Polytechnic School
Department of Computer Science, Bioengineering, Robotics and Systems Engineering
Master's degree in Computer Engineering

Class LM-32
DEGREE REGULATION - General part

Cohort 2020-2022

Art. 1 Premise and area of competence

This Regulation, in accordance with the Statute and the University Degree Regulation (general part and special part), discipline the organisational aspects of the teaching activity of the Master's degree course in Computer Engineering, as well as any other subject devolved to it by other legislative and regulatory sources.
The Degree Regulation of the Master's degree course in Computer Engineering is resolved, pursuant to article 18, paragraphs 3 and 4 of the University Degree Regulation, general part, by the Degree Programme Board (DPB) of Computer Engineering to the majority of the members and submitted for the approval of the Board of the reference Department (and of Boards the possible associated Departments), after consultation with the Polytechnic School, with the prior favourable opinion of the Joint Committee of the School and the Department, if provided.
The resolutions of the DPB can also be taken in telematic mode according to the above-mentioned regulations and, in particular, of Article 14 "meetings with telematic mode" of the current General Regulation of the University (in force since 19/12/2018).

Art. 2 Admission requirements and procedures for verifying individual preparation

Admission to the Master's degree course in Computer Engineering is subject to the possession of specific curriculum requirements and adequate personal preparation.

With reference to the curriculum requirements, admission to the Master's Degree in Computer Engineering requires knowledge equivalent to that provided for by the general training objectives of the Information Engineering Class Degrees (Class L-8 of Ministerial Decree No. 270/2004 or equivalent degrees ex Interministerial Decree of 9 July 2009) and the Computer Science and Technology Class (Class L-31 of Ministerial Decree No. 270/2004 or equivalent degrees ex Interministerial Decree of 9 July 2009).
All the following curricular requirements will be requested, without exclusion:

- possession of a Degree or Master's Degree ex DM 270/2004 obtained at an Italian University (or equivalent degree ex Interministerial Decree 9 July 2009), or equivalent foreign qualifications.
- possession of at least 36 ECTS, or equivalent knowledge, acquired in any university course in the scientific-disciplinary fields indicated for the basic training activities provided for by Class L-8 Information Engineering Degrees and Class L-31 Degrees in Computer Science and Technology;
- possession of at least 45 ECTS, or equivalent knowledge, acquired in any university course in the scientific-disciplinary fields indicated for the basic training activities provided for by the L-8 Information Engineering Degrees and the L-31 Class Degrees in Computer Science and Technology.

Candidates holding the following Degrees awarded by the University of Genoa meet the curricular requirements:

- Electronic Engineering
- Telecommunications Engineering
- Electronic Engineering and Information Technology
- Computer Engineering
- Biomedical Engineering
- Informatics

In the case of degrees other than those indicated in these regulations, the DPB will verify the presence of the curricular requirements or equivalent knowledge, on the basis of the exams taken by the student in the Degree Course of origin, as well as the presence of any extracurricular exams, internship activities and work experience gained.

With reference to the assessment of individual preparation, it is immediately passed by all Italian students with a Bachelor's degree obtained in the above admitted classes with an assessment equal to or higher than 9/10 of the maximum mark provided for by their degree and all students who have obtained a Bachelor's degree in Genoa class L9 ex D.M. 509/99 with an assessment equal to or higher than 99/110, in the case of equivalent foreign qualifications with a final mark corresponding at least to the "A" classification of the ECTS system.

Students who are not immediately admitted must submit the following documentation in paragraphs a) and b) to the assessment of the Teaching Committee, which will determine the adequacy of their individual preparation career on the basis of the following criteria and scores established ex ante and made public on the Course website.

a) knowledge of the English language

Students must demonstrate sufficient knowledge of the English language to enable them to make proper use of the content provided in the course. This knowledge is immediately recognised to all those who have passed the initial knowledge test according to what express above, by those who exhibit a certificate attesting a level of knowledge of at least B2, by all Italian students who have obtained a first level qualification in which there was an English language exam or, in the case of foreign students, who have obtained it in a country that provides for the provision of English. Those who do not fall into the previous cases will have to face an individual interview in front of a special Committee that will assess their knowledge of the English language.

b) documentation for the verification of individual preparation

For all candidates:

- degree certificate including the list of exams taken (transcript of records) containing everyone's training objectives
- resume

For foreign candidates only:

- brief description of the University where the three-year degree was obtained
- possible certification of knowledge of the Italian language at B1 level. In the absence of such certification, the student will have to face an individual interview in front of a special Committee that will assess his/her knowledge of the Italian language.

On the basis of the documentation submitted by the candidates, the committee will assess the following:

- adequate knowledge of English and Italian (for foreign candidates) (admitted/not admitted)
- academic potential (average grades, class rank, GPA...: max. rating 50)
- relevance of the first level qualification (max evaluation 30)
- quality of the University that has awarded the first level degree (max. evaluation 20)
- other aspects of the Curriculum Vitae (other qualifications, work experience, professional qualifications, motivation letter, cover letter, etc.) (max. evaluation 10)

Students with a score of at least 85 will be admitted to the Master's Degree in Computer Engineering. The specific criteria for the determination of scores and the procedures are listed at the end of these regulations in Annex A.
The interview to verify the English and Italian language for foreign candidates will be held only for those who exceed the threshold of 85 in the score for eligibility.
In the general part of the Degree Regulation, which can be consulted on the website of the Degree Course, the required documentation and how to exhibit it are explained. The analysis of the qualifications will determine whether or not the enrolment is admissible. The result of the test only includes the words "passed", "not passed".
All foreign students with a qualification obtained abroad who do not have a certificate of knowledge of the Italian language will be subjected to a specific relative test. The failure of the test will not prevent enrolment, but will entail the need to support additional language skills dedicated to learning the Italian language during the course.

Art. 3 Training activities

The list of teaching units and other possible training activities, in the cohort 2020-2022, is given in the appropriate annex (Annex 1) which constitutes an integral part of this regulation. A responsible professor is identified for each teaching unit.
A professor is responsible for teaching whoever is in charge of teaching according to the law, i.e. the one to whom the relative Department Board has attributed the responsibility itself when assigning teaching tasks to professors.
The language used to provide training activities (lessons, exercises, workshops) shall be English.

Art. 4 Enrolment in individual training activities

In accordance with Article 6 of the University Regulations for students, in order enrol in individual training activities you must have a qualification which allows access to the university.

Art. 5 Curricula

The Master’s degree course in Computer Engineering is structured in four curricula:

- SOFTWARE PLATFORMS AND CYBERSECURITY
- ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING
- INDUSTRIAL INFORMATICS
- CYBER-PHYSICAL SYSTEMS

Art. 6 Total time commitment

The definition of the hourly fraction dedicated to lessons or equivalent teaching activities is established, for each teaching unit, by the DPB and specified in the special part of this regulation (Annex 1). In any case, we assume the following interval of variability between classroom hours/ ECTS: 8 ÷ 10 (understanding by “classroom hours” the hours of lesson or assisted teaching activity).

The definition of the assumed total time commitment, reserved for personal study or other training activities of an individual type, is established, for each teaching unit, in the annex (Annex 1) to this regulation.
The director of the Department of Computer Science, Bioengineering, Robotics and Systems Engineering (DIBRIS) and the coordinator of the DPB shall be responsible for verifying compliance with the above provisions, also for the purposes of the publication of course programmes.

