



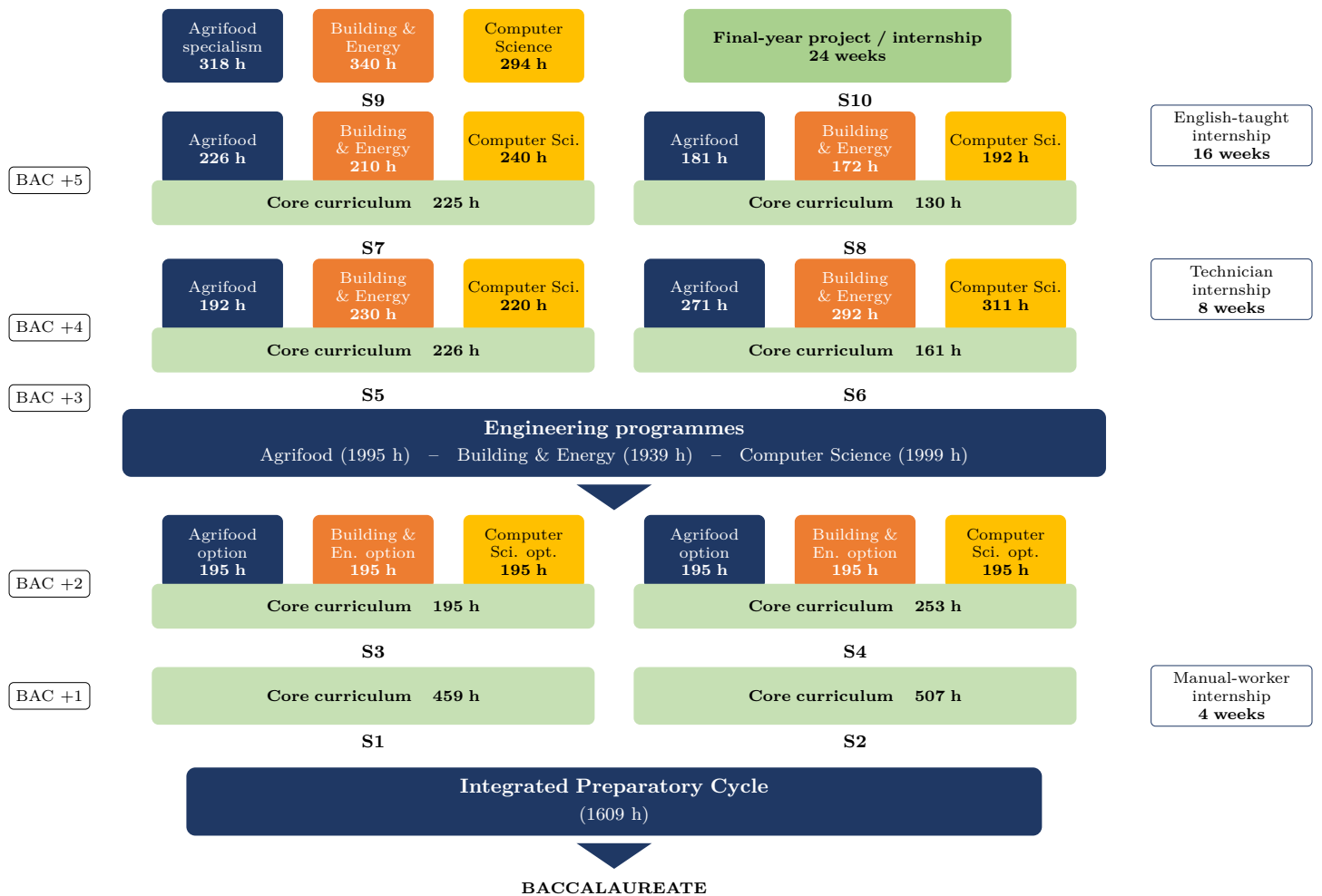
Syllabus of courses

ESIROI | University of La Réunion

ACADEMIC YEAR 2026 - 2027

CTI accreditation 2025 - 2030

Training programmes



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Curriculum overview

Informatique — 3A		SEMESTER S5			
Code	Title	CM	TD	TP	ECTS
UE5-CYBER: UE5-CYBER					
ANG503SEC	English	0	20	10	2
LV2504SEC	English or Second Foreign Language (LV2)	0	10	0	1
SEC501	Discrete Mathematics Fundamentals for Computer Science	8	16	0	2
SEC502	Cybersecurity: Principles, Practices, and Threats	0	16	0	1
UE5-DATA: UE5-DATA					
DAT501	Database Fundamentals: Concepts and Practices	4	12	8	2
DAT502	Data: Description, Presentation, and Analysis	4	4	8	2
DAT503	Geographic Information System (GIS)	4	10	0	1
TRANS505DAT	TES 1: Anthropocene and Diversity, Equity, Inclusion	12	4	0	1
UE5-DEV: UE5-DEV					
DEV501	Algorithms and Data Structures in C	0	26	10	2
DEV502	Web Programming: REST, APIs	0	14	0	1
DEV504	Tools for Engineers: Version Control, Deployment and Documentation	0	10	10	2
SPORT504DEV	Sports	0	12	0	1
UE5-IOT: UE5-IOT					
IOT501	Internet of Things: Principles and Architectures	6	6	12	1
IOT502	IoT SAE	4	0	0	2
SHS503IOT	Tools for Engineers: Software Project Management	0	28	0	2
SHS504IOT	Innovation Methodology	8	0	20	1
UE5-SYSRES: UE5-SYSRES					
SHS503SR	Tools for Engineers: Monitoring and Technical Document Writing	0	16	8	1
SR501	Computer Networks: Fundamental Concepts	4	12	8	1
SR502	System Administration: Concepts, Tools and Services	0	16	8	1
SR503	SAE Systems and Networks	4	0	0	2
SR504	Fundamentals: Probability, Random Variables	8	16	0	1

Informatique — 3A		SEMESTER S6			
Code	Title	CM	TD	TP	ECTS
UE6-CYBER: UE6-CYBER					
ANG604SEC	English	0	20	10	2
LV2605SEC	English or L2	0	10	0	1
SEC601	Information Theory	6	14	0	1
SEC602	Cybersecurity: Cryptography and Applications	6	22	0	1
SEC603	SAE Cybersecurity	4	0	0	1
UE6-DATA: UE6-DATA					
DAT601	Artificial Intelligence and Operations Research	4	10	6	1
DAT602	Data Mining	4	10	6	1
DAT603	SAE Data	4	0	0	2
DAT604	Stochastic processes, queues, simulation	6	18	0	1
TRANS605DAT	TES 2: New Economic and Corporate Governance Models	6	0	0	1
UE6-DEV: UE6-DEV					
DEV601	Software Modeling and Design	4	6	10	1
DEV602	Object-Oriented Programming	4	10	10	1
DEV603	SAE Dev	4	0	0	1
DEV604	Client-side programming and WEB/user interface	4	14	2	1
SHS606DEV	Development and Interpersonal Communication	4	16	10	1
SPORT604DEV	Sports	0	12	0	1
UE6-IOT: UE6-IOT					
IOT601	Internet of Things: Prototyping	2	8	20	1
PROJ603IOT	Supervised Project + Skills Assessment (English/Internship)	0	0	0	3
SHS602IOT	Digital Transformation	0	0	0	2
UE6-SYSRES: UE6-SYSRES					
SR601	Computer Networks: Switching and Routing	4	18	14	2
SR602	Directory Systems Administration	0	10	14	2
SR603	Tools for Engineers: Virtual Environments and Collaboration Practices	0	16	0	2

Informatique — 4A		SEMESTER S7			
Code	Title	CM	TD	TP	ECTS
UE7-CYBER: UE7-CYBER					
ESI-SPI-CI-IN4-UE4-EC1	Cybersecurity: Secure Architecture and Infrastructure	4	28	0	2
ESI-SPI-CI-IN4-UE4-EC2	Cybersecurity: Offensive Security Methodologies	0	14	10	1

Informatique — 4A		SEMESTER S7			
Code	Title	CM	TD	TP	ECTS
ESI-SPI-CI-IN4-UE4-EC3	English	0	20	10	2
ESI-SPI-CI-IN4-UE4-EC4	English or Second Foreign Language (L2)	0	10	0	1
UE7-DATA: UE7-DATA					
ESI-SPI-CI-IN4-S7-UE5-EC1	Massive Data Systems	4	16	4	1
ESI-SPI-CI-IN4-S7-UE5-EC2	Machine Learning	4	12	8	1
ESI-SPI-CI-IN4-S7-UE5-EC3	SAE Data	4	0	2	2
ESI-SPI-CI-IN4-S7-UE5-EC4	Law and Ethics in Computer Engineering	8	20	10	1
ESI-SPI-CI-IN4-S7-UE5-EC5	TES: OSH, CSR, Ethics	22	0	0	1
UE7-DEV: UE7-DEV					
ESI-SPI-CI-IN4-S7-UE3-EC1	Mobile Programming	4	10	10	1
ESI-SPI-CI-IN4-S7-UE3-EC2	Theory of Languages	4	10	10	1
ESI-SPI-CI-IN4-S7-UE3-EC3	Sports	0	12	0	1
UE7-IOT: UE7-IOT					
ESI-SPI-CI-IN4-S7-UE2-EC1	Internet of Things: Embedded and Real-Time Systems	0	18	10	1
ESI-SPI-CI-IN4-S7-UE2-EC2	IoT SAE	4	0	2	2
ESI-SPI-CI-IN4-S7-UE2-EC3	Innovation competition	4	0	16	1
ESI-SPI-CI-IN4-S7-UE2-EC4	Data Analysis for IoT	4	4	8	1

Informatique — 4A		SEMESTER S7			
Code	Title	CM	TD	TP	ECTS
ESI-SPI-CI-IN4-S7-UE2-EC5	Digital Innovation	0	20	0	1
UE7-SYSRES: UE7-SYSRES					
ESI-SPI-CI-IN4-S7-UE1-EC1	Computer Networks: Administration, Supervision and Management	4	10	6	2
ESI-SPI-CI-IN4-S7-UE1-EC2	System Administration: Orchestration, Containers and Automation	4	10	6	1
ESI-SPI-CI-IN4-S7-UE1-EC3	SAE Systems and Networks	4	0	2	2
ESI-SPI-CI-IN4-S7-UE1-EC4	Interconnection of Networks: Theories and Protocols	4	10	6	1

Informatique — 4A		SEMESTER S8			
Code	Title	CM	TD	TP	ECTS
UE8-CYBER: UE8-CYBER					
ESI-SPI-CI-IN4-S8-UE4-EC1	Cybersecurity: Exfiltration, Evasion and Malware	4	8	12	1
ESI-SPI-CI-IN4-S8-UE4-EC2	Cybersecurity SAE	4	0	2	1
ESI-SPI-CI-IN4-S8-UE4-EC3	Cybersecurity: Risks, Incidents and Compliance	4	12	4	1
ESI-SPI-CI-IN4-S8-UE4-EC4	English	0	20	10	2
ESI-SPI-CI-IN4-S8-UE4-EC5	English or L2	0	10	0	1
UE8-DATA: UE8-DATA					
ESI-SPI-CI-IN4-S8-UE5-EC1	Deep Learning	4	18	0	2
ESI-SPI-CI-IN4-S8-UE5-EC2	Data Analysis: Methods and Applications	4	16	0	2
UE8-DEV: UE8-DEV					

Informatique — 4A		SEMESTER S8			
Code	Title	CM	TD	TP	ECTS
ESI-SPI-CI-IN4-S8-UE3-EC1	Quality Management and Eco-Design of Software	4	8	6	1
ESI-SPI-CI-IN4-S8-UE3-EC2	Server-side Programming	4	8	6	2
ESI-SPI-CI-IN4-S8-UE3-EC3	Software Engineering SAE	4	0	2	2
ESI-SPI-CI-IN4-S8-UE3-EC4	Individual follow-up / Portfolio	0	0	2	0
ESI-SPI-CI-IN4-S8-UE3-EC5	Sports	0	12	0	1
UE8-IOT: UE8-IOT					
ESI-SPI-CI-IN4-S8-UE2-EC1	Internet of Things: Design Project	0	12	0	1
ESI-SPI-CI-IN4-S8-UE2-EC2	Management, Marketing and Entrepreneurship	10	36	0	1
ESI-SPI-CI-IN4-S8-UE2-EC3	Innovation competition	0	4	10	1
ESI-SPI-CI-IN4-S8-UE2-EC4	Project-based learning	0	0	0	3
UE8-SYSRES: UE8-SYSRES					
ESI-SPI-CI-IN4-S8-UE1-EC1	Next-Generation Networks: Concepts and Innovations	6	4	14	2
ESI-SPI-CI-IN4-S8-UE1-EC2	System Administration: Storage and Infrastructure Monitoring	4	6	6	2
ESI-SPI-CI-IN4-S8-UE1-EC3	System Administration: Virtualization	6	8	6	2

Informatique — 5A		SEMESTER S9			
Code	Title	CM	TD	TP	ECTS
UE9-Projet: UE9-Projet					
PROJ901	Final year project / Individualized SAE	40	40	0	3

Informatique — 5A		SEMESTER S9			
Code	Title	CM	TD	TP	ECTS
UE9-Ressources: UE9-Ressources					
ANG804SEC	English	10	0	0	2
DAT901	Advanced Data Science	10	8	6	3
DEV901	Introduction to Research	16	8	0	3
IOT903	Internet of Things: Deployment	10	8	6	3
SEC901	Cybersecurity: Reverse Engineering and Exploit Development	10	8	6	3
SR901	Culture DevOps: Continuous Improvement and Collaboration	8	8	8	3

Informatique — 5A		SEMESTER S10			
Code	Title	CM	TD	TP	ECTS
Stages: Stages					
PROJ100	Technical internship				
PROJ102	English-speaking Internship	0	0	0	10
PROJ103	Final Internship	0	0	0	20

IDENTIFICATION

Course code : ANG503SEC
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 20
Labs : 10
Total : 30

Project :
Personnal work :

ASSESSMENT

Internal assessment : Practical application of professional skills Minimum of 2 assessments per semester External assessment : TOEIC (S8/S9)

TEACHING MATERIALS

General English : Current events, press, Internet Specialized English : Technical and scientific resources Professional-oriented English : CV, cover letter, email TOEIC past papers

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-CYBER

COURSE : English

SCOPE OF THE COURSE

OBJECTIVES

This course, taught in English, aims to develop pragmatic, sociocultural, and linguistic competencies aligned with the CEFR (<https://rm.coe.int/16802fc3a8>) across the four language skills, through varied teaching methods in interactive lectures, tutorials, and practical sessions. Activities include listening and reading comprehension, written production (essays, summaries, memos, internship reports), and oral production (presentations, group projects, improvisations, discussions, and debates), preparing students for professional English use while fostering critical thinking.

