

## INTRODUCTION

The purpose of the Diploma Supplement is to provide sufficient independent data to improve the international '*transparency*' and fair academic and professional recognition of qualifications (diplomas, degrees, certificates etc.). It is designed to provide a description of the nature, level, context, content and status of the studies that were pursued and successfully completed by the individual named on the original qualification to which this supplement is appended. It is free from any value judgements, equivalence statements or suggestions about recognition. This Diploma Supplement model was developed by the European Commission, Council of Europe and UNESCO.

### 1 INFORMATION IDENTIFYING THE HOLDER OF THE QUALIFICATION

#### 1.1 Last name(s)

SCARLATTI

#### 1.2 First name(s)

TOMMASO

#### 1.3 Date of birth (dd/mm/yyyy)

30/04/1995

#### 1.4 Student identification number or code (if available)

897651

### 2 INFORMATION IDENTIFYING THE QUALIFICATION

#### 2.1 Name of the qualification and title conferred (in the original language)

Laurea magistrale in COMPUTER SCIENCE AND ENGINEERING  
Dottore magistrale

#### 2.2 Main field(s) of study for the qualification

Computer systems engineering (LM-32)  
ISCED code: 0688

#### 2.3 Name (in original language) and status of the awarding institution

Politecnico di Milano (Istituzione statale), Piazza Leonardo da Vinci 32, 20133 Milano

#### 2.4 Name and status of institution (if different from 2.3) administering studies (in original language)

Same as in 2.3

#### 2.5 Language(s) of instruction/examination

English

**3**
**INFORMATION ON THE LEVEL AND DURATION OF THE QUALIFICATION**
**3.1**
**Level of qualification**

Second Cycle QF-EHEA - Level 7 EQF

**3.2**
**Official duration of the programme in credits and/or years**

120 CFU/ECTS - 2 full time years

**3.3**
**Access requirement(s)**

First cycle degree (level 6 EQF) or comparable qualification

The admission to Laurea Magistrale (equivalent to Master of Science) is subject to an assessment process that aims to verify the candidate's adequacy. This process, according to the Law (D.M. 22/10/2004 n. 270 art. 6 comma 2 and D.M. del 16/3/2007, art.6 comma 1), is based on curricular requirements and on assessing the student's suitable preparation

**4**
**INFORMATION ON THE CONTENTS AND RESULTS GAINED**
**4.1**
**Mode of study**

The Course requires full time attendance and involves classroom and laboratory activities. Classroom attendance is not strictly mandatory, but strongly suggested.

**4.2**
**Programme learning outcomes**

Graduates will:

- possess in-depth knowledge of the theoretical and scientific aspects of mathematics and other base sciences and be able to use this knowledge to interpret and describe complex engineering problems or problems that require an interdisciplinary approach;
- possess in-depth knowledge of the theoretical and scientific aspects where complex problems that require an interdisciplinary approach can be identified, formulated and solved through an innovative approach;
- be able to ideate, plan, design and manage complex and/or innovative systems, processes and services;
- be able to design and manage highly complex experiments;
- possess context knowledge as well as the ability to think flexibly;
- possess knowledge of company and professional culture;
- be able to speak and write fluently in at least one European Union language, other than Italian, for professional purposes.

