforementioned hours for individual classes, by a limit of 20 per cent".

[4] The number of hours considers the instructions in Art. 6, par. 5 of the RDA: "of the total 25 hours, for each CFU, are reserved: a) 5 to 10 hours for lectures or guided teaching exercises; b) 5 to 10 hours for seminars; c) 8 to 12 hours for laboratory activities or fieldwork, 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.".

[5] For Internship activities (Inter-ministerial Decree 142/1998), subject to further specific provisions, the number of working hours equal to 1 CFU may not be less than 25.

[6] Article 22 of the University Didactic Regulations.

[7] Pursuant to the DD.MM. 16.3.2007 in each Degree Programs the examinations or profit tests envisaged may not be more than 20 (Bachelor's Degrees; Art. 4. par. 2), 12 (Master's Degrees; Art. 4, par. 2), 30 (five-year single-cycle Degrees) or 36 (six-year single-cycle Degrees; Art. 4, par. 3). Pursuant to the RDA, Art. 13, par. 4, "the assessments that constitute an eligibility evaluation for activities referred to in Art. 10, par. 5, letters c), d), and e) of Ministerial Decree no. 270/2004, including the final examination for obtaining the degree, are excluded from the calculation." For Master's Degree Program and single-cycle Master's Degree Program, however, pursuant to the RDA, Art. 14, par. 7, "the assessments that constitute a progress evaluation for activities referred to in Art. 10, par. 5, letters d) and e) of Ministerial Decree

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 course sheets and the examination schedule will be made known to students before the start of classes on the Department's website.[8]
3. Examinations are held subject to booking, which is made electronically. In case the student is unable to book an exam for reasons that the President of the Board considers justifiable, the student may still be admitted to the examination, following those students already booked.
4. Before 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 a unanimous vote of the Board. Examinations are marked out of 30 or with a simple pass mark. Assessments 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. The University Didactic Regulations govern Examination Boards [9].

Art. 9
Degree Program structure and Study Plan

1. The legal duration of the Degree Program is 2 years. It is also possible to enrol based, on the contract, in compliance with the provisions of Article 24 of the RDA and according to the criteria and procedures defined in the following paragraph.
   The student must acquire 120 CFU[10], attributable to the following Types of Training Activities (TAF):
   B) characterising,
   C) related or complementary,
   D) at the student's choice[11],
   E) for the final exam,
   F) further training activities.
2. The degree is awarded after having acquired 120 CFU by passing examinations, not exceeding 12, including the final[12], and the performance of other training activities.

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no. 270/2004 are excluded from the exam count; the final examination for obtaining the Master's Degree and single-cycle Master's Degree is included in the maximum number of exams".

[8] Reference is made to Art. 22, par. 8, of the University Teaching Regulations, which states that "the Department or School ensures that the dates for progress assessments are published on the portal with reasonable advance notice, which normally cannot be less than 60 days before the start of each academic period, and that an adequate period of time is provided for exam registration, which is generally mandatory."

[9] Reference is made to Art. 22, paragraph 4 of the RDA according to which "Examination Boards and other assessments committees are appointed by the Director of the Department or by the President of the School when provided for in the School's Regulations. This function may be delegated to the CCD Coordinator. The Commissions comprise of the President and, if necessary, other professors or experts in the subject. In the case of active courses, the President is the course instructor, and in such cases, the Board can validly make decisions even in the presence of the President alone. In other cases, the President is a professor identified at the time of the Board's appointment. In the comprehensive evaluation of the overall performance at the conclusion of an integrated course, the professors in charge of the coordinated modules participate, and the President is appointed when the Commission is appointed."

[10] The total number of CFU for the acquisition of the relevant degree must be understood as follows: six-year single-cycle Degree, 360 CFU; five-year single-cycle Degree, 300 CFU; Bachelor's Degree, 180 CFU; Master's Degree, 120 CFU.

[11] Corresponding to at least 12 ECTs for Bachelor's Degrees and at least 8 CFU for Master's Degrees (Art. 4, par. 3 of Ministerial Decree 16.3.2007).

[12] Art. 14, par. 7 of the University Didactic Regulations ('the final exam for the Master's Degree is included in the calculation of the maximum number of exams').

Unless otherwise provided for in the legal framework 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) are taken into consideration for counting purposes. Examinations or assessments relating to activities independently chosen by the student may be taken into account in the overall calculation corresponding to one unit[13]. Tests constituting an assessment of suitability for the activities referred to in Article 10, paragraph 5, letters d) and e) of Ministerial Decree 270/2004[14] are excluded from the count. Integrated Courses comprising of two or more modules are subject to a single examination.

3. In order to acquire the CFU relating to independent choice activities, the student is free to choose among 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 CFU relating to autonomous choice activities, the "passing the exam or other form of profit verification" is required (Art. 5, par. 4 of Ministerial Decree 270/2004).
4. The study plan summarises the structure of the Degree Program, listing the envisaged teachings broken down by course year and, in case, by curriculum. At the end, the propedeuticities envisaged by the Degree Program are listed. The study plan 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 educational activity, is set out in Annex 1 to these Didactic Regulations.
5. Pursuant to Art. 11, paragraph 4-bis, of Ministerial Decree 270/2004, it is possible to obtain the Degree according to an individual study plan that also includes educational activities different from those specified in the Didactic Regulations, as long as they are consistent with the CdS detail sheet of the academic year of enrollment. The individual study plan is approved by CCD.
6. To promote the training of engineering professionals with a strong interdisciplinary character, students enrolled in the Master's Degree Course are offered the opportunity to participate, in partial overlap with the Master's Degree studies, in the Minor training path in "Applied machine Learning", governed by a specific Regulation reported in Annex 3. It is obtained by submitting an individual study plan that provides for the acquisition of at least 6 additional extracurricular CFU (126 CFU in total), together with an appropriate choice of at least 21 curricular CFU. Annex 1 to the Degree Course Regulations specifies, for each of the aforementioned paths, the specific curricular and extracurricular training activities (and the related types, TAF) necessary for its achievement. Further information on the Minor is reported in Annex 3.

Art. 10
Attendance requirements[15]

1. In general, attendance of lectures is strongly recommended but not compulsory

[13] Pursuant to the D.M. 386/2007.

[14] Art. 10, par. 5 of Ministerial Decree. 270/2004: "In addition to the qualifying training activities, as provided for in paragraphs 1, 2 and 3, Degree Programs shall provide for: a) training activities autonomously chosen by the student as long as they are consistent with the training project [TAF D]; b) training 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) training 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 job sector to which the qualification may give access, including, in particular, training and guidance programs 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".

[15] Art. 22, par. 10 of the University Didactic Regulations.

In the case of individual courses with compulsory attendance, this option is indicated in the relative teaching/activity course sheet 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 Course details published on the CdS web page and on the teacher's UniNA website.
3. Attendance at seminar activities that award training credits is compulsory. The relative modalities for the attribution of CFU are the responsibility of the CCD.

Art. 11
Prerequisites and prior knowledge

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

Art. 12
Degree Program Calendar

The Degree Program calendar can be found on the Department's website well before the start of the activities (Art. 21, par. 5 of the RDA).

Art. 13
Criteria for the recognition of credits earned in other Degree Programs in the same Class[16]

For students coming from Degree Programs of the same Class, the Didactic Coordination Commission ensures the full recognition of CFU, when associated with activities that are culturally compatible with the training Degree Program, acquired by the student at the originating Degree Program, according to the criteria outlined in Article 14 below. Failure to recognise credits must be adequately justified. It is without prejudice to the fact that the number of credits relating to the same scientific-disciplinary sector directly recognised by the student may not be less than 50% of those previously achieved.

Art. 14
Criteria for the recognition of credits acquired in Degree Programs of different classes, in university or university-level Degree Programs, through single courses, at online Universities and in international Degree Programs[17]; criteria for the recognition of credits acquired in extra-curricular activities

1. With regard to the criteria for the recognition of CFU acquired in Degree Programs of different Classes, in university or university-level Degree Programs, through single courses, at online Universities and in International Degree Programs, the credits acquired are recognised by the CCD on the basis of the following criteria:
   - analysis of the activities carried out;
   - 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 Degree Program and of the individual training activities to be recognised.

[16] Art. 19 of the University Didactic Regulations.
[17] Art. 19 and Art. 27, par.6 of the University Didactic Regulations.

Recognition is carried out up to the number of credits envisaged by the didactic system of the Degree Program. Failure to recognise credits must be adequately justified. Pursuant to Art. 5, par. 5-bis, of Ministerial Decree 270/2004, it is also possible to acquire CFU at other Italian universities on the basis of agreements established between the concerned institutions, in accordance with the regulations current at the time [18].

2. Any recognition of CFU relating to examinations passed as single courses may take place within the limit of 36 CFU, upon request of the interested party and following the approval of the CCD. Recognition may not contribute to the reduction of the legal duration of the Degree Program, as determined by Art. 8, par. 2 of Ministerial Decree 270/2004, except for students who enrol while already in possession of a degree of the same level[19].
3. With regard to the criteria for the recognition of CFU acquired in extra-curricular activities, pursuant to Art. 3, par. 2, of Ministerial Decree (D.M.) 931/2024, within the limit of 24 CFU, the following activities may be recognised (Art. 2 of D.M. 931/2024):
   - Professional knowledge and skills, certified in accordance with the current regulations as well as knowledge and skills acquired in post-secondary-level training activities.
   - Training activities carried out in the cycles of study at the public administration training institutions as well as knowledge and skills acquired in post-secondary-level training activities, which the University contributed to developing and implementing.
   - Achievement of an Olympic or Paralympic medal or the title of absolute world champion, absolute European champion or absolute Italian champion in disciplines recognized by the Italian National Olympic Committee or the Italian Paralympic Committee.

Art. 15
Criteria for enrolment in individual teaching courses

Enrolment in individual teaching courses, provided for by the University Didactic Regulations[20], is governed by the "University Regulations for enrolment in individual teaching courses activated as part of the Degree Program"[21].

[18] Art. 6, par. 9 of the University Didactic Regulations.
[19] Art. 19, par. 4 of the University Didactic Regulations.
[20] Art. 19, par. 4 of the University Didactic Regulations.
[21] R.D. No. 348/2021.

Art. 16
Features and modalities for the final examination

The Master's Degree in Mechanical Engineering for Design and Manufacturing is awarded after passing a final exam, which involves the evaluation by an academic committee of the Master's thesis. The thesis is developed by the student under the guidance of one or more university supervisors, and may also involve external experts who are not affiliated with the University. The thesis may focus on theoretical, methodological, numerical, or experimental activities. Work for the thesis can also be conducted at external research laboratories or within companies and institutions, both in Italy and abroad, provided that it is part of a guided learning process supervised by a university instructor.

External tutors who have assisted the student in specific areas of their educational journey may be invited to the graduation session as co-supervisors, although they will not be part of the final examination committee. The written thesis and the discussion may be presented in English, and should demonstrate the work done, mastery of the subject, maturity, the ability to work independently, and a good level of communication skills, including the effective use of IT tools.

The final exam is publicly defended before a committee chaired by the Coordinator of the Study Course, or their delegate, and consists of a presentation of the work completed under the guidance of a faculty advisor, followed by a discussion with the members of the committee. During the session, the candidate presents the thesis, which must be available in the room. The candidate may use audio-visual aids to summarize their work or, alternatively, provide a summary booklet to be distributed to each member of the committee. At the end of the presentation, each faculty member may ask questions and make comments on the thesis. The presentation typically lasts 15 minutes.

Art. 17
Guidelines for traineeship and internship

1. Students enrolled in the Degree Program may decide to carry out internships or training periods with organisations or companies that have an agreement with the University. Traineeship and internship are compulsory and contribute to the award of credits for the other training 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[22].
2. The CCD regulates the modalities and characteristics of traineeship and internship with specific regulations.
3. The University of Naples Federico II, through University Internship Office (http://www.unina.it/didattica/tirocini-studenti), the COINOR (Center for Innovation and Knowledge Transfer) - Internship Section (http://www.orientamento.unina.it/tirocini-post-laurea/) and the University placement service (https://www.jobservice.unina.it) ensures constant contact with the world of work to offer students and graduates of the University concrete opportunities for internships and work experience and to promote their professional integration.

Art. 18
Disqualification of student status[23]

A student who has not taken any examinations for eight consecutive academic years incurs forfeiture unless his/her 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.

[22] Traineeships ex letter d) can be both internal and external; traineeships ex letter e) can only be external.
[23] Art. 24,par. 5 of the University Didactic Regulations.

Art. 19
Teaching tasks, including supplementary teaching, guidance, and tutoring activities

1. Professors and researchers carry out the teaching load assigned to them in accordance with the provisions of the RDA 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[24].
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 orienting 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 Schools and/or Departments under the coordination of the University, as established by the RDA in Article 8.

Art. 20
Evaluation of the quality of the activities performed

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

[24] R.D No. 2482//2020.

[25] 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.

Art. 21
Final Rules

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

Art. 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), Annex 2 (Teaching/Activity course sheet) and Annex 3 (Minor in Applied Machine Learning) are integral parts of this Didactic Regulations.

ANNEX 1

MECHANICAL ENGINEERING FOR DESIGN AND MANUFACTURING

CLASS LM-33

School: Polytechnic and Basic Sciences

Department: Industrial Engineering

Regulations in force since the academic year 2025-2026

STUDY PLAN

KEY

Type of Educational Activity (TAF):
B = Characterising
C = Related or Supplementary
D = At the student's choice
E = Final examination and language knowledge
F = Further training activities

Year I

Title Course	SSD	Module	CFU	Hours	Type Activities *(lectures, workshops, etc.)*	TAF	Disciplinary area	Mandatory/ optional
Mandatory curricular activities (36 CFU) chosen from the following subjects depending on the path (see note a)								
Advanced Structural Mechanics	IIND-03/A	single	9	72	Frontal lesson and exercises	B	Mechanical Engineering	36 CFU Mandatory electives
Mechanical vibrations	IIND-02/A	single	9	72	Frontal lesson and exercises	B		
Logistics and Operation Management	IIND-05/A	single	9	72	Frontal lesson and exercises	B		
Digital Modeling and Simulation for Industrial Engineering	IIND-03/B	single	9	72	Frontal lesson and exercises	B		
Advanced and Resource Efficient Manufacturing	IIND-04/A	single	9	72	Frontal lesson and exercises	B		
Curricular elective activities **(see note a)**		single	**A (1)**	A*8	Frontal lesson and exercises	B	Mechanical Engineering	To be chosen from suggested or approved exams in a study plan
Affiliated or Integrative Activity **(see note a)**		single	**B (2)**	B*8	Frontal lesson and exercises	C		
Free choice activities **(see note a)**		single	**C (3)**	C*8	Frontal lesson and exercises	D		
Additional language skills **(see note c)**			3			F		Mandatory

Year II

Title Course	SSD	Module	CFU	Hours	Type Activities *(lectures, workshops, etc.)*	TAF	Disciplinary area	Mandatory/ optional
Curricular elective activities **(see note a)**		single	36-**A** (1)	(36-A)*8	Frontal lesson and exercises	B	Mechanical Engineering	To be chosen from suggested or approved exams in a study plan
Affiliated or Integrative Activity **(see note a)**	**Dynamics of Mechanical Systems**	single	12-**B** (2)	(12-B)*8	Frontal lesson and exercises	C		
Free choice activities **(see note a)**		single	9-**C** (3)	(9-C)*8	Frontal lesson and exercises	D		
Internship **(see note b)**			9			F		
Final Exam **(see note d)**			15			E		

1) The curricular activities mentioned in note a) amount to a total of 36 CFU, distributed between the first year (max 18 CFU) and the second year, depending on the choices made.
2) The related or integrative activities mentioned in note a) amount to a total of 12 CFU, distributed between the first and second year, depending on the choices made.
3) The free choice activities mentioned in note a) amount to a total of 9 CFU, distributed between the first and second year, depending on the choices made.

Notes:

a) The choice of curricular activities by the student, in accordance with what is reported in tables A, B, C, D, and E, defines **a study plan that is automatically approved for the following pathways:**

- **Table A – Advanced and Smart Mechanical Design Pathway**
- **Table B – Advanced and Smart Production Pathway**
- **Table C – Road Vehicle Design Pathway**
- **Table D – Technological Processes Pathway**
- **Table E – Mechatronics Pathway**

The student can indicate their pathway choice and the automatically approved study plan during enrollment without any further formalities.
Students who opt for an individual study plan during enrollment must use the appropriate forms/procedures, which will be available on the website of the Master's Degree Course in Mechanical Engineering for Design and Manufacturing. The same forms must be used to modify the study plan for subsequent years. The Coordination Committee for the Master's Degree Course reserves the right to approve or reject such requests based on clear reasoning provided by the student, as required by law. It should be noted that, in all cases, an exam can only be taken after the respective course has been offered during the academic year when the study plan is presented.

b) The internship can be external (extramoenia) or internal (intramoenia). The external internship is carried out at companies, research centers, or other public and/or private entities, with the aim of acquiring specialized knowledge while working alongside personnel involved in design, production, and management activities, in order to gain initial exposure to the professional world. The internal internship is carried out at university research laboratories to acquire specialized knowledge by collaborating with faculty members and researchers in conducting research and development activities. In all cases, the internship must be documented in an internship booklet and certified by the university tutor using the AC form.

c) Students who do not possess certification of English language proficiency at least at the B2 level of the Common European Framework of Reference for Languages (CEFR) must include a sufficient number of CFUs for Additional Language Skills in their study plan to ensure they achieve this level of proficiency (3 CFUs). These credits can be acquired through external institutions or at the university's language center (cla.unina.it) and will be recognized upon presentation of the certification. Students who already hold a B2 level English certificate at the time of enrollment may request recognition of this for the Additional Language Skills (3 CFUs).

d) The thesis work can also be carried out at companies in Italy or abroad. It must always be carried out under the direct and full responsibility of a faculty member from the Didactic Area of Engineering at the University of Naples Federico II (the procedures for assigning the thesis advisor are specified in the Didactic Regulations of the Course of Study) and may include the collaboration of an external company tutor. The procedures for assigning the company tutor are regulated by the Didactic Regulations of the Course of Study and by specific agreements.