COMPETENCE AND SKILLS

- Use technical documents in English
- Communicate orally and in writing, adapting to the technical knowledge level of interlocutors
- Prepare for the TOEIC : Level 1 (B1.1)

PROGRAM

- Understanding written and oral documents
- Writing a short synthesis
- Paraphrasing/summarizing texts
- Grammatical accuracy : verb phrases, tenses, noun phrases
- Mastery of specific English phonemes, rhythm, and intonation
- Standard language register

BIBLIOGRAPHY

- Authentic written and oral documents, Internet, television resources, foreign press, digital tools, language-learning tools
- Global Exam, British Council, BBC Learning English, VoA, monolingual dictionaries
- TOEIC past papers
- Websites of international and European organizations, both general and specific :
 - General : UN, WHO, WEF, IMF, WTO, World Bank...
 - Specific : IEEE, IETF, NIST, ENISA, NCSC...

REQUIREMENTS

B1 level (CEFR)

IDENTIFICATION

Course code : LV2504SEC
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 10
Labs : 0
Total : 10

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and guided work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-CYBER

COURSE : English or Second Foreign Language (LV2)

SCOPE OF THE COURSE

OBJECTIVES

This course aims to develop students' linguistic, cultural, and communicative skills in a second foreign language (Chinese or Spanish). It focuses on acquiring language fundamentals, oral and written fluency, as well as discovering associated cultures, to prepare students for interactions in personal, professional, or academic contexts.

COMPETENCE AND SKILLS

- Communicate with various stakeholders (clients, management, users, IT managers, regulatory bodies such as CNIL, ANSSI) in both written and oral forms
- Ensure appropriate communication with stakeholders, including clients, administrations, citizens, and civil society.

PROGRAM

1. Linguistic initiation

- Basic grammatical structures : present indicative, adjectives, pronouns.

2. Oral communication

- Techniques to improve pronunciation and oral fluency.

3. Written comprehension and expression

- Writing simple letters or emails (self-introduction, information requests).

4. Linguistic and intercultural deepening

- Study of songs, poems, or literary excerpts adapted to the level.

5. Practical project and continuous assessment

- Regular oral and written evaluations to monitor progress.

BIBLIOGRAPHY

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REQUIREMENTS

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IDENTIFICATION

Course code : SEC501
ECTS : 2

DURATION

Lectures : 8
Tutorial classes : 16
Labs : 0
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessment : two written evaluations

TEACHING MATERIALS

Slides and guided-work worksheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-CYBER

COURSE : Discrete Mathematics Fundamentals for Computer Science

SCOPE OF THE COURSE

OBJECTIVES

Provide engineering students with the essential foundations of discrete mathematics required to solve common problems across all fields of computer science.

COMPETENCE AND SKILLS

- Select cryptographic tools suited to the requirements of a specification document
- Implement, from design to production deployment, a company's IT network while integrating QoS and security considerations
- Conduct exploratory data analysis

PROGRAM

- Reminders : fundamentals of set theory, propositional logic, proofs
- Equivalence relations and order relations, quotient set
- Algebraic structures : groups, rings, fields
- Basic arithmetic : Euclidean division, GCD, prime numbers, Bézout's theorem, Euler's totient function
- Structure of the set $\mathbb{Z}/n\mathbb{Z}$ and operations in this set
- Arithmetic theorems : Fermat-Euler, Chinese remainder theorem
- The ring $K[X]$ of polynomials, arithmetic in $K[X]$

BIBLIOGRAPHY

- Richard Hammack - *Book of Proofs* - Available for download : <http://www.people.vcu.edu/~rhammack/BookOfProofs/> (Creative Commons license)
- Jacques Vélú - *Mathematical Methods for Computer Science* - Dunod Éditions, *Sciences Sup* collection
- J.P. Ramis and A. Warusfel (edited by) - *Mathematics : All-in-One for the Bachelor's Degree, Level L1* - Dunod Éditions

REQUIREMENTS

Discrete Mathematics learned in high school then in CPGE/L1-L3/IUT/BTS

IDENTIFICATION

Course code : SEC502
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 16
Labs : 0
Total : 16

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides, SecNumAcademy MOOC (ANSSI).

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-CYBER

COURSE : Cybersecurity : Principles, Practices, and Threats

SCOPE OF THE COURSE

OBJECTIVES

Discover the risks faced by individuals and information systems on the Internet, and understand why cybersecurity is a challenging implementation.

COMPETENCE AND SKILLS

- Describe the operating methods of APTs (Advanced Persistent Threats)
- Select cryptographic tools suited to the requirements of a specification
- Use network/system penetration testing tools
- Work with technical documents in English

PROGRAM

- Cybersecurity organization in France : ANSSI (National Cybersecurity Agency of France).
- Security criteria : availability, integrity, confidentiality, and proof.
- Understanding risk, threat, vulnerability, and attack vector concepts (including the fact that perfect security does not exist).
- Cybercriminal actors and their operating methods
- Documenting an example of “countermeasures” for specific simple threats.
- Listing capabilities and tools that enable continuous identification of cybersecurity risks.
- Demonstrating the concept of identity management and its importance.
- Giving meaning to authentication, authorization, and access control concepts.
- Arguing the benefits of multi-factor authentication.

BIBLIOGRAPHY

Solange Ghernaoui - *Cybersecurity and Networks* - Sciences Sup Collection - Dunod Editions

REQUIREMENTS

No theoretical prerequisites for this module ; basic knowledge of computer science and networking.

IDENTIFICATION

Course code : DAT501
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 12
Labs : 8
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides and guided practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-DATA

COURSE : Database Fundamentals : Concepts and Practices

SCOPE OF THE COURSE

OBJECTIVES

The goal of this course is to understand the principles of data management.

- Data and information concepts
- Data modeling
- Database query languages
- Data organization architecture
- Specialized databases
- Database environment management

COMPETENCE AND SKILLS

Designing and querying databases efficiently

PROGRAM

- **Database Perspectives and Impact** Describe the evolution of data storage and retrieval. Understand the advantages of a database approach compared to traditional file processing. Describe the impact of Internet growth on data volume, manipulation, and processing. Outline the history of database models and their evolution.
- **Data and Information Concepts** Describe the role of data, information, and databases in organizations. Compare and use key terms such as : information, data, database, database management system, metadata, and data mining. Illustrate data quality, accuracy, and timeliness, and explain the impact of their absence on organizations. Describe data collection mechanisms and their implications (automated data collection, input forms, sources). Outline fundamental data retention issues, including the need for retention, physical storage, backup, and security.
- **Data Modeling** Design Entity-Relationship diagrams based on appropriate organizational rules for a given scenario. Describe the relationship between a logical model and a physical model. Evaluate the importance of database constraints. Design a physical model for optimal performance, including the impact of normalization and indexing. Compare and contrast the differences and similarities between the relational model and the dimensional data model (OLTP vs. OLAP).
- **Database Query Languages** Create, modify, and query database objects using Structured Query Language (SQL). Perform data filtering and sorting using various clauses, including WHERE, ORDER BY, BETWEEN, LIKE, GROUP BY, and HAVING. Use joins to select data from multiple tables. Use built-in SQL queries. Perform calculations in a query using computed fields and aggregate functions. Create updatable and non-updatable views.
- **Data Organization Architecture** Demonstrate relational operations such as selection, projection, union, intersection, set difference, and natural join using simple examples of provided relations. Contrast and compare relational database concepts with non-relational databases, including object-oriented databases, XML, NewSQL, and NoSQL. Express the relationship between functional dependencies and keys, and provide examples. Evaluate data integrity

and provide examples of entity integrity and referential integrity. Analyze how fragmentation, replication, and data allocation affect database performance.

- **Specialized Databases** Describe the main concepts of object-oriented databases, XML, NewSQL, and NoSQL. Demonstrate an understanding of online analytical processing and data warehouse systems. Describe data mining methods and what these methods can reveal.
- **Database Environment Management** Contrast and compare data administration and database administration. Describe common tasks performed by database administrators. Create and manage database users, roles, and privileges. Consider the concept of database security, backup, and recovery. Evaluate the importance of metadata in a database environment.

BIBLIOGRAPHY

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : DAT502
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 4
Labs : 8
Total : 16

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides and guided practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-DATA

COURSE : Data : Description, Presentation, and Analysis

SCOPE OF THE COURSE

OBJECTIVES

Presenting data in an appropriate form is a challenging yet important task. For data scientists, this fundamentally enables them to display data in an attractive, easily and correctly understandable form for users, while also potentially providing valuable insights into the underlying structure of the data. This course aims to describe the tools, methods, and best practices for extracting information and visualizing it, whether in the context of exploratory analysis or the description of final results.

COMPETENCE AND SKILLS

Perform exploratory data analysis Visualize data

PROGRAM

Visualization approaches tailored to data types The role of visualization in data science. Illustrations, including historical and contemporary examples of visualization. Characteristics of effective visualization. Suitability of different techniques for different data and different users. Dashboards and interactive visualization. Software tools for visualization. Inference based on visualization. Preparing visualization—scaling, role of color. Types of charts—tables, scatter plots, pie charts, histograms, graphs, data maps, including pixel-based, glyph-based, graph-based, and map-based representations.

Working with different data types Data representation : numbers, text, images, data precision. Text data processing : bag of words, word counting, TF-IDF, n-grams, lexical analysis, syntactic analysis, semantic analysis, stopword filtering, stemming, basic applications. Image processing : data representation : multidimensional integer matrices, features, image operators, video operators. Object recognition. Extraction of higher-order features.

Information extraction Information Extraction (IE) is the task of automatically extracting structured information from unstructured and/or semi-structured machine-readable documents. It is an important technique for acquiring data from documents, web pages, and even multimedia content.

Data transformation Data transformation pipeline. Simple transformation function methods and their applications. Data normalization and its applications. Data encoding approaches and their applications. Data smoothing approaches and their applications.

Data cleaning Dimensions of data quality. Approaches to improving data quality. Data cleaning algorithms, including entity resolution, truth discovery, rule-based data cleaning. Different forms for data quality rules such as functional dependencies (FD), conditional functional dependencies (CFD), conditional inclusion dependencies (CIND), and matching dependencies (MD).

BIBLIOGRAPHY

REQUIREMENTS

- Basic knowledge of Python.
- DATA 051 : Databases.
- DEV 052 : Web Programming

IDENTIFICATION

Course code : DAT503
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 0
Total : 14

Project :
Personnal work :

ASSESSMENT

A knowledge assessment and a lab report.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-DATA

COURSE : Geographic Information System (GIS)

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to provide the necessary concepts in geographic information systems to efficiently manipulate this data within IoT projects or spatial data analysis projects.

COMPETENCE AND SKILLS

Perform exploratory data analysis Visualize data

PROGRAM

Spatio-temporal Information Systems

- Spatio-temporal data and spatio-temporal modeling ;
- Spatial indexing ;
- Spatial queries ;
- Spatial integrity constraints ;
- GIS interoperability ;
- Major Geographic Information Systems (GIS) on the market.

Tele-geomatics

- Telecommunications geomatics ;
- Modern positioning systems (GPS, etc.) ;
- Real-time decision-making ;
- Information exchange between geographically distributed sites.

Applications

- Overview of potential applications : Natural disaster and emergency management, precision agriculture ; forestry ; health and public safety ; mobility information and tele-geomatics ; navigation and monitoring in transportation ; oceans and coastal areas ; land and wetlands.
- Examples of specialized applications (e.g., real-time volcano monitoring) ;
- Examples of web-based applications (e.g., hazardous materials traffic management).

BIBLIOGRAPHY

Geographic Information Systems : Course and exercises with Grass and Qgis

REQUIREMENTS

Python programming, basic database knowledge, high school-level geometry.

IDENTIFICATION

Course code : TRANS505DAT
ECTS : 1

DURATION

Lectures : 12
Tutorial classes : 4
Labs : 0
Total : 16

Project :
Personnal work :

ASSESSMENT

Individual assessment Oral presentation
Submission of a report

TEACHING MATERIALS

Course materials

LANGUAGE

English

CONTACT

François GARDE

Modifié le : 14 juillet 2026

UE : UE5-DATA

COURSE : TES 1 : Anthropocene and Diversity,
Equity, Inclusion

SCOPE OF THE COURSE

OBJECTIVES

Understand the functioning of the Earth system and its evolution (past, present, future) by highlighting the unprecedented nature of current changes (pace, great acceleration) and tipping points, demonstrating the anthropogenic origin of these disturbances, and considering all time scales

Gain an overview of forms of inequalities and discrimination in professional settings

COMPETENCE AND SKILLS

— Reduce the environmental impact of a product and integrate the challenges of a just, equitable, and inclusive ecological transition

— Integrate the challenges of a just, equitable, and inclusive ecological transition

PROGRAM

12h (10h lectures / 2h tutorials) - The Anthropocene : origins and global challenges — Climate and energy transitions — Biodiversity and living systems challenges — Natural resource management — Solutions and perspectives : towards a sustainable future

4h (2h lectures / 2h tutorials) - Collective workshop during the integration week : — Preventing inequalities and discrimination in human resources management

BIBLIOGRAPHY

UVED portal - MOOC

NF ISO 30415 : Human resources management - Diversity and inclusion, September 2021. NF ISO 53800 : Guidelines for promoting and implementing gender equality and women's empowerment, May 2024. AFNOR SPEC Z77-103-0 : Digital inclusion : Good practice guide for tailored adaptation, February 2022. Guide for non-discriminatory recruitment, French Ombudsman, June 2019. Discrimination based on sexual orientation and gender identity, French Ombudsman, March 2020.