### 4.3 Programme details, individual credits gained and grades/marks obtained

SSD Code	Code	Educational activities	CFU/ECTS credits	Recognition	Grade	Date
ING-INF/05	089216	SOFT COMPUTING	5.00		30	02/02/2018
ING-INF/05	097686	RECOMMENDER SYSTEMS	5.00		30 L	13/02/2018
ING-INF/05	089183	DATA BASES 2	5.00		30	15/02/2018
ING-INF/05	089184	SOFTWARE ENGINEERING 2	5.00		30 L	16/02/2018
ING-INF/05	097683	MACHINE LEARNING	5.00		25	04/07/2018
ING-INF/05	095898	COMPUTING INFRASTRUCTURES	5.00		30 L	16/07/2018
ING-INF/05	089165	COMPUTER SECURITY	5.00		30 L	17/07/2018
ING-INF/05	088949	ADVANCED COMPUTER ARCHITECTURES	5.00		30 L	10/09/2018
ING-INF/05	089181	THEORETICAL COMPUTER SCIENCE	5.00		26	13/09/2018
ING-INF/05	090950	DISTRIBUTED SYSTEMS	5.00		30	10/01/2019
ING-INF/05	052537	TECHNOLOGIES FOR INFORMATION SYSTEMS	5.00		30 L	22/01/2019
ING-INF/04	089194	COMPLEX SYSTEMS AND NETWORKS	5.00		27	15/02/2019
ING-INF/05	093206	MULTIDISCIPLINARY PROJECT	5.00		30 L	17/06/2019
ING-INF/03	099322	SIGNALS AND SYSTEMS FOR COMMUNICATIONS	10.00		30	25/06/2019
ING-IND/13	088804	MECHANICS	5.00		26	16/07/2019
ING-IND/10	088805	THERMODYNAMICS AND HEAT TRANSFER	5.00		26	17/07/2019
ING-INF/05	089182	FORMAL LANGUAGES AND COMPILERS	5.00		24	03/09/2019
ING-INF/05	052533	MIDDLEWARE TECHNOLOGIES FOR DISTRIBUTED SYSTEMS	5.00		30	05/09/2019
IUS/01	090940	INFORMATICS AND LAW	5.00		28	10/09/2019
	089254	FINAL EXAMINATION	20.00		--	22/05/2020
<b>Total CFU/ECTS credits</b>			<b>120</b>			

#### Thesis/Final Exam

Title	Supervisor	Reference discipline
Improving Domain-specific Transfer Learning Applications for Image Recognition and Differential Equations	BRAMBILLA MARCO	ING-INF/05 - INFORMATION PROCESSING SYSTEMS

### 4.4 Grading system and, if available, grade distribution table

Individual subjects are graded on a scale from 18 to 30, with 18 and 30 as minimum and maximum grade respectively. A "cum laude" can be added to the maximum grade as a special distinction.

#### GRADE DISTRIBUTION TABLE

ISCED code: 0688			Computer systems engineering (LM-32)										Second Cycle QF-EHEA - Level 7 EQF	
GRADE	18	19	20	21	22	23	24	25	26	27	28	29	30	30 cum laude
N marks	763	445	653	659	804	1036	1246	1431	1553	1908	2024	1627	2494	2522
%	3,98	2,32	3,41	3,44	4,20	5,41	6,50	7,47	8,10	9,96	10,56	8,49	13,01	13,15
Cumulative %	100,00	96,00	93,00	90,00	86,00	82,00	77,00	70,00	63,00	55,00	45,00	34,00	26,00	13,00
Years considered: from 01/11/2016 to 31/10/2019										Total number of final marks considered: 19165				

**4.5 Overall classification of the qualification (in original language)**

Final mark: 110/110 cum laude

Date 06/06/2020

For I and II cycle programmes the final grade is based on a maximum of 110points, with 66/110 as the lowest passing grade. In case of excellence, 110 cum laude may be awarded. The final grade is based on the curriculum as well as on the final exam.