Art. 7 Study plans and prerequisites

Students can enroll full-time or part-time; for the two types of student there are different rights and duties.
The student chooses the type of registration simultaneously with the presentation of the study plan.
The full-time student carries out his training activity considering the study plan prepared by the Master's degree course, which is distinguished by years of the course programme and published in the Degree Programme Table. The study plan formulated by the student must contain an indication of the training activities, with the relative credits that he intends to achieve, provided by the official study plan for this teaching period, up to a maximum of 65 credits provided in each year, except in cases of transfer from other universities which will be evaluated individually.
The part-time student is required to submit an individual study plan specifying the number of credits he intends to enter.
The enrolment of full-time and part-time students is regulated by the University Regulation for students considering the operational provisions resolved by the Central government bodies and indicated in the Student Guide (published annually and available at Guidance Service's Office, at Student Office of the Polytechnic School and on the University's website).
The educational path of the student can be bound by a system of propaedeuticity, indicated for each teaching unit in the special part of this Regulation (Annex 1). The Course of Study may, by express and reasoned resolution, authorise students who have demonstrated particularly high academic performance in the previous academic year to include in their study plan more than 65 credits.
"Particularly high performance" means that the student has passed all the exams of his/her study plan by the month of September.
The method and deadline for the presentation of the study plan are established annually by the Polytechnic School and reported in the Degree Programme Table.
In the absence of the completion of the study plan by the due date, a standard plan will be uploaded ex officio, except in cases where it is planned to complete an individual study plan (e.g. change of course of study, previous part-time individual study plan).

Art. 8 Attendance and methods of carrying out teaching activities

The courses may take the form of: (a) lectures, including distance learning by telematic means; (b) practical exercises; (c) laboratory exercises.
The articulated profile and the demanding nature of the lessons taught in the various Courses of Study offered make the attendance to the training activities strongly recommended for an adequate understanding of the topics and therefore for a good success in the exams.
The schedule of classes is divided into semesters. As a rule, the semester is divided into at least 12 weeks of lesson plus at least 4 weeks overall for verification tests and profit exams. The period for profit exams ends with the beginning of the lessons of the following semester.
In the middle of the semester, the normal teaching activity (lessons, exercises, laboratories) can be interrupted for the conduct of graduation exams, intermediate tests, seminars, tutoring activities and didactic activities of recovery.
The lesson schedule for the entire academic year is published on the Course of Study's website before the start of the lessons of the academic year.

The schedule of classes guarantees the possibility of attendance based on the years of the course programme provided for by the current Degree Programme Table of the Degree Course. For practical reasons, the compatibility of the timetable for all formally possible optional teaching choices is not guaranteed. Students must then formulate their study plan taking into account the time of the lessons.

Art. 9 Examinations and other profit exams

Profit exams can be carried out in written, oral, or written and oral, according to the methods indicated in the sheets of each teaching unit published on the website of the Master's degree course. On request, specific learning verification arrangements may be provided which take into account the needs of disabled students and students with specific learning disorders (D. S. A.), in accordance with art. 29 paragraph 4 of the University Degree Regulation.

In the case of teaching units structured in modules with several professors, they participate collegially in the overall evaluation of the student's profit which cannot, however, be split into separate evaluations on the individual modules.

The calendar of profit exams is established by September 30th for the following academic year and is published on the website of the Master's degree course. The calendar of any intermediate verification tests is established by the DPB and communicated to the students at the beginning of each teaching cycle.

Examinations are held in periods of interruption of classes. Examinations may be planned during the period of the classes only for students who, in the current academic year, have not included training activities in their study plan.

All profit examinations of training activities must be passed by the student at least twenty days before the expected date for taking the graduation exam.

The result of the examination, with the vote obtained, is verbalized in accordance with art. 29 of the University Degree Regulation.

Art. 10 Recognition of credits

The Degree Programme Board decides on the approval of applications for change or transfer from another degree course of the university or other universities in accordance with the rules provided for in the University Degree Regulation, art. 21. It also decides the recognition, as training credits and as activity of choice, for a maximum number of 12 ECTS, of professional knowledge and skills certified in accordance with the current legislation.

The evaluation of applications for change will take into account the didactic specificities and the actuality of the educational content of the individual exams taken, reserving to establish from time to time any forms of verification and supplementary exams.

Within the framework of the national and regional legislation on alternance education/work, it is possible for the course of study to provide, for selected students, learning paths that also take into account work experience carried out at companies under contract.

Art. 11 Mobility, studies abroad, international exchanges

Students enrolled in the Master's Degree in Computer Engineering are offered the opportunity to apply for the dual degree courses affiliated with the Degree Course and in particular the course with the University of Technology in Compiègne, the course with the Polytechnic of Barcelona and the course with the Polytechnic of Tirana.

The DPB strongly encourages internationalisation activities, in particular student participation in mobility and international exchange programmes. For this purpose, it shall ensure, in accordance with the rules in force, the recognition of the training credits obtained within these programmes and shall organise the training activities as appropriate in such a way as to make these activities easier and effective.

The DPB recognizes enrolled students, who have regularly completed a period of study abroad, the exams taken off-site and the achievement of the related credits with which the student intends to replace the exams of his own study plan.
For the purposes of the recognition of these examinations, the student at the time of the compilation of the plan of training activities, he intends to follow at the University abroad, must produce suitable documentation proving the equivalence of content between the teaching unit abroad and the teaching unit that intends to replace taught in the Master's degree course in Engineering for Natural Risk Management. Equivalence shall be evaluated by the DPB.
The conversion of marks will take place according to criteria approved by the DPB, in accordance with the European ECTS system.
In addition, as stated in Art. 11, the certification of the training activities carried out abroad for a period of not less than 100 hours, will lead to a better final evaluation through a higher minimum increase assigned at the end of the final examination.

Art. 12 Procedures for the final examination

The final examination consists in the discussion of a written thesis, aimed at ascertaining the candidate's technical-scientific and professional preparation.
For the purposes of obtaining a Master's Degree, the final examination consists of the writing of a theoretical, experimental or applicative thesis, elaborated by the student in an original way under the guidance of one or more supervisors, on subjects defined as relevant to a discipline for which the candidate has passed the exam; the thesis must in any case be coherent with the arguments discussed during the Master's degree.
The supervisors must include at least one lecturer from the Polytechnic School and/or the reference or associate Department.
The thesis must be carried out in English.
The thesis must reveal the student's ability to deal with research and/or application issues. The thesis must consist of a project and/or the development of an application that proposes innovative solutions with respect to the state of the art.
The thesis must also reveal:

- adequate preparation in the disciplines characterising the Master's Degree;
- adequate engineering preparation;
- correct use of sources and bibliography;
- systematic and argumentative skills;
- clarity in the exposition;
- design and experimental skills;
- critical skills.

The Committee for the final examination is composed of at least five members, the majority of whom must be tenured professors and researchers and it is appointed by the Director of the DIBRIS Department or by the delegated coordinator of the Course of Study.
The procedure for the final examination consists of the oral presentation of the thesis by the student to the Final Examination Committee, followed by a discussion of any questions raised by the members of the Committee.

1) The Committee, in the final evaluation for the purposes of awarding the qualification, attributes an increase, varying from 0 to a maximum of 6, established by the Polytechnic School in agreement with the Departments and reported in the Degree Programme Table, to the weighted and in one hundred and tenths normalised average of the marks reported in the verification tests relating to training activities that require a final grade, taking as weight the number of credits associated with the individual training activity.