REQUIREMENTS

None

IDENTIFICATION

Course code : DEV501
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 26
Labs : 10
Total : 36

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides and guided work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-DEV

COURSE : Algorithms and Data Structures in C

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to learn programming by reusing classic techniques and data structures while integrating complexity constraints. The required language is C, which will provide a deep understanding of data structure implementation, particularly useful in embedded systems.

COMPETENCE AND SKILLS

- Apply a methodology and formalism to design and develop an application
- Write and implement software tests

PROGRAM

General presentation of the C language : instructions and basic types, functions, pointers, files...

- **Program development** Develop a correct program to solve problems using an iterative process, documentation of program components, and consultation with program users. Use appropriate abstractions to facilitate program writing : collections, procedures, application programming interfaces, and libraries. Evaluate how a program is written in terms of program style, expected behavior for specific inputs, correctness of program components, and description of functionalities. Develop a program using tools adapted to current industry practices : version control, project hosting, and deployment services.
- **Fundamental data structures** Write programs that use data structures (built-in, library, and programmer-defined) : strings, lists, and maps. Analyze the performance of different data structure implementations. Choose appropriate data structures to model a given problem. Explain the rationale behind the chosen data structures.
- **Principles and development of algorithms** Describe why and how algorithms solve computational problems. Create algorithms to solve a computational problem. Explain how programs implement algorithms in terms of instruction processing, program execution, and ongoing processes. Apply appropriate mathematical concepts to programming : expressions, abstract data types, recurrence relations, and formal reasoning on algorithm efficiency and correctness. Empirically evaluate the efficiency of an algorithm.

BIBLIOGRAPHY

- Open data structures, Pat Morin (opensource <https://opendatastructures.org/>)
- Introduction to algorithms, Erik Demaine, Jason Ku, Justin Solomon <https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/>
- The C programming language. Kernighan, Brian W.; Ritchie, Dennis M. Prentice Hall, (2016)
- Data Structures and Program Design In C. Robert L. Kruse, Bruce P. Leung, Clovis L. Tondo, (1996, Pearson)

REQUIREMENTS

C and C++ programming from CPI (syntax, pointers, organization of C program files...).

IDENTIFICATION

Course code : DEV502
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 14
Labs : 0
Total : 14

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and guided practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-DEV

COURSE : Web Programming : REST, APIs

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to gain a deeper understanding of the design and implementation of web applications (e.g., using Python), JavaScript, and SQL. Specific frameworks may be used. Topics include database design, scalability, security, and user experience. Through practical projects, students learn to write and use APIs, and to create interactive user interfaces. Engineering students will thus gain experience with the principles, languages, and tools needed to design and deploy applications on the Internet.

COMPETENCE AND SKILLS

- Master the fundamental paradigms of programming, languages, and algorithms to design and develop applications for any environment
- Master and use essential procedures and mechanisms of operating systems, networks, virtualization, and cloud computing for the deployment and maintenance of accessible services

PROGRAM

- HTML, CSS
- Git
- Back-end programming language
- SQL
- JavaScript
- User interface
- Testing, CI/CD
- Security and scalability

BIBLIOGRAPHY

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : DEV504
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 10
Labs : 10
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides and guided practical work sheets.

LANGUAGE

English

CONTACT

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UE : UE5-DEV

COURSE : Tools for Engineers : Version Control, Deployment and Documentation

SCOPE OF THE COURSE

OBJECTIVES

This course aims to introduce students to essential tools used in the software development lifecycle : version control, deployment, and documentation. It seeks to provide the practical and theoretical skills necessary to collaborate effectively in a team, manage project versions, automate deployments, and produce clear, maintainable technical documentation.

COMPETENCE AND SKILLS

- Produce technical documentation
- Organize projects according to project management methodologies
- Write technical documentation and design presentation materials in French and English
- Manually deploy and administer services
- Produce and manage documentation for an IT infrastructure

PROGRAM

- Introduction to version control with Git
- Workflow automation
- Technical documentation and associated tools
- Integrated practice : end-to-end project management

BIBLIOGRAPHY

- Scott Chacon and Ben Straub, Pro Git Book, Apress (2014)

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : SPORT504DEV
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 12
Labs : 0
Total : 12

Project :
Personnal work :

ASSESSMENT

Performance tracking and establishment of personal objectives.

TEACHING MATERIALS

Documentation

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-DEV

COURSE : Sports

SCOPE OF THE COURSE

OBJECTIVES

This course aims to promote health, well-being, and the values of sports through the practice of varied physical activities, while strengthening their ability to work in teams and surpass themselves. Through a variety of sports activities and co-operative games, students will be encouraged to develop essential interpersonal skills such as communication, collaboration, and leadership.

COMPETENCE AND SKILLS

- Communicate orally, adapting to the technical knowledge level of the interlocutors
- Organize the project according to project management methodologies

PROGRAM

- Physical initiation and preparation
- Team sports and team spirit
- Individual sports and personal development
- Health and prevention

BIBLIOGRAPHY

- Jonny Wilkinson, *The Winning Mind*, 2012
- Mike Horn, *Dare to Reach the Stars*, 2016
- Grégoire Chevignard, *From My Couch to the World's Toughest Race*, 2018

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : IOT501
ECTS : 1

DURATION

Lectures : 6
Tutorial classes : 6
Labs : 12
Total : 24

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and guided work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-IOT

COURSE : Internet of Things : Principles and Architectures

SCOPE OF THE COURSE

OBJECTIVES

To provide engineering students with the foundations to identify IoT-enabled applications and the elements of the IoT ecosystem required to implement these applications.

COMPETENCE AND SKILLS

- List and implement IoT network protocols
- Implement IoT-specific data distribution protocols
- Select suitable development environments (IDE) for prototyping and product development

PROGRAM

1. Introduction to IoT and its applications
 - Definition and challenges of IoT.
 - Examples of applications in various fields (healthcare, agriculture, smart cities, Industry 4.0).
 - Case study of existing IoT projects.
2. IoT Connectivity : Protocols and Networks
 - LPWAN networks : LoRaWAN, SigFox, LTE-M, NB-IoT.
 - Sensor networks : Zigbee, Thread, 6TiSCH, BLE-mesh.
 - Criteria for selecting a protocol (range, power consumption, bandwidth).
3. Hardware Architectures : IoT Microcontrollers
 - Overview of ARM Cortex and RISC-V architectures.
 - Criteria for selecting a microcontroller based on IoT constraints.
 - Practical examples using development boards.
4. Programming Environments
 - Introduction to tools : Segger, STM32CubeIDE, Zephyr.
 - Practical implementation : creating a simple IoT project (sensor + communication).
5. Data Formats and Associated Protocols
 - Exploration of CBOR formats and CoAP, Matter, 6LoWPAN protocols.
 - Practical cases : transmission and interpretation of IoT data.
6. Review of Classic IoT Sensors
 - Presentation of temperature, humidity, accelerometer, vibration, light, and sound sensors.

- Methods for integrating sensors into an IoT ecosystem.

7. Measuring and Optimizing Energy Consumption

- Principles of consumption measurement.
- Optimization techniques to extend the lifespan of IoT devices.
- Study of trade-offs between performance and power consumption.

BIBLIOGRAPHY

- Timothy Chou, *Precision : Principles, Practices and Solutions for the Internet of Things*, 2016

REQUIREMENTS

Algorithms and data structures in C

IDENTIFICATION

Course code : IOT502
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 0
Total : 4

Project :
Personnal work :

ASSESSMENT

Skills will be assessed based on deliverables, using a criterion-based rubric presented to students beforehand.

TEACHING MATERIALS

All documents used during the course. Additional references may be provided if needed.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE5-IOT

IoT SAE

SCOPE OF THE CHALLENGE

WORKING SITUATION

Develop an application and connect a device to the Internet, while learning project management and IoT product valorization.

COMPETENCES AND LEVEL ASSESSED

Design an architecture for the Internet of Things

EXPECTED OUTPUTS

- Applications
- GIT repository
- Documentation
- Presentation

RESOURCES

- Lecturers in IoT-related subjects and engineering tools
- IoT professionals

IDENTIFICATION

Course code : SHS503IOT
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 28
Labs : 0
Total : 28

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides and guided practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-IOT

COURSE : Tools for Engineers : Software Project Management

SCOPE OF THE COURSE

OBJECTIVES

This course aims to equip students with essential skills to plan, organize, and effectively manage software projects. Through learning modern tools and agile methodologies, students will be able to collaborate in teams, monitor projects, and deliver results aligned with defined objectives and constraints.

COMPETENCE AND SKILLS

- Apply a methodology and formalism to design and develop an application
- Organize the project according to project management methodologies
- Select suitable development environments (IDE) for prototyping and product development

PROGRAM

- Introduction to software project management
- Tools for project management
- Project management methodologies
- Practical project : managing a software project

BIBLIOGRAPHY

Robert K. Wysocki, *Effective Project Management : Traditional, Agile, Extreme, Hybrid*, 2019

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : SHS504IOT
ECTS : 1

DURATION

Lectures : 8
Tutorial classes : 0
Labs : 20
Total : 28

Project :
Personnal work :

ASSESSMENT

Group assessment Individual assessment

TEACHING MATERIALS

Handouts, equipment

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-IOT

COURSE : Innovation Methodology

SCOPE OF THE COURSE

OBJECTIVES

Students are able to develop an innovative prototype based on immersion tools, creativity, marketing, economic feasibility and viability, and project management while respecting sustainability principles.

COMPETENCE AND SKILLS

Analyze needs and context Detect opportunities (using functional analysis) Generate ideas and combine them into innovative products/services Analyze simple technical and financial feasibility

PROGRAM

- Research : inspiration and analysis
- Understanding user needs, ideation, prototyping, and testing.
- Teamwork : Effective collaboration, task distribution, and communication.
- Rapid prototyping : Creating mockups and functional prototypes.
- Problem-solving : Identifying and analyzing complex problems, mastering problem-solving tools, generating and selecting innovative solutions, and developing an action plan
- Communication : Clear and persuasive presentation of ideas and solutions, responding to jury questions

BIBLIOGRAPHY

Design Sprint : A Practical Guidebook for Building Great Digital Products, Richard Banfield, Todd Lombardo, Trace Wax, 2015 Sprint, Jake Knapp, John Zeratsky, Braden Kowitz, 2016 Le Design Sprint en pratique, Pauline Thomas, 2020

REQUIREMENTS

Research and information monitoring tools (web...) Managing data (sorting, storing files, backup and sharing tools...) Word processing tools Using spreadsheets (organizing, classifying, sorting, simple operations...) Using word processing software

IDENTIFICATION

Course code : SHS503SR
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 16
Labs : 8
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides and guided work sheets.

LANGUAGE

English

CONTACT

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UE : UE5-SYSRES

COURSE : Tools for Engineers : Monitoring and Technical Document Writing

SCOPE OF THE COURSE

OBJECTIVES

This course aims to develop the skills necessary to conduct effective monitoring and write structured, clear reports. It will teach various monitoring methods, information analysis, and result presentation.

COMPETENCE AND SKILLS

- Produce technical documentation
- Write technical documentation and design presentation materials in French and English
- Produce and manage documentation for an IT infrastructure
- Use technical documents in English

PROGRAM

- Introduction to strategic monitoring
- Monitoring methodologies
- Analysis of collected information
- Report writing

BIBLIOGRAPHY

- Justin Zobel, *Writing for Computer Science*, Springer (2015)
- Hélène DESVALS and Henri DOU, *Technological monitoring : scientific, technical, and industrial information*, Bulletin des bibliothèques de France (BBF), 1993

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : SR501
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 12
Labs : 8
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-SYSRES

COURSE : Computer Networks : Fundamental Concepts

SCOPE OF THE COURSE

OBJECTIVES

The objective of this course is to provide an overview of all the elements and concepts constituting computer networks. Upon completion of this course, students should be able to configure workstations, identify configuration issues, propose a structuring of network entities, and select the appropriate protocols for a given application context.

COMPETENCE AND SKILLS

Set up, from design to production deployment, the computer network of a company while integrating QoS and security issues.

PROGRAM

- Introduction : objectives of a communication network, network architecture, OSI model.
- Overview : Data transmission (analog, digital), bit rate and modulation speed, digital multiplexing, switching, routing, addressing, routing, and congestion control.
- Reliability of exchanges : error control, error-detecting codes, flow control.
- Internet structure. Standardization actors in Internet technology.
- Network applications : remote connection, TELNET protocol, NVT representation, rlogin, ssh. File transfer, FTP and TFTP protocols, rcp, scp. Messaging architecture, message structure, MIME format, SMTP, POP, and IMAP protocols. Directory, Internet naming hierarchy, DNS protocol. Administration, MIB, SMI, SNMP protocol, RMON probe. Peer-to-peer applications
- The Transport layer : Introduction to transport layer services. Port concept. End-to-end control mechanisms (error control, timers, retransmission policies, flow and congestion control). Connectionless transport : UDP. Connection-oriented transport : TCP and its different versions
- The Network layer : Review of the network layer. IPv4 protocol, classful and classless addressing (CIDR), subnetting. Address resolution (ARP), ICMP protocol. Translation (NAT) and address filtering (Firewall). Auto-configuration (DHCP) and tunneling

BIBLIOGRAPHY

James F. KUROSE and Keith W. ROSS - Computer Networking - Pearson Editions

REQUIREMENTS

No prerequisites in networking.

IDENTIFICATION

Course code : SR502
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 16
Labs : 8
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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UE : UE5-SYSRES

COURSE : System Administration : Concepts, Tools and Services

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to provide basic knowledge of operating systems, their use, various utilities, and task automation scripts.