**GRADE DISTRIBUTION TABLE**

Computer systems engineering (LM-32)			
ISCED code: 0688		Second Cycle QF-EHEA - Level 7 EQF	
GRADE	N marks	%	Cumulative %
75	1	0.12	100,00
76	1	0.12	99,00
77	1	0.12	99,00
78	1	0.12	99,00
79	2	0.23	99,00
81	4	0.46	99,00
82	7	0.81	98,00
83	4	0.46	98,00
84	5	0.58	97,00
85	5	0.58	96,00
86	11	1.27	96,00
87	7	0.81	95,00
88	6	0.69	94,00
89	12	1.38	93,00
90	18	2.07	92,00
91	14	1.61	90,00
92	13	1.50	88,00
93	23	2.65	87,00
94	17	1.96	84,00
95	28	3.23	82,00
96	23	2.65	79,00
97	30	3.46	76,00
98	27	3.11	73,00
99	18	2.07	70,00
100	43	4.95	67,00
101	39	4.49	62,00
102	39	4.49	58,00
103	28	3.23	54,00
104	30	3.46	50,00
105	31	3.57	47,00
106	41	4.72	43,00
107	29	3.34	39,00
108	34	3.92	35,00
109	17	1.96	31,00
110	84	9.68	29,00
110 cum laude	175	20.13	20,00
Years considered: from 01/11/2016 to 31/10/2019			

Total number of final marks considered: 868

**5**
**INFORMATION ON THE FUNCTION OF THE QUALIFICATION**
**5.1**
**Access to further study**

The qualification grants access to "Dottorato di Ricerca" (Research Doctorate), "Corso di Specializzazione di secondo livello" (2nd level Specialization Course) and "Master Universitario di secondo livello" (2nd level University Master)

**5.2**
**Access to a regulated profession (if applicable)**

Gives access to the state exam required to practice as: INGEGNERE DELL'INFORMAZIONE, INGEGNERE DELL'INFORMAZIONE IUNIOR

**6**
**ADDITIONAL INFORMATION**
**6.1**
**Additional information**
**Innovative teaching: non-curricular items**

SSD Code	Code	Educational activities	CFU/ECTS credits	Recognition	Grade	Date
	054057	Harvard-Politecnico di Milano Joint Program on Data Science	4.00		--	03/07/2019

**6.2**
**Further information sources**

<http://www.polimi.it/>; <http://www.miur.it/>;

**7****CERTIFICATION OF THE SUPPLEMENT****7.1****Date (\*)****7.2****Signature (\*)**

Dott.ssa Assunta Marrese

**7.3****Capacity**

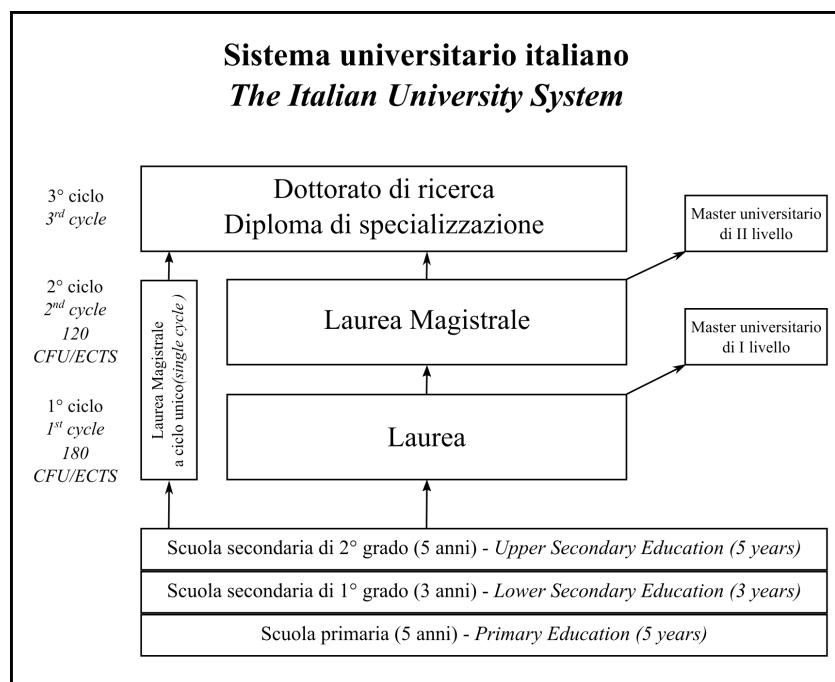
La Dirigente dell'Area Didattica

**7.4****Official stamp or seal (\*)**

(\*) Date, signature and stamp are available only if requested by the holder of the Diploma Supplement