Table A – Advanced and Smart Mechanical Design Pathway				
Course Name	***Semester***	***SSD***	***CFU***	***TAF***
Mandatory pathway exams				
Assisted Design of Mechanical Structures Progettazione Assistita di Strutture Meccaniche	I	IIND-03/A	9	B
Mechanical vibrations Dinamica dei Sistemi Meccanici	I	IIND-02/A	9	B
Digital Modeling and Simulation for Industrial Engineering Modellazione geometrica e prototipazione virtuale	II	IIND-03/B	9	B
At least one exam to be chosen from:				
Advanced and Resource Efficient Manufacturing Tecnologie Speciali	II	IIND-04/A	9	B
Logistics and Operation Management Gestione della Produzione Industriale	I	IIND-05/A	9	B
Affiliated or Integrative Activity: 12 CFU to be chosen from:				
Electrical Machines Macchine Elettriche	I	IIND-08/A	6	C
Electronic Power Converters Convertitori Elettronici di Potenza	I	IIND-08/A	6	C
Surface Engineering Ingegneria delle Superfici	I	IIND-03/C	12	C
Economics and Business Organization Economia ed Organizzazione Aziendale	I	IEGE-01/A	6	C
Business Management Gestione Aziendale	II	IEGE-01/A	6	C
Statistics for Technology Statistica per la Tecnologia	II	STAT-01/B	6	C
Statistical Learning for Industrial Engineering (*)	I	STAT-01/B	6	C
Electronics for Intelligent Mechanical Systems Elettronica per Sistemi Meccanici Intelligenti	I	IINF-01/A	6	C
Machine Learning for Engineering	II	IINF-05/A	6	C
Curricular elective activities: choose at least three exams from:				
Advanced Machine Design Complementi di Costruzione di Macchine	I	IIND-03/A	9	B
Experimental Mechanics Meccanica Sperimentale	II	IIND-03/A	9	B
Sustainable Product Design and Development Progettazione e Sviluppo di Prodotto Sostenibile	I	IIND-03/B	9	B
Applied Mechanics for Energy Efficiency	II	IIND-02/A	9	B
Curricular elective activities: choose one exam from Table 1			9	B
Recommended courses for free choice: Table 1 and Table 2			9	D

(*) The exam *Statistical Learning for Industrial Engineering* can be taken after completing *Statistics for Technology*.

Table B – Advanced and Smart Production Pathway				
Course Name	***Semester***	***SSD***	***CFU***	***TAF***
Mandatory pathway exams				
Assisted Design of Mechanical Structures Progettazione Assistita di Strutture Meccaniche	I	IIND-03/A	9	B
Logistics and Operation Management Gestione della Produzione Industriale	I	IIND-05/A	9	B
Advanced and Resource Efficient Manufacturing Tecnologie Speciali	II	IIND-04/A	9	B
at least one exam to be chosen from:				
Mechanical vibrations Dinamica dei Sistemi Meccanici	I	IIND-02/A	9	B
Digital Modeling and Simulation for Industrial Engineering Modellazione geometrica e prototipazione virtuale	II	IIND-03/B	9	B
Affiliated or Integrative Activity: 12 CFU to be chosen from:				
Electrical Machines Macchine Elettriche	I	IIND-08/A	6	C
Electronic Power Converters Convertitori Elettronici di Potenza	I	IIND-08/A	6	C
Surface Engineering Ingegneria delle Superfici	I	IIND-03/C	12	C
Economics and Business Organization Economia ed Organizzazione Aziendale	I	IEGE-01/A	6	C
Business Management Gestione Aziendale	II	IEGE-01/A	6	C
Statistics for Technology Statistica per la Tecnologia	II	STAT-01/B	6	C
Statistical Learning for Industrial Engineering(*)	I	STAT-01/B	6	C
Electronics for Intelligent Mechanical Systems Elettronica per Sistemi Meccanici Intelligenti	I	IINF-01/A	6	C
Machine Learning for Engineering	II	IINF-05/A	6	C
Polymer Science Scienza dei Polimeri	I	IMAT-01/A	6	C
Polymer Technology Tecnologia dei Polimeri	II	IMAT-01/A	6	C
Curricular elective activities: at least three exams to be chosen from:				
Computer-Aided Manufacturing Produzione Assistita da Calcolatore	I	IIND-04/A	9	B
Project Management for Industrial Production Project Management per la Produzione Industriale	I	IIND-05/A	9	B
Safety and Maintenance of Industrial Plants Sicurezza e manutenzione degli Impianti Industriali	II	IIND-05/A	9	B
Smart Modelling of Industrial Production Systems	I	IIND-05/A	9	B

Automated Production Systems Sistemi di Produzione Automatizzati	II	IIND-05/A	9	B
Green Manufacturing and Sustainability	I	IIND-04/A	9	B
Management and Control of Manufacturing Systems Gestione e Controllo dei Sistemi di Lavorazione	II	IIND-04/A	9	B
Additional curricular elective activity: one exam from Table 1	I/II		9	B
Recommended courses for free choice: Table 1 and Table 2	I/II		9	D

(*) The exam *Statistical Learning for Industrial Engineering* can be taken after completing *Statistics for Technology*.

Table C- Road Vehicle Design Pathway				
Course Name	***Semester***	***SSD***	***CFU***	***TAF***
Mandatory pathway exams				
Assisted Design of Mechanical Structures Progettazione Assistita di Strutture Meccaniche	I	IIND-03/A	9	B
Mechanical vibrations Dinamica dei Sistemi Meccanici	I	IIND-02/A	9	B
Digital Modeling and Simulation for Industrial Engineering Modellazione geometrica e prototipazione virtuale	II	IIND-03/B	9	B
at least one exam to be chosen from:				
Advanced and Resource Efficient Manufacturing Tecnologie Speciali	II	IIND-04/A	9	B
Logistics and Operation Management Gestione della Produzione Industriale	I	IIND-05/A	9	B
Affiliated or Integrative Activity: 12 CFU to be chosen from:				
Electrical Machines Macchine Elettriche	I	IIND-08/A	6	C
Electronic Power Converters Convertitori Elettronici di Potenza	I	IIND-08/A	6	C
Surface Engineering Ingegneria delle Superfici	I	IIND-03/C	12	C
Economics and Business Organization Economia ed Organizzazione Aziendale	I	IEGE-01/A	6	C
Business Management Gestione Aziendale	II	IEGE-01/A	6	C
Statistics for Technology Statistica per la Tecnologia	II	STAT-01/B	6	C
Statistical Learning for Industrial Engineering (*)	I	STAT-01/B	6	C
Electronics for Intelligent Mechanical Systems Elettronica per Sistemi Meccanici Intelligenti	I	IINF-01/A	6	C
Machine Learning for Engineering	II	IINF-05/A	6	C
Polymer Science Scienza dei Polimeri	I	IMAT-01/A	6	C
Polymer Technology Tecnologia dei Polimeri	II	IMAT-01/A	6	C
Curricular elective activities: at least three exams to be chosen from:				
Vehicle Construction Costruzione di Autoveicoli	I	IIND-03/A	9	B

Vehicle Mechanics Meccanica del Veicolo	II	IIND-02/A	9	B
Tribology and Diagnostics of Mechanical Systems Tribologia e Diagnostica dei sistemi meccanici	I	IIND-02/A	9	B
Mechanical Design Progettazione meccanica	II	IIND-03/A	9	B
Bio-Inspired Generative Design for Additive Manufacturing	II	IIND-03/B	9	B
Additional curricular elective activity: one exam from Table 1			9	B
Recommended courses for free choice: Table 1 and Table 2			9	D

(*) The exam *Statistical Learning for Industrial Engineering* can be taken after completing *Statistics for Technology*.

Table D – Technological Processes Pathway				
Course Name	***Semester***	***SSD***	***CFU***	***TAF***
Mandatory pathway exams				
Assisted Design of Mechanical Structures Progettazione Assistita di Strutture Meccaniche	I	IIND-03/A	9	B
Advanced and Resource Efficient Manufacturing Tecnologie Speciali	II	IIND-04/A	9	B
Logistics and Operation Management Gestione della Produzione Industriale	I	IIND-05/A	9	B
at least one exam to be chosen from:				
Mechanical vibrations Dinamica dei Sistemi Meccanici	I	IIND-02/A	9	B
Digital Modeling and Simulation for Industrial Engineering Modellazione geometrica e prototipazione virtuale	II	IIND-03/B	9	B
Affiliated or Integrative Activity: 12 CFU to be chosen from:				
Electrical Machines Macchine Elettriche	I	IIND-08/A	6	C
Electronic Power Converters Convertitori Elettronici di Potenza	I	IIND-08/A	6	C
Surface Engineering Ingegneria delle Superfici	I	IIND-03/C	12	C
Economics and Business Organization Economia ed Organizzazione Aziendale	I	IEGE-01/A	6	C
Business Management Gestione Aziendale	II	IEGE-01/A	6	C
Statistics for Technology Statistica per la Tecnologia	II	STAT-01/B	6	C
Statistical Learning for Industrial Engineering (*)	I	STAT-01/B	6	C
Electronics for Intelligent Mechanical Systems Elettronica per Sistemi Meccanici Intelligenti	I	IINF-01/A	6	C
Machine Learning for Engineering	II	IINF-05/A	6	C
Polymer Science Scienza dei Polimeri	I	IMAT-01/A	6	C
Polymer Technology Tecnologia dei Polimeri	II	IMAT-01/A	6	C
Curricular elective activities: at least three exams to be chosen from:				
Simulation and Modeling of Plastic Deformation Processes Simulazione e Modellazione dei Processi per Deformazione Plastica	I	IIND-04/A	9	B

Welding and Joining Techniques Tecnica della Saldatura e delle Giunzioni	I	IIND-04/A	9	B
Non-Conventional Materials Technologies Tecnologie dei Materiali non Convenzionali	II	IIND-04/A	9	B
Safety and Maintenance of Industrial Plants Sicurezza e Manutenzione degli Impianti Industriali	II	IIND-05/A	9	B
Additive Manufacturing	I	IIND-04/A	9	B
Additional curricular elective activity: one exam from Table 1	I/II		9	B
Recommended courses for free choice: Table 1 and Table 2	I/II		9	D

(*) The exam *Statistical Learning for Industrial Engineering* can be taken after completing *Statistics for Technology*.

Table E – Mechatronics Pathway				
Course Name	***Semester***	***SSD***	***CFU***	***TAF***
Mandatory pathway exams				
Mechanical vibrations Dinamica dei Sistemi Meccanici	I	IIND-02/A	9	B
Advanced and Resource Efficient Manufacturing Tecnologie Speciali	II	IIND-04/A	9	B
Digital Modeling and Simulation for Industrial Engineering Modellazione geometrica e prototipazione virtuale	II	IIND-03/B	9	B
at least one exam to be chosen from:				
Logistics and Operation Management Gestione della Produzione Industriale	I	IIND-05/A	9	B
Assisted Design of Mechanical Structures Progettazione Assistita di Strutture Meccaniche	I	IIND-03/A	9	B
Affiliated or Integrative Activity: 12 CFU to be chosen from:				
Electrical Machines Macchine Elettriche	I	IIND-08/A	6	C
Electronic Power Converters Convertitori Elettronici di Potenza	I	IIND-08/A	6	C
Surface Engineering Ingegneria delle Superfici	I	IIND-03/C	12	C
Economics and Business Organization Economia ed Organizzazione Aziendale	I	IEGE-01/A	6	C
Business Management Gestione Aziendale	II	IEGE-01/A	6	C
Statistics for Technology Statistica per la Tecnologia	II	STAT-01/B	6	C
Statistical Learning for Industrial Engineering (*)	I	STAT-01/B	6	C
Electronics for Intelligent Mechanical Systems Elettronica per Sistemi Meccanici Intelligenti	I	IINF-01/A	6	C
Machine Learning for Engineering	II	IINF-05/A	6	C
Curricular elective activities: at least three exams to be chosen from:				
Modeling and Simulation of Mechatronic Systems Modellazione e Simulazione di Sistemi Meccatronici	I	IIND-03/B	9	B
Mechanical Systems Control Controllo dei sistemi meccanici	II	IIND-02/A	9	B
Integration of Advanced Systems in Industrial Production Integrazione di sistemi avanzati nella produzione industriale	II	IIND-04/A	9	B
Robot Mechanics Meccanica dei Robot	I	IIND-02/A	9	B

Design of Mechatronic Systems	I	IIND-03/A	9	B
Additional curricular elective activity: one exam from Table 1	I/II		9	B
Recommended courses for free choice: Table 1 and Table 2	I/II		9	D

(*) The exam *Statistical Learning for Industrial Engineering* can be taken after completing *Statistics for Technology*.

Table F1 - Curricular Elective Exams

Course Name	*Semestre*	*CFU*	*SSD*	*TAF*
Applied Mechanics for Energy Efficiency	II	9	IIND-02/A	*B/D*
Mechanical Systems Control Controllo dei sistemi meccanici	II	9	IIND-02/A	*B/D*
Dynamics of Mechanical Systems Dinamica dei Sistemi Meccanici	I	9	IIND-02/A	*B/D*
Dynamics of Railway Vehicles Dinamica del veicolo ferroviario	I	9	IIND-02/A	*B/D*
Vehicle Mechanics Meccanica del Veicolo	II	9	IIND-02/A	*B/D*
Robot Mechanics Meccanica dei Robot	I	9	IIND-02/A	*B/D*
Tribology and Diagnostics of Mechanical Systems Tribologia e diagnostica dei sistemi meccanici	I	9	IIND-02/A	*B/D*
Advanced Machine Design Complementi di Costruzione di Macchine	I	9	IIND-03/A	*B/D*
Vehicle Construction Costruzione di Autoveicoli	I	9	IIND-03/A	*B/D*
Railway Construction Costruzioni Ferroviarie	I	9	IIND-03/A	*B/D*
Design of Mechatronic Systems Design of Mechatronic Systems	I	9	IIND-03/A	*B/D*
Experimental Mechanics Meccanica Sperimentale	II	9	IIND-03/A	*B/D*
Assisted Design of Mechanical Structures Progettazione Assistita di Strutture Meccaniche	I	9	IIND-03/A	*B/D*
Mechanical Design Progettazione Meccanica	II	9	IIND-03/A	*B/D*
Railway Construction Techniques Tecnica delle costruzioni ferroviarie	II	9	IIND-03/A	*B/D*
Modeling and Simulation of Mechatronic Systems Modellazione e Simulazione di Sistemi Meccatronici	I	9	IIND-03/B	*B/D*
Bio-Inspired Generative Design for Additive Manufacturing	II	9	IIND-03/B	*B/D*
Digital Modeling and Simulation for Industrial Engineering Modellazione Geometrica e Prototipazione Virtuale	II	9	IIND-03/B	*B/D*
Sustainable Product Design and Development Progettazione e Sviluppo di Prodotto Sostenibile	I	9	IIND-03/B	*B/D*
Additive Manufacturing	I	9	IIND-04/A	*B/D*
Management and Control of Manufacturing Systems Gestione e Controllo dei Sistemi di Lavorazione	II	9	IIND-04/A	*B/D*
Green Manufacturing and Sustainability	I	9	IIND-04/A	*B/D*
Integration of Advanced Systems in Industrial Production Integrazione di Sistemi Avanzati nella Produzione Industriale	II	9	IIND-04/A	*B/D*
Computer-Aided Manufacturing Produzione Assistita da Calcolatore	I	9	IIND-04/A	*B/D*
Simulation and Modeling of Plastic Deformation Processes Simulazione e Modellazione dei Processi per Deformazione Plastica	I	9	IIND-04/A	*B/D*

Welding and Joining Techniques Tecnica della Saldatura e delle Giunzioni	I	9	IIND-04/A	*B/D*
Non-Conventional Materials Technologies Tecnologie dei Materiali non Convenzionali	II	9	IIND-04/A	*B/D*
Advanced and Resource Efficient Manufacturing Tecnologie Speciali	II	9	IIND-04/A	*B/D*
Logistics and Operation Management Gestione della Produzione Industriale	I	9	IIND-05/A	*B/D*
Smart Modelling of Industrial Production Systems	I	9	IIND-05/A	*B/D*
Project Management for Industrial Production Project Management per la Produzione Industriale	I	9	IIND-05/A	*B/D*
Safety and Maintenance of Industrial Plants Sicurezza e Manutenzione degli Impianti Industriali	II	9	IIND-05/A	*B/D*
Automated Production Systems Sistemi di Produzione Automatizzati	II	9	IIND-05/A	*B/D*

Table F2 - Additional Exams recommended for Autonomous Choice

Course Name	*Semestre*	*CFU*	*SSD*	*TAF*
Applied Acoustics Acustica Applicata	I	9	IIND-07/A	*B/D*
Heating and Cooling systems Impianti di Climatizzazione	II	9	IIND-07/A	*B/D*
Fluid Power and Pneumatic Systems Oleodinamica e Pneumatica	II	9	IIND-06/A	*B/D*
Probability and Statistics Probabilità e Statistica	I	9	STAT-01/B	*B/D*
Electronics for Intelligent Mechanical Systems Elettronica per Sistemi Meccanici Intelligenti	I	9	IINF-01/A	*B/D*
Machine Learning for Engineering	II	9	IINF-05/A	*B/D*
Energy Management for Transportation	I	9	IIND-08/A	*B/D*
Railway and Transit Services	II	9	CEAR-03/B	*B/D*

Curriculum Railway Mechanics

I Year

Course Name	SSD	Module	CFU	Hours	Type of Activity (lectures, lab, etc.)	TAF	Disciplinary Area	Mandatory/Optional
First Semester								
Railway Vehicle Dynamics Dinamica del veicolo ferroviario	IIND-02/A	Single	9	72	Lectures and exercises	B	Mechanical Engineering	Mandatory
Railway Construction Costruzioni ferroviarie	IIND-03/A	Single	9	72	Lectures and exercises	B	Mechanical Engineering	Mandatory
Product Management and Maintenance for Railways Elementi di gestione e manutenzione del prodotto ferroviario	IIND-05/A	Single	9	72	Lectures and exercises	B	Mechanical Engineering	Mandatory
Second Semester								
Electric Drives for Railway Traction Azionamenti Elettrici per la Trazione Ferroviaria	IIND-08/A	Single	6	48	Lectures and exercises	C	Mechanical Engineering	Mandatory
Hybrid Diesel-Electric Propulsion Propulsione Ibrida Diesel-Elettrica	IIND-06/B	Single	6	48	Lectures and exercises	B	Mechanical Engineering	Mandatory
Special Technologies Tecnologie speciali	IIND-04/A	Single	9	72	Lectures and exercises	B	Mechanical Engineering	9 CFU mandatory electives
Geometric Modeling and Virtual Prototyping Modellazione geometrica e prototipazione virtuale	IIND-03/B	Single	9	72	Lectures and exercises	B	Mechanical Engineering	
Curricular elective activity chosen by the student **(Table F1)**		Single	**A** (1)	A*8	Lectures and exercises	B	Mechanical Engineering	Elective (from suggested or approved study plan)
Free choice activity by the student **(see note a)**		Single	**B** (2)	B*8	Lectures and exercises	D		Elective (from suggested or approved study plan)
Additional language skills **(see note c)**			3			F		Mandatory

II Year

Course Name	SSD	Module	CFU	Hours	Type of Activity (lectures, lab, etc.)	TAF	Disciplinary Area	Mandatory/Optional
Organization and Safety of Railway Network Operations Organizzazione e sicurezza dell'esercizio delle reti ferroviarie	CEAR-03/B	Single	9	72	Lectures and exercises	C		Mandatory
Railway Construction Techniques Tecnica delle costruzioni ferroviarie	IIND-03/A	Single	9	72	Lectures and exercises	B	Mechanical Engineering	Mandatory

Curricular elective activity chosen by the student **(Table F1)**		Single	18-**A** (1)	(18-A)*8	Lectures and exercises	B	Mechanical Engineering	Elective (from suggested or approved study plan)
Free choice activity by the student **(Table F2 and Table F1)**		Single	9-**B** (2)	(9-B)*8	Lectures and exercises	D		Elective (from suggested or approved study plan)
Internship **(see note c)**			9			F		
Final Exam			15			E		

1) The curricular activities in note a) total 18 CFU, distributed between the first and second year depending on the choices made.
2) The free choice activities in note a) total 9 CFU, distributed between the first and second year depending on the choices made.