COMPETENCE AND SKILLS

Manually deploy and administer services

PROGRAM

- Operating modes and functions of an operating system
- Processes : representation, operations, lightweight processes (Unix and Java threads), processor : state switching, interrupts.
- Synchronization and concurrency : the mutual exclusion problem, semaphores, monitors, classic mutual exclusion and synchronization problems, concurrent programming in CSP, Java.
- Information management : link editing, execution stack.
- Main memory management : zone-based, paging, segmentation management.
- File management : sequential access, direct access, hash-coding.
- User management : Login, basic commands, groups and user identification
- File system management : concepts, protections, main commands for file and directory management, disk device management.
- User and process management : understanding rights and priority management under Unix, process states and current management.
- Advanced commands : Redirections, piping, Sed, awk, regexp
- The shell : Different shells, Environment variables, Script writing.
- Network operations : X11, standard network commands (traceroute, ping, nmap, ...).

BIBLIOGRAPHY

- Operating Systems : Three Easy Pieces. Remzi H Arpaci-Dusseau, Andrea C Arpaci-Dusseau (2020)
- Operating System Concepts (Tenth Edition). Abraham Silberschatz, Peter B. Galvin, Greg Gagne (2018)

REQUIREMENTS

No prerequisites

IDENTIFICATION

Course code : SR503
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 0
Total : 4

Project :
Personnal work :

ASSESSMENT

Skills will be assessed based on the elements provided in the deliverable, which will be specified in advance to the engineering students.

TEACHING MATERIALS

All documents used during teaching sessions or resources mobilized. If necessary, additional documentary references will be provided.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE5-SYSRES

SAE Systems and Networks

SCOPE OF THE CHALLENGE

WORKING SITUATION

Designing and administering an enterprise network, deploying servers and services.

COMPETENCES AND LEVEL ASSESSED

Designing the architecture of an information system

EXPECTED OUTPUTS

The deliverables will be included in a GIT repository that has been used throughout the SAE. It must include evidence of task structuring and distribution (e.g., issues, commits, branches, etc.). Task 1 will result in a report detailing the chosen architecture and justifying its relevance with respect to the constraints outlined in the specifications. It will be based on scientific articles or expert feedback published by editors or domain specialists. All elements required for Task 2 must be included in the GIT repository. Documentation enabling the deployment to be reproduced must also be present. The procedure for evaluating the robustness and load tolerance of the solution must also be included in the repository.

RESOURCES

- Network lecturers
- System administration lecturer
- Database lecturer
- Engineering tools lecturer

IDENTIFICATION

Course code : SR504
ECTS : 1

DURATION

Lectures : 8
Tutorial classes : 16
Labs : 0
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessment : two written evaluations.

TEACHING MATERIALS

Slides and guided exercise handouts.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE5-SYSRES

COURSE : Fundamentals : Probability, Random Variables

SCOPE OF THE COURSE

OBJECTIVES

Consolidate essential probability knowledge required to solve problems modeled by random experiments, frequently encountered in computer science.

COMPETENCE AND SKILLS

- Select cryptographic tools suited to a project specification
- Design, from conception to production deployment, a company's IT network while addressing QoS and security issues
- Perform exploratory data analysis

PROGRAM

- Probability space : sample space, sigma-algebra, probability measure
- Conditional probability
- Discrete and continuous random variables : common distributions, expectation, variance
- Convergence of sequences of random vectors : law of large numbers, central limit theorem
- Estimation (point estimation, confidence intervals), hypothesis testing

BIBLIOGRAPHY

J.P. Ramis and A. Warusfel (edited by) - *Mathématiques : tout-en-un pour la Licence, Niveau L2* - Éditions Dunod

REQUIREMENTS

Probability learned in high school followed by CPGE/L1-L3/IUT/BTS

IDENTIFICATION

Course code : ANG604SEC
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 20
Labs : 10
Total : 30

Project :
Personnal work :

ASSESSMENT

Internal assessment : Situational tasks on professional skills, at least 2 assessments per semester
External assessment : TOEIC (Semester 8/9)

TEACHING MATERIALS

General English : Current affairs topics, press, Internet
Specialized English : Technical and scientific resources
Professional English : CV, cover letter, email
TOEIC past papers

LANGUAGE

English

CONTACT

Edel LYNCH
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Modifié le : 14 juillet 2026

UE : UE6-CYBER

COURSE : English

SCOPE OF THE COURSE

OBJECTIVES

This course, taught in English, aims to develop pragmatic, sociocultural, and linguistic CEFR skills in the four language activities through varied teaching methods in interactive lectures, tutorials, and practical labs. Activities include listening and reading comprehension, written productions (essays, summaries, memos, internship reports), and oral productions (presentations, group projects, improvisations, discussions, and debates) to prepare students for professional English use while fostering critical thinking.

COMPETENCE AND SKILLS

- Use technical documents in English
- Communicate orally and in writing, adapting to the technical knowledge level of interlocutors
- Argue, explain, persuade, and nuance orally
- Prepare for the TOEIC : Level 2 (B1.2)

PROGRAM

- Comprehension of written and oral documents
- Writing a summary based on a series of oral and written documents
- Interaction, discussion, defending a point of view, debate
- Grammatical correction – advanced syntax, level 1 linking words, argumentative structures
- English rhythm and prosody
- Level 1 formal register

BIBLIOGRAPHY

- Authentic written and oral documents, Internet, television resources, foreign press, digital tools, linguistic tools
- Global Exam, British Council, BBC Learning English, VoA, monolingual dictionaries
- TOEIC past papers
- Websites of international and European organizations, both general and specific :
 - General : UN, WHO, WEF, IMF, WTO, World Bank...
 - Specific : IEEE, IETF, NIST, ENISA, NCSC...

REQUIREMENTS

CEFR Level B1.1

IDENTIFICATION

Course code : LV2605SEC
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 10
Labs : 0
Total : 10

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and guided work sheets.

LANGUAGE

English

CONTACT

Jean Jacques KADJO
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Modifié le : 14 juillet 2026

UE : UE6-CYBER

COURSE : English or L2

SCOPE OF THE COURSE

OBJECTIVES

This course aims to develop students' linguistic, cultural, and communicative skills in a second foreign language (Chinese or Spanish). It focuses on acquiring language fundamentals, oral and written fluency, as well as discovering associated cultures, to prepare students for interactions in personal, professional, or academic contexts.

COMPETENCE AND SKILLS

- Communicate with various stakeholders (clients, management, users, IT managers, regulatory bodies—CNIL, ANSSI—) in writing and orally
- Ensure adequate communication with stakeholders, including clients, administrations, citizens, and civil society.

PROGRAM

1. Linguistic initiation

- Basic grammatical structures : present indicative, adjectives, pronouns.

2. Oral communication

- Techniques to improve pronunciation and oral fluency.

3. Written comprehension and expression

- Writing simple letters or emails (self-introduction, information requests).

4. Linguistic and intercultural deepening

- Study of songs, poems, or literary excerpts adapted to the level.

5. Practical project and continuous assessment

- Regular oral and written evaluations to monitor progress.

BIBLIOGRAPHY

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REQUIREMENTS

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IDENTIFICATION

Course code : SEC601
ECTS : 1

DURATION

Lectures : 6
Tutorial classes : 14
Labs : 0
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessment : two written exams

TEACHING MATERIALS

Slides and guided exercise handouts.

LANGUAGE

English

CONTACT

Joël GROUFFAUD
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Modifié le : 14 juillet 2026

UE : UE6-CYBER

COURSE : Information Theory

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to enable engineering students to understand how information theory mathematically evaluates the performance limits of communication and data processing systems.

COMPETENCE AND SKILLS

- Select cryptographic tools suited to a project specification
- Design, from concept to production deployment, a company's IT network while addressing QoS and security issues
- List and implement network protocols for IoT
- Perform exploratory data analysis

PROGRAM

- Information source : information quantity, source entropy and source coding, mutual information, Huffman algorithm.
- Channel capacity : communication channel concept and description in information theory, conditional entropy, definition of a discrete channel and a code on this channel.
- Error detection and correction codes : different types of codes (block, convolutional), optimal decision on a binary-input channel.
- Error detection : cyclic redundancy check (CRC) codes
- Error correction : Reed-Solomon

BIBLIOGRAPHY

Abdelghafour Berraissoul - Introduction to Information Theory and Source Coding
Éditions Ellipses

REQUIREMENTS

Module "Probability, Random Variables" from S5.

IDENTIFICATION

Course code : SEC602
ECTS : 1

DURATION

Lectures : 6
Tutorial classes : 22
Labs : 0
Total : 28

Project :
Personnal work :

ASSESSMENT

At least two written continuous assessments, and a lab report.

TEACHING MATERIALS

Slides, directed and practical work sheets, online learning platforms (CryptoHack, Root-Me).

LANGUAGE

English

CONTACT

Joël GROUFFAUD
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Modifié le : 14 juillet 2026

UE : UE6-CYBER

COURSE : Cybersecurity : Cryptography and Applications

SCOPE OF THE COURSE

OBJECTIVES

This course aims to provide essential cryptography knowledge for any computer science engineer, enabling them to select appropriate security tools for software or hardware systems, considering technical constraints (real-time data, energy-autonomous devices, etc.) and ANSSI recommendations to account for known weaknesses in certain protocols.

COMPETENCE AND SKILLS

- Select cryptographic tools suited to a specification requirement
- List and implement network protocols for IoT
- Design, from concept to production deployment, a company's IT network while integrating QoS and security considerations
- Manually deploy and administer services

PROGRAM

- Introduction to cryptography : basic vocabulary, key concepts.
- Classical cryptography : mono- and polyalphabetic substitutions, transposition, cryptanalysis.
- Symmetric block cryptography (AES), stream cryptography (ChaCha20).
- Asymmetric cryptography : Diffie-Hellman, RSA, ElGamal, elliptic curves.
- Hash functions, applications for integrity and authenticity : signatures, HMAC.
- Certificates, key management infrastructures.
- Use in classic protocols : SSH, TLS.
- Application examples : blockchain, anonymization on the Internet (Tor).
- Cryptanalysis : studying weaknesses in cryptographic tools and protocols.
- Introduction to SMPC and homomorphic encryption capabilities.
- Post-quantum cryptography : the quantum threat, post-quantum algorithms.
- Steganography.

BIBLIOGRAPHY

Johannes Buchmann - Introduction to Cryptography - Sciences Sup Collection
- Dunod Editions

REQUIREMENTS

Modules "Discrete Mathematics for Computer Science" (S5) and "Cybersecurity Principles 1" (S6).

IDENTIFICATION

Course code : SEC603
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 0
Total : 4

Project :
Personnal work :

ASSESSMENT

The skill will be assessed based on the deliverables provided, using a criterion-based grid presented to the engineering students in advance.

TEACHING MATERIALS

All documents used during the course. If necessary, new documentary references may be included.

LANGUAGE

English

CONTACT

Joël GROUFFAUD
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Modifié le : 14 juillet 2026

UE6-CYBER

SAE Cybersecurity

SCOPE OF THE CHALLENGE

WORKING SITUATION

Raise company staff awareness of cybersecurity by applying the DICP criteria and the legal framework

COMPETENCES AND LEVEL ASSESSED

Managing the security of an information system

EXPECTED OUTPUTS

Task 1 : Video capsule + tutorial to reproduce the demonstration Task 2 : Summary of the article (in English) + slideshow and oral presentation (in English)
In addition to the technical aspects specified in the expected level description, the SAE will be assessed based on the following criteria :

- Compliance with national and international standards and legal frameworks
- Continuous monitoring of scientific and technological developments
- Communication with all involved parties, in writing and orally, in French and English
- Continuous reduction of cyberattack risks and impacts

RESOURCES

- Mathematics and cryptography teacher
- Cybersecurity specialist, particularly in regulatory aspects
- English teacher

IDENTIFICATION

Course code : DAT601
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 6
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

All documents used during teaching sessions. If needed, additional references may be introduced.

LANGUAGE

English

CONTACT

Kévin HOARAU
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Modifié le : 14 juillet 2026

UE : UE6-DATA

COURSE : Artificial Intelligence and Operations Research

SCOPE OF THE COURSE

OBJECTIVES

This course aims to train students at the intersection of artificial intelligence (AI) and operations research (OR), with a particular focus on the diversity of problems that can be modeled using classical AI tools. A data scientist must be aware of the wide range of problems that can be addressed using formal logic methods, probabilistic methods, and exploratory methods. This course enables students to develop a deep understanding of fundamental principles and their application in various contexts.

COMPETENCE AND SKILLS

- Conduct exploratory data analysis
- Process massive datasets using data mining techniques
- Visualize data

PROGRAM

AI and formal logic :

- Predicate logic and examples of applications
- Automated reasoning : forward chaining, backward chaining
- Reasoning integrated into large-scale systems (e.g., Watson)

Probabilistic approaches

- Causal models
- Bayesian networks
- Markov Decision Processes (MDP)

Search and optimization strategies

- Representation of possible solutions to a problem in the state space
- Depth-first and breadth-first (i.e., uninformed) search of a state space
- Heuristic (i.e., informed) search of a state space (e.g., A* search)

BIBLIOGRAPHY

Russell, S. J., & Norvig, P. (2021). Artificial Intelligence : A Modern Approach, 4th US ed.

REQUIREMENTS

- Probability and random variables
- Stochastic processes
- DATA course (UE) from S5

IDENTIFICATION

Course code : DAT602
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 6
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides, guided and practical work sheets, online learning platforms.

LANGUAGE

English

CONTACT

Kévin HOARAU
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Modifié le : 14 juillet 2026

UE : UE6-DATA

COURSE : Data Mining

SCOPE OF THE COURSE

OBJECTIVES

This course aims to enable students to identify the opportunities offered by data mining and explore its main application areas. It introduces the theoretical concepts necessary to understand data mining algorithms and presents practical methods for implementing these techniques on real datasets.