**8**
**INFORMATION ON THE NATIONAL HIGHER EDUCATION SYSTEM**

The Italian university system is organised in three cycles, according to the Bologna structure: the main academic degrees are the Laurea (1st cycle), the Laurea Magistrale (2nd cycle) and the Dottorato di Ricerca (3rd cycle). The system also offers other study programmes and related qualifications.


**First cycle**

This cycle consists exclusively of Corsi di Laurea. These degree programmes provide students with an adequate command of general scientific methods and contents as well as with specific professional skills. The general access requirement is the Italian school leaving qualification awarded after completion of 13 years of schooling and passing the relevant State examination; comparable foreign qualifications may also be accepted. Admission to some degree courses may be based on specific course requirements. The studies last 3 years. The Laurea is awarded to students who have gained 180 ECTS credits (called Crediti Formativi Universitari - CFU) and satisfied all curricular requirements, including the production of a final written paper or equivalent final project. The Laurea gives access to the Corsi di Laurea Magistrale as well as to other 2nd cycle study programmes.

**Second cycle**

The main degree programmes in this cycle are the Corsi di Laurea Magistrale. They provide education at an advanced level for the exercise of highly qualified activities in specific areas. Access is by a Laurea degree or a comparable foreign degree; admission is based on specific course requirements determined by single universities. The studies last 2 years. The Laurea Magistrale degree is awarded to students who have gained 120 ECTS/CFU credits and satisfied all curricular requirements, including the production and public defence of an original dissertation.

Some programmes (namely, those in dentistry, medicine, veterinary medicine, pharmacy, architecture, construction engineering/architecture, law, primary education) are defined "single cycle programmes" (Corsi a ciclo unico); for these programmes access is by the Italian school leaving qualification (or a comparable foreign qualification); admission is based on entrance exams. The studies last 5 years (6 years and 360 ECTS/CFU credits in the cases of medicine

and dentistry). A Laurea Magistrale degree is awarded to students who have gained 300 ECTS/CFU credits and satisfied all curricular requirements, including the production and public defence of an original dissertation.

A Laurea Magistrale degree gives access to Corsi di Dottorato di Ricerca as well as to other 3rd cycle study programmes.

### Third cycle

The main degree programmes in this cycle are Corsi di Dottorato di Ricerca (research doctorate programmes); the students/young researchers enrolled in these programmes will acquire methodologies for advanced scientific research, will be trained in new technologies and will work in research laboratories, wherever appropriate. Access is by a Laurea Magistrale degree (or a comparable foreign degree); admission is based on a competitive exam; studies last at least three years and include the completion and public defence of an original research project.

### Other programmes

- **Corsi di Specializzazione:** these are 3rd cycle programmes intended to provide students with the knowledge and skills required for the practice of highly qualified professions, mainly in medical, clinical and surgical specialities. Admission is by a Laurea Magistrale degree (or by a comparable foreign degree) and is based on a competitive exam; studies may last from 2 (120 ECTS/CFU credits) to 6 years (360 ECTS/CFU credits) depending on the discipline. The final degree awarded is a Diploma di Specializzazione.
- **Corsi di Master Universitario di primo livello:** these are 2nd cycle programmes intended to provide students with further specialization or higher continuing education after completion of the first cycle. Access is by a Laurea degree (or a comparable foreign degree); admission may be subject to additional requirements. Studies last at least 1 year (60 ECTS/CFU credits). The qualification awarded (Master Universitario di primo livello) does not give access to Corsi di Dottorato di Ricerca or to any other 3rd cycle programme, since this type of course does not belong to the general requirements established at national level, but it is offered under the autonomous responsibility of each university.
- **Corsi di Master Universitario di secondo livello:** these are 3rd cycle programmes intended to provide students with further specialization or higher continuing education studies after completion of the second cycle. Access is by a Laurea Magistrale degree (or a comparable foreign degree); admission may be subject to additional requirements. Studies last at least 1 year (60 ECTS/CFU credits). The qualification awarded (Master Universitario di secondo livello) does not give access to Corsi di Dottorato di Ricerca or to any other 3rd cycle programmes, since this type of course does not belong to the general requirements established at national level, but it is offered under the autonomous responsibility of each university.