2) If the student has carried out training activities abroad (in relation to the thesis or other activities) for at least the equivalent of 100 hours of commitment (certified by the responsible person(s) of any foreign institution), the minimum increase will be increased to 2 points.
3) The Committee, without prejudice to the maximum final grade of one hundred and ten, may award “Cum Laude” the student who, on the basis of the increases referred to in the previous paragraphs, has a score equal to or greater than one hundred and eleven, before any rounding up.
4) Furthermore, the "dignity of printing" may be conferred by the Committee if voted unanimously and if the scientific value of the thesis has been certified by at least one publication in an international journal/conference that provides for the peer-review of the full paper and officially accepted before the time of discussion.

Art. 13 Guidance services and tutoring

The Polytechnic School, in agreement with the DIBRIS Department, organizes and manages a tutoring service for the welcome and support of students, in order to prevent dispersion and delay in studies and to promote a profitable active participation in university life in all its forms.
The DPB identifies within it a number of tutors in proportion to the number of students enrolled. The names of the tutors can be found on the website of the Master’s degree course.

Art. 14 Verification of obsolescence of credits

Credits acquired within the framework of the Master’s degree course are valid for 6 years. After the indicated period, the credits must be validated by special resolution if the DPB recognises the non-obsolescence of the related educational contents. If the DPB recognizes the obsolescence of even a single part of the relative educational content, the DPB itself establishes the supplementary tests that must be taken by the student, defining the topic and the methods of verification.

Once the required tests have been passed, the DPB validates the credits acquired with a resolution. If the related training activity provides for a vote, it may be varied from the one previously obtained, on a proposal from the Examination Committee which carried out the verification.

Art. 15 Degree Programme Table

The DIBRIS Department, after consulting the School, publishes annually the Degree Programme Table. In the Degree Programme Table are indicated the main provisions of the didactic system and the Degree Regulation of the Master’s degree course, to which additional information may be added. The Degree Programme Table of the Master’s degree course contains the list of the teaching units activated for the academic year in question. The individual teaching sheets are published on the website of the degree course.

ANNEX A. CRITERIA FOR THE EVALUATION OF THE DOCUMENTATION SUBMITTED FOR ADMISSION
THE MASTER'S DEGREE IN COMPUTER ENGINEERING
Cohort 2020-22

According to Art. 2 of the Degree Regulation, candidates must submit the following documents:

FOR ALL CANDIDATES:

- degree certificate including the list of examinations taken (Transcript of records) containing the training objectives of each one
- documentation to verify knowledge of the English language in accordance with the Regulation. In the absence of such certification the student will have to face an individual interview in front of a special Committee that will assess his/her knowledge of the English language
- curriculum vitae

FOR FOREIGN CANDIDATES ONLY:

- brief description of the University where the three-year degree was obtained
- certification of knowledge of the Italian language at B1 level according to the Regulation. In the absence of this certification, the student will have to face an individual interview in front of a special Committee that will assess his/her knowledge of the Italian language.

CAREER ASPECTS ASSESSED FOR ADMISSION TO THE COURSE - ADMISSION THRESHOLD: 85/110 POINTS:

1. adequate knowledge of English language (admitted/not admitted)
2. academic potential (average of grades, class rank, GPA...: max evaluation 50)
3. relevance of the first level qualification (max evaluation 30)
4. quality of the University that has awarded the first level degree (max evaluation 20)
5. other aspects of the Curriculum Vitae (other qualifications, work experience, professional qualifications, etc.) (max. evaluation 10)

In order to be admitted to the Course of Study, the qualifications will first be evaluated according to the criteria specified below. Eligibility is achieved with a minimum score of 85. Only those who pass this score will be tested (if necessary) for knowledge of languages. The interview calendar will be published on the website of the Course of Study.

The following rules will be applied when assessing the documentation submitted by candidates:

1. KNOWLEDGE OF ENGLISH LANGUAGE (ADMITTED/NOT ADMITTED)

i. A student who has a language certification of at least B2 will be assessed as eligible and admitted.
ii. A student who has completed their first level studies in English, or who has obtained a first level qualification in which an English exam was present, will be assessed as eligible and admitted.
iii. A student without any certification will be interviewed by the Committee and, if assessed as sufficient, will be admitted.

2. ACADEMIC POTENTIAL (MAX. 50):

The score for academic potential will be awarded according to the following table

Graduation grade in 110th	GPA minimum base 4	GPA minimum base 5	Academic potential score
109-110 (e lode)	3.73-4	4.67-5	**50/50**
98-108	3.33-3.72	4.17-4.62	**45/50**
87-97	3.07-3.32	4-4.16	**40/50**
66-86	< 3.07	<4	**35/50**

3 - RELEVANCE OF THE QUALIFICATION (MAX. 30):

Score	Type of Degree
30	30 COMPUTER ENGINEERING - COMPUTER SCIENCE ELECTRONIC ENGINEERING, BIOMEDICAL ENGINEERING, TELECOMMUNICATION ENGINEERING or other titles (including foreign titles) with at least 45% ECTS in computer science, automatic, mathematical, physics content.
20	Titles (including foreign ones) with between 40% and 44% ECTS in computer, automatic, mathematical, physics content
15	Other titles (including foreign ones) with between 30% and 39% ECTS in computer, automatic, mathematical, physics content

4. RANKING OF THE UNIVERSITY WHERE THE FIRST LEVEL QUALIFICATION WAS OBTAINED (MAX. 20):

Since in Italy the legal value of the title is foreseen, the score of the Italian universities will be according to the international rankings:

http://www.shanghairanking.com/
http://www.webometrics.info/en

For non-Italian universities:
20 if the institute is among the top 500 in the international ranking,
15 if the institute is between 501 - and 1000,
12 if the institute is between 1001-1500,
10 if the institute is between 1501-2000,
9 if the institute is between 2001-2500,
0 over 2500 or absent from the ranking of both previous sites

5. OTHER ASPECTS OF CURRICULUM VITAE (other qualifications, work experience, professional qualifications, motivation letter, cover letter, etc.) (MAX.10):

The standard score in the presence of a correctly filled in CV letter is 5. The score will be increased if the candidate has had some particular professional experience e.g. language skills, additional qualifications, certified professional qualifications, etc.

This Degree Regulation was approved by resolution of the Board of the Master's degree course in Computer Engineering on 20th March 2020 and followings changes in the DPB of 19th June 2020.

