

Engineering Master

Courses	Semester	Number of hours	Number of ECTS delivered
Module Language	1 - Fall semester & 2 - Spring Semester	86	4

1. English (1- Fall Semester, 20h)

The third-year course includes the following orientations: Continuation of training in computer terminology; Drafting of scientific/formal abstract on the third year project; the professional environment and business world; Training in external language exams (TOEIC).

2. French as a foreign Language (all year, 66h)

Training to listening and reading skills at beginner's level, training to oral and written communication in everyday life, French civilization, intercultural differences

Courses	Semester	Number of hours	Number of ECTS delivered
Module Simulation	1 - Fall semester	60	5

1. Discrete Event Simulation (20h)

Discrete Event Simulation is an imitation of the operation of a real-world system: it models the operation of a system as a discrete sequence of events in time, where each event occurs at a particular instant in time and marks a change of the state of the system. In this course, we discuss different types of dynamic systems, different modeling frameworks for such systems (queueing models, finite automata, vector addition systems and Petri nets), and why and how to perform simulations.

2. Stochastic Simulation (20h)

This course is devoted to discrete simulation, and more particularly stochastic discrete event simulation. Students will learn the main concepts and they will also use and develop simulation tools. Implementation problems including concerns of parallelism will be discussed and practiced on a local computing grid.

3. High Performance Computing (20h)

High Performance Computing (HPC) has moved from a selective and expensive endeavor to a cost-effective technology within reach of virtually every budget with the arrival of many core processors. The purpose of this course is to present the main concepts of HPC: computing, storage and networking resources with their accompanying software and their deployment on various distributed architecture.

Courses	Semester	Number of hours	Number of ECTS delivered
Module Optimization and Logistics	1 - Fall semester & 2 - Spring Semester	94	6

1. Operations Research Techniques (1- Fall Semester, 20h)

Operations Research is concerned with the application of advanced analytical methods to complex decision-making or optimization problems. In this course, we present some theoretical background, some major optimization problems and several common techniques how to solve them. For that, we discuss how to model the problems in mathematical terms, present different solution strategies, and criteria to prove optimality of the obtained solutions.

2. Algorithms and Complexity (1- Fall Semester, 24h)

The lecture will be subdivided into three parts. A first part is dedicated to analyzing complexity of algorithms (iterative and recursive). The second part shows how to define difficulty of decision/search problems. Finally, the third part suppose that that decision problems are not easy, and how to solve search problems using an oracle $P=NP$.

3. Case Studies in Operations Research (2- Spring Semester, 30h)

Operations Research is concerned with the application of advanced analytical methods to complex decision-making or optimization problems. Employing techniques from different mathematical fields such as mathematical modeling and mathematical optimization, the goal is to determine the maximum (of profit, performance, or yield) or minimum (of loss, risk, or cost) of some real-world objective. In this course, we discuss case studies for some real-world applications in transportation and telecommunication: we model such problems, present different solution strategies, and analyze the quality of the obtained solutions.

4. Manufacturing systems and logistics (all year, 20h)

Opportunity to introduce supply chain concepts. Order winner, qualifier. We describe and explain the different production strategies Make To stock, make to order... to finally study the MRP 2 model and detail the business plan, S&OP, MPS, MRP. We finish with new supply chain techniques.

Courses	Semester	Number of hours	Number of ECTS delivered
Module Data Science	1 - Fall semester & 2 - Spring Semester	84	6

1. Database Management (1- Fall Semester, 24h)

The aim of this course is to provide an understanding of the main principles underlying the design and the implementation of database management systems. It focuses on the topics related to crash recovery, storage structure and indexing, database security and query optimization.

2. Information Integration (2- Spring Semester, 20h)

The goal of this course is to provide an understanding of the core concepts of the semantic web. After a general introduction to the semantic web fundamentals and technological components, it focuses on the issues related to web data modeling using RDF (Resource Description Format), web data querying using SPARQL and semantic reasoning with the family of OWL language.

3. Big Data Analysis (2- Spring Semester, 20h)

This module provides a current overview of Big Data analysis. It successively tackles the major issues of the field and presents the major advances of recent years, illustrating them through a new application. The content consists of an overview of architecture for Big Data analysis, the concept of scalability in learning (supervised and unsupervised), an overview of deep learning, an exploration and visualization of Big Data analysis, and an overview of tools (SPARK/FLINK, TensorFlow, Scikit Learn).

4. Data Mining and Machine Learning (1- Fall Semester, 24h)

This course is an introduction to data mining and machine learning techniques. It introduces basic concepts, principles, methods, implementation techniques, and applications of datamining, with a focus on three major data mining functions: (1) classification and regression, (2) pattern discovery and (3) cluster analysis. The course develops skills of using recent datamining software for solving practical problems.

Courses	Semester	Number of hours	Number of ECTS delivered
Module Networks and Mobile Systems	1 - Fall semester & 2 - Spring Semester	66	5

1. Security Models (2- Spring Semester, 24h)

In this lecture, we present the different security models for analyzing the security of the cryptographic primitives and also for the cryptographic protocols. We also give several examples of concrete systems. We also see how we can automatically verify the security of such protocols.

2. Mobile Application Programming (2- Spring Semester, 18h)

This course introduces development on mobile platforms and limitations belonging to such development. Design patterns learning and usage inside applications developed during practical works. Mobile network usage with poor liability and bandwidth is eventually introduced.