### CREDITS

Degree courses are structured in credits (Crediti Formativi Universitari - CFU). University credits are based on the workload students need in order to achieve the expected learning outcomes. Each credit corresponds to 25 hours of student workload, including independent study. The average workload of a full time student is conventionally fixed at 60 credits per year. Thus, the CFU fully coincide with ECTS credits



### **Classes of Degree Courses**

All degree programmes of Laurea and Laurea Magistrale sharing general educational objectives are grouped into "classes". In developing the specific learning outcomes of single programmes, Universities have to comply with some national requirements for each class concerning the types (and corresponding amount of credits) of teaching-learning activities to be included. Degrees belonging to the same class have the same legal value.

### **Academic Titles**

Those who receive the Laurea are entitled to be called "Dottore", the holders of a Laurea Magistrale have a right to the title of "Dottore Magistrale", the Dottorato di ricerca confers the title of "Dottore di Ricerca" or "PhD".

### **Joint Degrees**

Italian universities are allowed to establish degree programmes in cooperation with Italian and foreign partner universities, on completion of which joint or double/multiple degrees can be awarded.

### **Further information**

Italian Qualifications Framework (Quadro dei Titoli Italiani - QTI) <http://www.quadrodeititoli.it>



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**1****INFORMATION IDENTIFYING THE HOLDER OF THE QUALIFICATION****1.1****Last name(s)**

SCARLATTI

**1.2****First name(s)**

TOMMASO

**1.3****Date of birth (dd/mm/yyyy)**

30/04/1995

**1.4****Student identification number or code (if available)**

897651

**2****INFORMATION IDENTIFYING THE QUALIFICATION****2.1****Name of the qualification and title conferred (in the original language)**

Laurea magistrale in COMPUTER SCIENCE AND ENGINEERING

Dottore magistrale

**2.2****Main field(s) of study for the qualification**

Computer systems engineering (LM-32)

ISCED code: 0688

**2.3****Name (in original language) and status of the awarding institution**

Politecnico di Milano (Istituzione statale), Piazza Leonardo da Vinci 32, 20133 Milano

**Description of curriculum****SOFT COMPUTING**

Code: 089216  
Credits: 5.00  
Grade: 30  
Date: 02/02/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

What is "Soft Computing": fuzzy systems, Neural networks, stochastic algorithms - Fuzzy models: fuzzy sets, fuzzy logic, fuzzy rules. What can be represented by a fuzzy model and why. - Neural networks: basic principles, supervised and unsupervised learning, the main models, selection and evaluation criteria. Stochastic algorithms: basic principles, model optimization, fitness function, model definition, genetic algorithms, reinforcement learning. Hybrid models: motivations, neuro-fuzzy systems, genetic algorithms to optimize neural networks and fuzzy systems. Applications of Soft computing techniques: motivations, design choices, models case studies.

**RECOMMENDER SYSTEMS**

Code: 097686  
Credits: 5.00  
Grade: 30 L  
Date: 13/02/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

Recommender systems aim to support users in their decision-making while interacting with large information spaces. They recommend items of interest to users based on preferences they have expressed, either explicitly or implicitly. Recommender systems help overcome the information overload problem by exposing users to the most interesting items, and by offering novelty, surprise, and relevance. This course gave a tutorial about the leading approaches in recommender systems. The techniques described touch both collaborative and content-based approaches and include a number of algorithms that result in techniques. The course also explore alternative techniques of evaluating recommender systems.