Notes:

a) A student who wishes to follow the Railway Mechanics Curriculum must notify this in writing at the time of enrollment. The selection of curricular activities by the student, in accordance with what is stated in Tables F1 and F2, defines an automatically approved study plan. Alternative solutions can be followed by presenting an individual study plan. The Coordinating Committee of the Master's Degree Program reserves the right to approve or reject such plans based on the justification provided by the student, as required by law. It should be noted that, in all cases, an exam can only be taken after the corresponding course has been delivered in the academic year of the study plan submission.

b) The internship can be either external (extramoenia) or internal (intramoenia). The external internship is carried out at companies, research centers, or other public and/or private entities, aiming to acquire specialized knowledge by working alongside professionals involved in design, production, and management of production or research plants, providing a first introduction to the professional world. The internal internship is conducted at university research laboratories to acquire specialized knowledge by collaborating with faculty members and researchers in carrying out research and development activities. In all cases, the internship must be documented in an internship booklet and certified by the university tutor using the AC form.

c) Students who do not possess certification of English language proficiency at least at the B2 level of the Common European Framework of Reference for Languages (CEFR) are required to include in their study plan a sufficient number of CFUs for Additional Language Skills to ensure they achieve this level of proficiency (3 CFUs). These credits can be acquired from external institutions or at the university's language center (cla.unina.it) and will be recognized upon submission of the certification. Students who already possess an English certificate at least at the B2 level at the time of enrollment may request its recognition for Additional Language Skills (3 CFUs).

d) The thesis work can also be carried out at companies in Italy or abroad. It must always be conducted under the direct and full responsibility of a faculty member from the Didactic Area of Engineering at the University of Naples Federico II (the procedures for assigning the thesis supervisor are specified in the Didactic Regulations of the Course of Study) and may, if necessary, include the collaboration of a company tutor. The procedures for assigning the company tutor are governed by the Didactic Regulations of the Course of Study as well as specific agreements.

TABLE F1 – Curricular Elective Activities Chosen by the Student

Course Name	Semester	CFU	SSD	Type
Applied Mechanics for Energy Efficiency	II	9	IIND-02/A	*B/D*
Mechanical Systems Control Controllo dei sistemi meccanici	II	9	IIND-02/A	*B/D*
Dynamics of Mechanical System Dinamica dei Sistemi Meccanici	I	9	IIND-02/A	*B/D*
Vehicle Mechanics Meccanica del Veicolo	II	9	IIND-02/A	*B/D*
Robot Mechanics Meccanica dei Robot	I	9	IIND-02/A	*B/D*
Tribology and Diagnostics of Mechanical Systems Tribologia e diagnostica dei sistemi meccanici	I	9	IIND-02/A	*B/D*
Advanced Machine Design Complementi di Costruzione di Macchine	I	9	IIND-03/A	*B/D*
Vehicle Construction Costruzione di Autoveicoli	I	9	IIND-03/A	*B/D*
Design of Mechatronic Systems	I	9	IIND-03/A	*B/D*
Experimental Mechanics Meccanica Sperimentale	II	9	IIND-03/A	*B/D*
Assisted Design of Mechanical Structures Progettazione Assistita di Strutture Meccaniche	I	9	IIND-03/A	*B/D*
Mechanical Design Progettazione Meccanica	II	9	IIND-03/A	*B/D*
Modeling and Simulation of Mechatronic Systems Modellazione e Simulazione di Sistemi Meccatronici	I	9	IIND-03/B	*B/D*
Bio-Inspired Generative Design for Additive Manufacturing Bio-Inspired Generative Design for Additive Manufacturing	II	9	IIND-03/B	*B/D*
Geometric Modeling and Virtual Prototyping Modellazione Geometrica e Prototipazione Virtuale	II	9	IIND-03/B	*B/D*
Sustainable Product Design and Development Progettazione e Sviluppo di Prodotto Sostenibile	I	9	IIND-03/B	*B/D*
Additive Manufacturing	I	9	IIND-04/A	*B/D*
Management and Control of Manufacturing Systems Gestione e Controllo dei Sistemi di Lavorazione	II	9	IIND-04/A	*B/D*
Green Manufacturing and Sustainability	I	9	IIND-04/A	*B/D*
Integration of Advanced Systems in Industrial Production Integrazione di sistemi avanzati nella produzione industriale	II	9	IIND-04/A	*B/D*
Computer-Aided Manufacturing Produzione Assistita da Calcolatore	I	9	IIND-04/A	*B/D*
Simulation and Modeling of Plastic Deformation Processes Simulazione e Modellazione dei Processi per Deformazione Plastica	I	9	IIND-04/A	*B/D*
Welding and Joining Techniques Tecnica della Saldatura e delle Giunzioni	I	9	IIND-04/A	*B/D*
Non-Conventional Materials Technologies Tecnologie dei Materiali non Convenzionali	II	9	IIND-04/A	*B/D*
Special Technologies Tecnologie Speciali	II	9	IIND-04/A	*B/D*
Industrial Production Management Gestione della Produzione Industriale	I	9	IIND-05/A	*B/D*
Smart Modelling of Industrial Production Systems	I	9	IIND-05/A	*B/D*
Project Management for Industrial Production Project Management per la Produzione Industriale	I	9	IIND-05/A	*B/D*
Safety and Maintenance of Industrial Plants Sicurezza e Manutenzione degli Impianti Industriali	II	9	IIND-05/A	*B/D*

Automated Production Systems Sistemi di Produzione Automatizzati	II	9	IIND-05/A	*B/D*

Table F2 - Additional Exams recommended for Autonomous Choice

Course Name	Semestre	CFU	SSD	TAF
Internal Combustion Engines Motori a combustione interna	I	9	IIND-06/A	D
Hydraulics and Pneumatics Oleodinamica e Pneumatica	II	9	IIND-06/B	D
Heat Transfer Trasmissione del calore	I	9	IIND-07/A	D
Applied Acoustics Acustica Applicata	I	9	IIND-07/A	D
Air Conditioning Systems Impianti di Climatizzazione	II	9	IIND-07/B	D
Electrical Engineering for Automotive and Mechatronics Elettrotecnica per l'Automotive e la Meccatronica	II	9	IIET-01/A	D
Electric Systems for Renewable Energy Sistemi Elettrici per le Fonti Rinnovabili	II	9	IIND-08/B	D
Design of Electronic Circuits and Systems Progettazione di Circuiti e Sistemi Elettronici	I	9	IINF-05/A	D
Power Devices and Circuits Dispositivi e Circuiti di Potenza	I	9	IINF-05/A	D
Energy Management for Transportation Gestione dell'Energia per i Trasporti	I	9	IIND-08/A	D
Electric Technologies for Mobility Tecnologie elettriche per la mobilità	I	9	IIND-08/A	D
Surface Engineering Ingegneria delle Superfici	I	12	IMAT-01/A	D
Business Economics and Organization Economia ed Organizzazione Aziendale	I	6	IEGE-01/A	D
Business Management Gestione Aziendale	II	6	IEGE-01/A	D
Statistics for Technology Statistica per la Tecnologia	II	6	STAT-01/B	D
Statistical Learning for Industrial Engineering Apprendimento Statistico per l'Ingegneria Industriale	I	6	STAT-01/B	D
Electronics for Intelligent Mechanical Systems Elettronica per Sistemi Meccanici Intelligenti	I	6	IINF-05/A	D
Machine Learning for Engineering Apprendimento Automatico per l'Ingegneria	II	6	IINF-05/A	D
Polymer Science Scienza dei Polimeri	I	6	IMAT-01/A	D
Polymer Technology Tecnologia dei Polimeri	II	6	IMAT-01/A	D

Curriculum Sustainable Development

I Year

Course Name	SSD	Module	CFU	Hours	Type of Activity (lectures, lab, etc.)	TAF	Disciplinary Area	Mandatory/ Optional
Mandatory curricular activities (36 CFU) chosen from the following subjects depending on the path (see note a)								
Advanced Structural Mechanics	IIND-03/A	Single	9	72	Lectures and exercises	B	Mechanical Engineering	36 CFU Mandatory electives
Mechanical vibrations	IIND-02/A	Single	9	72	Lectures and exercises	B		
Logistics and Operation Management	IIND-05/A	Single	9	72	Lectures and exercises	B		
Digital Modeling and Simulation for Industrial Engineering	IIND-03/B	Single	9	72	Lectures and exercises	B		
Advanced and Resource Efficient Manufacturing	IIND-04/A	Single	9	72	Lectures and exercises	B		
Curricular elective activities **(see note a)**		Single	**A** (1)	A*8	Lectures and exercises	B	Mechanical Engineering	Elective (from suggested or approved study plan)
Affiliated or Integrative Activity **(see note a)**		Single	**B** (2)	B*8	Lectures and exercises	C		Elective (from suggested or approved study plan)
Free choice activity by the student **(see note a)**		Single	**C** (3)	C*8	Lectures and exercises	D		Elective (from suggested or approved study plan)
Additional language skills **(see note c)**			3			F		Mandatory

II Year

Course Name	SSD	Module	CFU	Hours	Type of Activity (lectures, lab, etc.)	TAF	Disciplinary Area	Mandatory/ Optional
Curricular elective activity **(see note a)**		Single	36-A (^)	36-**A** (1)	Lectures and exercises	B	Mechanical Engineering	Elective (from suggested or approved study plan)
Affiliated or Integrative Activity **(see note a)**		Single	12-B (°)	12-**B** (2)	Lectures and exercises	C		Elective (from suggested or approved study plan)
Free choice activity by the student **(see note a)**		Single	9-C (°)	9-**C** (3)	Lectures and exercises	D		Elective (from suggested or approved study plan)
Internship **(see note b)**			9			F		
Final Exam **(see note d)**			15			E		

1) The curricular activities mentioned in note a) amount to 36 CFU, distributed between the first year (max 18 CFU) and the second year, depending on the choices made.
2) The affiliated or integrative activities mentioned in note a) amount to 12 CFU, distributed between the first and second year, depending on the choices made.
3) The free choice activities mentioned in note a) amount to 9 CFU, distributed between the first and second year, depending on the choices made.

Notes:

a) A student who wishes to follow the Sustainable Development Curriculum must notify this in writing at the time of enrollment. The selection of curricular activities by the student, in accordance with what is stated in Tables G1, G2, and G3, defines an **automatically approved study plan**. Alternative solutions can be followed by presenting an individual study plan. The Coordinating Committee of the Master's Degree Program reserves the right to approve or reject such plans based on the justification provided by the student, as required by law. It should be noted that, in all cases, an exam can only be taken after the corresponding course has been delivered in the academic year of the study plan submission.

b) The internship can be either external (extramoenia) or internal (intramoenia). The external internship is carried out at companies, research centers, or other public and/or private entities, aiming to acquire specialized knowledge by working alongside professionals involved in design, production, and management of production or research plants, providing a first introduction to the professional world. The internal internship is conducted at university research laboratories to acquire specialized knowledge by collaborating with faculty members and researchers in carrying out research and development activities. In all cases, the internship must be documented in an internship booklet and certified by the university tutor using the AC form.

c) Students who do not possess certification of English language proficiency at least at the B2 level of the Common European Framework of Reference for Languages (CEFR) are required to include in their study plan a sufficient number of CFUs for Additional Language Skills to ensure they achieve this level of proficiency (3 CFUs). These credits can be acquired from external institutions or at the university's language center (cla.unina.it) and will be recognized upon submission of the certification. Students who already possess an English certificate at least at the B2 level at the time of enrollment may request its recognition for Additional Language Skills (3 CFUs).

d) The thesis work can also be carried out at companies in Italy or abroad. It must always be conducted under the direct and full responsibility of a faculty member from the Didactic Area of Engineering at the University of Naples Federico II (the procedures for assigning the thesis supervisor are specified in the Didactic Regulations of the Course of Study) and may, if necessary, include the collaboration of a company tutor. The procedures for assigning the company tutor are governed by the Didactic Regulations of the Course of Study as well as specific agreements.

TABLE G1 – Curricular Elective Activities Chosen by the Student

Course Name	Semester	CFU	SSD	Type
Applied Mechanics for Energy Efficiency	II	9	IIND-02/A	*B/D*
Mechanical vibrations	I	9	IIND-02/A	*B/D*
Design of Mechatronic Systems	I	9	IIND-03/A	*B/D*
Advanced Structural Mechanics	I	9	IIND-03/A	*B/D*
Bio-Inspired Generative Design for Additive Manufacturing	II	9	IIND-03/B	*B/D*
Digital Modeling and Simulation for Industrial Engineering	II	9	IIND-03/B	*B/D*
Additive Manufacturing	I	9	IIND-04/A	*B/D*
Advanced and Resource Efficient Manufacturing	II	9	IIND-04/A	*B/D*
Green Manufacturing and Sustainability	I	9	IIND-04/A	*B/D*
Logistics and Operation Management	I	9	IIND-05/A	*B/D*
Smart Modelling of Industrial Production Systems	I	9	IIND-05/A	*B/D*

TABLE G2 – Affiliated or Integrative Activities Chosen by the Student

Course Name	Semester	CFU	SSD	TAF	Disciplinary Area
Statistical Learning for Industrial Engineering (1)	I	6	STAT-01/B	D	LM-IMPP
Machine Learning for Engineering	II	6	IINF-05/A	D	LM-IMPP
Sustainable Metallurgy	II	6	IIND-03/C	D	LM-IMPP
Materials Selection for Engineering Applications	I	6	IMAT-01/A	D	LM-IMPP

(1) The course Statistical Learning for Industrial Engineering can only be chosen if the student has documented prior knowledge of basic statistics.

TABLE G3 – Additional Recommended Courses for Free Choice

Course Name	Semester	CFU	SSD	TAF	Disciplinary Area
Principles and Applications of Fluid Machinery	II	9	IIND-06/A	D	LM-IMEA
Heat Transfer Principles in Engineering	I	9	IIND-07/A	D	LM-IMEA
Smart Production Systems	II	9	IIND-05/A	D	LM_IELT
Design of Electronic Circuits and Systems	I	9	IINF-01/A	D	LM-IELN
Power Devices and Circuits	I	9	IINF-01/A	D	LM-IELN
Energy Management for Transportation	I	9	IIND-08/A	D	LM_TEAM
Railway and Transit Services	II	9	CEAR-03/B	D	LM_TEAM

ANNEX 2.1

DEGREE PROGRAM DIDACTIC REGULATIONS

MECHANICAL ENGINEERING FOR DESIGN AND MANUFACTURING

LM-33

School: Polytechnical of Basic Sciences

Department: Industrial Engineering

Didactic Regulations in force since the academic year 2025-2026

Course: Acustica Applicata Applied Acoustics	**Teaching Language:** Italian
SSD (Subject Areas): IIND-07/A (ex ING-IND/10)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
The subject area includes skills relating to the following topics: thermodynamic, thermokinetic analysis of energy processes and their environmental impact, principles, methodologies and technologies for sustainable energy conversion from renewable and conventional energy sources, final uses of energy, energy management, techniques for monitoring and processing energy data and models, energy efficiency technologies and applications, thermoeconomics, technologies for the energy transition, physics of the built environment, with particular reference to the interaction among occupants and the environment, thermophysics of buildings, technical plants for civil applications, energy diagnosis and optimization of the building-plant-territory system, applied acoustics, lighting engineering, air quality, passive systems and plant technologies for air conditioning and environmental well-being. It also studies thermo-fluid-dynamic phenomena in biological and agri-food systems, refrigeration technologies, thermotechnics, heat exchange and energy storage systems and components, fire safety, thermophysical properties of materials, measurements and thermo-fluid-dynamic controls, materials for energy, acoustics and lighting engineering.

Objectives:
The course aims to provide students with the fundamentals related to the wave equations and the main solutions, the analysis of acoustic signals and linear time invariant acoustic systems and knowledge on the perception of sounds and psychoacoustics. These will be useful in addressing problems of measurement and control of noise in closed and outdoor environments, in identifying and recognizing the main causes of noise (due to rotating machines, aero-acoustic sources or vibrating surfaces) and methods for containing noise through suitable sound-absorbing and sound-insulating systems. For this, during the course practical and numerical exercises of measurement of sound and design will be carried out by using commercial software. The course will highlight that the main objective is the psychoacoustic well-being which can be evaluated by using objective parameters deriving from measurement procedures, from numerical algorithms or through appropriate “sound virtualization” techniques, that is, the auralization techniques. Furthermore, the basic concepts of the sound quality of the noise / sound emitted by an industrial product will be introduced. All the above-mentioned issues will be contextualized within industrial realities through supplementary seminars held by companies and research centers.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Project discussion and oral examination

Course: Additive Manufacturing	**Teaching Language:** English	
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, to assembly, to controls, to recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes.		
Objectives: The aim of the course is to provide students with in-depth knowledge on digital manufacturing processes based on additive layer manufacturing for both metals, polymers and composites, in order to allow students to acquire knowledge on the complex thermal, chemical and mechanical mechanisms occurring in the transformation processes and link these to the characteristics and performance of the manufactured products, with a special focus on their anisotropy.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and oral examination		