Annex 1 to the Degree Regulation of the Master's degree course in Computer Engineering
List of possible training activities and related training objectives

Curriculum	Year of course programme	Teaching unit's code	Teaching unit in Italian	Teaching unit in English	ECTS (credits)	SSD (disciplinary-scientific area)	Type	Area	Language	Prerequisites	Training objectives	Hours reserved for assisted teaching activities	Hours reserved for personal study
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	61884	ADVANCED DATA MANAGEMENT	ADVANCED DATA MANAGEMENT	6	INF/01	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Related or supplementary learning activity	English		Students will be provided with a sound grounding on theoretical, methodological, and technological fundamentals concerning data management for advanced data processing architectures, with a specific reference to large-scale distributed environments. Students will learn key elements of NoSQL and stream-based systems as well as basic issues in parallel and distributed query processing, multi-query processing, and high-throughput transactional systems. Students will be involved in project activities.	56	94
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	80154	SOFTWARE ENGINEERING	SOFTWARE ENGINEERING	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Software Engineering is a discipline that rules every aspect of the software development process. In other word is the application of Engineering to the Software. It is concerned with requirement specification, design, models, writing documentation and also writing unit tests, not just coding. Moreover it also provide metrics to quantify the quality of the product, i.e. the software developed. Software Development Templates, Requirement Analysis, UML Modeling Systems, Design Patterns, Verification and Validation, Time Template Specification Languages, Temporary Property Verification Algorithms, Modeling and Case Resolution using Model Checkers "	72	153
CYBER-PHYSICAL SYSTEMS	1	80154	SOFTWARE ENGINEERING	SOFTWARE ENGINEERING	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Software Engineering is a discipline that rules every aspect of the software development process. In other word is the application of Engineering to the Software. It is concerned with requirement specification, design, models, writing documentation and also writing unit tests, not just coding. Moreover it also provide metrics to quantify the quality of the product, i.e. the software developed. Software Development Templates, Requirement Analysis, UML Modeling Systems, Design Patterns, Verification and Validation, Time Template Specification Languages, Temporary Property Verification Algorithms, Modeling and Case Resolution using Model Checkers "	72	153
INDUSTRIAL INFORMATICS	1	80154	SOFTWARE ENGINEERING	SOFTWARE ENGINEERING	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Software Engineering is a discipline that rules every aspect of the software development process. In other word is the application of Engineering to the Software. It is concerned with requirement specification, design, models, writing documentation and also writing unit tests, not just	72	153

											coding. Moreover it also provide metrics to quantify the quality of the product, i.e. the software developed. Software Development Templates, Requirement Analysis, UML Modeling Systems, Design Patterns, Verification and Validation, Time Template Specification Languages, Temporary Property Verification Algorithms, Modeling and Case Resolution using Model Checkers "		
SOFTWARE PLATFORMS AND CYBERSECURITY	1	80154	SOFTWARE ENGINEERING	SOFTWARE ENGINEERING	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Software Engineering is a discipline that rules every aspect of the software development process. In other word is the application of Engineering to the Software. It is concerned with requirement specification, design, models, writing documentation and also writing unit tests, not just coding. Moreover it also provide metrics to quantify the quality of the product, i.e. the software developed. Software Development Templates, Requirement Analysis, UML Modeling Systems, Design Patterns, Verification and Validation, Time Template Specification Languages, Temporary Property Verification Algorithms, Modeling and Case Resolution using Model Checkers "	72	153
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	80155	OPERATIONS RESEARCH	OPERATIONS RESEARCH	9	MAT/09	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Related or supplementary learning activity	English		The Course introduces to optimization models and methods for the solution of decision problems. It is structured in the main topics of problem modelling, computational tractability, and solution by means of algorithms that can be implemented on a computer. Several applications are considered and various case studies are detailed. The target of the Course consists in making the students acquire the expertise to face decision problems by means of models and methods that can operate in the presence of limited resources. The students will be taught to: understanding and modelling a decision process in terms of an optimization problem by defining the decision variables, the cost function to be minimized (or the figure of merit to be maximized), and the constraints; framing the obtained problem within the range of the reference optimization problems (linear/nonlinear, discrete/continuous, deterministic/stochastic, static/dynamic, etc); achieving the matching between the corresponding solving algorithm and a suitable software.	72	153
CYBER-PHYSICAL SYSTEMS	1	80155	OPERATIONS RESEARCH	OPERATIONS RESEARCH	9	MAT/09	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Related or supplementary learning activity	English		The Course introduces to optimization models and methods for the solution of decision problems. It is structured in the main topics of problem modelling, computational tractability, and solution by means of algorithms that can be implemented on a computer. Several applications are considered and various case studies are detailed. The target of the Course consists in making the students acquire the expertise to face decision problems by means of models and methods that can operate in the presence of limited resources. The students will be taught to: understanding and modelling a decision process in terms of an optimization problem by defining the decision variables, the cost function to be minimized (or the figure of merit to be maximized), and the constraints; framing the	72	153

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SOFTWARE PLATFORMS AND CYBERSECURITY	1	80155	OPERATIONS RESEARCH	OPERATIONS RESEARCH	9	MAT/09	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Related or supplementary learning activity	English		The Course introduces to optimization models and methods for the solution of decision problems. It is structured in the main topics of problem modelling, computational tractability, and solution by means of algorithms that can be implemented on a computer. Several applications are considered and various case studies are detailed. The target of the Course consists in making the students acquire the expertise to face decision problems by means of models and methods that can operate in the presence of limited resources. The students will be taught to: understanding and modelling a decision process in terms of an optimization problem by defining the decision variables, the cost function to be minimized (or the figure of merit to be maximized), and the constraints; framing the obtained problem within the range of the reference optimization problems (linear/nonlinear, discrete/continuous, deterministic/stochastic, static/dynamic, etc); achieving the matching between the corresponding solving algorithm and a suitable software.	72	153
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	80156	COMPUTER SECURITY	COMPUTER SECURITY	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		1. Introduction 2. Introduction to Cryptography 3. Symmetric Cryptography 4. Public-Key Cryptography 5. Message Authentication and Digital Signatures 6. Public Key Infrastructure (PKI) 7. Authentication Protocols 8. Internet Security 9. Secure Programming 10. Network Security 11. Web Security 12. Malware 13. Access Control	72	153

CYBER-PHYSICAL SYSTEMS	1	80156	COMPUTER SECURITY	COMPUTER SECURITY	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		1. Introduction 2. Introduction to Cryptography 3. Symmetric Cryptography 4. Public-Key Cryptography 5. Message Authentication and Digital Signatures 6. Public Key Infrastructure (PKI) 7. Authentication Protocols 8. Internet Security 9. Secure Programming 10. Network Security 11. Web Security 12. Malware 13. Access Control	72	153
INDUSTRIAL INFORMATICS	1	80156	COMPUTER SECURITY	COMPUTER SECURITY	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		1. Introduction 2. Introduction to Cryptography 3. Symmetric Cryptography 4. Public-Key Cryptography 5. Message Authentication and Digital Signatures 6. Public Key Infrastructure (PKI) 7. Authentication Protocols 8. Internet Security 9. Secure Programming 10. Network Security 11. Web Security 12. Malware 13. Access Control	72	153
SOFTWARE PLATFORMS AND CYBERSECURITY	1	80156	COMPUTER SECURITY	COMPUTER SECURITY	9	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		1. Introduction 2. Introduction to Cryptography 3. Symmetric Cryptography 4. Public-Key Cryptography 5. Message Authentication and Digital Signatures 6. Public Key Infrastructure (PKI) 7. Authentication Protocols 8. Internet Security 9. Secure Programming 10. Network Security 11. Web Security 12. Malware 13. Access Control	72	153
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	80158	HUMAN COMPUTER INTERACTION	HUMAN COMPUTER INTERACTION	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The course provides the student with the methodology, the theory, and the techniques for the design of interactive products to support the way people communicate and interact in their everyday and working lives. This relies on the mastery of the development process for the understanding of the capabilities and desires of people and on the kinds of technology available to interaction designers, together with a knowledge of how to identify requirements and develop them into a suitable design. The course will cover standard techniques as well as an introduction to advanced topics, including sound and music computing (as a complementary component of visual and haptic interfaces), and emotional and social interfaces. A coursework devoted to the realization of the development process of a concrete interaction design project of an interactive product will be implemented during the whole semester, in a simulated working environment typical of Startups. Further, students will learn to design and manage motion capture sessions using the Qualisys industry standard motion capture system available at Casa Paganini-InfoMus. Finally, students will learn techniques to present their results, including elevator pitches and reporting to stakeholders.	48	102
CYBER-PHYSICAL SYSTEMS	1	80158	HUMAN COMPUTER INTERACTION	HUMAN COMPUTER INTERACTION	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The course provides the student with the methodology, the theory, and the techniques for the design of interactive products to support the way people communicate and interact in their everyday and working lives. This relies on the mastery of the development process for the understanding of the capabilities and desires of people and on the kinds of	48	102