**DATA BASES 2**

Code: 089183  
Credits: 5.00  
Grade: 30  
Date: 15/02/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

The course aims to prepare software designers on the effective development of database applications. First, the course presents the fundamental features of current database architectures, with a specific emphasis on the concept of transaction and its realization in centralized and distributed systems. Then, the course illustrates the main directions in the evolution of database systems, presenting approaches that go beyond the relational model, like active databases, object systems and XML data management solutions.

**SOFTWARE ENGINEERING 2**

Code: 089184  
Credits: 5.00  
Grade: 30 L  
Date: 16/02/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

The software process and software standards; lifecycles (waterfall, prototype-based, evolutionary/incremental, spiral, agile); standards (ISO2001, SPICE, CMM); software business models, licensing, intellectual properties, open-source software. Requirements engineering. Software technologies: middleware, component models (J2EE and .NET). Design patterns. Software architectures and architectural styles. Methods and notations for specification: FSMs, StateCharts, Petri nets, temporal logics, Alloy. Verification and validation: testing and analysis, model checking.

**MACHINE LEARNING**

Code: 097683  
Credits: 5.00  
Grade: 25  
Date: 04/07/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

The course is an introduction to the area of Artificial Intelligence, known as Machine Learning, that deals with the development of algorithmic techniques to extract knowledge from large amount of data (e.g., retail databases, web logs, etc.). The course focuses mainly on supervised and unsupervised techniques, e.g., decision trees, decision rules, induction of Horn clauses, hierarchical clustering, etc. And it will consider mainly Data Mining applications.

**COMPUTING INFRASTRUCTURES**

Code: 095898  
Credits: 5.00  
Grade: 30 L  
Date: 16/07/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

Data center infrastructures has made impressive transformations with the recent advent of web-based services and distributed systems. New architectures, such as cloud computing, have recently been recently proposed for approaching the challenging problems related to the requirements of the actual enterprise infrastructures that must be very powerful, highly available, scalable, well performing, green, open and secure at the same time. The course covers the basics of the actual data center architectures, ranging from the analysis of the single components to the global infrastructure. (Course held in english)

**COMPUTER SECURITY**

Code: 089165  
Credits: 5.00  
Grade: 30 L  
Date: 17/07/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

Modern computer systems routinely handle high-value information such as financial data, economic transactions, and various forms of valuable intellectual property. Moreover, information systems are becoming pervasive, always-on and increasingly interconnected. Ensuring information security in this landscape is an extremely challenging task. Designing and building secure information systems is a complex, interdisciplinary problem mixing elements of cryptography, software engineering, secure networking, as well as political and social challenges. This course is an extensive introduction to the challenges of security engineering and to the methodology to build, validate, and (ethically) bypass security systems with the goal of learning how to secure them properly. During the lectures, we will analyze the various building blocks of a computer and information system, including their security subsystems. We will constructively analyze their vulnerabilities, see how these can be exploited, and deductively learn what was wrong and how to avoid repeating such engineering mistakes. The course has a strong "hands-on" philosophy. Practical exercises will be conducted for all the topics marked with a (\*) in the following syllabus. A "virtual hacking lab" will be available, where students can practice how to bypass and secure computer applications

**ADVANCED COMPUTER ARCHITECTURES**

Code: 088949  
Credits: 5.00  
Grade: 30 L  
Date: 10/09/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

Objective of the course is that the student will understand all the major concepts used in modern microprocessors by the end of the semester. The course will cover the different forms of parallelism found in applications (instruction-level, data-level, thread-level, gate-level) and how these can be exploited with various architectural features. It will cover pipelining, superscalar, speculative and out-of-order execution, vector machines, VLIW machines, multithreading, graphics processing units, and parallel microprocessors. Final goal is to show how the software interacts with the hardware to provide performance and how trends in technology, application and economics have driven and drive continuing changes in the field.

