2nd-cycle (Laurea Magistrale) Degree Course
COMPUTER ENGINEERING
A.Y. 2019/20

This MSc (*laurea magistralis*) provides its students with a solid and in-depth background, in both fundamental sciences and engineering disciplines, in line with the needs of innovation in the field of computer engineering. This allows graduates to interact with engineering professionals from diverse backgrounds, as well as to complete their mastering of computer engineering. The programme includes a first part, which delves deep into methodological and engineering disciplines and completes the expertise on computer engineering. Students are then presented with the following subjects: mobile computing, distributed systems and applications, software systems engineering, intelligent systems. In order to complete their MSc, students can then choose among three tracks, namely: Computer Systems and Networks, Cyber-physical systems, and Cybersecurity. The first one advances further on large-scale computing and networking infrastructures; the second one provides students with expertise on embedded systems and the Internet of Things; the third one focuses on the design of secure systems and applications.

Knowledge requirements (international students)
Knowledge of basic methodologies of computer systems engineering is a mandatory prerequisite. In particular, candidates should be able to demonstrate background in algorithms and programming, operating systems, computer networks, and database systems. Degree Courses in Computer Engineering or Computer Science typically cover this knowledge

Provisional study plan A.Y. 2019/20
The course schedule per year and semester reported in the following table is provisional, subject to final approval by the University bodies before the opening of the enrollment period.

YEAR 1 (60 ECTS)

Course	ECTS	Semester
Performance Evaluation of Computer Systems and Networks	9	1
Large-Scale and Multi-Structured Databases	9	1
Electronics and Communications Systems	9	1
Computer Architecture	9	2
Intelligent Systems	6	2
Foundations of Cybersecurity	9	2
Track Course (1)	9	2

YEAR 2 (60 ECTS)

Course	ECTS	Semester
Distributed Systems and Middleware Technologies	6	1
Software Systems Engineering	6	1
Track Course (2)	9	1
Elective Course (free choice)	9	-
Mobile and Social Sensing Systems	6	2
Final Examination (Thesis)	24	2

COMPUTER SYSTEMS AND NETWORKS TRACK

Course	ECTS	Year	Semester
Cloud Computing	9	1	2
Advanced Network Architectures and Wireless Systems	9	2	1

CYBER-PHYSICAL SYSTEMS TRACK

Course	ECTS	Year	Semester
Internet of Things	9	1	2
Industrial Applications	9	2	1

CYBERSECURITY TRACK

Course	ECTS	Year	Semester
Formal Methods for Secure Systems	9	1	2
Network and System Hacking	9	2	1

LEARNING OBJECTIVES BY COURSE

Advanced Network Architectures and Wireless Systems (9 ECTS)

Learning objectives: The objective of the course is to teach cutting-edge topics in computer networking systems by blending theoretical understanding with hands-on technical knowledge. Key principles and advanced network technologies are discussed covering both the core as well as the access segments of a network (with specific emphasis on wireless solutions). At the end of the course, students are able to demonstrate the knowledge and skills required to understand, design, and analyze current and future networking systems and technologies.
Language: English

Cloud Computing (9 ECTS)

Learning objectives: The objective of the course is to teach topics in cloud computing, including also hands-on technical knowledge. Foundation principles of cloud computing and advanced technologies are discussed, covering concepts of the cloud infrastructure as well as cloud platforms. Cloud programming models and practical examples of cloud application deployments are also covered. At the end of the course, students are expected to develop in-depth knowledge of the cloud computing infrastructure and platforms, required to design current and future cloud infrastructures and applications.
Language: English

Computer Architecture (9 ECTS)

Learning objectives: The course explores the organization of general purpose and embedded processing systems, with particular reference to the Intel and ARM micro-architectures. It allows the student to acquire the architecture knowledge of superscalar and multithread microprocessors, multicore, GPU, domain-specific architecture and programmable logic systems. The course provides the ability to exploit the microprocessor features in application design, to analyze the performance of the microprocessor-based system and to use benchmarks to choose suitable computing system resources.
Language: English

Distributed Systems and Middleware Technologies (6 ECTS)

Learning objectives: The course is aimed at providing students with the proper conceptual and technological tools for the development of modern distributed applications. After the introduction of models, paradigms

and algorithms for distributed software, various classes of middleware systems are presented, focusing on the issues they have been designed to deal with. Students will learn to design, implement, and integrate distributed software, possibly made of heterogeneous components; moreover, they will acquire the ability to choose and apply the most suitable middleware solutions to address practical problems in distributed enterprise applications.
Language: English

Electronics and Communications Systems (9 ECTS)

Learning objectives: The aim of the course is twofold, as it is organized in two modules.
In the first module, the objective is to enable students to master digital integrated circuit design trade-offs. Experience state-of-the-art electronic design automation tools and high-level design methodologies for FPGA and semi-custom technologies. Understand sensor based electronic systems including sensor measurements, conditioning and sensor data fusion.
In the second module, the objective is to describe the main architectural features and the underlying technology of the communication systems and equipment that is used in the field of networking, and to provide specific examples of communication systems using such technologies. In particular, the students i) will build-up a general knowledge of the basic technologies that enable the design of wired (copper, fiber) and wireless communication systems; ii) will bear a specific knowledge of the main standard for communications in the transport and access network, and iii) will evaluate the relevance of such standards and technologies in the general context of a wide-area digital communications and computing network.
Language: English