											technology available to interaction designers, together with a knowledge of how to identify requirements and develop them into a suitable design. The course will cover standard techniques as well as an introduction to advanced topics, including sound and music computing (as a complementary component of visual and haptic interfaces), and emotional and social interfaces. A coursework devoted to the realization of the development process of a concrete interaction design project of an interactive product will be implemented during the whole semester, in a simulated working environment typical of Startups. Further, students will learn to design and manage motion capture sessions using the Qualisys industry standard motion capture system available at Casa Paganini-InfoMus. Finally, students will learn techniques to present their results, including elevator pitches and reporting to stakeholders.		
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	80165	ARTIFICIAL INTELLIGENCE	ARTIFICIAL INTELLIGENCE	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The goal of the course is to introduce students to topics in Artificial Intelligence, mostly on the “deductive” side of the discipline. Students will learn basics in propositional and first order logic and apply them in the context of knowledge representation and reasoning. Also the basic principles of heuristic search and planning in the context of full observability and deterministic action effects will be added on top of the basic capabilities for representation and reasoning.	50	100
SOFTWARE PLATFORMS AND CYBERSECURITY	1	80165	ARTIFICIAL INTELLIGENCE	ARTIFICIAL INTELLIGENCE	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The goal of the course is to introduce students to topics in Artificial Intelligence, mostly on the “deductive” side of the discipline. Students will learn basics in propositional and first order logic and apply them in the context of knowledge representation and reasoning. Also the basic principles of heuristic search and planning in the context of full observability and deterministic action effects will be added on top of the basic capabilities for representation and reasoning.	50	100
CYBER-PHYSICAL SYSTEMS	1	80169	REAL-TIME OPERATING SYSTEMS	REAL-TIME OPERATING SYSTEMS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		By attending the course, the student will learn how to deal with issues concerning real-time applications and real-time operative systems, real-time design and programming, embedded system.	48	102
INDUSTRIAL INFORMATICS	1	80172	METHODS AND MODELS FOR DECISION SUPPORT	METHODS AND MODELS FOR DECISION SUPPORT	6	MAT/09	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Related or supplementary learning activity	English		Model and solve complex decision problems, in particular considering applications to manufacturing production planning and scheduling, and logistics. Network flow models and algorithms with application to planning problems. Models for combinatorial optimization problems, in particular mixed integer programming (MIP) models, heuristic and metaheuristic methods. MIP models as well as heuristics and metaheuristics approach are applied to scheduling and vehicle routing problems (VRP). Multi-criteria decision problems, in particular fundamental concepts and approaches for multi-objective optimization problems.	48	102

CYBER-PHYSICAL SYSTEMS	1	80186	SYSTEM IDENTIFICATIO N	SYSTEM IDENTIFICATIO N	6	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The goal of the course is to provide methodologies and tools for designing systems' models to be used for control, estimation, diagnosis, prediction, etc. Different identification methods are considered, both in a "black box" context (where the structure of the system is unknown), as well as in a "grey box" (uncertainty on parameters) one. Methods are provided for choosing the complexity of the models, for determining the values of their parameters, and to validate them. Moreover, state estimation problems are addressed and their connections with control and identification are considered.	48	102
INDUSTRIAL INFORMATICS	1	86794	TRANSACTION AL SYSTEMS & DATA WAREHOUSE	TRANSACTION AL SYSTEMS & DATA WAREHOUSE	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The first part of the course will focus on architectural aspects of transactional systems, query processing, transaction management and recovery. The second part will deal with the issues of data warehouse design, data mining and knowledge discovery techniques .The student will be able to apply the acquired skills in : Query processing Transaction management and recovery. Conceptual data warehouse project Fact and Snowflake models Logical data warehouse project Architecture of a Data Mart. Data mining and knowledge discovery techniques Frequent Pattern Analisys Classification techniques Decision tree and Bayesian Classifiers	48	102
SOFTWARE PLATFORMS AND CYBERSECURI TY	1	86794	TRANSACTION AL SYSTEMS & DATA WAREHOUSE	TRANSACTION AL SYSTEMS & DATA WAREHOUSE	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The first part of the course will focus on architectural aspects of transactional systems, query processing, transaction management and recovery. The second part will deal with the issues of data warehouse design, data mining and knowledge discovery techniques .The student will be able to apply the acquired skills in : Query processing Transaction management and recovery. Conceptual data warehouse project Fact and Snowflake models Logical data warehouse project Architecture of a Data Mart. Data mining and knowledge discovery techniques Frequent Pattern Analisys Classification techniques Decision tree and Bayesian Classifiers	52	98
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	86795	INDUSTRIAL AUTOMATION	INDUSTRIAL AUTOMATION	9	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims at providing the modeling and methodological tools for the formalization and resolution of some important decision-making and management problems in the context of industrial systems. During the course, planning, scheduling and control problems will be formalized and solved according to the framework proposed by the ANSI/ISA-95 international standard. Special focus will be devoted to the primary and support functions given by the Manufacturing Execution System (MES). At the end of the course, the student will be able to position an industrial automation problem in the context of ANSI/ISA-95 and to formalize and to	72	153

											solve decision-making problems, using proper methods and tools.		
CYBER-PHYSICAL SYSTEMS	1	86795	INDUSTRIAL AUTOMATION	INDUSTRIAL AUTOMATION	9	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims at providing the modeling and methodological tools for the formalization and resolution of some important decision-making and management problems in the context of industrial systems. During the course, planning, scheduling and control problems will be formalized and solved according to the framework proposed by the ANSI/ISA-95 international standard. Special focus will be devoted to the primary and support functions given by the Manufacturing Execution System (MES). At the end of the course, the student will be able to position an industrial automation problem in the context of ANSI/ISA-95 and to formalize and to solve decision-making problems, using proper methods and tools.	72	153
INDUSTRIAL INFORMATICS	1	86795	INDUSTRIAL AUTOMATION	INDUSTRIAL AUTOMATION	9	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims at providing the modeling and methodological tools for the formalization and resolution of some important decision-making and management problems in the context of industrial systems. During the course, planning, scheduling and control problems will be formalized and solved according to the framework proposed by the ANSI/ISA-95 international standard. Special focus will be devoted to the primary and support functions given by the Manufacturing Execution System (MES). At the end of the course, the student will be able to position an industrial automation problem in the context of ANSI/ISA-95 and to formalize and to solve decision-making problems, using proper methods and tools.	72	153
SOFTWARE PLATFORMS AND CYBERSECURITY	1	86795	INDUSTRIAL AUTOMATION	INDUSTRIAL AUTOMATION	9	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims at providing the modeling and methodological tools for the formalization and resolution of some important decision-making and management problems in the context of industrial systems. During the course, planning, scheduling and control problems will be formalized and solved according to the framework proposed by the ANSI/ISA-95 international standard. Special focus will be devoted to the primary and support functions given by the Manufacturing Execution System (MES). At the end of the course, the student will be able to position an industrial automation problem in the context of ANSI/ISA-95 and to formalize and to solve decision-making problems, using proper methods and tools.	72	153
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	86798	MACHINE LEARNING AND DATA ANALYSIS	MACHINE LEARNING AND DATA ANALYSIS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Students will be provided with advanced skills related to data analysis. Students will learn insights on data mining methodologies and specific applications of these methodologies to particular data organization.	48	102
INDUSTRIAL INFORMATICS	1	86798	MACHINE LEARNING AND DATA ANALYSIS	MACHINE LEARNING AND DATA ANALYSIS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Students will be provided with advanced skills related to data analysis. Students will learn insights on data mining methodologies and specific applications of these methodologies to particular data organization.	48	102
SOFTWARE PLATFORMS AND	1	86798	MACHINE LEARNING AND	MACHINE LEARNING AND	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Students will be provided with advanced skills related to data analysis. Students will learn insights on data mining methodologies and specific	48	102