Course: Advanced and Resource Efficient Manufacturing	**Teaching Language:** English
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The study of transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, to assembly, to controls, to recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods)	
Objectives: The objective of the course is to provide a comprehensive understanding of the mechanical behavior of metals, with a particular focus on the alloys that represent the most employed in industry, namely steels and non-ferrous alloys. Additionally, the course will cover the fundamentals of both conventional and unconventional manufacturing processes for metals. This will enable students to gain insight into the complex thermal, chemical and mechanical mechanisms that occur during the transformation processes and to understand how these mechanisms affect the performance of manufactured products. Finally, the course will provide the fundamental knowledge required to make informed decisions about the most appropriate technological process to produce parts, balancing economic, performance and technological aspects.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Advanced Structural Mechanics	**Teaching Language:** English
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area collects the skills related to the design, construction and testing of machines, structures and mechanical systems: principles and methodologies of mechanical design, from the construction elements of machines and the mechanical behavior of materials to the reliability design of mechanical systems, optimization, integrated design of product and process; numerical modeling, methods for dynamic and modal analysis, mechanics of materials subjected to typical operating stresses.	
Objectives: Objective of the course is to provide advanced knowledge of the structural calculation methodology using FEM (Finite Element Method), providing the capabilities to deal with the advanced design of structures and machine components. At the end of the course, the student will be able to apply the numerical approach to solving structural problems related to practical case studies.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Applied Mechanics for Energy Efficiency	**Teaching Language:** English
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Cultural aspects related to the study of mechanical systems using the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to driving and operating machines, mechanical devices, automatic machines and robots, vehicles and biomechanical systems. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into modeling, simulation, regulation and control of the same. Particular emphasis is placed on the study of the vibratory and tribological phenomena of the machines. Strong interrelations are implemented with the methodologies and algorithms developed in the areas of design and methods of industrial engineering, mechanical design and construction of machines and fluid dynamics.	
Objectives: The aim of the course is to provide knowledge about techniques typical of applied mechanics useful to improve the energy efficiency of mechanical systems. Two paths are followed for improving efficiency: the first concerns the reduction of the energy used while the second concerns the recovery of energy that should be dissipated. Therefore, the main causes of dissipation due to dynamic phenomena and the techniques to reduce their effects will be faced. Furthermore, the mechanical phenomena that allow energy recovery and the techniques used in the case of low-power applications will be illustrated, with a focus on modelling and design methodologies.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Azionamenti elettrici per trazione ferroviaria Electric drives for railway traction	**Teaching Language:** Italian
SSD (Subject Areas): IIND-08/A (ex ING-IND/32)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area includes studies concerning electrical machines, electrical sensors and actuators, power electronic components and converters, electrical and electronic materials, electrical drives, electrical systems for transportation. The studies involve, for these topics, in addition to traditional electrical methodologies, also those of industrial power electronics, control devices, automation systems and processes and mechatronics, aimed at the study in static and dynamic regime of their behavioral models. The studies extend to the problems of integration of components in energy systems for industry, transportation and the tertiary sector.	
Objectives: The course aims to provide students with the necessary tools for analyzing the behavior and operating characteristics of electric drives for the propulsion of railway vehicles connected to an electrical supply network or with energy generation.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Bio-Inspired Generative Design for Additive Manufacturing	**Teaching Language:** English
SSD (Subject Areas): IIND-03/B (ex ING-IND/15)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the set of methods and tools to produce a technically valid project, in the field of industrial engineering. It is, therefore, the reasoned and innovative choice of technical solutions, which can be perfected through the systematic use of rational methods for the conception and optimization of machines; it is, therefore, a fundamental expression of technical creativity. Today this is implemented with the intensive help of computer tools; therefore, the concepts that govern the use of such means in industrial design are studied.	
Objectives: Taking advantage of the Additive Manufacturing processes which allow to manufacture ‘‘complex’’ geometries, in some cases unrealizable with other manufacturing processes, the course introduces to Bio-Inspired Generative Design (GD), a design method that mimics nature’s evolutionary approach to design. GD is used to design complex shapes and optimized forms in relationship to forces, cost, weight and other data that may influence the design. Starting from design goals and using machine learning algotithms, GD explores all of the possible permutations of a solution to find the best option. GD alghoritms cycle through thousand – or even millions – of design choices, testing configurations and learning from each iteration what works and what doesn’t. The process lets designers generate new options, beyond what a human alone could create, to arrive at the most effective design.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Complementi di Costruzione di Macchine Machine Construction Complements	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**

Teaching Methods:

In person

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

The subject area collects the skills related to the design, construction and testing of machines, structures and mechanical systems: principles and methodologies of mechanical design, from the construction elements of machines and the mechanical behavior of materials to the reliability design of mechanical systems, optimization, integrated design of product and process; numerical modeling, methods for dynamic and modal analysis, mechanics of materials subjected to typical operating stresses.

Objectives:

The course aims to deepen knowledge of the mechanical behaviour of materials and methods for analyzing the mechanical behaviour of structures and machine parts for advanced design. Applying design methods on a normative basis for the benefit of an executive design. At the end of the course, the student must be able to apply theoretical concepts to real design problems and to use FEM technique.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Project discussion and oral examination

Course: Controllo dei Sistemi Meccanici Mechanical Systems Control	**Teaching Language:** Italian
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
The subject area includes the cultural and professional aspects inherent to the study of mechanical systems through the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to driving and operating machines, mechanical devices, automatic machines and robots, vehicles and biomechanical systems. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into their modeling, simulation, regulation and control; the synthesis is aimed at their functional design.

Objectives:
The course aims to provide the fundamental elements for designing controlled mechanical systems through a model-based approach. Therefore, methodologies needed to address the identification and control of mechanical systems, with particular reference to the modelling of mechatronic systems (relating to the mechanical system, actuators and control logic), are employed in this course.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Oral examination

Course: Convertitori elettronici di potenza Power electronic converters	**Teaching Language:** Italian
SSD (Subject Areas): IIND-08/A (ex ING-IND/32)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area includes studies concerning electrical machines, electrical sensors and actuators, power electronic components and converters, electrical and electronic materials, electrical drives, electrical and electronic technologies, electromechanical constructions and electrical industrial applications, and which translate basic and applicative problems of energy conversions, with the aim of making it available in the form, measure and quality necessary for the various applications in industry, in rail, cableway and road transport, in civil buildings and in services, starting from traditional and renewable energy sources.	
Objectives: The course aims to provide specialist knowledge of power electronics, presenting the operating characteristics of the main semiconductor electronic devices, analyzing the fundamental topological structures for electrical energy conversion, both into alternating current and direct current. Moreover, the course presents the criteria for the choice and the rough sizing of a conversion system, which must be intended as an element of a more general electromechanical system.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Costruzione di Autoveicoli Automotive Design	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area collects the skills related to the design, construction and testing of machines, structures and mechanical systems: principles and methodologies of mechanical design, from the construction elements of machines and the mechanical behavior of materials to the reliability design of mechanical systems, optimization, integrated design of product and process; design and construction of mechanical systems and engines; theory and technique of land vehicles, mechanical and systemic design and testing of motor vehicles.	
Objectives: The aim of course is to provide tools and methods for the design of the main groups and systems of a motor vehicle. The practical exercises are aimed at showing design methodologies, also computer aided. It therefore falls within the design oriented subjects.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Costruzioni Ferroviarie Railway Design	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Design, construction and testing of machines, structures and mechanical systems; numerical modelling; mechanics of materials subjected to typical operating stresses; prototype testing; theory and technique of land vehicles, mechanical and systemic design and testing of railway vehicles.	
Objectives: Main aim of this course is providing students the basic knowledges and the methodologies for solving the sizing problems related to the design of the components of the railway vehicles and infrastructure and to the implementing of the constructive solutions, both by theoretical lectures, tutorials.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Design of Electronic Circuits and Systems	**Teaching Language:** English
SSD (Subject Areas): IINF-01/A (ex ING-INF/01)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area gathers the technical and scientific skills needed to conceive, analyze, design, realize, characterize and test devices, circuits and systems that represent the basis of modern communication and information technologies. The activities of interest include: design and realization of devices, circuits, apparatus and systems based on the specifications, regulations and costs set by the applications. The subject area contains a wide range of skills (low and high frequency semiconductor devices, circuits, microcircuits, architectures and algorithms for information processing, sensors, actuators and microsystems, electronic instrumentation, devices and circuits for industrial and power applications, devices and circuits for energy conversion and production, computer tools for computer-aided design, etc.), each including methodological, design, technological and experimental aspects. It is strongly interested in the applications of electronic systems, such as: information processing and transmission; industrial and power electronics; electronics for health, the car, the environment, tourism, cultural heritage, the home and space.	
Objectives: Study of the main design metodologies and approaches for analog, mixed-mode, power and digital circuit and systems. Design of integrated and discrete circuits and systems. CAD tools for the implementation of actual projects and layout optimization. Ability to develop practical design of complex electronic systems.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Design of Mechatronic Systems	**Teaching Language:** English
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Principles and methodologies of mechanical design, from the construction elements of machines and the mechanical behavior of materials to the reliability design of mechanical systems. Design and experimentation related to quality, safety, human-machine interaction, environmental compatibility, producibility and maintainability. Design and construction of mechanical and mechatronic systems, motors, pressure vessels, automatic machines and robots, lifting and transport machines, biomechanical systems, micromechanical systems and components, components and structures for industrial plants. Mechanics of materials subjected to typical operating stresses, tests on prototypes. Experimental methods of measurement and analysis of the state of deformation and tension.	
Objectives: To provide advanced methodologies for the selection and interfacing of motors, structures and components or assemblies, starting from the structural and quantitative design specifications of a mechanical system. Evaluate the response of the structure as an elastic chain by introducing the criteria of controlled compliance. To present the main construction elements of mechatronic systems including displacement, strain and force sensors, discussing the different types with particular regard to the design principles and characteristics of use. To develop an understanding of advanced constitutive models for describing the mechanical behaviour of materials, with the aim of consciously determining the response of the material according to the environmental, loading or processing boundary conditions to which it is subject.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Digital Modeling and Simulation for Industrial Engineering	**Teaching Language:** English
SSD (Subject Areas): IIND-03/B (ex ING-IND/15)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the set of methods and tools to produce a technically valid project, in the field of industrial engineering. The concepts that govern the use of IT tools in industrial design are studied. The morphological, functional and aesthetic study of construction solutions is accompanied by the development of representation methods, which also concern the simulation of operation and virtual prototypes. The fundamentals and methods of design and the related representation, modeling and simulation tools are treated in reference to the various industrial areas: aerospace, mechanical, naval and plant engineering. The conception of overall architectures then involves the breakdown into components for manufacturing, down to the detail of the construction elements and the choice of tolerances, in relation to cost and operation requirements.	
Objectives: The course aims providing students with specialized knowledge that contributes to the training of the engineer who operates, through virtual prototyping, in the design of innovative and sustainable industrial products and manufacturing.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination and Discussion of exercises carried out during the course	

Course: Dinamica dei Sistemi Meccanici Dynamics of Mechanical Systems		**Teaching Language:** Italian
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**	

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
The subject area includes the cultural and professional aspects inherent to the study of mechanical systems through the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to driving and operating machines, mechanical devices, automatic machines and robots, vehicles and biomechanical systems. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into the modeling, simulation, regulation and control of the same; the synthesis is aimed at their functional design. Particular emphasis is placed on the study of the vibratory and tribological phenomena of the machines. Strong interrelations are implemented with the methodologies and algorithms developed in the areas of design and methods of industrial engineering, mechanical design and construction of machines and fluid dynamics.

Objectives:
The course aims to provide the advanced concepts for the identification, mathematical formulation, simulation and experimentation of the most significant dynamic phenomena in the field of machines and mechanical systems, with particular reference to the vibrations of systems with many degrees of freedom, to the critical velocities, to torsional oscillations and to the dynamics of rigid bodies elastically suspended.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Oral examination

Course: Dinamica del Veicolo Ferroviario Railway Vehicle Dynamics	**Teaching Language:** Italian
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area includes the cultural and professional aspects inherent to the study of mechanical systems through the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to driving and operating machines, mechanical devices, automatic machines and robots, vehicles and biomechanical systems. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into the modeling, simulation, regulation and control of the same; the synthesis is aimed at their functional design. Particular emphasis is given to the study of the vibratory and tribological phenomena of the machines.	
Objectives: The course aims to provide the fundamental elements for understanding the dynamical phenomena characterizing the railway vehicle. Interaction between the vehicle with the external environment is deepened starting from the wheel-rail contact to explore the dynamicl behaviour of wheelset, bogie, and entire vehicle.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Economia ed Organizzazione Aziendale Economic and Business Organization	**Teaching Language:** Italian
SSD (Subject Areas): IEGE-01/A (ex ING-IND/35)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**

Teaching Methods:

In person

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

The scientific-disciplinary sector focuses on developing and transferring the knowledge necessary to design and manage complex organizational systems within the framework of the intricate relationships between technology, economics, and management. The sector integrates engineering culture with the economics and management of businesses, organizations, and public and private institutions. The studies and main educational content pertain to processes of transformation, change, and innovation, i.e., the complex interactions between technological and social variables, aiming to understand their impacts on organizations and economic systems as well as strategic, managerial, and policy decisions. In studying these topics, the sector adopts modeling, design, and systemic approaches based on rigorous analytical methodologies.

Objectives:

The course aims to provide the fundamental concepts and analytical tools to model, describe and understand economic systems from the micro and macroeconomic perspectives.

From a microeconomic point of view, the course will cover the main models describing the behavior and decision-making mechanisms for allocating resources of individual economic actors, typically consumers and businesses. Furthermore, emphasis will be given to analyzing how these actors interact in a market economy and how equilibria are determined in terms of prices and demanded quantities.

From the macroeconomic perspective, the course will introduce the primary indicators used to describe national economic systems (e.g., gross domestic product, inflation, employment) and the methods used to determine the main macroeconomic variables.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Written and oral tests. The written test includes numerical exercises. The outcome of the written test is binding for the purposes of access to the oral test. If passed, the evaluations of the two tests will be weighted equally.

Course: Elementi di Gestione del Prodotto Ferroviario Elements of Railway Product Management	**Teaching Language:** Italian
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)	**CREDITS:** 9
Course year: I	**Type of Educational Activity: B**

Teaching Methods:

In person

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

Analysis and design of industrial plants, including feasibility studies, location selection and economic evaluation of the initiative; analysis and design of general plant services, including technical-economic optimization methods; analysis, ergonomic design and safety of production systems; management of production systems, including quality and maintenance management; logistics of industrial plants, including management and handling of materials; automation of production systems, including analysis of the economic feasibility of integrated and flexible systems and industrial instrumentation for automatic process control.

Objectives:

The course aims to provide students with the knowledge and skills needed to tackle industrial problems related to the conception, realisation, and management of railway vehicle production activities from a systems perspective. Starting with the product "engineering" phase based on the customer's requirements and the applicable regulations, we proceed to the critical analysis of the production, logistics, and maintenance processes, as well as the analysis of typical management contents. The lectures will be supplemented by seminars on specific topics and company visits, allowing students to gain a better understanding of the topics covered.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Oral examination

Course: Elettronica per Sistemi Meccanici Intelligenti Electronics for Intelligent Mechanical Systems	**Teaching Language:** Italian
SSD (Subject Areas): IINF-01/A (ex ING-INF/01)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**

Teaching Methods:

In person

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

The subject area gathers the technical and scientific skills needed to conceive, analyze, design, realize and characterize devices, circuits and systems that represent the basis of modern communication and information technologies. The activities of interest include the design and realization of devices, circuits, apparatus and systems based on the specifications, regulations and costs set by the applications. The subject area contains a wide range of skills (circuits, microcircuits, sensors, actuators and microsystems, architectures and algorithms for information processing, energy efficiency of circuits and systems, computer tools for computer-aided design, etc.), each including methodological, design, technological and experimental aspects. It is strongly interested in the applications of electronic systems, such as: information processing and transmission; industrial and power electronics; electronics for health, the environment, the home and space.

Objectives:

The course of Elettronica per Sistemi Meccanici Intelligenti aims at letting the students acquire the fundamental concepts related to circuits based on microcontroller, sensors and digital interconnections (wired and wireless) for the electronic systems used in the Internet of Things (IoT), Industrial IoT (IIoT) and the Industry 4.0. In this context, the main applications of analog and digital electronics relevant to mechanical systems will be illustrated. Students will be involved in the analysis of the structure of simple sensory nodes based on microcontrollers, actuation circuits and communication protocols of interest for the various industrial and application scenarios.

Therefore, the necessary theoretical tools will be provided for the analysis and synthesis of firmware for: (i) the implementation of algorithms useful for interfacing microcontroller circuits with analog and digital sensors; (ii) processing of data collected in numerical form; (iii) communication via digital protocols of microcontroller systems with external peripherals useful for connecting to the internet. The basic concepts for the implementation of real-time processing via RTOS are also introduced. Finally, the course includes a part of circuit synthesis where the students can verify the correct hardware/firmware operation of simple IoT sensory node applications.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Computer and oral examination

Course: Elettrotecnica per l'Automotive e la Meccatronica Automotive and Mechatronics Electrical Engineering		**Teaching Language:** Italian
SSD (Subject Areas): IIET-01/A (ex ING-IND/31)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the theoretical and experimental aspects and the development of the related applications of the two complementary strands of electromagnetic fields and electric and electronic circuits in civil, industrial and information engineering.		
Objectives: The course illustrates the main applications of electrical engineering in the mechatronic and automotive fields. In particular, the mechanisms of generation, recovery and storage of electrical energy relevant to automotive applications and the treatment of non-linear circuits used in mechatronics will be highlighted, also through numerical simulations and laboratory experience.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and oral examination		

Course: Energy management for transportation	**Teaching Language:** English
SSD (Subject Areas): IIND-08/A (ex ING-IND/32)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area deals, among other things, with studies concerning electrical machines and which translate basic and applicative problems of energy conversion, with the aim of making it available in the form, measure and quality necessary for the various applications in industry, in rail, cableway and road transport, in civil buildings and in services, starting from traditional and renewable energy sources.	
Objectives: The course aims to provide the knowledge of the main constituents of the electric/hybrid propulsion systems of road and rail vehicles with particular regard to their principle of operation and controls. The analysis methodologies of vehicles powertrain allow the discussion to be then focused on energy management strategies, pursuing environmental sustainability goals in the incoming energy transition.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Gestione Aziendale Business Management	**Teaching Language:** Italian
SSD (Subject Areas): IEGE-01/A (ex ING-IND/35)	**CREDITS:** Mod. 1: 6
Course year: I or II	**Type of Educational Activity: C**

Teaching Methods:

In person

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

The scientific-disciplinary sector focuses on developing and transferring the knowledge necessary to design and manage complex organizational systems within the framework of the intricate relationships between technology, economics, and management. The sector integrates engineering culture with the economics and management of businesses, organizations, and public and private institutions. The studies and main educational content pertain to processes of transformation, change, and innovation, i.e., the complex interactions between technological and social variables, aiming to understand their impacts on organizations and economic systems as well as strategic, managerial, and policy decisions. In studying these topics, the sector adopts modeling, design, and systemic approaches based on rigorous analytical methodologies.

Objectives:

The course aims to provide the knowledge and tools necessary for the study, evaluation, and analysis of the internal and external environment of the enterprise. During the course, the behavior of economic actors within the context in which they operate will be examined, providing the foundations and tools to evaluate and suggest appropriate organizational strategies and configurations. The course will cover both the internal and external environment of the company.