**THEORETICAL COMPUTER SCIENCE**

Code: 089181  
Credits: 5.00  
Grade: 26  
Date: 13/09/2018

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

Computer science models. Automata, grammars, applications of mathematical logic to system modeling. Theory of computation. Church's thesis; unsolvable problems. Computational complexity. Computational models and relations between their computational complexities. Linear acceleration.

**DISTRIBUTED SYSTEMS**

Code: 090950  
Credits: 5.00  
Grade: 30  
Date: 10/01/2019

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

The course aims at describing the principles and paradigms that guide the design and development of modern distributed systems. The course identifies the issues to be resolved in developing a distributed system and it describes the successful approaches in addressing these issues, in terms of abstract models, algorithms, and case studies. The course spans the following main topics: Naming, Synchronization, Fault tolerance, Consistency and Replication, Security, and Simulation.

**TECHNOLOGIES FOR INFORMATION SYSTEMS**

Code: 052537  
Credits: 5.00  
Grade: 30 L  
Date: 22/01/2019

**Subject groups**

ING-INF/05 INFORMATION PROCESSING SYSTEMS

**The programme**

Decision-making is based on information, not just on data. More accurate information leads to better decisions and gives competitive advantages to organizations. Hence, processing, manipulating, and organizing data in a way that adds new knowledge to the person or organization receiving it has become a necessary issue. The goal of the course is to enable the students to master the engineering methods and processes that are necessary to manage modern information system, and especially data-intensive systems: these include all the large data collections, belonging to corporate, scientific, social or other sources. The ultimate goal is to understand the utility of the methods that precede and support the data analysis process, to obtain useful knowledge and improve decision-making. As a consequence, we expose the students to some of the most advanced methodologies adopted to understand the conceptual and technological problems encountered in the design and implementation of "data products": tangible results based on the analysis of complex systems whose basic materials are collections of data that must be integrated, organized and analyzed mainly through automatic tools

**COMPLEX SYSTEMS AND NETWORKS**

Code: 089194  
Credits: 5.00  
Grade: 27  
Date: 15/02/2019

**Subject groups**

ING-INF/04 SYSTEMS AND CONTROL ENGINEERING

**The programme**

Unavailable



### MULTIDISCIPLINARY PROJECT

Code: 093206  
Credits: 5.00  
Grade: 30 L  
Date: 17/06/2019

#### Subject groups

ING-INF/05 INFORMATION PROCESSING SYSTEMS

#### The programme

The main goal of this course, addressed to students from all MS Programs, is to expose student to projects emphasizing information technology but also requiring interdisciplinary (horizontal) skills, needed to work in a truly multidisciplinary environment, which characterizes the current industry trends. This goal is fulfilled through multi-disciplinary projects, which are conducted throughout the semester by teams of students with different backgrounds and skills. The project emphasizes requirements specification, design and feasibility analysis of the envisioned solution, and implementation of a proof of concept show-casing the most innovative part and feasibility of the solution.

### SIGNALS AND SYSTEMS FOR COMMUNICATIONS

Code: 099322  
Credits: 10.00  
Grade: 30  
Date: 25/06/2019

#### Subject groups

ING-INF/03 TELECOMMUNICATIONS

#### The programme

Continuous and discrete signals: the step and impulse signals, complex exponentials, elementary operations on signals. ; Continuous and discrete Linear Time-Invariant systems: the impulse response, convolution. ; Representation of signals in the frequency domain: Fourier transform of continuous-time signals, Fourier transform of sequences, Fourier series. ; From continuous to discrete time: the sampling theorem, energy and power of sampled signals, conversion to base-band by sampling, sampling in the frequency domain. ; The discrete Fourier transform (DFT): circularity in time and frequency, properties, practical applications. ; Continuous and discrete random processes: power spectral density, processes through LTI systems. ; Source coding: quantization, binary coding, Huffman coding, Entropy of the source. ; Digital transmission in base-band: PAM and PCM, interference between symbols, matched filter, probability error.