CYBERSECURITY			DATA ANALYSIS	DATA ANALYSIS							applications of these methodologies to particular data organization.		
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	1	90529	DATA VISUALIZATION	DATA VISUALIZATION	6	INF/01	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Related or supplementary learning activity	English		Learning principles, methods, and techniques for effective visual analysis of data, including techniques for visualizing both spatial and non-spatial data, principles from computer graphics and human perception.	40	110
SOFTWARE PLATFORMS AND CYBERSECURITY	1	90538	DATA PROTECTION & PRIVACY	DATA PROTECTION & PRIVACY	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Students will learn key elements in data protection and privacy: data privacy and anonymity, metrics and techniques; macro and microdata protection; data protection in outsourcing scenarios; privacy on the web; advanced access control. Students will be involved in project activities.	48	102
CYBER-PHYSICAL SYSTEMS	1	98436	CONTROL OF CYBER-PHYSICAL SYSTEMS	CONTROL OF CYBER-PHYSICAL SYSTEMS	6	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The goal of the course is to introduce the students to the problems related to the analysis, design and implementation of discrete time control systems for cyberphysical systems (CPS). Control of CPS arise in many different application domains including: process control, manufacturing machine control, robotics, automotive systems, aircraft control systems, critical infrastructure control (e.g. electric grid control, water resources control etc.) etc.	48	102
SOFTWARE PLATFORMS AND CYBERSECURITY	1	98459	INTERNET INFRASTRUCTURE AND DATA CENTER TECHNOLOGY	INTERNET INFRASTRUCTURE AND DATA CENTER TECHNOLOGY	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims to provide the student of an overall understanding of the architecture of the Internet, starting from its original setup, arriving to its complex and articulated organization of nowadays, and providing also the tools for understanding the dynamics of its continuous evolution. The structure of the Internet Governance is briefly depicted, with the goal of understanding which forces have to be balanced in order to drive the technological, economic and social evolution of the global network. The basic concepts of Distributed Systems and Cloud Computing will be briefly recapped (the student must have a sound knowledge of the principles from previous courses). The course will explore in depth mainly the industrial and economic aspects of CC, with special reference to the evolution of Information and Communication Technologies (ICT) since year 2000. Finally, the course aims to provide basic knowledge of the complex ICT infrastructures, describing the various logical modules of a Data Center, with special emphasis to energy efficiency and environmental impact.	48	102
INDUSTRIAL INFORMATICS	1	98460	SOFTWARE PLATFORMS	SOFTWARE PLATFORMS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Software Platforms is a fundamental module in the software development path. The development of complex software systems does not only require proficency in programming but also the knowledge of advanced models, paradigms and tools. Software Platforms describes the models, the paradigms and the tools which support Web Applications, Web Services and Microservices, and introduces the evolution toward serverless computing.	52	98
SOFTWARE PLATFORMS AND CYBERSECURITY	1	98460	SOFTWARE PLATFORMS	SOFTWARE PLATFORMS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		Software Platforms is a fundamental module in the software development path. The development of complex software systems does not only require proficency in programming but also the knowledge of advanced models, paradigms and tools. Software Platforms describes the models, the paradigms and	48	102

											the tools which support Web Applications, Web Services and Microservices, and introduces the evolution toward serverless computing.		
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	80164	MULTIMODAL SYSTEMS	MULTIMODAL SYSTEMS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		This course provides students with foundational conceptual knowledge, methodologies, and tools for designing, implementing, and evaluating computer systems that can capture, represent, and automatically analyze the behavior of their users (e.g., in terms of gesture, movement, facial expressions, speech) and interact with them by generating multisensory feedback (e.g., images, sounds, control of actuators) in real-time.	48	102
INDUSTRIAL INFORMATICS	2	80167	PRODUCTION SYSTEMS	PRODUCTION SYSTEMS	6	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		Under the title 'Production Systems' one can place very many different problems. This course is related with the decomposition of a planning and control problem of a production systems in different subproblems. For any of the subproblems after a analysis process, a set of solving technques will be considered. Such solving techniques have to be integrated in possible solution of the 'main' production problem.	48	102
SOFTWARE PLATFORMS AND CYBERSECURITY	2	80169	REAL-TIME OPERATING SYSTEMS	REAL-TIME OPERATING SYSTEMS	6	ING-INF/05	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		By attending the course, the student will learn how to deal with issues concerning real-time applications and real-time operative systems, real-time design and programming, embedded system.	48	102
SOFTWARE PLATFORMS AND CYBERSECURITY	2	80170	CONCURRENT AND DISTRIBUTED PROGRAMMING	CONCURRENT AND DISTRIBUTED PROGRAMMING	6	ING-INF/05	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		The goals of this course are: 1) Acquire familiarity with cornerstone problems in concurrent and distributed programming; 2) Acquire familiarity with the tools provided by Java 2 Standard Edition (J2SE) to tackle those problems and their practical use.	48	102
CYBER-PHYSICAL SYSTEMS	2	80171	TECHNOLOGIES FOR WIRELESS NETWORKS	TECHNOLOGIES FOR WIRELESS NETWORKS	6	ING-INF/03	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		The course aims to provide a framework for all major network technologies that use wireless (wireless) transmissions, considering application areas and architectures both from a structural and protocollary point of view. More specifically, the main objective is to provide knowledge and insight on the following topics: i) Introduction to architectures with the classification of wireless networks in mobile cellular systems, technologies for wireless local area networks (LAN) and Personal-Sensor-Body Area Networks (PAN, SAN, and BAN). ii) The cellular mobile radio networks from the second generation (2G-GSM) and evolutions (GPRS and EDGE), to the third generation (3G-UMTS) and the fourth (4G, LTE) for ending with the current 5G technology. iii) The standard for IEEE802.11 (Wi-Fi) WLAN networks, described in all its evolutions starting from version 11b up to version 11ax. iv) Personal communications through the Bluetooth standard, including the latest variants like Bluetooth low-power. The result of learning is to give the student, oriented to a specific field of Engineering, the ability to understand the different technologies of wireless networks and make effective design choices for their effective use.	48	102