COMPETENCE AND SKILLS

- Exploit massive datasets using data mining techniques
- Visualize data
- Design and efficiently query a database

PROGRAM

Proximity Measurement

- Basic properties of metrics.
- Measures and special cases - Euclidean distance, Manhattan distance.
- Use of scores and rankings; desirable characteristics of scores and rankings.
- Data normalization to facilitate comparison.
- Metrics involving text
- Correlation coefficient for data sequences.
- Similarity metrics for relationships in graphs (e.g., SimRank).
- Metrics on graphs.
- Similarity of time series (e.g., DTW)

Data Preparation

- Data collection, its relation to problem-solving, the importance of specialized knowledge and openness to expert opinions
- Data sources, including databases, Internet of Things, photographs and videos, online information sources; suitability of data for objectives
- Ethical considerations regarding data acquisition and use; privacy
- Identifying potential biases in data
- Munging data - handling data errors, data gaps, cleaning data, validating data, transforming data;
- Methods for addressing dataset issues such as imbalance, insufficient attributes, and external attributes; automated and manual approaches and trade-offs between them
- The concept of features; extraction and representation of features; feature selection and feature generation

Information Extraction

- Identifying applications where information extraction plays a useful role.
- Entity and relation extraction.
- Rule-based information extraction approaches and their applications.

- Statistical-based information extraction approaches and their applications.
- Possible issues in extracted data.

Cluster Analysis

- Identifying the appropriate similarity measure for clustering activity.
- Evaluating clustering quality.
- k-means clustering algorithm, including iteration considerations.
- Density-based algorithms.
- Applications of clustering.

Classification and Regression

- Considerations for feature selection for classification
- Instance-based methods such as K-Nearest Neighbor (KNN)
- Decision tree methods
- Probabilistic models, Naïve Bayes

Pattern Mining

- The concept of association pattern mining.
- Computational complexity considerations.
- Association rule mining; Apriori and Frequent Pattern Growth (FP) algorithms.
- Sequential pattern mining; GSP algorithms.
- Efficient and parallel algorithms for pattern mining.
- Application domains

Outlier Detection

- Concept of an outlier.
- General approach - build a model of the data, then observe that a data point does not fit
- Parametric methods, such as the z-score for identifying numerical outliers in 1-D.
- Use of probability distribution functions.
- Use of depth-first approaches - after identifying the expected convex hull of a set of points, is it inside or outside; use of related graphical approaches.

Time Series

- The nature of time series data, including comparison with sequential temporal data.
- Data transformation - noise removal, normalization of time series data.
- Stationary and non-stationary time series.
- Converting time series data into discrete sequence data.
- Time series forecasting - predicting future values based on past values.
- Time series patterns - frequently encountered patterns in time series data.
- Clustering and classification of time series.
- Detecting anomalies in time series - point anomalies and shape anomalies.

BIBLIOGRAPHY

Aggarwal, C. C. (2015). Data mining : the textbook (Vol. 1). New York : Springer.

REQUIREMENTS

- Probability and random variables
- Stochastic processes
- DATA course from S5

IDENTIFICATION

Course code : DAT603
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 0
Total : 4

Project :
Personnal work :

ASSESSMENT

Skills will be assessed based on the elements provided in the deliverable, which will be specified in advance to the engineering students.

TEACHING MATERIALS

All documents used during teaching sessions or resources mobilized. If necessary, additional documentary references will be provided.

LANGUAGE

English

CONTACT

Kévin HOARAU
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Modifié le : 14 juillet 2026

UE6-DATA

SAE Data

SCOPE OF THE CHALLENGE

WORKING SITUATION

Prepare, store, and analyze multidimensional data.

COMPETENCES AND LEVEL ASSESSED

Process massive data using artificial intelligence techniques

EXPECTED OUTPUTS

- Demonstration
- Git repository
- Documentation
- Presentation

RESOURCES

- Lecturers in DATA-related subjects and engineering tools
- Data analysis professionals

IDENTIFICATION

Course code : DAT604
ECTS : 1

DURATION

Lectures : 6
Tutorial classes : 18
Labs : 0
Total : 24

Project :
Personnal work :

ASSESSMENT

At least two written continuous assessments.

TEACHING MATERIALS

Slides and guided work sheets.

LANGUAGE

English

CONTACT

Joël GROUFFAUD
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Modifié le : 14 juillet 2026

UE : UE6-DATA

COURSE : Stochastic processes, queues, simulation

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to provide essential basic knowledge for engineers so they can model some engineering problems using analytical tools (Markov chains, queues).

COMPETENCE AND SKILLS

- Perform exploratory data analysis
- Exploit massive data using data mining techniques
- Set up, from design to production deployment, a company's IT network while integrating QoS and security issues.

PROGRAM

- Conditioning relative to a tribe of events : limited to the case of a tribe generated by a finite or countable family of pairwise disjoint events.
- Conditioning relative to a random variable : restricted to the case of a discrete random variable.
- Markov chains : Definitions, communication between states, simulation.
- Theoretical results on queues.

BIBLIOGRAPHY

Bruno BAYNAT - Théorie des files d'attente : Des chaînes de Markov aux réseaux à forme produit - Éditions Hermes

REQUIREMENTS

SR504 : Fundamentals : Probability, Random variables

IDENTIFICATION

Course code : TRANS605DAT
ECTS : 1

DURATION

Lectures : 6
Tutorial classes : 0
Labs : 0
Total : 6

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

Fabrice DOUBLET
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Modifié le : 14 juillet 2026

UE : UE6-DATA

COURSE : TES 2 : New Economic and Corporate Governance Models

SCOPE OF THE COURSE

OBJECTIVES

This course aims to explore the transformations of economic models and governance practices in a context marked by environmental, social, and technological challenges. Students will learn to identify, analyze, and implement innovative strategies tailored to contemporary issues such as sustainability, social responsibility, and the digital economy.

COMPETENCE AND SKILLS

- Comply with constraints, standards, and legal frameworks while considering digital, environmental, and societal challenges.
- Integrate specific constraints related to IoT, such as available technologies, customer requirements, physical security, deployment context, or social and environmental responsibility, as well as energy management, size, computing power, and memory.

PROGRAM

- Introduction to new economic models
- Corporate strategies for sustainable transition
- Corporate governance : principles and new frameworks
- Technology and transformation of economic models

BIBLIOGRAPHY

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : DEV601
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 6
Labs : 10
Total : 20

Project :
Personnal work :

ASSESSMENT

TEACHING MATERIALS

Slides, guided work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

Fanilo HARIVÉLO
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Modifié le : 14 juillet 2026

UE : UE6-DEV

COURSE : Software Modeling and Design

SCOPE OF THE COURSE

OBJECTIVES

This course aims to understand the analysis and design of programs meeting various Software Engineering criteria through the use of the Object-Oriented approach, UML, project management techniques, design patterns, and eco-design techniques.

COMPETENCE AND SKILLS

- Apply a methodology and formalism to design and develop an application
- Produce technical documentation
- Write and implement software tests

PROGRAM

- Elements of Software Engineering and Object-Oriented Methodology : Software Engineering recap ; Industrial software development life cycles for object-oriented applications ; From functional methods to "Object" methods ; From analysis to design.
- Modeling diagrams : UML, object diagrams, collaboration diagrams, class diagrams, use case diagrams, sequence diagrams, state-transition diagrams, activity diagrams, component diagrams, deployment diagrams. Relationships between the different diagrams.
- Object specification software environments : software tools for object application specification, reverse engineering issues.
- Design Patterns : Interests and objectives ; Types of patterns ; Formalism ; Application of design patterns through concrete examples.
- Green IT / software eco-design : Global assessment and challenges ; Representative examples ; Scope of action (Green IT 1.0, Green IT 1.5, and Green IT 2.0) ; ICT eco-labels, standards, and guides ; Action levers ; Eco-design through concrete examples.

BIBLIOGRAPHY

REQUIREMENTS

Algorithms and data structures in C and Engineering tools : Versioning, Deployment and Documentation, Object-Oriented Programming

IDENTIFICATION

Course code : DEV602
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 10
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides, directed work sheets and practical work sheets.

LANGUAGE

English

CONTACT

Rémy COURDIER
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Modifié le : 14 juillet 2026

UE : UE6-DEV

COURSE : Object-Oriented Programming

SCOPE OF THE COURSE

OBJECTIVES

The objective of this course is to acquire the fundamentals of the object-oriented programming model. This model is based on reusable objects and classes. The system to be developed is viewed as a set of objects that collaborate and interact with each other. Concepts such as inheritance or polymorphism allow these relationships to be described. The maintenance, modification and evolution of the resulting software are thereby facilitated.

COMPETENCE AND SKILLS

- Apply a methodology and formalism to design and develop an application
- Write and perform software tests

PROGRAM

- The Object-Oriented approach : Objects, Classes, Attributes, Methods, Constructors, Messages and inter-object communication
- Abstraction and overloading
- Object-oriented concepts : Encapsulation and data hiding, Inheritance, Polymorphism, Composition and Aggregation
- Object-based architectures.

BIBLIOGRAPHY

The Object-Oriented Thought Process (Matt Weisfeld)

REQUIREMENTS

Algorithms and data structures in C and Engineering Tools : Versioning, Deployment and Documentation

IDENTIFICATION

Course code : DEV603
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 0
Total : 4

Project :
Personnal work :

ASSESSMENT

Skills will be assessed based on the elements provided in the deliverable, which will be specified in advance to the engineering students.

TEACHING MATERIALS

All documents used during teaching sessions or resources mobilized. If necessary, new documentary references will be provided.

LANGUAGE

English

CONTACT

Rémy COURDIER Fanilo HARIVÉLO
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Modifié le : 14 juillet 2026

UE6-DEV

SAE Dev

SCOPE OF THE CHALLENGE

WORKING SITUATION

Develop an application for a platform or environment based on provided design elements

COMPETENCES AND LEVEL ASSESSED

Design and develop software

EXPECTED OUTPUTS

Task 1 : Functional specification + Domain analysis documents Task 2 : Design documents and diagrams Task 3 : Code Task 4 : Application, demonstration, and documentation In addition to the technical aspects specified in the expected level description, the SAE will be assessed based on the following criteria :

- Efficient organization and mobilization of available human and material resources
- Conducting ongoing scientific and technological monitoring
- Justification of technology, tool, and solution choices
- Appropriate response to the specification in interaction with users and commissioning parties

RESOURCES

- Software development instructor

IDENTIFICATION

Course code : DEV604
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 14
Labs : 2
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides, directed work sheets and practical work sheets.

LANGUAGE

English

CONTACT

Denis PAYET
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Modifié le : 14 juillet 2026

UE : UE6-DEV

COURSE : Client-side programming and WEB/user interface

SCOPE OF THE COURSE

OBJECTIVES

This course aims to provide students with the knowledge, understanding and mastery of the languages required for client-side Web programming while adhering to standards that guarantee interoperability. It also explores the design and direction of dynamic interfaces for Internet and Intranet sites, with a focus on user experience and adaptability.

COMPETENCE AND SKILLS

- Create a human-machine interface
- Write and implement software tests

PROGRAM

Client-side code and interaction with the server :

- JavaScript : Language elements, JavaScript and HTML. Objects, prototypes and inheritance, standard objects
- Document Object Model : structure, nodes, programming interface
- Serialization and persistence : JSON, cookies, JavaScript persistence
- Development of rich-client applications
- Dynamic web : AJAX and jQuery
- Integration of graphical and multimedia elements
- Exchange of complex and structured data with the server
- APIs to external services

WEB interface design :

- Aspects of the application domain
- Users' affective experiences
- Human-centered evaluation
- Assistive technologies and accessibility

BIBLIOGRAPHY

REQUIREMENTS

- Tools for engineers
- Courses from the UE DEV (S5)

IDENTIFICATION

Course code : SHS606DEV
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 16
Labs : 10
Total : 30

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides, guided work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE6-DEV

COURSE : Development and Interpersonal Communication

SCOPE OF THE COURSE

OBJECTIVES

This course aims to develop students' interpersonal communication skills and relationship management in professional environments. By drawing on theories and tools such as Transactional Analysis, the VAKOG model, and assertiveness principles, students will learn to better understand human interactions, manage conflicts, and assert themselves constructively. The ultimate goal is to foster effective communication and harmonious collaboration.

COMPETENCE AND SKILLS

- Communicate orally, adapting to the technical knowledge level of one's interlocutors

PROGRAM

1. Fundamentals of Communication

- The stages of the communication process (formulation, transmission, reception) and Shannon's model.
- Key elements of interpersonal communication : verbal, non-verbal, and paraverbal.
- Identifying communication noise and barriers, and strategies to overcome them (reformulation, feedback).

2. Transactional Analysis (TA)

- Understanding ego states (Parent, Adult, Child) and their interactions in human relationships.
- Parallel, crossed, and ulterior transactions.
- Identifying and managing "psychological games" and roles (Persecutor, Rescuer, Victim) according to Karpman's triangle.

3. Assertiveness and Personal Development

- Life positions (OK/Not-OK) and their impact on behaviors (passive, aggressive, manipulative, assertive).
- Assertiveness techniques to better manage interactions : saying "no", negotiating, and expressing needs clearly and respectfully.
- Approaches to overcome communication-related fears (fear of judgment, ridicule, or failure).

4. NLP and the VAKOG Model

- Introduction to Neuro-Linguistic Programming (NLP) and its applications in communication.
- Identifying perception channels (Visual, Auditory, Kinesthetic, Olfactory, Gustatory) and synchronization to improve active listening.
- Using dynamic reformulations and open-ended questions to resolve ambiguities and establish rapport with interlocutors.

5. Practical Project : Improving Interactions and Communication

- Case study to analyze difficult communication scenarios in a professional setting.
- Developing tailored strategies to manage situations such as conflicts, misunderstandings, or psychological games.
- Applying assertiveness and synchronization concepts through role-playing and simulations.

BIBLIOGRAPHY

- Marshall B. Rosenberg, *Nonviolent Communication : A Language of Life*, 2016
- Ian Stewart and Vann Joines, *TA Today : A New Introduction to Transactional Analysis*, 2014

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : SPORT604DEV
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 12
Labs : 0
Total : 12

Project :
Personnal work :

ASSESSMENT

Performance tracking and setting of personal objectives.