**MECHANICS**

Code: 088804  
Credits: 5.00  
Grade: 26  
Date: 16/07/2019

**Subject groups**

ING-IND/13 APPLIED MECHANICS

**The programme**

The first part of the course is dedicated to the study of the kinematics of the rigid bodies in plane motion with geometry and algebra of vector solutions and complex numbers method. Arguments such the phenomenon of the contact between solids, as friction are introduced. The second part of the course deal with the dynamics of rigid bodies system in plane motion. General equations of dynamics are discussed and is introduced the D`Alambert principle. Work-Energy relations are treated in the study of the energy flow in a machine with the characterization of engine, transmission and utilizator. Concepts of steady and transient rate, direct and retrograde motion are discussed. For all the arguments the development of various numerical applications are provided.

**THERMODYNAMICS AND HEAT TRANSFER**

Code: 088805  
Credits: 5.00  
Grade: 26  
Date: 17/07/2019

**Subject groups**

ING-IND/10 THERMAL ENGINEERING AND INDUSTRIAL ENERGY SYSTEMS

**The programme**

Fundamentals of Thermodynamics: First Law for closed and open systems: internal energy and enthalpy. Second Law for closed and open systems: entropy. External and internal irreversibilities. Applied thermodynamics: turbine, pump, heater and cooler. Analysis of power generation and refrigeration systems. Heat transfer. Conduction: The Fourier law. Unidirectional steady conduction. Extended surfaces (Fins). The lumped capacitance model for unsteady conduction. Convection: basic principles of convection: forced and natural convection. Dimensional analysis and model theory. Correlations in forced and natural convection. Radiation: black body radiation. Heat transfer between black surfaces. Diffuse-gray surfaces. Application: heat exchanger, electronic cooling.

## FORMAL LANGUAGES AND COMPILERS

Code: 089182  
Credits: 5.00  
Grade: 24  
Date: 03/09/2019

### Subject groups

ING-INF/05 INFORMATION PROCESSING SYSTEMS

### The programme

Theoretical concepts and algorithms for language definition and compiler design. Regular expressions, finite automata, and conversion from one model to the other. Context free grammars, ambiguity, structural adequacy. Linguistic abstraction. Syntax directed translation, attribute grammars, and semantic analysis. Principles of data flow analysis for programs.

## MIDDLEWARE TECHNOLOGIES FOR DISTRIBUTED SYSTEMS

Code: 052533  
Credits: 5.00  
Grade: 30  
Date: 05/09/2019

### Subject groups

ING-INF/05 INFORMATION PROCESSING SYSTEMS

### The programme

The course presents the main families of middleware technologies that aim to simplify the design and development of complex distributed applications. First, the course discusses the main issues in building distributed software systems and shows established approaches to mitigate them. Then, the course overviews modern middleware technologies that implement these approaches and exemplifies their use within concrete case studies. The technologies presented cover a wide range of scenarios, including: high-performance computing, big-data processing, event-based and service-oriented architectures, wireless sensor networks.

## INFORMATICS AND LAW

Code: 090940  
Credits: 5.00  
Grade: 28  
Date: 10/09/2019

### Subject groups

IUS/01 PRIVATE LAW

### The programme

This course deals with the problems that arise at the intersection of computer science and law. First, a wide analysis of legal problems in computer engineering will be performed. Then, in the second part of the course, we will analyze the main techniques and methods of forensic investigation on digital devices, as well as the technical and legal aspects of how such findings are reported in court. The course will join practical and theoretical sides, with case studies



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## FINAL EXAMINATION

Code: 089254  
Credits: 20.00  
Grade: --  
Date: 22/05/2020

### Subject groups

Unavailable

### The programme

Unavailable