INDUSTRIAL INFORMATICS	2	80171	TECHNOLOGIES FOR WIRELESS NETWORKS	TECHNOLOGIES FOR WIRELESS NETWORKS	6	ING-INF/03	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		The course aims to provide a framework for all major network technologies that use wireless (wireless) transmissions, considering application areas and architectures both from a structural and protocollary point of view. More specifically, the main objective is to provide knowledge and insight on the following topics: i) Introduction to architectures with the classification of wireless networks in mobile cellular systems, technologies for wireless local area networks (LAN) and Personal-Sensor-Body Area Networks (PAN, SAN, and BAN). ii) The cellular mobile radio networks from the second generation (2G-GSM) and evolutions (GPRS and EDGE), to the third generation (3G-UMTS) and the fourth (4G, LTE) for ending with the current 5G technology. iii) The standard for IEEE802.11 (Wi-Fi) WLAN networks, described in all its evolutions starting from version 11b up to version 11ax. iv) Personal communications through the Bluetooth standard, including the latest variants like Bluetooth low-power. The result of learning is to give the student, oriented to a specific field of Engineering, the ability to understand the different technologies of wireless networks and make effective design choices for their effective use.	48	102
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	80190	EMBEDDED SYSTEMS	EMBEDDED SYSTEMS	6	ING-INF/04	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		What is an embedded system and what are its main characteristics. Introduction to the basic hardware needed for the realization of an embedded system. Architectures of processing systems. Specific architectures for embedded systems. Specific tools for developing code for embedded systems. Programming embedded systems. Communication protocols. Scheduling	48	102
CYBER-PHYSICAL SYSTEMS	2	80190	EMBEDDED SYSTEMS	EMBEDDED SYSTEMS	6	ING-INF/04	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		What is an embedded system and what are its main characteristics. Introduction to the basic hardware needed for the realization of an embedded system. Architectures of processing systems. Specific architectures for embedded systems. Specific tools for developing code for embedded systems. Programming embedded systems. Communication protocols. Scheduling	48	102
INDUSTRIAL INFORMATICS	2	80268	OPTIMISATION AND CONTROL OF LOGISTICS SYSTEMS	OPTIMISATION AND CONTROL OF LOGISTICS SYSTEMS	6	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims to present general issues and provide basic knowledge about the theory and technologies for optimizing and controlling logistic systems. The learning outcomes of the course are the following, always with reference to planning/organizing logistic networks: - identification of the decisional class to which a specific problem belongs; - definition of the most appropriate modelling method for the problem statement - definition of the most adequate solution	48	102

											methodology for the problem - identification of a software solution for the problem - definition and discussion of the problem relevance and effects on the overall system planning.		
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	80269	FORMAL LANGUAGES AND COMPILERS	FORMAL LANGUAGES AND COMPILERS	6	ING-INF/05	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		The course objective is to provide the tools, both formal and practical, for the definition of programming languages and their translators and provide application design skills and interoperable web systems in compliance with international standards. The course aims to provide a necessary preparation to the formation of the profiles of the Information Engineers skills that are emerging at national and European level.	48	102
SOFTWARE PLATFORMS AND CYBERSECURITY	2	80269	FORMAL LANGUAGES AND COMPILERS	FORMAL LANGUAGES AND COMPILERS	6	ING-INF/05	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		The course objective is to provide the tools, both formal and practical, for the definition of programming languages and their translators and provide application design skills and interoperable web systems in compliance with international standards. The course aims to provide a necessary preparation to the formation of the profiles of the Information Engineers skills that are emerging at national and European level.	48	102
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	80394	MASTER THESIS	MASTER THESIS	27		FINAL EXAMINATION	Final examination	English			0	675
CYBER-PHYSICAL SYSTEMS	2	80394	MASTER THESIS	MASTER THESIS	27		FINAL EXAMINATION	Final examination	English			0	675
INDUSTRIAL INFORMATICS	2	80394	MASTER THESIS	MASTER THESIS	27		FINAL EXAMINATION	Final examination	English			0	675
SOFTWARE PLATFORMS AND CYBERSECURITY	2	80394	MASTER THESIS	MASTER THESIS	27		FINAL EXAMINATION	Final examination	English			0	675
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	80459	SEMANTIC WEB TECHNOLOGIES: INNOVATION AND SMART APPLICATIONS	SEMANTIC WEB TECHNOLOGIES: INNOVATION AND SMART APPLICATIONS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		In this course, you will learn the fundamentals of Semantic Web technologies. You will learn how to collect information form linked data and metadata to represent knowledge an build knowledge bases, and how to access and benefit from semantic web technologies applied to smart applications in a H2020 perspective.	48	102
CYBER-PHYSICAL SYSTEMS	2	80551	TECHNOLOGIES FOR INDUSTRIAL AUTOMATION	TECHNOLOGIES FOR INDUSTRIAL AUTOMATION	6	ING-INF/07	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Attività Formative Related or supplementary learning activity	English		The course describes the technologies and the solutions used for the Industrial Automation. The main items of the course are: different environment for IA (factory, continuous process, technological networks, building automation), instrumentation and actuators, Intelligent Field Devices, fieldbus, architectures for IA, Industry 4.0 (Smart Manufacturing).	48	102
INDUSTRIAL INFORMATICS	2	80551	TECHNOLOGIES FOR INDUSTRIAL AUTOMATION	TECHNOLOGIES FOR INDUSTRIAL AUTOMATION	6	ING-INF/07	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Attività Formative Related or supplementary learning activity	English		The course describes the technologies and the solutions used for the Industrial Automation. The main items of the course are: different environment for IA (factory, continuous process, technological networks, building automation), instrumentation and actuators, Intelligent Field Devices, fieldbus, architectures for IA, Industry 4.0 (Smart Manufacturing).	48	102

SOFTWARE PLATFORMS AND CYBERSECURITY	2	80551	TECHNOLOGIES FOR INDUSTRIAL AUTOMATION	TECHNOLOGIES FOR INDUSTRIAL AUTOMATION	6	ING-INF/07	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		The course describes the technologies and the solutions used for the Industrial Automation. The main items of the course are: different environment for IA (factory, continuous process, technological networks, building automation), instrumentation and actuators, Intelligent Field Devices, fieldbus, architectures for IA, Industry 4.0 (Smart Manufacturing).	48	102
CYBER-PHYSICAL SYSTEMS	2	86798	MACHINE LEARNING AND DATA ANALYSIS	MACHINE LEARNING AND DATA ANALYSIS	6	ING-INF/05	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		Students will be provided with advanced skills related to data analysis. Students will learn insights on data mining methodologies and specific applications of these methodologies to particular data organization.	48	102
SOFTWARE PLATFORMS AND CYBERSECURITY	2	86799	DISTRIBUTED SYSTEMS	DISTRIBUTED SYSTEMS	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims to provide an understanding of the principles on which the Internet and other distributed systems are based; their architecture, algorithms and design; and how they meet the demands of contemporary distributed applications. 1. Distributed systems characterization 2. Coordination of distributed systems Physical and logical clock synchronization Distributed mutual exclusion Election algorithms and protocols 3. Consistency of distributed systems Data centric systems Client centric systems Consistency protocols 4. Resilience of distributed systems Distributed process pooling and resilience Reliable distributed communication services Distributed operation commit Recovery of faulty systems 5. Case studies Hyperledger permissioned blockchains Google distributed storage and computation In memory Distributed Data Store Office online collaboration platforms	48	102
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	86800	VIRTUALIZATION AND CLOUD COMPUTING	VIRTUALIZATION AND CLOUD COMPUTING	6	ING-INF/05	ELECTIVE LEARNING ACTIVITY	Student's elective learning activity	English		The course provides the foundations of the main virtualization technologies at the state of the art. In detail, the course focuses on several types of virtualization, like Storage-level, OS-level, Application-level, and Enterprise-level virtualization. The course is mostly practical, with the aim to teach the student how to deal with current virtualization technologies to build actual virtualized architectures.	48	102
SOFTWARE PLATFORMS AND CYBERSECURITY	2	86800	VIRTUALIZATION AND CLOUD COMPUTING	VIRTUALIZATION AND CLOUD COMPUTING	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The course provides the foundations of the main virtualization technologies at the state of the art. In detail, the course focuses on several types of virtualization, like Storage-level, OS-level, Application-level, and Enterprise-level virtualization. The course is mostly practical, with the aim to teach the student how to deal with current virtualization technologies to build actual virtualized architectures.	48	102

ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	94977	LINGUA ENGLISH 2	ENGLISH LANGUAGE 2	3		OTHER ACTIVITY	Other language knowledge	English		Provide a level of knowledge and understanding of the English language equivalent to the B2.1 level of the European framework. At the end of the course the student will be able to: - understand the key topics of a complex text on both concrete and abstract topics, including technical discussions; - express themselves with a certain fluency and spontaneity, interacting with native speakers effortlessly for both parties; - produce a clear and detailed text on a wide range of topics and express an opinion on a topical issue, indicating the advantages and disadvantages of the different options.	30	45
CYBER-PHYSICAL SYSTEMS	2	94977	LINGUA ENGLISH 2	ENGLISH LANGUAGE 2	3		OTHER ACTIVITY	Other language knowledge	English		Provide a level of knowledge and understanding of the English language equivalent to the B2.1 level of the European framework. At the end of the course the student will be able to: - understand the key topics of a complex text on both concrete and abstract topics, including technical discussions; - express themselves with a certain fluency and spontaneity, interacting with native speakers effortlessly for both parties; - produce a clear and detailed text on a wide range of topics and express an opinion on a topical issue, indicating the advantages and disadvantages of the different options.	30	45
INDUSTRIAL INFORMATICS	2	94977	LINGUA ENGLISH 2	ENGLISH LANGUAGE 2	3		OTHER ACTIVITY	Other language knowledge	English		Provide a level of knowledge and understanding of the English language equivalent to the B2.1 level of the European framework. At the end of the course the student will be able to: - understand the key topics of a complex text on both concrete and abstract topics, including technical discussions; - express themselves with a certain fluency and spontaneity, interacting with native speakers effortlessly for both parties; - produce a clear and detailed text on a wide range of topics and express an opinion on a topical issue, indicating the advantages and disadvantages of the different options.	30	45
SOFTWARE PLATFORMS AND CYBERSECURITY	2	94977	LINGUA ENGLISH 2	ENGLISH LANGUAGE 2	3		OTHER ACTIVITY	Other language knowledge	English		Provide a level of knowledge and understanding of the English language equivalent to the B2.1 level of the European framework. At the end of the course the student will be able to: - understand the key topics of a complex text on both concrete and abstract topics, including technical discussions; - express themselves with a certain fluency and spontaneity, interacting with native speakers effortlessly for both parties; - produce a clear and detailed text on a wide range of topics and express an opinion on a topical issue, indicating the advantages and disadvantages of the different options.	24	51
CYBER-PHYSICAL SYSTEMS	2	98457	COOPERATIVE ROBOTICS	COOPERATIVE ROBOTICS	6	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The course presents modern task-priority based control approaches to complex robotic systems. A general framework capable of controlling robotic structures ranging from fixed-base arms to dual arm mobile manipulators is discussed. The same framework is extended to cooperative anipulation by multiple agents in a distributed way.	48	102

CYBER-PHYSICAL SYSTEMS	2	98458	SMART SYSTEMS CONTROL AND APPLICATIONS	SMART SYSTEMS CONTROL AND APPLICATIONS	6	ING-INF/04	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims at providing modeling and methodological approaches to sensing, actuation, and control in order to describe and analyze a system, and make decisions based on the available data in a distributed, predictive and/or adaptive manner, thereby performing “smart actions”. The student will approach such smart systems by studying proper models and methods in different applicative contexts, such as smart power grids, connected autonomous vehicles and platooning, energy efficient buildings, distributed logistics, and environmental monitoring.	48	102
INDUSTRIAL INFORMATICS	2	98458	SMART SYSTEMS CONTROL AND APPLICATIONS	SMART SYSTEMS CONTROL AND APPLICATIONS	6	ING-INF/04	ELECTIVE LEARNING ACTIVITY	Student’s elective learning activity	English		The course aims at providing modeling and methodological approaches to sensing, actuation, and control in order to describe and analyze a system, and make decisions based on the available data in a distributed, predictive and/or adaptive manner, thereby performing “smart actions”. The student will approach such smart systems by studying proper models and methods in different applicative contexts, such as smart power grids, connected autonomous vehicles and platooning, energy efficient buildings, distributed logistics, and environmental monitoring.	48	102
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	98463	ADVANCED ARTIFICIAL INTELLIGENCE	ADVANCED ARTIFICIAL INTELLIGENCE	6	ING-INF/05	CORE LEARNING ACTIVITY	Computer science engineering	English		The course aims at studying the methodology at the interface between inductive and deductive reasoning techniques, and their integration to cope with real-world applications.	48	102
SOFTWARE PLATFORMS AND CYBERSECURITY	2	98683	BINARY ANALYSIS AND SECURE CODING	BINARY ANALYSIS AND SECURE CODING	6	INF/01	RELATED OR SUPPLEMENTARY LEARNING ACTIVITY	Attività Formative Related or supplementary learning activity	English		Being able to write secure code, analyze the behavior and assess security properties of source and binary programs, pinpointing and fix their vulnerabilities or apply corrective counter-measures.	56	94
INDUSTRIAL INFORMATICS	2	100051	SISTEMI ERP	ERP SYSTEMS	6	INF/01	ELECTIVE LEARNING ACTIVITY	Student’s elective learning activity	Italian		Acquisire i concetti fondanti di un’architettura di un sistema di Enterprise Resource Planning e maturare esperienza diretta in un ambiente di sviluppo molto diffuso presso l'impresa.	48	102
ARTIFICIAL INTELLIGENCE AND HUMAN-CENTERED COMPUTING	2	100276	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	3		OTHER ACTIVITY	Other language knowledge	Italian			0	0
CYBER-PHYSICAL SYSTEMS	2	100276	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	3		OTHER ACTIVITY	Other language knowledge	Italian			0	0
INDUSTRIAL INFORMATICS	2	100276	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	3		OTHER ACTIVITY	Other language knowledge	Italian			0	0
SOFTWARE PLATFORMS AND CYBERSECURITY	2	100276	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	ITALIAN LANGUAGE FOR FOREIGN STUDENTS (2 LEVEL)	3		OTHER ACTIVITY	Other language knowledge	Italian			0	0