Furthermore, basic notions for the analysis of costs and business performance will be provided, enabling students to analyze and advise on the most appropriate strategic and structural approaches for economic actors, in relation to the specific context. Students will acquire skills to analyze and evaluate the economic results of business activities. The course aims to develop knowledge of the principles of financial statement preparation (balance sheet and income statement) and to promote the use of the main financial analysis indicators. Additionally, it will provide skills for cash flow analysis and offer a comprehensive understanding of the various dimensions of corporate sustainability and reporting methods.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Written and oral examination and project work (optional)

Course: Gestione della Produzione Industriale Industrial Production Management	**Teaching Language:** Italian
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Analysis and design of industrial plants, including feasibility studies, location selection and economic evaluation of the initiative; analysis and design of general plant services, including technical-economic optimization methods; analysis, ergonomic design and safety of production systems; management of production systems, including quality and maintenance management; logistics of industrial plants, including management and handling of materials; automation of production systems, including analysis of the economic feasibility of integrated and flexible systems and industrial instrumentation for automatic process control.	
Objectives: The course's goal is to study the fundamental models of industrial production logic through the presentation of the most advanced techniques of medium and short term planning, with special reference to the most relevant algorithms for industrial production planning, scheduling, and control, all the way up to the configuration of Lean Production systems. The course includes the application of planning models for solving the fundamental problems of industrial production planning for each topic studied.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination	

Course: Gestione e Controllo dei Sistemi di Lavorazione Management and Control of Processing Systems		**Teaching Language:** Italian
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, to assembly, to controls, to recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods); the programming, management and control of processing, assembly, control and recycling systems; the management of quality and environmental protection in the perspective of sustainable development.		
Objectives: For a correct use of the course, a basic knowledge of manufacturing processes is required, it is therefore recommended that the student has already assimilated the concepts of the teachings of Mechanical Technology and possibly the Computer Aided Production exam.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and oral examination		

Course: Green Manufacturing and Sustainability	**Teaching Language:** English
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, to assembly, to controls, to recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods); the programming, management and control of processing, assembly, control and recycling systems; the management of quality and environmental protection in the perspective of sustainable development.	
Objectives: The objective of the teaching is to give students an in-depth knowledge of metrics and enabling technologies for the ecological transition of manufacturing processes. The aim of the course is to introduce students to the paradigm of life cycle thinking and sustainable production.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Heat Transfer Principles in Engineering	**Teaching Language:** English
SSD (Subject Areas): IIND-07/A (EX ING-IND/10)	**CREDITS:** 9
Course year: I	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Fundamental and applicative aspects of applied thermodynamics, applied thermofluid-dynamics and heat transfer. Thermodynamic analysis of energy processes and their environmental impact, conversion and use of energy, thermotechnics, thermophysical properties of materials, thermofluiddynamic measurements and controls.	
Objectives: At the end of the course, the student will have acquired knowledge relating to the fundamental principles and methods of heat transfer. The goals of the course are to: teach the fundamental principles and laws of heat transfer and to apply these principles to the resolution of practical problems; to formulate the models necessary to study, analyze and design heat exchange equipment; to develop the ability to solve heat transfer problems by making use of methods specific to a broad-spectrum technical training and fundamental tools for the development of a study also based on the aid of numerical models (finite volumes, finite differences, finite elements).	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination with project discussion	

Course: Impianti di Climatizzazione Heating and Cooling systems	**Teaching Language:** Italian
SSD (Subject Areas): IIND-07/A (ex ING-IND/10)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
The subject area includes skills relating to the following topics: thermodynamic, thermokinetic analysis of energy processes and their environmental impact, principles, methodologies and technologies for sustainable energy conversion from renewable and conventional energy sources, final uses of energy, energy management, techniques for monitoring and processing energy data and models, energy efficiency technologies and applications, thermoeconomics, technologies for the energy transition, physics of the built environment, with particular reference to the interaction among occupants and the environment, thermophysics of buildings, technical plants for civil applications, energy diagnosis and optimization of the building-plant-territory system, applied acoustics, lighting engineering, air quality, passive systems and plant technologies for air conditioning and environmental well-being. It also studies thermo-fluid-dynamic phenomena in biological and agri-food systems, refrigeration technologies, thermotechnics, heat exchange and energy storage systems and components, fire safety, thermophysical properties of materials, measurements and thermo-fluid-dynamic controls, materials for energy, acoustics and lighting engineering.

Objectives:
The course, of crucial importance for engineers dealing with energy topics, aims at developing knowledge on the energy-efficient design of the envelope-HVAC plant system (building, ship, train, vehicle, aircraft) also with the target of economic and environmental sustainability. Fundamentals on the envelope thermo-physics and on the HVAC systems are provided by highlighting the technical-application aspects with particular attention to energy efficiency.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Project discussion and oral examination

Course: Ingegneria delle Superfici Surface Engineering	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/C (ex ING-IND/21)	**CREDITS:** 12
Course year: I or II	**Type of Educational Activity: C**

Teaching Methods:

In person

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

The subject area studies the fundamentals and the implementation of the manufacturing and transformation processes of metallic materials; the raw materials and the related treatments; the forming processes; the chemical, physical, technological properties of metals and alloys; the related study and control methods; the relationship between submicroscopic and microscopic structure and properties; the treatments aimed at modifying the aforementioned properties, the mechanisms of alteration/degradation of metallic materials and the related interventions; the treatments (mechanical, thermal, thermochemical, thermomechanical and others, involving mass and surface) of metallic materials in view of their use.

Objectives:

The course aims to provide in-depth knowledge of surface modification processes and techniques for analysing the surface properties of materials.

Emphasis is placed on the study of methodologies aimed at obtaining surface properties different from those of the material's bulk and such as to give the item specific functional and/or aesthetic properties.

The validation of the changes implemented in the material is carried out through the use of analysis techniques that will be illustrated in relation to specific application examples and for which the chemical/physical principles that allow their implementation will also be defined.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Oral examination

Course: Integrazione di Sistemi Avanzati nella Produzione Industriale Advanced Systems Integration in Industrial Production	**Teaching Language:** Italian	
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**	

Teaching Methods:

In person

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

The transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, assembly, control, recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods); the programming, management and control of processing, assembly, control, recycling systems; the management of quality and environmental protection in the perspective of sustainable development.

Objectives:

The course aims to provide the knowledge and skills required to develop and integrate innovative technologies, like artificial intelligence and vision, into production systems. The basis will be provided for the understanding, developing and implementing of modern data collection, transmission and analysis techniques for production systems; furthermore, the understanding and application of "Internet of Things" (IoT) concepts in an industrial environment will be covered. After the course, the student will be able to develop and implement production systems that are controlled, monitored and coordinated via computational networks.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Written and oral examination

Course: Logistics and Operation Management	**Teaching Language:** English
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The course covers the following topics from the SSD declaratory: analysis and design of production systems for goods and services; design of production processes and techniques, plant services, and systems for energy production, recovery, and use; layout planning; study and design of manufacturing, remanufacturing, assembly, disassembly, recovery and recycling systems; ergonomic and safety design in production and service processes; management of production systems for goods and services; management and maintenance of the life cycle of products, plants and equipment, production infrastructures and product-service systems; design and integrated management of logistics systems and services; production systems automation.	
Objectives: The course aims to provide a comprehensive understanding of the principles, techniques, and tools used in modern production planning, scheduling, and control. It delves into the world of lean production systems, exploring their philosophies and methodologies. The course also introduces the fundamentals of internal logistics and provides an overview of supply chain management, enabling an understanding of the interconnectedness of these domains. By the end of the course, a solid foundation in operations management will be developed, empowering the ability to analyse, design, and optimize production systems for efficiency, quality, and customer satisfaction. Analytical tools and techniques will be applied to tackle real-world production planning and scheduling challenges, design efficient production systems based on lean principles utilising simulation and other software tools, develop skills in demand forecasting, inventory management, and capacity planning to make data-driven decisions, and gain hands-on experience in bridging the gap between theory and practice, preparing for careers in operations management.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Macchine elettriche Macchine elettriche	**Teaching Language:** Italian
SSD (Subject Areas): IIND-08/A (ex ING-IND/32)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area deals, among other things, with studies concerning electrical machines and which translate basic and applicative problems of energy conversion, with the aim of making it available in the form, measure and quality necessary for the various applications in industry, in rail, cableway and road transport, in civil buildings and in services, starting from traditional and renewable energy sources.	
Objectives: To provide students with basic knowledge of electrical machines (transformers, motors and generators) to allow the understanding and determination of operating characteristics and performance in different operating conditions and within electric drives.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination	

Course: Machine Learning for Engineering	**Teaching Language:** English
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**

Teaching Methods:

In person

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

The subject area is characterized by the set of scientific fields and scientific-disciplinary skills related to the design and implementation of information processing systems, as well as their management and use in various application contexts with engineering methodologies and techniques. This area includes the theoretical foundations, methods and technologies aimed at producing technically valid projects, from the point of view of both the adequacy of the proposed solutions and the possibility of technical implementation, as well as economic convenience and organizational effectiveness. These foundations, methods and technologies cover all aspects related to a processing system, from hardware to software, from operating systems to computer networks, from databases to information systems, from programming languages to software engineering, from human-machine interaction to signal and image recognition, multimedia processing, knowledge engineering, artificial intelligence and robotics. This subject area also includes skills relating to the design and construction of IT systems and various applications of processing systems, such as, for example, industrial telematics applications to socio-economic systems.

Objectives:

This course provides the students with the opportunity to develop a broad understanding of machine learning techniques and their application in various engineering fields, within the context of the data-driven Artificial Intelligence. After learning basics of machine learning, the attendees will learn the most diffused classical and advanced techniques for regression, classification, and clustering issues, together with some notions for feature engineering and ensemble learning. In addition, a practical overview of the most diffused deep learning architectures will be provided. Eventually, the attendees will learn how to use some tools and libraries for supporting machine learning applications, and thus they will be able to select the most appropriate machine learning models for the technical problem at hand and to solve it by exploiting the different computational tools.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Oral examination

Course: Materials Selection for Engineering Applications	**Teaching Language:** English
SSD (Subject Areas): IMAT-01/A (ex ING-IND/22)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area encompasses the totality of cultural and professional aspects related to the science and technology of materials. More specifically, it includes the skills related to structure and properties, design, production and transformation processes, use, analysis, characterization and quality control, corrosion and degradation, conservation, restoration and recycling of materials and their assemblies or combinations, having engineering, industrial and biomedical interest.	
Objectives: Introduce the student to the relationships that exist between the structure of materials and their main structural and functional properties. Acquisition of the basic aspects relating to the effect of the microstructure and related transformations on the structure of materials. Acquisition of the ability to identify the most suitable materials for a specific type of application and the related technologies necessary to transform a material into a product. Know the main techniques for verifying the behavior of a material in operation. Evaluate the environmental impact of materials and related transformation processes.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination	

Course: Meccanica dei Robot Robot Mechanics	**Teaching Language:** Italian
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area includes the cultural and professional aspects inherent to the study of mechanical systems through the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to driving and operating machines, mechanical devices, automatic machines and robots, vehicles and biomechanical systems. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into their modeling, simulation, regulation and control; the synthesis is aimed at their functional design.	
Objectives: The aim of the course is to provide the student with the fundamental notions for the study of kinematics and dynamics, direct and inverse, of multilink systems in general, and of industrial robots in particular, and for the planning of their motion. Also provide the knowledge of the main mechanical and electromechanical components, the basis for the mechanical design of a robot also using modeling tools, and finally the basis for the study of vision systems applied to robots.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Meccanica del Veicolo Vehicle Mechanics	**Teaching Language:** Italian
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area includes the cultural and professional aspects inherent to the study of mechanical systems through the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to mechanical devices and vehicles. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into the modeling, simulation, regulation and control of the same; the synthesis is aimed at their functional design. Particular emphasis is placed on the study of the vibratory and tribological phenomena of the machines. Strong interrelations are implemented with the methodologies and algorithms developed in the areas of design and methods of industrial engineering, mechanical design and construction of machines and fluid dynamics.	
Objectives: The aim of the course is to introduce the fundamentals of road vehicle dynamics. The course aims to provide methodologies to approach the study of road vehicles dynamics, based on the use of deductively developed physical-analytical models. The main problems concerning the tire-road interaction, the longitudinal, lateral and vertical dynamics of the vehicle are addressed.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Meccanica Sperimentale Experimental Mechanics	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area gathers the skills related to the design, construction and testing of machines, structures and mechanical systems; numerical modelling and testing related to safety; experimental methods of measurement and analysis of the state of deformation and stress, point and full-field methods of experimental mechanics of solids, mechanics of materials subjected to typical operating stresses, tests on prototypes, testing and control in operation, structural diagnostics, non-destructive testing, design of experiments; testing of motor vehicles, railway vehicles, agricultural and earth-moving machines and their components.	
Objectives: The course provides the fundamentals of experimental methodologies for the mechanical characterization of materials, machine parts and structures, as well as techniques and methodologies for experimental stress analysis in materials. The basics of numerical simulation of experimentation are also provided. The introductory theoretical part is followed by an application part during which the student has the opportunity to practice in the laboratory some of the analysis techniques covered in the lecture.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Mechanical Vibrations	**Teaching Language:** English
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area includes the cultural and professional aspects inherent to the study of mechanical systems through the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to driving and operating machines, mechanical devices, automatic machines and robots, vehicles and biomechanical systems. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into the modeling, simulation, regulation and control of the same; the synthesis is aimed at their functional design. Particular emphasis is placed on the study of the vibratory and tribological phenomena of the machines. Strong interrelations are implemented with the methodologies and algorithms developed in the areas of design and methods of industrial engineering, mechanical design and construction of machines and fluid dynamics.	
Objectives: The course aims to provide the advanced concepts for the identification, mathematical formulation, simulation and experimentation of the most significant dynamic phenomena in the field of machines and mechanical systems, with particular reference to the vibrations of systems with many degrees of freedom, to the critical velocities, to torsional oscillations and to the dynamics of rigid bodies elastically suspended.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Modellazione e simulazione di sistemi meccatronici Modeling and simulation of mechatronic systems	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/B (ex ING-IND/15)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the set of methods and tools needed to produce a technically valid project, in the field of industrial engineering. The concepts that govern the use of IT tools in industrial design are studied. The morphological, functional and aesthetic study of construction solutions is accompanied by the development of representation methods, which also concern the simulation of operation and virtual prototypes. In addition to geometric models, the methods of modeling products in their life cycle, development and engineering of industrial products are used.	
Objectives: The course aims to provide students with specialized knowledge that contributes to the training of engineer who works within the design and development of mechatronic systems.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Modellazione geometrica e prototipazione virtuale Geometric modeling and virtual prototyping		**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/B (ex ING-IND/15)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the set of methods and tools to produce a technically valid project, in the field of industrial engineering. The concepts that govern the use of IT tools in industrial design are studied. The morphological, functional and aesthetic study of construction solutions is accompanied by the development of representation methods, which also concern the simulation of operation and virtual prototypes. The fundamentals and methods of design and the related representation, modeling and simulation tools are treated in reference to the various industrial areas: aerospace, mechanical, naval and plant engineering. The conception of overall architectures then involves the breakdown into components for manufacturing, down to the detail of the construction elements and the choice of tolerances, in relation to cost and operation requirements.		
Objectives: The course aims providing students with specialized knowledge that contributes to the training of the engineer who operates, through virtual prototyping, both in innovation and in the development of industrial products, and in the design of even complex mechanical systems.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Computer test and oral examination		

Course: Motori a Combustione Interna Internal Combustion Engines	**Teaching Language:** Italian
SSD (Subject Areas): IIND-06/B (ex ING-IND/09)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Energy systems and the machines that compose them are studied with reference to thermodynamic, fluid dynamic, technological, environmental, safety, diagnostic and control issues.	
Objectives: The course aims to deepen the study of latest generation alternative internal combustion engines (MCI), for sustainable mobility from an energy and environmental point of view. With reference to propulsion systems for urban and extra-urban vehicular traction, in particular the most recent methodologies available for reducing consumption and emissions will be explored. With reference to high performance or racing engines, the aim is to analyze in detail the techniques for maximizing power. The study of innovative combustion systems will be addressed (HCCI, lean combustion, pre-chamber engines, etc.) and their impact on the production of CO2 will be quantified on approval cycles currently in force in Europe (WLTP), and in real operating conditions (Real Driving Emission, RDE). The Course will highlight the complex interactions between the different subsystems that make up a modern propulsion system, in order to achieve specific objectives in terms of performance and consumption. A brief mention will be made of hybrid propulsion systems and the use of non-conventional fuels (hydrogen, methanol, methane, etc.).	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Oleodinamica e Pneumatica Hydraulics and Pneumatics	**Teaching Language:** Italian	
SSD (Subject Areas): IIND-06/B (ex ING-IND/09)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Energy systems and the machines that compose them are studied with reference to thermodynamic, fluid dynamic, technological, environmental, safety, diagnostic and control issues.		
Objectives: The aim of the course is to introduce, deepen and specialize the issues for a mechanical engineer regarding hydraulic drives. Therefore being able to define a service in terms of forces or torques required, actuation time and a sequence of operations he must be able to design the system capable of realizing it.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and oral examination		

Course: Organizzazione e Sicurezza dell'Esercizio delle Reti Ferroviarie Organisation and Safety of the Operation of Railway Networks	**Teaching Language:** Italian
SSD (Subject Areas): CEAR-03/B (ex ICAR/05)	**CREDITS:** 9
Course year: II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The contents are aimed at understanding the phenomena of mobility of people and goods; at knowing the performance of components and systems of transport systems; at configuring the best system from the technological, functional, economic, financial, territorial, environmental and safety perspectives, with reference also to logistics, management and operation of systems. They therefore concern the methods and techniques for simulating mobility demand, transport supply, supply/demand interaction, economic, territorial, environmental impacts and accident rates; tactical and strategic transport planning; the specific technologies of the different modes of transport, their regulation and control; the functional design of components, systems and complex transport systems; the management and operation of transport services.	
Objectives: The aim of the course is to provide students with a specialized knowledge of all the different design and management techniques of the operation of railway transport systems, of the regulatory details, of the contractual management tools of LPT services (with particular attention to the railway and metro systems) as well as the regulatory-technological aspects relating to the interoperability of railway systems.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Power Device and Circuits	**Teaching Language:** English
SSD (Subject Areas): IINF-01/A (ex ING-INF/01)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**

Teaching Methods:

In person

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

Technical and scientific skills needed to conceive, analyze, design, implement and characterize devices, circuits and systems that form the basis of modern communication and information technologies. Activities of interest include the design and implementation of devices, circuits, apparatus and systems based on the specifications, regulations and costs set by applications. The subject area contains a wide range of skills (circuits, microcircuits, architectures and algorithms for information processing, computer tools for computer-aided design, etc.), each including methodological, design, technological and experimental aspects. It is strongly interested in the applications of electronic systems, such as: information processing and transmission; industrial and power electronics; electronics for health, the environment, tourism, cultural heritage, home and space.