3. Information System Security (1- Fall Semester, 24h)

Nowadays security is one of the main concerns. In a first part we present historical and modern cryptographic mechanisms. After we describe existing models for evaluation the security of cryptographic primitives presented. Then we see how it is possible to use these primitives in order to ensure secure communication over unsecure channels and in a hostile environment, i.e. in presence of an intruder controlling the communication.

Computer Science Master

Courses	Semester	Number of hours	Number of ECTS delivered
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French as a foreign Language

All year

66

3

Training to listening and reading skills at beginner's level, training to oral and written communication in everyday life, French civilization, intercultural differences

Courses	Semester	Number of hours	Number of ECTS delivered
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Operations Research Techniques

1 - Fall semester

20

3

Operations Research is concerned with the application of advanced analytical methods to complex decision-making or optimization problems. In this course, we present some theoretical background, some major optimization problems and several common techniques how to solve them. We discuss how to model the problems in mathematical terms, present different solution strategies.

Courses	Semester	Number of hours	Number of ECTS delivered
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Algorithms and Complexity

1 - Fall semester

24

3

The lecture will be subdivided into three parts. A first part is dedicated to analyzing complexity of algorithms (iterative and recursive). The second part shows how to define difficulty of decision/search problems. Finally, the third part suppose that that decision problems are not easy, and how to solve search problems using an oracle $P=NP$.

Courses	Semester	Number of hours	Number of ECTS delivered
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High Performance Computing

1 - Fall semester

20

3

High Performance Computing (HPC) has moved from a selective and expensive endeavor to a cost-effective technology within reach of virtually every budget with the arrival of many core processors. The purpose of this course is to present the main concepts of HPC: computing, storage and networking resources with their accompanying software and their deployment on various distributed architecture.

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Data Mining and Machine Learning

1 - Fall semester

20

3

This course is an introduction to data mining and machine learning techniques. It introduces basic concepts, principles, methods, implementation techniques, and applications of datamining, with a focus on three major data mining functions: (1) classification and regression, (2) pattern discovery and (3) cluster analysis. The course develops skills of using recent datamining software for solving practical problems.

Courses	Semester	Number of hours	Number of ECTS delivered
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Research Project

1 - Fall semester

60

6

This research project consists of realizing a state-of-the-art study of some computer-science (or applied-mathematics) topic.

Courses	Semester	Number of hours	Number of ECTS delivered
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Advanced Research Project

All year

120

12

This advanced research project is the continuation of the research project and corresponds to a research ontribution to the computer-science (or applied-mathematics) topic.

Courses	Semester	Number of hours	Number of ECTS delivered
Module Algorithms and Optimization	2 – Spring Semester	40	6

1. Approximation Algorithms (20h)

In discrete optimization, the two classical resolution techniques are (i) exact resolution algorithms that, for numerous NP-complete problems, lead to non-polynomial methods and are unusable in practice and (ii) heuristics or meta-heuristics where the main question is to measure the quality of the solutions produced by these methods but in general, they offer no guarantee. To avoid these strong drawbacks, approximation algorithms have been proposed a few decades ago. The main idea is to relax the constraint of obtaining an exact solution to get an approximate solution in polynomial time. Approximation algorithms are polynomial time and space algorithms (some of them are “greedy style”) and they offer analytically proven guarantees on the quality of the output produced compared to the optimal solution (even if this last cannot be constructed in polynomial time). Hence, they provide a theoretical and practical framework for addressing (some) NP-complete problems solving.

2. Combinatorial Optimization (20h)

In this course, we introduce polyhedral techniques to solve combinatorial-optimization problems. Combinatorial-optimization problems are defined, with examples. It is shown how these problems reduce to the solution of linear programs. In general, the system of inequalities is huge and not easy to describe. However, for particular objective functions, a partial description is sometimes sufficient. A cutting-plane algorithm is presented to find integer solutions to linear programs having a very large number of inequalities. This approach is based on solving separation problems that generate violated valid inequalities. It is applied to the maximum weight matching and the traveling salesman problems.

Courses	Semester	Number of hours	Number of ECTS delivered
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Module Data and knowledge

All year

40

6

1. Big Data Analysis (1- Fall Semester, 20h)

This module provides a current overview of Big Data analysis. It successively tackles the major issues of the field and presents the major advances of recent years, illustrating them through a new application. The content consists of an overview of architecture for Big Data analysis, the concept of scalability in learning (supervised and unsupervised), an overview of deep learning, an exploration and visualization of Big Data analysis, and an overview of tools (SPARK/FLINK, TensorFlow, Scikit Learn).

2. Semantic Web (2- Spring Semester, 20h)

The goal of this course is to provide an understanding of the core concepts of the semantic web. After a general introduction to the semantic web fundamentals and technological components, it focuses on the issues related to web data modeling using RDF (Resource Description Format), web data querying using SPARQL and semantic reasoning with the family of OWL language.

Courses	Semester	Number of hours	Number of ECTS delivered
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Module Networks and Security

1 - Fall Semester

48

6

1. Internet of Things (24h)

This course presents the key concepts of the Internet of Things. It briefly describes what is a connected/smart object and how the objects interact. The course presents various related domains: embedded systems, computer networks (including many low-power radio technologies), data storage, data analysis. The course also discusses recent challenges: interoperability, maintainability, lifetime, security, performance. Overall, the course is organized as a discussion around several case studies.

2. Information System Security (24h)

Nowadays security is one of the main concerns. In a first part we present historical and modern cryptographic mechanisms. After we describe existing models for evaluation the security of cryptographic primitives presented. Then we see how it is possible to use these primitives in order to ensure secure communication over unsecure channels and in a hostile environment, i.e. in presence of an intruder controlling the communication.