Formal Methods for Secure Systems (9 ECTS)

Learning objectives: The aim of this course is to provide students with the theoretical background of formal methods and the basic issues in the usage of formal methods in the development of secure systems.
The course introduces the students to formal modeling of hardware and software components and to formal verification of security properties of a system using basic techniques (abstract interpretation, model checking and theorem proving). The course covers the practical application of the theory to some security issues: data confidentiality; malware detection; and cyber-physical systems security (automotive, robotics and biomedical systems). Furthermore, the course introduces formal approaches to reliability modeling and evaluation of computer-based systems under security attacks.
Language: English

Foundations of Cybersecurity (9 ECTS)

Learning objectives: The aim of the course it to provide students with the knowledge and related expertise about the basic methodologies for the design and implementation of secure distributed protocols and applications. In particular, the course will present basic methodologies for threat analysis, risk modelling, and secure programming. Furthermore, the course will introduce the main modern cryptographic schemes which the students will learn to correctly use to protect data “at rest” or “in transit” and of which the students will learn to evaluate impact on performance. Concepts will be exemplified by discussing real cases. Students will apply methodologies in hands-on activities.
Language: English

Industrial Applications (9 ECTS)

Learning objectives: The course aim is to teach the foundations and basic design methodologies for developing resource constrained embedded and industrial applications. Then it explains the architectures and technologies that characterize the domain. Students will be able to design and realize embedded and industrial applications, by considering algorithms, interface with sensors and actuators, hardware infrastructures, and programming interfaces. Besides, students will acquire, in experimental sessions, competences in product and service innovation in the industrial/embedded field, up to the implementation of a demonstrator prototype.
Language: English

Intelligent Systems (6 ECTS)

Learning objectives: the objective of this course is to teach the theoretical foundations and basic methodologies for the development of intelligent systems, i.e., systems with human-like capabilities in terms of reasoning, learning and adaptation. The student who successfully completes the course will be able to design and develop intelligent systems in several application domains. The main topics will include artificial neural networks, fuzzy systems and genetic algorithms.
Language: English

Internet of Things (9 ECTS)

Learning objectives: This course aims to provide the theoretical background on the Internet of Things (IoT) and the basic methodologies for developing IoT applications. It enables students to design and implement applications, based on the IoT paradigm, in several application domains, including smart cities, smart buildings, smart energy, smart industry, etc.
Language: English

Large-Scale and Multi-Structured Databases (9 ECTS)

Learning objectives: This course aims to provide the theory and practice of modern large-scale and multi-structured database systems. At the end of the course, students understand how a possibly very large set of complex multi-structured data can be managed and stored, and know the principles of several common large-scale data systems including their architecture, performance, and costs.
Language: English

Mobile and Social Sensing Systems (6 ECTS)

Learning objectives: The course is aimed at providing students with an overview of issues, solutions, methods and technologies related to mobile, wearable and social networking systems. Key principles and advanced techniques are discussed covering the collection, filtering and analysis of information from both mobile and social platforms, with a specific focus on data from physical and human sensors. At the end of the course, students are expected to develop the knowledge and skills required to design and implement smart applications in a wide range of domains, from personalized e-health to the analysis of social information streams.
Language: English

Performance Evaluation of Computer Systems and Networks

Learning objectives: The objective of the course is to enable students to model and analyze computer systems, networks, services, mastering both analytical techniques (specifically, queueing theory) and discrete-event simulation. In order to achieve this, a first part of the course will cover all the prerequisites from applied probability and statistics that are needed for both queueing theory and simulation. A second part will cover the principles of discrete-event simulations, including an analysis of the simulation workflow, data structures used in simulation, random number generation, transient elimination and output data analysis. A third part will explore both the theory and application of queuing theory, covering single-queue systems, and queueing networks.
Language: English

Software Systems Engineering (6 ECTS)

Learning objectives: The aim is to show advanced techniques for designing software systems. The software system development take account the quality of both the development process and the produced system. At the end of the course, the student will be able to perform, working in a group, a software project and produce all necessary documentation. Through the project, the student must demonstrate the ability to put into practice and to execute, with critical awareness, the activities illustrated or carried out under the guidance of the teacher during the course.
Language: English

System and Network Hacking (9 ECTS)

Learning objectives: The aim of the course is to provide students with a complete and operational view of the main vulnerabilities of computing systems and networks, the techniques used by attackers to exploit these vulnerabilities, and related countermeasures to mitigate attacks. Students will learn to recognize vulnerabilities in all components of a computing system, from hardware, to the operating system, to programming languages, to applications that interface with the network. They will learn to use the main tools used by the attackers and to implement the most effective measures to combat them.
Language: English

Free Activity (9 ECTS)

Learning objectives: Free choice course, to be submitted for approval by the Degree Program Board.