TEACHING MATERIALS

Documentation

LANGUAGE

English

CONTACT

Thomas BARBEREAU
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Modifié le : 14 juillet 2026

UE : UE6-DEV

COURSE : Sports

SCOPE OF THE COURSE

OBJECTIVES

This course aims to promote health, well-being, and the values of sports through varied physical activities, while strengthening students' ability to work in teams and push their limits. Through a variety of sports and cooperative games, students will be encouraged to develop essential interpersonal skills such as communication, collaboration, and leadership.

COMPETENCE AND SKILLS

- Communicate orally, adapting to the technical knowledge level of the interlocutors
- Organize the project according to project management methodologies

PROGRAM

- Physical initiation and preparation
- Team sports and team spirit
- Individual sports and personal development
- Health and prevention

BIBLIOGRAPHY

- Jonny Wilkinson, *The Winning Mind*, 2012
- Mike Horn, *Dare to Reach the Stars*, 2016
- Grégoire Chevignard, *From My Couch to the World's Hardest Race*, 2018

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : IOT601
ECTS : 1

DURATION

Lectures : 2
Tutorial classes : 8
Labs : 20
Total : 30

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides, directed work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

Pierre Ugo TOURNOUX
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Modifié le : 14 juillet 2026

UE : UE6-IOT

COURSE : Internet of Things : Prototyping

SCOPE OF THE COURSE

OBJECTIVES

This course aims to introduce students to the fundamental concepts of the Internet of Things (IoT) and equip them with the skills needed to design, develop, and prototype connected devices. Through a practical approach, students will learn to use suitable hardware and software platforms while exploring the technical challenges and real-world applications of IoT across various domains.

COMPETENCE AND SKILLS

- Organize the project according to project management methodologies
- List and implement network protocols for IoT
- Implement data distribution protocols specific to IoT
- Select suitable development environments (IDEs) for prototyping and product development

PROGRAM

- Digital electronics :
 - Introduction : concepts of logic circuits, asynchronous and synchronous sequential systems.
 - Analysis of digital circuits.
 - Use of elementary circuits (gates, multiplexers, decoders, flip-flops, registers, memories).
 - Practice with digital circuit synthesis languages (ABEL, VHDL).
 - Implementation of a programmable digital circuit.
- Study of assembly language :
 - Addressing modes.
 - Instructions, specialized instructions - processor interactions with its environment.
 - Virtual memory, cache memory, pipelining.

BIBLIOGRAPHY

Noam Nisan, Shimon Schocken - *The Elements of Computing Systems. Building a Modern Computer from First Principles* - MIT (2005)

REQUIREMENTS

- DEV UE course from S5
- IoT UE course from S5

IDENTIFICATION

Course code : PROJ603IOT
ECTS : 3

DURATION

Lectures : 0
Tutorial classes : 0
Labs : 0
Total : 0

Project :
Personnal work :

ASSESSMENT

Report, presentations, project deliverables, completion of the project management tool, stakeholder evaluation.

TEACHING MATERIALS

LANGUAGE

English

CONTACT

Pierre Ugo TOURNoux
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Modifié le : 14 juillet 2026

UE : UE6-IOT

COURSE : Supervised Project + Skills Assessment
(English/Internship)

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to place engineering students in a project-based approach and apply the various concepts studied in the first-year engineering cycle modules.

COMPETENCE AND SKILLS

- Organize the project using project management methodologies
- Write technical documentation and design presentation materials in French and English
- Apply a methodology and formalism to design and develop an application

PROGRAM

Types of topics

Based on a problem proposed by a partner company or administration of ESIROI, engineering students must propose a solution addressing the issue. Students must define a jointly developed specification with the company, prioritize features, and associate them with tasks, milestones, and deliverables using a project management method. Although existing IS processes of the company must be considered, proposed topics require the implementation of a complete solution. *E.g.* developing a Moodle QCM plugin does not meet this criterion, whereas proposing a pervasive object for thermal comfort assessment calls for a far more comprehensive solution including sensor development, data processing, visualization via a web interface, addressing privacy issues, and securing the entire data collection, processing, and storage chain. Thus, students are expected to integrate and articulate elements from each of the domains taught at ESIROI (CYBER, DATA, DEV, SYS/RES, and IOT) and enable the assessment of INF block competencies.

Specification and planning

Based on the specification, students will estimate the cost associated with development, deployment, and operation of the solution. This cost includes labor (man-months) and materials. The cost may include the carbon footprint across the entire solution lifecycle according to methodologies covered in class. The specification and initial cost estimate will be assessed.

Soft skills

Students will interact with the company and must pay particular attention to their communication. In writing, students must ensure the quality of their writing, clarity of expression, and use of language appropriate to the professional context. They must also be mindful of the presentation and structure of their documents, ensuring they are well-organized. Where possible, students should use project tracking tools (e.g., GitLab, GitHub, Jira ...) to interact with the company but must first adapt to the project stakeholders' habits and technical level. In oral presentations, students must practice delivering their work clearly, concisely, and convincingly before each meeting. They must also be able to respond

to company questions in a relevant and professional manner. Students' "soft skills" are assessed throughout the project.

Project management

Students are expected to leverage project management tools to define deadlines, objectives, ongoing and upcoming tasks. Meetings with partners must align with well-defined project stages (milestones, features, technical tasks) and have clear objectives announced in advance, accompanied by documents enabling participants to prepare and be effective during the meeting. The project management tool must be updated following the meeting. Additionally, each meeting must result in clear and concise minutes, possibly accompanied by detailed technical notes. Students will be assessed on the project management aspect and the quality of their written contributions in the project management tool.

Group members, roles, and competencies

Projects are carried out by groups of first- and second-year engineering students (3A and 4A). Second-year students are expected to take a more leading role in project management. They will serve as project managers but must still take on technical tasks. First-year students must progressively build their project management skills to eventually become autonomous when second-year students leave 2 to 4 months before the project's end.

Deliverables

Projects are associated with a minimum of four presentations :

- Kick-off presentation (specification, cost estimate, task breakdown, milestones, and schedule)
- Mid-term presentation (mid-December)
- Presentation upon departure of second-year students (end of March)
- Final project presentation (end of May)

These presentations are internal to ESIROI, but the project stakeholder is invited. However, the stakeholder may request additional presentations for the company or a broader audience.

At the end of the project, first-year students must write a report that may be shared within ESIROI, the company, and, if possible, externally. This report may accompany the student's portfolio.

Support

When necessary concepts for project implementation have not been covered in prior teaching modules, the teaching team may provide short introductory sessions on the relevant concepts and technologies. The teaching team may also involve external contributors when they are particularly relevant to the use of a tool. The teaching team is not required to address potential technical shortcomings. In such cases, students must self-train, assess whether they have the time to do so, and, if necessary, evaluate alternatives.

Additionally, students may request support from the teaching team for :

- Technical support
- Support on solution design

- Support on project management
- Support on report writing and presentation materials

The quantity and type of support requested by students will impact the competency levels validated as part of this project.

Competency assessment modalities

To be defined.

0.0.1 Workload

An average of 4 hours per week is expected throughout the year. Specific weeks are identified in the timetable as being primarily dedicated to projects to minimize context switching between different required or optional student activities.

BIBLIOGRAPHY

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REQUIREMENTS

All modules from S5 courses.

IDENTIFICATION

Course code : SHS602IOT
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 0
Labs : 0
Total : 0

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

SPOC supports on digital transformation for businesses and the industry of the future, presentation materials.

LANGUAGE

English

CONTACT

To be defined

Modifié le : 14 juillet 2026

UE : UE6-IOT

COURSE : Digital Transformation

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to understand the changes that digital transformation can bring to businesses, to anticipate transformations generated by technologies, and to determine the impact and added value of digital transformation for the various business functions, organizational structures, and management approaches.

COMPETENCE AND SKILLS

- Define and conduct a risk analysis based on documentary research, an offensive cybersecurity campaign, and the regulatory framework (1.5)-(3.4)
- Design a robust and optimized data storage architecture for data processing, compliant with regulatory requirements (1.5)-(2.4)
- Master and apply essential procedures and mechanisms of operating systems, networks, virtualization, and cloud computing for the deployment and maintenance of accessible services (1.5)-(2.4)

PROGRAM

TBD

BIBLIOGRAPHY

TBD

REQUIREMENTS

TBD

IDENTIFICATION

Course code : SR601
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 18
Labs : 14
Total : 36

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments and one lab report.

TEACHING MATERIALS

Slides, directed work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE6-SYSRES

COURSE : Computer Networks : Switching and Routing

SCOPE OF THE COURSE

OBJECTIVES

This course will enable students to understand enterprise LAN technologies in order to manage and/or design a secure, robust, and high-performance communication infrastructure for a company, as well as to know, implement, and evaluate the main internal routing protocols.

COMPETENCE AND SKILLS

- Implement, from design to production, a company's computer network while integrating QoS and security issues.
- Produce and manage documentation for a computer infrastructure

PROGRAM

- Functions of enterprise local area networks (LAN).
- IEEE standards, protocols, and media access methods.
- Enterprise network topology, cabling plan, hardware components.
- Switched Ethernet, Spanning Tree, VLANs and inter-VLAN routing, Layer 3 switches.
- Quality of Service (QoS)
- LAN security
- High-speed technologies : Fibre Channel and Ethernet evolutions.
- Hierarchical routing and Internet architecture : autonomous systems.
- IPv4 address translation (NAT).
- Intra-domain routing : OSPF.
- Layer 3 redundancy : HSRP

BIBLIOGRAPHY

- Danièle DROMARD and Dominique SERET - *Network Architecture : Course Summary and Corrected Exercises* - Synthex Collection - Pearson Education
- James F. KUROSE and Keith W. ROSS - *Computer Networking* - Pearson

REQUIREMENTS

- SYSRES 501 : Computer Networks : Fundamental Concepts
- SR502 : System Administration : Concepts, Tools, and Services

IDENTIFICATION

Course code : SR602
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 10
Labs : 14
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and a lab report.

TEACHING MATERIALS

Slides, guided work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE6-SYSRES

COURSE : Directory Systems Administration

SCOPE OF THE COURSE

OBJECTIVES

This course aims to train students in the administration and management of directory systems, which play a key role in centralizing and securing identity information and resources within an IT infrastructure. Students will learn to configure, administer, and operate directories to manage access, users, and permissions in a network environment.

COMPETENCE AND SKILLS

- Set up, from design to production deployment, a company's IT network while integrating QoS and security issues.
- Manually deploy and administer services
- Produce and manage documentation for an IT infrastructure

PROGRAM

1. Introduction to directory systems

- Definition and role of directories in system administration.
- Fundamental concepts : hierarchy, objects, attributes, and schemas.
- Standards and protocols : LDAP (Lightweight Directory Access Protocol) and Active Directory.

2. Installation and configuration of directory services

- Setting up a directory server.
- Creating and managing schemas : defining structures and custom attributes.
- Integrating directories into heterogeneous environments.

3. User and group management

- Creating, modifying, and deleting user objects.
- Managing groups and roles : organizing permissions and access.
- Synchronization with other systems (SSO, identity management tools).

4. Securing and optimizing directory systems

- Implementing security policies : role-based access control (RBAC) and secure authentication.
- Backup, replication, and high availability of directories.
- Performance optimization : indexing and advanced configuration.

5. Practical project : designing and administering a directory

- Setting up a directory service for a fictional environment.
- Managing users, groups, and permissions.
- Applying security and performance concepts to the directory system.

BIBLIOGRAPHY

UNIX and Linux System Administration Handbook, Fifth edition, 2017

REQUIREMENTS

- Engineering tools
- SYSRES UE course from S5

IDENTIFICATION

Course code : SR603
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 16
Labs : 0
Total : 16

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical evaluations.

TEACHING MATERIALS

Slides, guided work sheets and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE6-SYSRES

COURSE : Tools for Engineers : Virtual Environments and Collaboration Practices

SCOPE OF THE COURSE

OBJECTIVES

This course aims to train students in the use of virtual environments and best collaboration practices in engineering. It enables the acquisition of skills necessary to work effectively in distributed environments, using modern tools for development, project management and communication.

COMPETENCE AND SKILLS

- Manually deploy and administer services
- Organize projects according to project management methodologies
- Write and implement software tests
- Integrate OpenData APIs into an ETL pipeline
- Select suitable development environments (IDEs) for prototyping and product development

PROGRAM

- Introduction to virtual environments
- Collaboration and source code management
- Tools for real-time collaboration
- Project management practices in distributed environments
- Collaboration in virtual environments

BIBLIOGRAPHY

Sameer Naik, Sébastien Goasguen, Jonathan Michaux, *Kubernetes Cookbook : Building Cloud Native Applications*, 2024

REQUIREMENTS

- Tools for Engineers : Version Control, Deployment and Documentation
- Tools for Engineers : IT Project Management
- Tools for Engineers : Monitoring and Technical Document Writing

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
UE4-EC1
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 28
Labs : 0
Total : 32

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides, guided and practical work sheets.

LANGUAGE

English

CONTACT

Design a secure architecture for an information system.

Modifié le : 14 juillet 2026

UE : UE7-CYBER

COURSE : Cybersecurity : Secure Architecture and Infrastructure

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Propose a secure architecture for an information system (network / systems)
- Select and administer tools for detecting and correlating security incidents
- Write technical documents in French and English

PROGRAM

- Detect the presence of malware in a system (network, computer, or application).
- Use countermeasures based on signatures or behavior detection to combat malware infection mechanisms : antivirus, EDR, IDS/IPS.
- Securing the information system : firewalls and demilitarized zones (DMZ).
- Stateful firewalls : operating principles, address and URL filtering, content filtering.
- Secure remote access : IPsec, SSL VPN.
- CERTs (Computer Emergency Response Teams).
- Implement high availability.
- Tools for monitoring and administering security through event collection, correlation, and remote intervention : SOC (Security Operations Center) and SIEM (Security Information and Event Management).