Objectives:

Il corso si pone come obiettivo lo studio delle principali problematiche, con le relative soluzioni circuitali, connesse al condizionamento dell'energia elettrica in tutte quelle applicazioni in cui l'efficienza di conversione assume fondamentale importanza, indipendentemente dalla quantità di potenza gestita, e dunque nei regolatori di tensione utilizzati nei microchip fino agli alimentatori per i grandi carichi elettrici. Se da un lato la crescente diffusione di apparati elettronici portatili alimentati a batteria pone infatti il problema della limitata disponibilità di energia con il conseguente obiettivo di massimizzare l'efficienza per prolungare il più a lungo possibile il loro funzionamento, d'altro canto l'emergenza climatica globale richiede sempre maggiore attenzione verso l'uso efficiente dell'energia elettrica in grandi apparati o in interi impianti industriali. In queste, come in moltissime altre applicazioni intermedie, i moderni dispositivi a stato solido ed i circuiti elettronici hanno un ruolo essenziale, e la loro conoscenza ed ottimizzazione sono l'oggetto centrale di questo corso.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Oral examination

Course: Principles and Applications of Fluid Machinery	**Teaching Language:** English
SSD (Subject Areas): IIND-06/A (EX ING-IND/08)	**CREDITS:** 9
Course year: I	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The discipline covers the scientific and educational issues related to thermodynamic, fluid dynamic […] problems of all fluid machinery and fluid-based energy conversion systems. Of interest are the design, […], optimization, operation, testing […] of fluid machinery and power systems (such as turbines […]), as well as fans, compressors and pumps. […].	
Objectives: The purpose of the course is to provide the students with the knowledge needed for an accurate study of fluid machines and energy conversion systems, which are considered to be fundamental subjects dealt with in the second level degree in Energy and Environmental Mechanical Engineering. The general scheme of the course envisages the study of the thermofluid dynamic fundamentals of fluid machines and energy systems with practical examples. The course focuses on the study of turbomachines, as standalone components or part of a power plant. The course deepens the analysis of the thermodynamic processes taking place in fluid machines, the evaluation of the mechanical energy transfer, the flow in variable-area ducts, the dimensional analysis, the operating curves and the aerodynamics of airfoils and blade cascades.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Probabilità e Statistica Probability and Statistics	**Teaching Language:** Italian
SSD (Subject Areas): STAT-01/B (ex SECS-S/02)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area is characterized by a specific attention to modern statistical problems arising in the field of experimental sciences (statistics and probability calculation, design and analysis of experiments) and in particular in engineering (reliability, statistical quality control) and biomedical sciences (anthropometry, biometry, medical statistics). The main fields of application concern technology, safety, environment, territory, production processes, products, natural resources.	
Objectives: The course introduces the student to the fundamental notions of probability, data analysis and statistical inference and their engineering applications. At the end of the course the student will be able to apply probabilistic models in the field of engineering and statistical methods in the analysis and control of non-deterministic phenomena in general.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written test and oral examination	

Course: Produzione Assistita dal Calcolatore Computer Aided Manufacturing	**Teaching Language:** Italian
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**

Teaching Methods:

In person

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

The transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, assembly, control, recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods); the programming, management and control of processing, assembly, control, recycling systems; the management of quality and environmental protection in the perspective of sustainable development.

Objectives:

The course aims to provide students with specialist knowledge about the most advanced computer-assisted mechanical production techniques in the field of chip removal operations. In the first part of the course the machining will be studied in depth so that students can reach a complete knowledge on the mechanisms underlying these processes and on the various types of machine tools used in these processes, from the traditional ones to the fully automated multi-axial CNC (Computerized Numerical Control) machines. In particular, in this phase the students will learn the critical tools to consciously choose the most appropriate processing cycle to obtain parts characterized by certain characteristics in terms of geometrical and dimensional tolerances and surface finish, balancing the economic, performance and technological aspects involved. The knowledge learned so far will form the basis for the subsequent study of the programming language of numerical control and of the programming of CNC machine tools using the G code. Finally, the most advanced Computer-Aided Manufacturing (CAM) techniques will be studied using specialized software.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Written and oral examination

Course: Progettazione Assistita di Strutture Meccaniche Computer Aided Design of Mechanical Structures		**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area collects the skills related to the design, construction and testing of machines, structures and mechanical systems: principles and methodologies of mechanical design, from the construction elements of machines and the mechanical behavior of materials to the reliability design of mechanical systems, optimization, integrated design of product and process; numerical modeling, methods for dynamic and modal analysis, mechanics of materials subjected to typical operating stresses.		
Objectives: The aim of course is to provide knowledge of the FEM (Finite Element Method) numerical methodology for structural analysis, as well as basic knowledge of alternative numerical methodologies such as multybody and BEM (Boundary Element Method), acquiring applicative skills in fundamental topics.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and oral examination		

Course: Progettazione e Sviluppo di Prodotto Sostenibile Sustainable Product Design and Development	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/B (ex ING-IND/15)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the set of methods and tools to produce a technically valid project, in the field of industrial engineering. It is, therefore, the reasoned and innovative choice of technical solutions, which can be perfected through the systematic use of rational methods for the conception and optimization of machines; it is, therefore, a fundamental expression of technical creativity. The foundations and methods of design and the related tools of representation, modeling and simulation are treated with reference to the various industrial areas: aerospace, mechanical, naval and plant engineering. The conception of overall architectures, and of any human-machine interfaces, then involves the decomposition into components for manufacturing. The methods of interaction with virtual models, of modeling of products in their life cycle, of development and engineering of industrial products are used.	
Objectives: The course aims at providing students with advanced and innovative methods for designing and developing of new green products that satisfy new and evolved user needs. Further, the course is focused on new materials evaluation and innovative system architecture generation that allow to understand how to sustainably improve perfomances.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Progettazione Meccanica Mechanical Design	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area collects the skills related to the design, construction and testing of machines, structures and mechanical systems: principles and methodologies of mechanical design, from the construction elements of machines and the mechanical behavior of materials to the reliability design of mechanical systems, optimization, integrated product and process design; design and construction of mechanical systems and engines; numerical modeling, design and testing related to quality, safety, human-machine interaction, economic evaluation, environmental compatibility, producibility and maintainability.	
Objectives: The expected learning outcome is acquiring a synthetic understanding of the structural design as a well specified problem (design requirements) which requires some solutions (design of an element or of a small mechanical structure) subject to some constraints (technological limitations, relevant standards, etc.) and also being the best possible solution with respect to one or more pre-defined aspects (cost, weight, innovation, etc.).	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Project Management nella Produzione Industriale Project Management in Industrial Production	**Teaching Language:** Italian
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Analysis and design of industrial plants, including feasibility studies, location selection and economic evaluation of the initiative; analysis and design of general plant services, including technical-economic optimization methods; analysis, ergonomic design and safety of production systems; management of production systems, including quality and maintenance management; logistics of industrial plants, including management and handling of materials; automation of production systems, including analysis of the economic feasibility of integrated and flexible systems and industrial instrumentation for automatic process control.	
Objectives: The course aims to introduce students to the methodology of Project Management. It also intends to provide the most important methodological and operational tools needed to plan, monitor and control a project, both technically and economically, according to standards recognized at national and international level.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Propulsione Ibrida Diesel-Elettrica Diesel-Electric Hybrid Propulsion	**Teaching Language:** Italian
SSD (Subject Areas): IIND-06/A (ex ING-IND/08)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**

Teaching Methods:

In person

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

The subject area studies the thermodynamic, fluid dynamic, energy, ecological, technological and environmental issues of fluid machines, both at the level of the individual component and at the level of the systems and plants in which the machines are inserted. The subject area's skills cover the design, management, diagnostics, control, environmental impact, experimentation and testing aspects of fluid machines, both motors (steam turbines, gas turbines, hydraulic turbines, process expanders, internal combustion engines) and operators (pumps, fans, compressors) and sites of chemical reactions (combustors, gasifiers, reactors) and sites of heat exchange (evaporators, condensers, recuperators, etc.). The subject area also studies the insertion of machines in stationary systems for the generation of electrical and thermal energy, in land, marine and air propulsion systems, in industrial processes, in the tertiary and residential areas.

Objectives:

The course aims to provide students with the tools necessary to analyze the behavior and operating characteristics of hybrid propulsion systems of railway vehicles generally not connected to an electrical power supply network, with on-board generation of the electricity used for traction.
The most common scheme is the Diesel-Electric Propulsion. The basic notions of modern internal combustion diesel engines used in railway traction will be provided. We want to highlight the potential and limitations of this type of traction compared to the electric traction of rail vehicles connected to the network. We will focus in particular on the constructive characteristics of the engine, highlighting the performance and environmental impact aspects. Finally, some achievements currently on the market will be presented, as well as the most innovative solutions suitable for the ecological transition towards more sustainable rail mobility.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Written and oral examination

Course: Railway and Transit Services	**Teaching Language:** Italian
SSD (Subject Areas): CEAR-03/B (ex ICAR/05)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The contents are aimed at understanding the phenomena of mobility of people and goods; at knowing the performance of components and systems of transport systems; at configuring the best system from the technological, functional, economic, financial, territorial, environmental and safety perspectives, with reference also to logistics, management and operation of systems. They therefore concern the methods and techniques for simulating mobility demand, transport supply, supply/demand interaction, economic, territorial, environmental impacts and accident rates; tactical and strategic transport planning; the specific technologies of the different modes of transport, their regulation and control; the functional design of components, systems and complex transport systems; the management and operation of transport services.	
Objectives: The aim of the course is to provide students with general concepts relating to the simulation, design and management of railway and transit services. The different simulation techniques, design methodologies, regulatory aspects and contractual management tools for railway and transit systems will be presented.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Scienza dei Polimeri Polymer Science		**Teaching Language:** Italian
SSD (Subject Areas): IMAT-01/A (ex ING-IND/22)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area encompasses the totality of cultural and professional aspects related to the science and technology of materials. More specifically, it includes the skills related to structure and properties, design, production and transformation processes, use, analysis, characterization and quality control, corrosion and degradation, conservation, restoration and recycling of materials and their assemblies or combinations, having engineering, industrial and biomedical interest.		
Objectives: At the end of the course the student will have to demonstrate: (i) knowledge of polymeric materials being able to correlate their properties of engineering interest to the synthesis methodologies and their molecular structure; (ii) know the main techniques for characterizing polymeric materials and the information that can be deduced from them.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Written and oral examination		

Course: Sicurezza e manutenzione degli Impianti Industriali Industrial Plant Safety and Maintenance	**Teaching Language:** Italian
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Analysis and design of industrial plants, including feasibility studies, location selection and economic evaluation of the initiative; analysis and design of general plant services, including technical-economic optimization methods; analysis, ergonomic design and safety of production systems; management of production systems, including quality and maintenance management; logistics of industrial plants, including management and handling of materials; automation of production systems, including analysis of the economic feasibility of integrated and flexible systems and industrial instrumentation for automatic process control.	
Objectives: The course aims to develop the following skills: qualitative and numerical modelling of the production reality according to good Safety and Maintenance practices; use of simulation methods, to support the related decision-making choices and evaluate their economic and production impact, as well as consistency with legal requirements; structure a safety and maintenance plan according to WCM principles; evaluation of production costs in light of cost deployment criteria; implementation of an autonomous and professional maintenance plan.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination	

Course: Simulazione e modellazione dei processi per deformazione plastica Simulation and modeling of plastic deformation processes	**Teaching Language:** Italian
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
The transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, to assembly, to controls, to recycling; the mechanical and technological characterization of the transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of the processes, components and transformation systems (capital goods).

Objectives:
The teaching aims to provide tools and methods for the study of the processes for plastic deformation of metal materials (rolling, drawing, extrusion, molding, hydroforming, superplastic forming, etc) starting from the basic concepts such as the plastic deformation of metals linked to the movement of dislocations or the superplastic deformation mechanisms of some metals, up to the analytical relationships (theoretical, empirical or semi-empirical) for the choice of the process parameters for the different manufacturing technologies. The numerical simulation of the processes allows to obtain a tool for the analysis of the manufacturing processes where the analytical relationships fail to give reliable results.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Project discussion and oral examination

Course: Sistemi di Produzione Automatizzati Automated Production Systems	**Teaching Language:** Italian	
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**	

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
Analysis and design of industrial plants, including feasibility studies, location selection and economic evaluation of the initiative; analysis and design of general plant services, including technical-economic optimization methods; analysis, ergonomic design and safety of production systems; management of production systems, including quality and maintenance management; logistics of industrial plants, including management and handling of materials; automation of production systems, including analysis of the economic feasibility of integrated and flexible systems and industrial instrumentation for automatic process control.

Objectives:
The course aims to provide the student with specialistic methodologies for the design and management of automated production systems, as well as their techno-economical assessment.
The student will acquire technical competences for the design of automated production plants and automated storage and picking systems to be integrated with production lines. The theorical models presented in the course will be experimented in project works, also by means of software tools, to facilitate the acquisition of knowledge and competences by the student.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Written examination

Course: Sistemi Elettrici per le Fonti Rinnovabili Electrical Systems for Renewable Sources		**Teaching Language:** Italian
SSD (Subject Areas): IIND-08/B (ex ING-IND/33)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Study of systems of interconnected components that use energy-significant electrical vectors. Applications of production, transmission, distribution and use of electrical energy. Covered aspects of analysis, planning, design, implementation, management and control of the same systems.		
Objectives: The course aims to give students skills in the industrial sector of the electrical energy. The contents are aimed at acquiring the fundamental elements of power systems analyses and the design of electrical installations related to electricity production plants from renewable sources.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Oral examination		

Course: Smart Modeling of Industrial Production Systems	**Teaching Language:** English
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Analysis and design of industrial plants, including feasibility studies, location selection and economic evaluation of the initiative; analysis and design of general plant services, including technical-economic optimization methods; analysis, ergonomic design and safety of production systems; management of production systems, including quality and maintenance management; logistics of industrial plants, including management and handling of materials; automation of production systems, including analysis of the economic feasibility of integrated and flexible systems and industrial instrumentation for automatic process control.	
Objectives: The course will provide the student with fundamental knowledge for the development of agent-based, discrete-event and multi-method simulation models for industrial production systems in deterministic and stochastic domains. The main architectures of the smart factory and smart logistics models for material handling will be presented, with particular emphasis on Reference Models and Reference Architecture. By means of application examples, the student will acquire knowledge on the use of software tools for the integration of information coming from IoT sensors and PLC systems.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Smart Production Systems	**Teaching Language:** English
SSD (Subject Areas): IIND-05/A (ex ING-IND/17)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Analysis and design of industrial plants, including feasibility studies, location selection and economic evaluation of the initiative; analysis and design of general plant services, including technical-economic optimization methods; analysis, ergonomic design and safety of production systems; management of production systems, including quality and maintenance management; logistics of industrial plants, including management and handling of materials; automation of production systems, including analysis of the economic feasibility of integrated and flexible systems and industrial instrumentation for automatic process control.	
Objectives: Modern approaches and trends in industrial production are fusing Information Technology and Operation Technology to decentralise decision-making for more flexible, autonomous and adaptive systems. The course aims to provide students with the technical skills to understand and apply modern management and control techniques in industrial production through the innovation provided by the application of digital technologies to the manufacturing world.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Statistica per la Tecnologia Statistics for Technology		**Teaching Language:** Italian
SSD (Subject Areas): STAT-01/B (ex SECS-S/02)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area is characterized by a specific attention to modern statistical problems arising in the field of experimental sciences (statistics and probability calculation, design and analysis of experiments) and in particular in engineering (reliability, statistical quality control) and biomedical sciences (anthropometry, biometry, medical statistics). The main fields of application concern technology, safety, environment, territory, production processes, products, natural resources.		
Objectives: The course introduces the student to the fundamental notions of probability, data analysis and statistical inference and their engineering applications with particular interest to technological phenomena and statistical quality control.		
Propaedeuticities: **Is a propaedeuticity for:** Statistical Learning for Industrial Engineering		
Types of examinations and other tests: Written and/or oral examination		

Course: Statistical Learning for Industrial Engineering	**Teaching Language:** English
SSD (Subject Areas): STAT-01/B (ex SECS-S/02)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area is characterized by a specific attention to modern statistical problems arising in the field of experimental sciences (statistics and probability calculation, design and analysis of experiments) and in particular in engineering (reliability, statistical quality control) and biomedical sciences (anthropometry, biometry, medical statistics). The main fields of application concern technology, safety, environment, territory, production processes, products, natural resources.	
Objectives: Problem-based learning course whose aim is to train students on the application (illustrated through open-source statistical software environment R) of interpretable statistical learning techniques for industrial engineering, possibly scalable up to big data frameworks. Every student should choose a data analysis project gathered along the course by experts in industrial engineering fields and develop it by working in team. The industrial engineering experts may want to take part to initial, intermediate and final workshops, where student groups shall show their project work in progress. In this way, students will have the opportunity to improve the ability of recognizing and implementing the most suitable statistical learning technique to the problem at hand as well as of communicating relevant results and impact of their analysis also to non-statisticians.	
Propaedeuticities: Statistica per la Tecnologia [Statistics for Technology] **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Sustainable Metallurgy	**Teaching Language:** English
SSD (Subject Areas): IIND-03/C (ex ING-IND/21)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the fundamentals and the implementation of the manufacturing and transformation processes of metallic materials; the raw materials and the related treatments; the forming processes; the chemical, physical, technological properties of metals and alloys; the related study and control methods; the relationship between submicroscopic and microscopic structure and properties; the treatments aimed at modifying the aforementioned properties, the mechanisms of alteration/degradation of metallic materials and the related interventions; the treatments (mechanical, thermal, thermochemical, thermomechanical and others, involving mass and surface) of metallic materials in view of their use.	
Objectives: The course aims to provide the student with the main notions relating to the extraction and production processes of metal materials and artefacts, historically used, starting from the raw materials and up to the final product. Notions will be provided relating to the influence of the chemical composition and microstructure on the chemical-physical properties of materials. The problems inherent in the environmental impact determined by the use of historically consolidated production processes will therefore be presented, in terms of CO2 production, water consumption and strongly acidic or basic substances in the processing cycles, also taking into account their effects on workplace safety. The environmental impact of these processes will be compared to that exhibited by possible highly sustainable alternatives, such as: low CO2 emission primary synthesis, the improvement of the durability in service of metallic materials and alloys through corrosion protection and the development of high-performance alloys, the recycling of end-of-life materials with green processes, solvometallurgical processes for the recovery of precious metals from electrical and electronic waste. Finally, the benefits brought by the introduction of these innovations in production processes on workplace safety will be highlighted.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Tecnica della Saldatura e delle Giunzioni Welding and Jointing Technique	**Teaching Language:** Italian
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, assembly, control, recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods); the programming, management and control of processing, assembly, control, recycling systems; the management of quality and environmental protection in the perspective of sustainable development.	
Objectives: The course provides specialised knowledge for welding metal alloys with reference to the ability to choose the technological process, determine temperature ranges and thermal regimes, predict final crystal structures and control defectology. Aspects concerning automation techniques in welding are examined in depth. The specialised knowledge to define, realise and characterise adhesive joints is also provided.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination	

Course: Tecnica delle Costruzioni Ferroviarie Railway Construction Technique	**Teaching Language:** Italian
SSD (Subject Areas): IIND-03/A (ex ING-IND/14)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**

Teaching Methods:

In person

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

The subject area collects the skills related to the design, construction and testing of machines, structures and mechanical systems: principles and methodologies of mechanical design, from the construction elements of machines and the mechanical behaviour of materials to the reliability design of mechanical systems; numerical modelling, design and testing related to safety, producibility and maintainability; experimental methods of measurement and analysis of the state of deformation and tension, mechanics of materials subjected to typical operating stresses, tests on prototypes, testing and control in operation, structural diagnostics, non-destructive testing, construction of models; theory and technique of land vehicles, mechanical and systemic design and testing of railway vehicles.