BIBLIOGRAPHY

Solange Ghernaoui - *Cybersecurity and Networks* - Sciences Sup Collection - Dunod Editions

REQUIREMENTS

Cybersecurity and Systems and Networks courses from previous semesters.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-UE4-EC2
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 14
Labs : 10
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, guided work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

Train students in offensive security methodologies and tools so they can conduct penetration tests in a structured and documented manner. Through an ethical hacking approach, they will learn to identify, exploit, and report vulnerabilities in an information system, while respecting the applicable legal and regulatory framework (GDPR, NIS2).

UE : UE7-CYBER

COURSE : Cybersecurity : Offensive Security Methodologies

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Apply an audit and penetration testing methodology (PTES, OWASP, MITRE ATT&CK) on a real or simulated information system
- Conduct a risk analysis based on documentation, an offensive cybersecurity campaign, and the regulatory framework
- Identify and exploit network, system, and application vulnerabilities using appropriate tools
- Carry out an ethical hacking process in compliance with national and international legal frameworks (GDPR, NIS2)
- Write a structured intrusion report, including an executive summary, CVSS-scored findings, and associated recommendations

PROGRAM

- **Introduction to offensive security and ethical hacking** : legal framework (GDPR, NIS2, criminal law), pentester responsibilities, Red Team / Blue Team / Purple Team distinctions, engagement types (black box, gray box, white box).
- **Methodologies and standards for penetration testing** : PTES, OWASP Testing Guide, OSSTMM, MITRE ATT&CK — tactics, techniques, and procedures (TTP), phases of a pentest.
- **Reconnaissance and OSINT** : passive information gathering (WHOIS, DNS, Shodan, FOCA), social engineering, attack surface mapping.
- **Scanning and enumeration** : host and port discovery (Nmap), service and OS detection, service enumeration (SMB, SNMP, LDAP, HTTP).
- **Vulnerability analysis and exploitation** : CVE research (Exploit-DB, NVD), network and system exploitation with Metasploit, attacks on unpatched services.
- **Identity and web service attacks** : brute force, password spraying, SQL injection, XSS, IDOR, buffer overflow.
- **Network attacks** : denial-of-service attacks (DoS/DDoS), man-in-the-middle, ARP poisoning.
- **Post-exploitation** : privilege escalation, pivoting, persistence, log cleaning.
- **Detection and countermeasures** : honeypots, intrusion detection systems (IDS/IPS), event correlation.
- **Writing the intrusion report** : professional structure, executive summary, CVSS-scored findings, recommendations, and remediation plan.

BIBLIOGRAPHY

- Georgia Weidman - *Penetration Testing : A Hands-On Introduction to Hacking* - No Starch Press, 2014
- Kim Crowley - *The Pentester Blueprint* - Wiley, 2020

- Chris McNab - *Network Security Assessment* - O'Reilly, 3rd ed., 2016
- Dafydd Stuttard & Marcus Pinto - *The Web Application Hacker's Handbook* - Wiley, 2nd ed., 2011
- Jon Erickson - *Hacking : The Art of Exploitation* - No Starch Press, 2nd ed., 2008
- PTES - *Penetration Testing Execution Standard* : <http://www.pentest-standard.org>
- OWASP Testing Guide v4.2 : <https://owasp.org/www-project-web-security-testing-guide/>
- MITRE ATT&CK Framework : <https://attack.mitre.org>
- NIST SP 800-115 - *Technical Guide to Information Security Testing and Assessment* : <https://csrc.nist.gov/publications/detail/sp/800-115/final>
- OSSTMM v3 - ISECOM : <https://www.isecom.org/OSSTMM.3.pdf>
- ANSSI - Guides and recommendations : <https://www.ssi.gouv.fr/guide/>
- PortSwigger Web Security Academy : <https://portswigger.net/web-security>
- HackTheBox Academy : <https://academy.hackthebox.com>
- TryHackMe : <https://tryhackme.com>

REQUIREMENTS

- **SEC502 - Cybersecurity : Principles, Practices, and Threats** : CIA model, threat typology (malware, phishing, DoS), introduction to attacks and defenses.
- **SEC602 - Cryptography and Applications** : symmetric/asymmetric encryption, hash functions, PKI, TLS/SSL protocols — essential for understanding protocol vulnerabilities.
- **SEC701 - Cybersecurity : Secure Architecture and Infrastructure (parallel)** : networks, firewalls, DMZ, segmentation, security policies — deployment context for offensive techniques.
- **SYSRES 501 - Principles of Networks and IoT** : OSI model, TCP/IP protocols, IP addressing, routing, DNS, HTTP, SMTP — essential foundation for network scanning and exploitation.
- **SYSRES 502 - Operating Systems and Command Language** : Linux/Windows administration, process management, permissions, Bash scripting — proficiency with Kali Linux environment.
- **Expected cross-disciplinary skills** :
 - Linux terminal practice (shell, permissions, networking)
 - Scripting basics (Bash, Python)
 - Understanding of client-server architectures and web services
 - Ability to read technical documentation in English

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
UE4-EC3
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 20
Labs : 10
Total : 30

Project :
Personnal work :

ASSESSMENT

Internal assessment : Situational tasks on professional skills, at least 2 assessments per semester External assessment : TOEIC (Semesters 8/9)

TEACHING MATERIALS

General English : Current affairs topics, press, Internet Specialized English : Technical and scientific resources Professional English : CV, cover letter, email TOEIC past papers

LANGUAGE

English

CONTACT

This English language course aims to develop pragmatic, sociocultural and linguistic skills aligned with the CEFR across all four language activities, using varied teaching methods in interactive lectures (CM), tutorials (TD) and practical sessions (TP). Activities include listening and reading comprehension, written production (essays, summaries, memos, work placement reports) and oral production (presentations, group projects, improvisations, discussions and debates), preparing students for professional English use while fostering critical thinking.

UE : UE7-CYBER

COURSE : English

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Understand spoken and written English
- Express oneself in writing and speaking (continuous and interactive production)
- Use technical and professional documents
- Prepare for the TOEIC : Level 3 (B2.1)

PROGRAM

- Comprehension of technical documents in the field of study, both written and oral.
- Writing a work placement report, level 1.
- Technical and professional presentations with slides, level 1.
- Grammatical correction – complex syntax, rhetorical tools, collocations and phrasal verbs.
- Linguistic varieties in English.
- Formal register level 2 : consideration of language hierarchies.

BIBLIOGRAPHY

- Authentic written and oral documents, Internet, television resources, foreign press, digital tools, linguistic tools
- Global Exam, British Council, BBC Learning English, VoA, monolingual dictionaries
- TOEIC past papers
- Websites of international and European organizations, both general and specific :
 - General : UN, WHO, WEF, IMF, WTO, World Bank...
 - Specific : IEEE, IETF, NIST, ENISA, NCSC...

REQUIREMENTS

- **CEFR Level B1.2**
- Can understand the essential content of concrete or abstract topics in a complex text, including a technical discussion in their field of study.
- Can communicate with a degree of spontaneity and fluency such that conversation with a native speaker involves no tension for either party.
- Can express oneself clearly and in detail on a wide range of subjects, give an opinion on a current topic and present the advantages and disadvantages of different possibilities.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-UE4-EC4
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 10
Labs : 0
Total : 10

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and guided work sheets.

LANGUAGE

English

CONTACT

This course aims to develop students' linguistic, cultural, and communicative skills in a second foreign language (Chinese or Spanish). It focuses on acquiring language basics, oral and written fluency, as well as discovering associated cultures, to prepare students for interactions in personal, professional, or academic contexts.

UE : UE7-CYBER

COURSE : English or Second Foreign Language (L2)

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Communicate with various stakeholders (clients, management, users, IT managers, regulatory bodies -CNIL, ANSSI-) in both written and oral forms
- Ensure appropriate communication with stakeholders, including clients, administrations, citizens, and civil society.

PROGRAM

1. Linguistic initiation

- Basic grammatical structures : present tense, adjectives, pronouns.

2. Oral communication

- Techniques to improve pronunciation and oral fluency.

3. Written comprehension and expression

- Writing simple letters or emails (self-introduction, requests for information).

4. Linguistic and intercultural deepening

- Study of songs, poems, or literary excerpts adapted to the level.

5. Practical project and continuous assessment

- Regular oral and written evaluations to monitor progress.

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE5-EC1
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 16
Labs : 4
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, guided and practical work sheets.

LANGUAGE

English

CONTACT

Understand the technical and algorithmic challenges related to processing massive data volumes (Big Data), and master the architectural solutions and distributed frameworks that address them. Through a combined theoretical and practical approach, students will acquire the skills needed to design, deploy, and operate large scale data processing pipelines, considering performance, scalability, and reliability constraints.

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UE : UE7-DATA

COURSE : Massive Data Systems

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Identify and analyze scalability issues in projects involving large volumes of data
- Design and implement a distributed architecture suitable for storing and processing massive data
- Apply parallel and distributed programming paradigms (MapReduce, Spark) to solve large-scale processing problems
- Define, implement, and use descriptive and predictive analysis by leveraging massive data
- Evaluate and compare the performance of parallel and distributed algorithms considering hardware and architectural constraints

PROGRAM

— Scalability challenges :

- The need for measurement in the context of Big Data : size, capacity, throughput, and latency.
- Consequences of rapid data growth on computing and storage.
- Complexity models suited to distributed systems ; the need to prioritize architectural simplicity.
- Coordination approaches between computing entities ; horizontal and vertical scalability.

— Hardware architectures for Big Data :

- Fast and efficient input/output mechanisms ; memory hierarchy and cache coherence.
- Parallel computing architectures : multicore, GPU, grid computing, shared and distributed memory, vector processing.
- Flynn's taxonomy (SISD, SIMD, MISD, MIMD) and implications for architectural choices.
- Parallel storage hierarchy ; instruction optimization considerations.

— Frameworks for distributed computing :

- Classification of parallel and distributed computing models.
- Hadoop and the HDFS / YARN ecosystem ; MapReduce paradigm.
- Apache Spark : RDDs, DataFrames, Spark SQL, Spark Streaming.
- Distributed messaging systems : Apache Kafka for real-time data streams.
- Process interaction : communication, coordination, fault tolerance.

— Distributed data storage :

- Distributed storage approaches : HDFS, object storage (S3), NoSQL databases (HBase, Cassandra, MongoDB).

- Ensuring data quality : consistency, cleaning, representativeness.
- CAP theorem and trade-offs between consistency, availability, and partition tolerance.
- Scalability techniques : consistent hashing, partitioning, replication, sharing.
- Data backup, archiving, and recovery.
- **Parallel and distributed programming :**
 - Concurrency, parallelism, and distributed systems : differences and use cases.
 - Amdahl's Law and Gustafson's Law : theoretical limits of parallelism.
 - Parallel algorithms : load balancing, task and data decomposition.
 - Complexity of parallel and distributed algorithms ; state and side-effect management.
- **Data pipelines and stream processing :**
 - Lambda and Kappa architectures : batch and stream processing.
 - Data pipeline orchestration : Apache Airflow.
 - Use cases : ingestion, transformation, aggregation, and visualization of massive data.

BIBLIOGRAPHY

- Sakr, S. & Zomaya, A. Y. (Eds.) - *Encyclopedia of Big Data Technologies* - Springer International Publishing, 2019
- Tom White - *Hadoop : The Definitive Guide* - O'Reilly, 4th ed., 2015
- Bill Chambers & Matei Zaharia - *Spark : The Definitive Guide* - O'Reilly, 2018
- Martin Kleppmann - *Designing Data-Intensive Applications* - O'Reilly, 2017
- Jimmy Lin & Chris Dyer - *Data-Intensive Text Processing with MapReduce* - Morgan & Claypool, 2010
- Apache Spark Documentation : <https://spark.apache.org/docs/latest/>
- Apache Kafka Documentation : <https://kafka.apache.org/documentation/>
- Apache Hadoop Documentation : <https://hadoop.apache.org/docs/stable/>
- Apache Airflow Documentation : <https://airflow.apache.org/docs/>

REQUIREMENTS

- **Probability and Random Variables (S5) :** distributions, expectation, variance — statistical foundations for analyzing and sampling massive data.
- **Stochastic Processes (S6) :** modeling data flows and time series.
- **Data Mining (S6) :** clustering, classification, and association algorithms — directly applied to distributed volumes.
- **Machine Learning (S7, parallel) :** predictive models and ML pipelines to integrate into Big Data architectures.
- **Expected cross-disciplinary skills :**
 - Python programming (pandas, NumPy) and functional programming concepts
 - Proficiency in Linux terminal and basic commands (files, processes, network)

- Understanding of algorithmics and complexity (Big O notation)
- Knowledge of client-server architectures and relational databases
- Ability to read technical documentation in English

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE5-EC2
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 12
Labs : 8
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, guided exercises sheets, and practical work sheets.

LANGUAGE

English

CONTACT

Given the central role of machine learning algorithms in many data science tasks, data scientists must be aware of a wide range of machine learning approaches, as well as the field's long history. A data scientist must know where to look for possible techniques to apply to new problems. A data scientist must also be aware of cross cutting concepts, such as the need to evaluate performance and the general classes of challenges encountered in machine learning. This course provides both the overview and the technical knowledge required.

UE : UE7-DATA

COURSE : Machine Learning

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Identify and select the appropriate machine learning algorithm family (supervised, unsupervised, deep learning) for a given problem, justifying this choice using objective criteria
- Implement, train, and evaluate classification and regression models by applying best practices : train/test/validation split, cross-validation, hyperparameter tuning
- Analyze and interpret model performance using appropriate metrics (precision, recall, F1, AUROC, RMSE, R^2) and diagnose bias and variance issues
- Apply unsupervised learning algorithms for dimensionality reduction (PCA, ICA, NMF) and clustering (k-means, GMM, hierarchical clustering) on real-world datasets
- Apply multimedia data analysis methods (images, signals) using suitable machine learning models
- Design, develop, and integrate tools and applications leveraging machine learning models for data valorization

PROGRAM

— Foundations of Machine Learning :

- Overview of paradigms : supervised, unsupervised, reinforcement learning, and deep learning.
- Symbolic vs. numerical learning; statistical vs. structural/syntactic approaches.
- Learning as an optimization problem; data exploration through machine learning.
- Cross-cutting challenges : data quality, regularization, generalization, curse of dimensionality.