Objectives:

The course is set downstream from Machine and Railway Construction and provides the student with the fundamentals of the methodologies for the design of the main components of railway superstructure and rolling stock. The introductory theoretical part is followed by an applied part during which the student has the opportunity to understand the problems faced in railway design and the different solutions to be adopted.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Project discussion and oral examination

Course: Tecnologia dei Polimeri Polymer Technology		**Teaching Language:** Italian
SSD (Subject Areas): IMAT-01/A (ex ING-IND/22)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area encompasses the totality of cultural and professional aspects related to the science and technology of materials. More specifically, it includes the skills related to structure and properties, design, production and transformation processes, use, analysis, characterization and quality control, corrosion and degradation, conservation, restoration and recycling of materials and their assemblies or combinations, having engineering, industrial and biomedical interest.		
Objectives: The course aims to provide the scientific and technological basis of the polymer processing technologies. Students will learn the features of various polymers, common polymer processing technologies (extrusion, injection molding, filming and foaming, among others) and the properties of polymeric materials relevant to polymer processing.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Oral examination		

Course: Tecnologie dei Materiali non Convenzionali Unconventional Materials Technologies	**Teaching Language:** Italian
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Transformation processes that involve manufactured products, made of traditional and innovative materials, and range from manufacturing, to assembly, to controls, to recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods).	
Objectives: The course aims to provide students with both an understanding of the potential and applications of the most innovative processing technologies in the most advanced engineering sectors, such as aerospace, mechanical and naval engineering, and the engineering tools needed to design production processes with these technologies. It also aims to train a professional figure capable of being able to deal adequately with the problems and aspects related to the field of innovative technologies.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written examination	

Course: Tecnologie elettriche per la mobilità Electric technologies for mobility	**Teaching Language:** Italian
SSD (Subject Areas): IIND-08/A (ex ING-IND/32)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**

Teaching Methods:

In person

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

Studies concerning electrical machines, electrical sensors and actuators, power electronic components and converters, electrical and electronic materials, electrical drives, electrical and electronic technologies, electromechanical constructions and electrical industrial applications, and which translate basic and applicative problems of energy conversions, with the aim of making it available in the form, measure and quality necessary for the various applications in industry, in rail, cableway and road transport, in civil buildings and in services, starting from traditional and renewable energy sources.

Objectives:

The course aim is to provide the student with the elements necessary for understanding the main configurations of the electric and hybrid power trains through the analysis of the operating principles of the related subsystems and the identification of the issues posed by their integration and management. The student will learn how to approach the design of a complex power train and how to define proper power management strategies.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:

Oral examination

Course: Tecnologie Speciali Special Technologies	**Teaching Language:** Italian
SSD (Subject Areas): IIND-04/A (ex ING-IND/16)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The study of transformation processes that affect manufactured products, made of traditional and innovative materials, and range from manufacturing, to assembly, to controls, to recycling; the mechanical and technological characterization of transformed materials and the connection of their properties with the parameters that govern the processes; the methodologies and tools for the design of processes, components and transformation systems (capital goods)	
Objectives: The objective of the course is to provide students with a comprehensive understanding of light and medium-light metal alloys of industrial interest and of the main non-conventional manufacturing processes for metallic materials. This will enable them to gain insight into the complex thermal, chemical and mechanical mechanisms involved in the transformation processes and to link these to the performance of the manufactured products. Furthermore, the mechanical mechanisms involved in the transformation processes are examined, and these are linked to the performance of the manufactured products. In addition, the tools for a critical and conscious choice of the most appropriate technological process for the production of parts are provided, with a view to balancing the economic, performance and technological aspects involved.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Trasmissione del Calore Heat Transfer	**Teaching Language:** Italian
SSD (Subject Areas): IIND-07/A (ex ING-IND/10)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies, in general, the fundamental and applicative aspects of technical physics, applied thermodynamics, applied thermofluid dynamics and heat transmission. More specifically, it includes the skills related to the thermodynamic analysis of energy processes and their environmental impact, energetics, energy conversion and use, renewable and non-renewable energy sources, energy management, thermoeconomics, heat transmission and applied thermofluid dynamics, thermotechnics and refrigeration technology, thermotechnical systems and thermal apparatus, thermophysical properties of materials, thermofluid dynamic measurements and regulations.	
Objectives: The course provides fundamentals and methods to study heat transfer. Course objectives consists in: teaching heat transfer fundamentals and laws to apply these to solve practical engineering problems, developing model necessary to study, analyze and design heat transfer devices, solving heat transfer problems by means of instruments and techniques typical of a wide technical education.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination and project discussion	

Course: Tribologia e Diagnostica dei Sistemi Meccanici Tribology and Diagnostics of Mechanical Systems	**Teaching Language:** Italian
SSD (Subject Areas): IIND-02/A (ex ING-IND/13)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Study of mechanical systems using the methodologies of theoretical mechanics. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is divided into modeling, simulation, regulation and control of the same; the synthesis is aimed at their functional design. Particular emphasis is given to the study of the vibratory and tribological phenomena of the machines.	
Objectives: The learning goal is to cover issues related to mechanical organ behavior, including mechanical organ size and lubrication. In addition, the course provides notions on monitoring and diagnostics of mechanical components using innovative techniques based on the application of the Wavelet Transform and Chaos Theory, and the study of complex systems.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

ANNEX 2.2

DEGREE PROGRAM DIDACTIC REGULATIONS

MECHANICAL ENGINEERING FOR DESIGN AND MANUFACTURING

CLASS LM-33

School: Polytechnic and Basic Sciences

Department: Industrial Engineering

Regulations in force since the academic year 2025-2026

Fill in for further training activities (art. 10, c. 5, letter d) included in the study plan

Training Activity: under Art. 10, c. 5, letter d	**Training Activity Language:** Italian, English

Content of the activities consistent with the training objectives of the course:
• Traineeship and internship, classified as:
  ○ Intramoenia
  ○ Extramoenia
• Other knowledges, among which:
  ○ Additional language skills
  ○ IT and telematics skills
  ○ Other knowledge useful for job placement
	CFU:
	• Internship: 9
	• Other knowledges: 3

Course year: I and II	**Type of Training Activity: F**
Teaching Methods: in-person and/or by distance teaching	
Objectives: Those activities have the objective of giving to the student the ability to communicate correctly (also in English) in the technical-scientific field, to use the relevant scientific literature profitably and to acquire new knowledge and methodologies (including IT) during the development of one professional activity. They therefore contribute to the achievement of linguistic, IT and professional training objectives for the world of work.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: • Internship:: aptitude • Other knowledges: aptitude	

ANNEX 3.1

DIDACTIC REGULATIONS OF THE MINOR

IN APPLIED MACHINE LEARNING

Regulations in force since the academic year 2024-2025

ACRONYMS

AF	[Attività Formative]	Training Activities
CCD	[Commissione di Coordinamento Didattico]	Didactic Coordination Commission
CdS/CCdSS	[Corso/i di Studio]	Degree Program
L	[Laurea]	Bachelor Degree
LM	[Laurea Magistrale]	Master's Degree
PM	[Percorso Minor]	Minor
RDA	[Regolamento Didattico di Ateneo]	University Didactic Regulations

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Art. 1
Object

1. These Didactic Regulations govern the organisational aspects of the Minor (PM) in Applied Machine Learning (pursuant to Art. 3.3 and Art. 18.1, 18.2 of the RDA)
2. The Minor in Applied Machine Learning is offered by the following Departments within the following Study Courses:

PROPOSING DEPARTMENTS	
DEPARTMENT OF CHEMICAL, MATERIALS AND PRODUCTION ENGINEERING	CdS in Industrial Bio-Engineering LM-21
	CdS in Chemical Engineering LM-22
DEPARTMENT OF ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY	CdS in Computer Science LM-18
	CdS in Telecommunications and Digital Media Engineering LM-27
	CdS in Computer Engineering LM-32
DEPARTMENT OF INDUSTRIAL ENGINEERING	CdS in Mechanical Engineering for Design and Production LM-33
DEPARTMENT OF CIVIL, BUILDING AND ENVIRONMENTAL ENGINEERING	CdS in Transportation Engineering and Mobility LM-23
DEPARTMENT OF CHEMICAL SCIENCES	CdS in Chemical Sciences LM-54

3. The PM in Applied Machine Learning is supported by a Coordination Committee, hereinafter referred to as the 'Committee', consisting of the Coordinators of the proposing Study Courses or their delegates.
4. The Committee performs the following functions:
   - coordinates training activities;
   - verifies and takes decisions on PM students (verification of applications, admission or disqualification from PM, allocation of training plans);
   - oversees the general teaching organisation of the PM, in close connection with the Departments and CCDs of the CCdSS with which the PM is associated;
   - carries out periodic monitoring and verification of results, submitting its assessments to the Departments and CCDs of the CCdSS with which the PM is associated, for the purpose of quality assurance of the CCdSS.
5. The members of the Committee designate among its members a Committee Coordinator, hereinafter referred to as the "PM Coordinator". The PM Coordinator is responsible for the functioning of the Committee and convenes its meetings.
6. The administrative management of the PM is entrusted to the PM Coordinator's department.
7. The Table of PM Training Activities is annexed to these Rules.

Art. 2
Knowledge and Skills of the Minor

Two innovations are radically revolutionising R&D approaches and programmes both in industry and in the world of research. On the one hand, instrumentation capable of generating large amounts of data is increasingly being used, such as High Throughput Experimentation in chemistry and materials science or the collection of high-frequency data using the latest generation of sensors in the process

industry or even in civil engineering. On the other hand, the rise of Artificial Intelligence tools and methods, with techniques such as Machine Learning or Deep Learning, makes it possible to develop predictive statistical modelling precisely from large databases.
Machine Learning methods are increasingly used in chemical and engineering applications to reduce development time and costs, and improve productivity, efficiency and quality. For example:
- Predictive maintenance uses machine learning algorithms to predict when a complex machine, artefact, work or service is likely to fail, on the one hand reducing unplanned downtime and maintenance costs, and on the other increasing the longevity of equipment and services;
- Quality control with machine vision tools to detect defects and anomalies in production lines enables timely interventions and improvements in the production process;
- Machine learning algorithms are used in process optimisation, analysing data from sensors to identify patterns and make changes online, but they also assist in the observation and automation of mobility;
- High Throughput Experimentation allows massive experiments - parallel or serial - capable of providing large experimental data sets, which are then analysed with artificial intelligence tools to arrive at a rapid selection of optimal process conditions.
Developments in the broad field of data science have generated artificial intelligence-based methodologies of great interest in the fields of engineering and applied sciences. The real implementability of these methodologies in these application domains is made possible by their hybridisation with modelling bases informed by specific chemical/physical/mechanical aspects.
These new methodological approaches promise a true technological revolution, and require new generations of engineers, scientists and technologists to be trained with multidisciplinary skills and mindsets that provide a structural interface between artificial intelligence-based methodologies and industrial and civil application domains. With this in mind, the Minors are establishing themselves - within the framework of the most modern university education at international level - as flexible paths of in-depth thematic study with an interdisciplinary character to complement professional training, to give space to specific interests or to make skills more attractive in the world of work.
The Minor Applied Machine Learning, developed in close collaboration with industry, is an interdisciplinary thematic track that aims to train students by providing them with basic and advanced skills in the use of typical artificial intelligence approaches in specific application domains.
The Minor Applied Machine Learning is aimed at students of Master's Degree Courses who want to give their studies a specific slant, and also at professionals already in the world of work who want to broaden their spectrum of skills in the field of artificial intelligence technologies as part of lifelong learning processes for professional qualification/retraining.
The Minor Applied Machine Learning intends to complete the training of a professional figure with solid knowledge of the use of Artificial Intelligence-based methodologies in the fields of chemistry and engineering, capable of qualified intervention to support the implementation of effective, safe, and sustainable solutions through the use of the most advanced analysis methodologies and enabling technologies.

Art. 3
Admission Requirements for Access to PM for Students Enrolled in a University Degree Course

1. Students enrolled in the CCdSS listed in the Table in Art. 1, section 2, in partial overlap with the studies of the Master's degree in which they are enrolled, may enrol in the Minor.

Art. 4
Requirements for Admission to the PM for Graduate Students or Students from other Universities

1. Access to the Minor is also open to students enrolled at other universities in degree courses in the same degree classes as the degree courses associated with the Minor (as per Article 1, paragraph 2) and students who have already graduated in the degree classes of the degree courses associated with the Minor (as per Article 1, paragraph 2) or equivalent regulations such as ex-Ministerial Decree 509/1999, or who hold degrees acquired abroad and recognised as equivalent for admission purposes by the Coordination Committee.
2. Admission of students who have already graduated or are enrolled at other universities is arranged subject to verification of the compatibility of their previous academic career with the PM's educational objectives.

Art. 5
Mode of Access to the Minor and Personale Preparations Pathway

1. In addition to what is specified in Articles 3 and 4, access to the Minor also requires compliance with specific criteria aimed at assessing the adequacy of the student's personal preparation.
2. For students enrolled in the CCdSS listed in the Table in Art. 1, paragraph 2, and for students enrolled at other Universities in CdS of the same degree classes as the CdS associated with the Minor, the verification of the possession of the requirements relating to the student's personal preparation shall be carried out by the Committee on the basis of the average M of the marks (in thirtieths) obtained in the profit examinations for the degree, weighted on the basis of the relative consistencies in ECTSs. The criterion for the student's automatic admission to the Master's degree courses is $M \geq 24$.
   In the case of applications for enrolment in the Minor from students who do not meet the criteria for automatic admission, the Committee may examine the curriculum followed by the interested party in order to assess their admission.
3. For students who enter the Minor as graduates, the Committee verifies that they meet the requirements for admission to the PM on the basis of their degree grade and/or curriculum vitae and assesses their admission.

Art. 6
Educational Activities and University Credits

1. The training activities envisaged by the PM correspond to 27 ECTS. These activities may be recognised within the career of students enrolled in a degree course at the University; in any case, at least 6 ECTSs must be reserved for extracurricular activities in addition to the ECTSs of the statutory plan for obtaining the degree (pursuant to Art. 18, c. 1 of the RDA).
2. Students enrolled in an LM among those listed in the Table in Art. 1, paragraph 2, when submitting the application for enrolment in the Minor, shall at the same time submit a study plan for the degree course in which they are enrolled that is consistent with the Minor course, also for the purpose of verifying the criterion regarding extra-curricular credits. The study plan must be approved by the competent CCD prior to the student's admission to the Minor and is considered active upon admission to the Minor.
3. The hours of assisted teaching for each ECTS are determined in relation to the type of training activity pursuant to Art. 6, c. 5 of the RDA.
4. The activities are divided into ~~4~~ teaching and training activities for the promotion of transversal skills, organised in three groups: Alignment courses shown in Table A that provide the basic

knowledge on Machine Learning technologies, Application courses shown in Table B that present the implementation of Machine Learning technologies in specific application domains, training activities for the promotion of transversal skills such as seminars, Soft Skills, Internships at qualified public or private institutions.

Table A			
Course of Studies	Selectable training activities	SSD	ECTS
CdS in Computer Science LM-18	Advanced Databases - Module: NoSql	INF/01	6
	Machine Learning - Module: Neural Networks and Deep Learning	INF/01	6
	Methods for Artificial Intelligence	INF/01	6
CdS in Telecommunications and Digital Media Engineering LM-27	Multimedia Signal Processing	ING-INF/03	9
	Image Processing for Computer Vision	ING-INF/03	6
CdS in Computer Engineering - L8	Databases	ING-INF/05	9
	Advanced Computer Programming	ING-INF/05	9
	Elements of Artificial Intelligence	ING-INF/05	6
CdS in Computer Engineering LM-32	Cognitive Computing Systems	ING-INF/05	6
CdS in Computer Science - L-31	Programming Laboratory	ING-INF/05	9
CdS in Mechanical Engineering for Design and Production LM-33	Machine Learning for Engineering	ING-INF/05	6
CdS in Autonomous Vehicle Engineering (MOVE) LM-33	Image and Video Processing for Autonomous Driving	ING-INF/03	6
CdS in Transportation Engineering And Mobility LM-23	Machine Learning and big data	ING-INF/05	9

Table B			
Course of Studies	Selectable training activities	SSD	ECTS
CdS in Chemical Engineering LM-22	Machine learning for Product and Process Engineering (Modular course)	ING-IND/25 ING-IND/26 ING-IND/27	6
CdS in Mechanical Engineering for Design and Production LM-33	Bio-inspired Generative Design for Additive Manufacturing	ING-IND/15	9
	Statistics for Technology	SECS-S/02	6
	Statistical Learning for Industrial Engineering	SECS-S/02	6
CdS in Chemical Sciences LM-54	Chemistry and Catalysis Technology	CHIM/03	6
	Computational Chemistry	CHIM/02	6
CdS in Transportation Engineering and Mobility LM23	Unmanned Aircraft Systems for Transportation and Mobility	ICAR/05 ING-IND/05	6

	Resilience of Transportation Systems	ICAR/05	6
	Structural Health Monitoring for Infrastructures	ICAR/09	9

5. Students enrolled in a LM from among those listed in the Table in Art. 1, paragraph 2, may integrate the PM into their Study Plan, incorporating the training activities of the Minor as specified below, and may use ECTSs of additional knowledge for the transversal activities of the Minor.
    a. PM students enrolled in LM-18, LM-27, LM-32 degree courses are required to select at least two courses from Tab. B and at least one course from Tab. A.
    b. PM students enrolled in LM-21, LM-22, LM-23, LM-33 and LM-54 degree courses are required to select at least two courses from Tab. A and at least one course from Tab. B.
6. The ECTSs corresponding to each learning activity are acquired by the student by satisfying the methods of profit verification (examination, suitability) indicated in the Schedule relating to the teaching/activity.
7. Students already in possession of an LM degree (or equivalent) or students enrolled at other universities are required to submit a study plan upon enrolment. The Committee verifies the consistency of the activities chosen by the student with his or her academic career, in order to avoid repeating training activities already undertaken and to check for any propedeuticity. In the case of students enrolled in degree courses at other universities, this check is repeated after the relevant degree has been awarded. The student must accept the study plan approved by the Committee. If the approved study plan is not adhered to, the student will not be able to obtain the PM completion certificate.
8. For the purposes of the Minor career, students (whether enrolled in a degree course or already graduated) may request the recognition of examinations envisaged in the Minor (or examinations equivalent to them) already taken, subject to the constraint that at least 6 ECTSs of the Minor must relate to extra-curricular activities in addition to those that concur or have concurred in the awarding of the degree. Under no circumstances may examinations already passed by students in their previous career be taken again for the purposes of completing the Minor.

Art. 7
Mode of delivery of teaching activities

1. The PM's teaching activities are carried out in the manner laid down by the relevant teaching bodies.
2. Detailed information on how each course is conducted can be found on the Course Sheets on the UniNA lecturers' website.

Art. 8
Period of Running and conclusion of the Minor

1. The Minor is obtained on completion of all the activities envisaged in the course and, for students entering the Minor as enrolled in a CdS, not before the achievement of the relevant degree. For students enrolled in a CdS, the Minor is completed on the attainment of the final degree, or subsequently within a time frame of normally no more than 1 year. For students who have already graduated, the Minor must be completed within an interval of normally no more than 2 years from admission.
2. At the conclusion of the PM the University issues a specific certification (pursuant to Art. 18, c. 1, of the RDA) also by means of an Open Badge. In the case of students enrolled in the CCdSS listed

in the Table in Art. 1, paragraph 2, the Open Badge will highlight the extracurricular credentials acquired.
3. The certificate attests that the student has successfully attended the activities envisaged by these PM in Applied Machine Learning regulations. It is accompanied by a grade corresponding to the average of the grades obtained in all the training activities envisaged by the PM.
4. For the purposes of PM certification, the competent CCD in relation to the student's degree class, having consulted the Committee, certifies the overall skills acquired.

Art. 9
Propaedeuticities and previous knowledge

1. The list of propaedeuticities can be deduced from the teaching schedules in the regulations of the relevant degree programmes.
2. Any prior knowledge deemed necessary for access to the activities envisaged by the PM is indicated in the individual Teaching Schedule published on the UniNA lecturers' website.

Art. 1 0
Minor Course Schedule

1. The PM's teaching calendar is made available on the website of each PM's proposing department and school, prior to the start of the activities.

Art. 11
Fees and Contributions for Access to the Minor

1. Students enrolled in one of the University's degree programmes who are admitted to the PM have access to the programme free of charge, or, if envisaged by the Board of Directors (BoD), by paying the University a contribution set annually by the BoD. All other students admitted to the PM pay the University a contribution set by the BoD.
2. Pursuant to Article 18.2 of the RDA, admission to the PM gives rise to a career distinct from that of the course of study to which they are enrolled.

Art. 12
Publicity and Entry into Force

1. The PM regulations are published on the websites of the CCdSS involved well in advance of the start of the training activities.

ANNEX 3.2

DIDACTIC REGULATIONS OF THE MINOR

IN APPLIED MACHINE LEARNING

COURSE SHEETS

School: Polytechnical of Basic Sciences

Department: Industrial Engineering

Didactic Regulations in force since the academic year 2024-2025

Course: Advanced Computer Programming	**Teaching Language:** Italian
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course:	
Objectives: The course aims to provide knowledge and skills in advanced programming in the concurrent and distributed fields, introducing the tools for programming and debugging multithreaded and networked applications in Java and Python, and providing the basis of the concept of middleware and the different solutions adopted in the industrial field, focusing mainly on the message-oriented model and the service model, with applications on real technologies. The course also introduces the tools for programming web applications, both front-end and back-end.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination and computer test	

Course: Advanced Databases – Modulo NoSql Advanced Databases – Module NoSql	**Teaching Language:** Italian	
SSD (Subject Areas): INFO-01/A (ex INF/01)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: The module is focused on DBMS adopting a data model which either extends the relational data model or adopt alternative data models. In particular, the module will discuss data definition and query languages for DBMS adopting the object model, object relational model, semi-structured model and the models following the recent NoSQL trend for databases: columnar DB, graph DB, document DB, key-value DB etc. The goal of the course is to allow the student to choose properly data models and DB technologies depending on the specific concrete needs of the problem under modelling and design.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Written examination (Open answer and numeric)		

Course: Basi di Dati Databases		**Teaching Language:** Italian
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: The course presents the main methodologies for the design of a relational database and the fundamental characteristics of the technologies and architectures of database systems. After this module, students should have acquired concepts related to data modeling in software systems, the characteristics of an information and computer system, the characteristics of a transactional system, the use of SQL (Structured Query Language) and SQL immersed in programming languages and the physical organization of a database system.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and written examination		

Course: Bio-Inspired Generative Design for Additive Manufacturing	**Teaching Language:** English
SSD (Subject Areas): IIND-03/B (ex ING-IND/15)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: B**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area studies the set of methods and tools to produce a technically valid project, in the field of industrial engineering. It is, therefore, the reasoned and innovative choice of technical solutions, which can be perfected through the systematic use of rational methods for the conception and optimization of machines; it is, therefore, a fundamental expression of technical creativity. Today this is implemented with the intensive help of computer tools; therefore, the concepts that govern the use of such means in industrial design are studied.	
Objectives: Taking advantage of the Additive Manufacturing processes which allow to manufacture ‘‘complex’’ geometries, in some cases unrealizable with other manufacturing processes, the course introduces to Bio-Inspired Generative Design (GD), a design method that mimics nature’s evolutionary approach to design. GD is used to design complex shapes and optimized forms in relationship to forces, cost, weight and other data that may influence the design. Starting from design goals and using machine learning algotithms, GD explores all of the possible permutations of a solution to find the best option. GD alghoritms cycle through thousand – or even millions – of design choices, testing configurations and learning from each iteration what works and what doesn’t. The process lets designers generate new options, beyond what a human alone could create, to arrive at the most effective design.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Chimica Computazionale Computational Chemistry	**Teaching Language:** Italian	
SSD (Subject Areas): CHEM-02/A (ex CHIM/02)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives:		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests:		

Course: Chimica e Tecnologia della Catalisi Chemistry and Technology of Catalysis		**Teaching Language:** Italian
SSD (Subject Areas): CHEM-03/A (ex CHIM/03)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: The course has two main objectives: 1) Provide the fundamentals of organometallic catalysis on surfaces, with special reference to nanostructured solids and supported systems on controlled-morphology glasses, and using as exemplifications two large-volume industrial processes (namely, Fischer-Tropsch and Ziegler-Natta catalysis); 2) Introduce the methods of High Throughput Experimentation integrated with instruments of Artificial Intelligence (e. g. Machine Learning, Deep Learning) for the rapid screening of organometallic catalyst formulations and optimization thereof by means of predictive statistical modeling.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Oral examination		

Course: Cognitive Computing Systems	**Teaching Language:** English	
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: The aim of the course is to provide the in-depth knowledge and skills needed to understand systems based on the cognitive computing paradigm. Cognitive computing is an emerging discipline that, by combining knowledge of cloud, Big Data, IOT, network connections, machine learning, natural language processing, AI, deep learning and knowledge representation, develops automatic systems that try to simulate the human thought process. Students will also have the opportunity to develop the specialized skills needed to develop cognitive applications that can interact with people and/or things (machines and/or other computers). The course will be accompanied by an exercise and application development activity in the laboratory.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and oral examination		

Course: Elaborazione di Segnali Multimediali Multimedia Signal Processing	**Teaching Language:** Italian	
SSD (Subject Areas): IINF-03/A (ex ING-INF/03)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: The aim of the course is to provide knowledge of the basic concepts and algorithms for digital image processing and to present the main techniques for encoding still images and video sequences, with particular attention to the most common standards. In addition to providing the mathematical and conceptual tools to analytically deal with these topics, the course aims to provide the knowledge necessary to develop the main image processing algorithms in Python.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Written and oral examination		

Course: Elementi di Intelligenza Artificiale Elements of Artificial Intelligence		**Teaching Language:** Italian
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: The course aims at providing the basic methodologies and techniques to understand and address issues related to Artificial Intelligence. Students will acquire the theoretical background related to intelligent agents, their interaction, problem-solving, search strategies and adversarial search. They will learn the methods and techniques in the domain of game theory, which include optimal, imperfect real-time decisions, games with random elements, and state-of-the-art of game programs. Students will acquire the basics of first-order logic, inference, and deduction, as well as they will master methods and techniques of logic programming with ProLog. They will be able to model uncertain knowledge and reasoning in order to act in uncertainty. Finally, the course will introduce basic concepts behind probabilistic reasoning and machine learning.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Project discussion and written and oral examination		

Course: Image and Video Processing for Autonomous Driving	**Teaching Language:** English
SSD (Subject Areas): IINF-03/A (ex ING-INF/03)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course:	
Objectives: The aim of the course is to provide students with basic notions and algorithms for processing digital images and videos, with special focus on autonomous driving vehicles. Beyond providing the mathematical and conceptual tools, the course aims to provide the knowledge needed to develop the main algorithms for image processing in Python.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written and oral examination	

Course: Image Processing for Computer Vision	**Teaching Language:** English
SSD (Subject Areas): IINF-03/A (ex ING-INF/03)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course:	
Objectives: The course aims to provide students with in-depth knowledge on the development and application of image processing techniques for the solution of typical computer vision problems, ranging from traditional signal processing methods, i.e. modeling-oriented, to modern approaches based on convolutional neural networks. Specific computer vision problems considered as training objectives of the course are the detection, characterization and matching of local features, the fitting and alignment of geometric models, image classification, semantic or instance segmentation of images, object detection, localization and recognition, pose estimation, depth estimation, stereo correspondence, 3D reconstruction from multiple views.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: The exam includes the presentation of a project carried out individually or in a group, with a related discussion, and a general interview on the contents of the course. The project is usually developed in itinere and presented at the end of the course in a closing workshop, while the interview can be held in any session of the current academic year without time constraints.	

Course: Laboratorio di Programmazione Programming Lab		**Teaching Language:** Italian
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)		**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: Provide the methodological, theoretical and practical skills of object-oriented, generic, concurrent and network programming, necessary for the correct development of small and medium-sized software projects using the C++ and Python programming languages.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Written and oral examination and computer test		

Course: Machine Learning - Modulo Neural Networks and Deep Learning Machine Learning - Module Neural Networks and Deep Learning		**Teaching Language:** Italian
SSD (Subject Areas): INFO-01/A (ex INF/01)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course:		
Objectives: The course aims to introduce the students to the main theoretical and applicative aspects regarding how to design and train feed forward and recurrent neural networks for tasks such as text classification and image recognition. This course, moreover, provides an introduction to deep neural network models, such as convolutional neural networks, and gives an overview of deep network architectures which have been particularly successful. The course also provides an introduction to the use of some of the software libraries available for building and training shallow and deep neural networks.		
Propaedeuticities: **Is a propaedeuticity for:**		
Types of examinations and other tests: Oral examination		

Course: Machine Learning and Big Data	**Teaching Language:** English
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Design, implementation, management and use of information processing systems, including aspects of databases, knowledge engineering and artificial intelligence.	
Objectives: The course aims to present the main machine learning techniques, covering all aspects, from data preparation to performance evaluation, through practical exercises with commercial and/or open-source tools. An introduction to Big Data and Data Analytics lifecycle is also provided, with reference to the design of large and complex databases and the process of modeling, acquiring, sharing, analyzing, and visualizing the information embedded into Big Data.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination and discussion of numerical exercises developed during the course.	

Course: Machine Learning for Engineering	**Teaching Language:** English
SSD (Subject Areas): IINF-05/A (ex ING-INF/05)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
The subject area is characterized by the set of scientific fields and scientific-disciplinary skills related to the design and implementation of information processing systems, as well as their management and use in various application contexts with engineering methodologies and techniques. This area includes the theoretical foundations, methods and technologies aimed at producing technically valid projects, from the point of view of both the adequacy of the proposed solutions and the possibility of technical implementation, as well as economic convenience and organizational effectiveness. These foundations, methods and technologies cover all aspects related to a processing system, from hardware to software, from operating systems to computer networks, from databases to information systems, from programming languages to software engineering, from human-machine interaction to signal and image recognition, multimedia processing, knowledge engineering, artificial intelligence and robotics. This subject area also includes skills relating to the design and construction of IT systems and various applications of processing systems, such as, for example, industrial telematics applications to socio-economic systems.

Objectives:
This course provides the students with the opportunity to develop a broad understanding of machine learning techniques and their application in various engineering fields, within the context of the data-driven Artificial Intelligence. After learning basics of machine learning, the attendees will learn the most diffused classical and advanced techniques for regression, classification, and clustering issues, together with some notions for feature engineering and ensemble learning. In addition, a practical overview of the most diffused deep learning architectures will be provided. Eventually, the attendees will learn how to use some tools and libraries for supporting machine learning applications, and thus they will be able to select the most appropriate machine learning models for the technical problem at hand and to solve it by exploiting the different computational tools.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Oral examination

Course: Machine Learning for Product and Process Engineering	**Teaching Language:** English
SSD (Subject Areas): ICHI-02/A (module 1), ICHI-01/C (module 2), ICHI-02/B (module 3)	**CREDITS:** 2 (module 1) + 2 (module 2) + 2 (module 3)
Course year: I or II	**Type of Educational Activity: D**

Teaching Methods:
In person

Contents extracted from the SSD declaratory consistent with the training objectives of the course:
Module 1: "study of methodologies for the construction of industrial plants based on chemical-physical transformations of matter aimed at the production of goods, the provision of services .... Plant design includes quantified process diagrams, the definition of the equipment constituting the process, the drafting of the related specifications, the development of functional diagrams including protection and control instrumentation, risk and environmental protection analysis, cost assessment."
Module 2: "the development and application of: mathematical methods for the analysis and computational modelling of process industry systems; optimization and life cycle analysis methods; statistical and probabilistic methods for data analysis and experimentation programming, including machine learning and artificial intelligence tools."
Module 3: "engineering of new processes (including biological ones), catalysts and products, as well as the refinement of existing ones, with particular reference to chemical reactions, separation and purification operations and the safety and environmental impact issues involved, as well as the optimal choice of catalysts, reactor, equipment and materials."

Objectives:
Module 1: Starting from a case study related to the design and/or operation of a chemical plant/process, module 1 intends to present some introductory elements on data science and data analytics techniques applied to process engineering, starting from the logic of building a typical experimental dataset (e.g. from the analysis of the P&ID). The module intends to show the potential of machine learning (ML), but above all to highlight the possibilities offered by the integration between analytical modeling (physical driven) and modeling based on ML approaches (data driven) in creating hybrid models for the design and management of process plants. To this end, the case study will be presented in a general way (to make it usable for an audience without basic knowledge in chemical engineering), described through the presentation of the equations that govern the process and analyzed starting from an experimental dataset that will provide the basis for the application of ML models and hybrid models of data analysis.
Module 2: Module 2 aims to provide a basic overview of machine/deep learning tools (e.g., neural networks) for the analysis and classification of images extracted from contexts related to the production of formulated liquids. Module 2 also aims to provide the elements necessary for the implementation of the above tools to case studies based on real industrial datasets.
Module 3: Module 3 aims to provide a basic overview of the Gaussian Processes tool for the estimation of unknown functions and their uncertainty in the presence of a limited number of experimental observations and their integration into closed-loop-optimization routines. Starting from this context, Module 3 also aims to provide the elements necessary for the application of the computational tools to real case studies in the field of optimization of chemical reactions and properties of formulated products.

Propaedeuticities:

Is a propaedeuticity for:

Types of examinations and other tests:
Project discussion

Course: Methods for Artificial Intelligence	**Teaching Language:** English
SSD (Subject Areas): INFO-01/A (ex INF/01)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course:	
Objectives: The objective of this course is to provide the students with a full and comprehensive knowledge of AI methods and techniques. We will introduce classic AI problems, as well as the models and the algorithms devised to address them. The course is divided in three main parts. In the first one, we will study algorithms for the resolution of informed search problems in state space, online search with/without the presence of an opponent, and constraint satisfiability problems. The second part will focus on the reasoning and decisional processes in the case of uncertainty. We will discuss ways to represent knowledge, including incomplete and uncertain knowledge of the real world. We will then focus on the logical reasoning over the acquired knowledge, using probabilities, and on using these reasoning methods and models to decide what to do. In the last part of the course, we will introduce distributed decision problems. Particularly, we will address game theory approaches for non-cooperative interaction decision problems, and the enforcement of such methods to concrete challenges.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Written (open answer and numeric) and oral examination	

Course: Resilience of Transportation Systems	**Teaching Language:** English
SSD (Subject Areas): CEAR-03/B (ex ICAR/05)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Analysis of the mobility phenomena of people and goods, knowledge of the performance of transport components and systems. Methods and techniques for the simulation of mobility demand, transport supply, supply/demand interaction. Analysis of the phenomena of the mobility of people and goods for the configuration of the best system from technological, functional, and other aspects.	
Objectives: The course deals with the resilience of transport infrastructures. Starting from local aspects due to service stress, ageing deterioration and rare catastrophic events, the effect on networks and broad areas is estimated/forecasted, including the social and economic impacts. The resilience of transportation networks is viewed from the point of view of both public authorities and operators of infrastructures.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination	

Course: Statistica per la Tecnologia Statistics for Technology		**Teaching Language:** Italian
SSD (Subject Areas): STAT-01/B (ex SECS-S/02)		**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**	
Teaching Methods: In person		
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area is characterized by a specific attention to modern statistical problems arising in the field of experimental sciences (statistics and probability calculation, design and analysis of experiments) and in particular in engineering (reliability, statistical quality control) and biomedical sciences (anthropometry, biometry, medical statistics). The main fields of application concern technology, safety, environment, territory, production processes, products, natural resources.		
Objectives: The course introduces the student to the fundamental notions of probability, data analysis and statistical inference and their engineering applications with particular interest to technological phenomena and statistical quality control.		
Propaedeuticities: **Is a propaedeuticity for:** Statistical Learning for Industrial Engineering		
Types of examinations and other tests: Written and/or oral examination		

Course: Statistical Learning for Industrial Engineering	**Teaching Language:** English
SSD (Subject Areas): STAT-01/B (ex SECS-S/02)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: C**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: The subject area is characterized by a specific attention to modern statistical problems arising in the field of experimental sciences (statistics and probability calculation, design and analysis of experiments) and in particular in engineering (reliability, statistical quality control) and biomedical sciences (anthropometry, biometry, medical statistics). The main fields of application concern technology, safety, environment, territory, production processes, products, natural resources.	
Objectives: Problem-based learning course whose aim is to train students on the application (illustrated through open-source statistical software environment R) of interpretable statistical learning techniques for industrial engineering, possibly scalable up to big data frameworks. Every student should choose a data analysis project gathered along the course by experts in industrial engineering fields and develop it by working in team. The industrial engineering experts may want to take part to initial, intermediate and final workshops, where student groups shall show their project work in progress. In this way, students will have the opportunity to improve the ability of recognizing and implementing the most suitable statistical learning technique to the problem at hand as well as of communicating relevant results and impact of their analysis also to non-statisticians.	
Propaedeuticities: Statistica per la Tecnologia [Statistics for Technology] **Is a propaedeuticity for:**	
Types of examinations and other tests: Project discussion and oral examination	

Course: Structural Health Monitoring for Infrastructures	**Teaching Language:** English
SSD (Subject Areas): CEAR-07/A (ex ICAR/09)	**CREDITS:** 9
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Theories and techniques addressing both the structural design and dimensioning of new constructions and the verification and structural rehabilitation of existing ones. It includes methods and tools for construction monitoring.	
Objectives: The course aims to provide general knowledge about the structural health monitoring of infrastructures with a particular focus on bridges. The fundaments of the static and dynamic behavior of bridges, made of various construction materials and static schemes, are necessary to understand the causes of damage and degradation that must be monitored during the structure's life.	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination, including the discussion of the exercises developed during the course.	

Course: Unmanned Aircraft Systems for transportation and mobility	**Teaching Language:** English
SSD (Subject Areas): IIND-01/E (ex ING-IND/05) + CEAR-03/B (ex ICAR/05)	**CREDITS:** 6
Course year: I or II	**Type of Educational Activity: D**
Teaching Methods: In person	
Contents extracted from the SSD declaratory consistent with the training objectives of the course: Analysis of the phenomena of the mobility of people and goods for the configuration of the best system from technological, functional, and other aspects. Technologies peculiar to the different modes of transport, their regulation and control.	
Objectives:	
Propaedeuticities: **Is a propaedeuticity for:**	
Types of examinations and other tests: Oral examination, including the discussion of the project works developed during the course.	