— Supervised Learning :

- Regression and classification tasks : use cases and selection criteria.
- Bias/variance trade-off; model complexity and generalization ability.
- Evaluation protocols : train/test/validation split, cross-validation, hyperparameter tuning.
- Classification metrics : precision, recall, F1, AUROC, confusion matrix; regression metrics : RMSE, MAE, R^2 .
- Fundamental algorithms : linear and logistic regression, KNN, Naive Bayes, decision trees.
- Extensions and ensemble methods : bagging, boosting, random forests, polynomial features.
- Model diagnosis : high bias vs. high variance; feature selection and engineering strategies.

- Multiclass classification ; advanced algorithm : SVM (Support Vector Machine).
- **Unsupervised Learning :**
 - Main tasks : clustering and dimensionality reduction.
 - Clustering algorithms : k-means, hierarchical clustering (connectivity vs. centroid), DBSCAN, Gaussian Mixture Models (GMM).
 - Dimensionality reduction algorithms : PCA (Principal Component Analysis), ICA (Independent Component Analysis), NMF (Non-negative Matrix Factorization).
 - Evaluating unsupervised learning results : silhouette scores, inertia, interpretation of components.
- **Deep Learning — Introduction :**
 - Artificial neural networks : architecture, activation functions, backpropagation.
 - Convolutional networks (CNN) for image analysis ; recurrent networks (RNN/LSTM) for signals and time series.
 - Tools and frameworks : TensorFlow, PyTorch, Keras.
- **Practical challenges and implementation :**
 - Data preprocessing : normalization, handling missing values, encoding categorical variables.
 - Machine learning pipelines with scikit-learn.
 - Model interpretability : SHAP, feature importance.
 - Model deployment : prediction APIs, MLOps best practices.

BIBLIOGRAPHY

- Barra, V., Miclet, L. and Cornuéjols, A. - *Artificial Learning — Concepts and Algorithms, from Bayes and Hume to Deep Learning* - Eyrolles, 4th ed.
- Aurélien Géron - *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow* - O'Reilly, 3rd ed., 2022
- Christopher M. Bishop - *Pattern Recognition and Machine Learning* - Springer, 2006
- Ian Goodfellow, Yoshua Bengio & Aaron Courville - *Deep Learning* - MIT Press, 2016 : <https://www.deeplearningbook.org>
- scikit-learn documentation : <https://scikit-learn.org/stable/>
- TensorFlow / Keras documentation : https://www.tensorflow.org/api_docs
- PyTorch documentation : <https://pytorch.org/docs/stable/>
- Kaggle — Datasets and ML competitions : <https://www.kaggle.com>
- Papers With Code — State of the art in ML : <https://paperswithcode.com>

REQUIREMENTS

- **Probability and Random Variables (S5)** : probability distributions, expectation, variance, law of large numbers — foundations of probabilistic models (Naive Bayes, GMM, regression).

- **Stochastic Processes (S6)** : modeling of time series and random signals — useful for sequential models and deep learning.
- **Data Mining (S6)** : data preprocessing, association rules, introduction to clustering — direct foundation for this course.
- **Expected cross-disciplinary skills** :
 - Intermediate-level Python programming (numpy, pandas, matplotlib)
 - Linear algebra basics (vectors, matrices, eigenvalues) and differential calculus (gradient)
 - Understanding of data structures and basic algorithms
 - Ability to read technical documentation and scientific articles in English

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE5-EC3
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 2
Total : 6

Project :
Personnal work :

ASSESSMENT

Skills will be assessed based on elements provided in the deliverable, which will be specified in advance to the engineering students.

TEACHING MATERIALS

All documents used during teaching sessions or resources mobilized. If needed, new documentary references will be provided.

LANGUAGE

English

CONTACT

Apply and evaluate machine learning algorithms and discuss their relevance for a given context.

Modifié le : 14 juillet 2026

UE7-DATA

SAE Data

SCOPE OF THE CHALLENGE

WORKING SITUATION

COMPETENCES AND LEVEL ASSESSED

Process massive datasets using artificial intelligence techniques

EXPECTED OUTPUTS

- A **documented Git repository** containing all source code, analysis notebooks, and architecture deployment scripts.
- A **structured technical report** including :
 - Description and justification of the chosen architecture (architecture diagram included)
 - Dataset description : origin, volume, quality, preprocessing steps
 - Applied analysis methodology, selected parameters, and their justification
 - Results obtained, their interpretation, and limitations
 - Compliance with best practices : code quality, reproducibility, version control
- A **results visualization dashboard** (Jupyter Notebook, Streamlit, or equivalent)
- A **20-minute oral presentation** before a jury, including a live demonstration of the pipeline and results

RESOURCES

- Lecturers from DATA-related courses and engineering tools
- Data analysis professionals

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE5-EC4
ECTS : 1

DURATION

Lectures : 8
Tutorial classes : 20
Labs : 10
Total : 38

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, guided and practical work sheets.

LANGUAGE

English

CONTACT

Understand the legal and ethical challenges faced by computer engineers in their professional practice. Through the study of personal data protection law (GDPR), intellectual property law and the regulatory framework for artificial intelligence (AI Act), students will acquire the essential legal reflexes to design, develop and deploy digital systems compliant with European and national legal requirements, while respecting the fundamental rights of individuals.

UE : UE7-DATA

COURSE : Law and Ethics in Computer Engineering

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Identify and apply legal obligations arising from the GDPR when designing and developing an IT system processing personal data
- Implement *privacy by design* and *privacy by default* principles in a software or application development project
- Conduct a Data Protection Impact Assessment (DPIA) and derive appropriate technical and organizational measures
- Identify intellectual property rights applicable to a digital creation and adopt best practices regarding the use of content generated or used by AI
- Analyze obligations imposed by the Artificial Intelligence Regulation (AI Act) based on the risk class of the developed system and align them with GDPR requirements
- Adopt an ethical and responsible stance in the practice of computer engineering, integrating legal dimensions from the design phase

PROGRAM

— Introduction to Digital Law :

- Hierarchy of norms in France ; integration of European law (directives and regulations).
- Overview of the legal framework applicable to digital : GDPR, AI Act, intellectual property law.

— General Data Protection Regulation (GDPR) :

- Fundamental definitions : personal data, processing, controller, processor, DPO, processing register, legal bases.
- Conditions for appointing a DPO ; fundamental principles : lawfulness, purpose limitation, data minimization, accuracy, storage limitation, security and confidentiality.
- Consent : validity conditions, proof and right to withdraw.
- Data subject rights : access, rectification, erasure, portability, restriction, objection.
- Data Protection Impact Assessments (DPIAs / PIAs) : definition, conditions for conducting, balancing of interests.
- Incident management : notification deadline to the CNIL, declaration conditions.
- Sanctions for non-compliance with the GDPR.

— Intellectual Property (IP) Law :

- International, European and national sources ; distinction between economic rights and moral rights.
- Types : copyright, patent, trademarks, designs and models, geographical indications, trade secrets, e-Soleau envelope.

- Principles of exclusivity, temporality and territoriality according to the type of IP.
 - Specific case of IP and AI : citation obligations, *Creative Commons* licenses (BY, NC, ND, SA), U.S. *copyright*, NFTs.
 - Works created by AI : 100% AI creation vs shared AI/human creation; what about copyright ?
 - Best practices regarding AI : legal monitoring, contractual clauses, preference for licensed models.
- **GDPR and Artificial Intelligence Regulation (AI Act) :**
- New European bodies : European AI Board, AI Office, Advisory Forum, Independent Scientific Panel of Experts.
 - Classification of AI systems by risk level (AI Act) and implications for connected objects.
 - Proportional application of the GDPR to data processing by AI.
 - Obligations of AI system providers and users ; CNIL recommendations on automated individual decision-making.
 - Balancing act : competitiveness / GDPR compliance / respect for intellectual property.
 - Practical case — *to-do list* for creating compliant AI : purpose, controller, legal basis, data minimization, retention period, data subject rights, *privacy by design* and *by default*, DPIA.

BIBLIOGRAPHY

- Gilles Vercken & Stéphane Leriche - *Droit de l'informatique et des réseaux* - Lamy, latest edition
- Jean Frayssinet - *Informatique, fichiers et libertés* - Litec
- CNIL - *Practical GDPR Guide for Developers* : <https://www.cnil.fr/en/gdpr-developers>
- CNIL - *Guide to the Security of Personal Data* : <https://www.cnil.fr/en/personal-data-security>
- CNIL - *Recommendations on the Development of AI Systems* : <https://www.cnil.fr/en/artificial-intelligence>
- European Commission - *General Data Protection Regulation (GDPR)* : <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R0679>
- European Commission - *Artificial Intelligence Regulation (AI Act)* : <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32024R1689>
- INPI - *Intellectual Property Resources* : <https://www.inpi.fr/en>
- Creative Commons - *Licenses and Tools* : <https://creativecommons.org/licenses/>
- ANSSI - *Security Recommendations for Mobile Applications* : <https://www.ssi.gouv.fr/en/guide/>

REQUIREMENTS

- **Expected transversal skills :**
- General knowledge of how a computer system, a web application and a mobile application work

- Basic understanding of data processing and storage (databases, APIs, cloud services)
- Ability to read and analyze regulatory texts and official documents
- Proficiency in written French for drafting legal and technical documents
- Curiosity about societal, ethical and legal issues in digital technology

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE5-EC5
ECTS : 1

DURATION

Lectures : 22
Tutorial classes : 0
Labs : 0
Total : 22

Project :
Personnal work :

ASSESSMENT

2 individual grades (OHS, CSR/Ethics) 2
project grades (CSR/Ethics)

TEACHING MATERIALS

Course materials Regulations and standards

LANGUAGE

English

CONTACT

— Be able to identify and assess risks to health and safety at work and contribute to the company's prevention approach —
Be capable of developing, implementing, and improving a Corporate Social Responsibility approach within a company —
Develop a professional and responsible ethical practice, taking into account societal stakes

UE : UE7-DATA

COURSE : TES : OSH, CSR, Ethics

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

— Identify, assess, and control risks to health and safety at work — Identify the issues related to the corporate social responsibility of an organization and adopt an ethical behavior

PROGRAM

Part 1 : Occupational Health and Safety (OHS) — Definitions and stakes (human, economic, and legal) and statistics on work-related accidents and occupational diseases — Regulations and general principles of prevention — Roles and missions of OHS stakeholders — Assessment of occupational risks and Single Document of Occupational Risk Assessment (DUER) — Main hazards and prevention measures — Practical exercises : risk assessment with Tutoprev

Part 2 : Corporate Social Responsibility (CSR) — History of sustainable development / CSR and global, national, and regional stakes — Implementing a CSR approach in a company (ISO 26000, ISO 53001) — Identification of SDGs / relevant action areas and prioritization of action plans

Part 3 : Engineering Ethics — Concepts of professional ethics for engineers — Methodology for resolving an ethical dilemma

BIBLIOGRAPHY

— French Labour Code (Code du travail) — Annual reports from the French National Health Insurance Fund (Assurance Maladie) — INRS, OPPBTP, and ANACT-ARACT network websites and documentation — The Sustainable Development Goals Reports — Réunion Island SDG progress reports : analysis of indicator evolution over the past 20 years (DEAL Réunion) — AFNOR NF EN ISO 26000 (2010) — ISO 53001 Management systems for sustainable development goals (SDGs) — WFEO Code of Ethics (2023-10-06) — Ethical Charter of Engineers and Scientists of France (Charte éthique Ingénieurs et Scientifiques de France)

REQUIREMENTS

General knowledge of business management

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE3-EC1
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 10
Total : 24

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments, practical work sessions, and a project.

TEACHING MATERIALS

Slides, guided work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

Understanding and developing applications in current mobile application ecosystems (iOS and Android), and mastering one of them for designing mobile services for the general public and businesses.

Modifié le : 14 juillet 2026

UE : UE7-DEV

COURSE : Mobile Programming

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Understanding multiplatform and multi-environment development
- Integrating technical constraints and system environments
- Applying integration engineering
- Producing comprehensive documentation

PROGRAM

This module aims to acquire knowledge, understanding, and use of essential techniques for developing applications for mobile devices such as smartphones and tablets. The typical content is listed below. It will be adapted as much as possible to technological evolutions :

- Introduction to the development approach and the economic model for mobile application distribution. Study of target devices, the specificities of mobility contexts, and their interaction modes.
- Learning the supporting programming language. Mastery of design tools (IDE, graphical interface editor, simulator, and documentation service).
- Study of software architecture principles underlying the supported libraries (foundation framework, MVC model, interface API, principles of communication/file/multimedia managers, etc.).
- Introduction to advanced features : geolocation, accelerometer, multipoint touch interaction, push notifications, etc.
- Practice in deploying applications, signing applications, and validating submission on a digital distribution platform.

BIBLIOGRAPHY

REQUIREMENTS

Development modules from previous semesters.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE3-EC2
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 10
Total : 24

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments, practical work, and a project.

TEACHING MATERIALS

Slides, directed work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

This course introduces the formal foundations of programming languages : how to describe, recognize, and transform a language, and what the intrinsic limits of computation are. It aims to understand the mechanisms underlying the design of compilers and interpreters, to evaluate the expressiveness of different models (automata, grammars, Turing machines), and to assess the algorithmic complexity of problems.

UE : UE7-DEV

COURSE : Theory of Languages

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Master the fundamental paradigms of programming, languages, and algorithms to design and develop applications for any type of environment.
- Identify and classify problems according to their complexity (P, NP, NP-complete) and select appropriate algorithmic strategies.

PROGRAM

- Foundations (Alphabet, word, language, Chomsky hierarchy, finite automata, etc.) and regular languages
- Context-free languages (Context-free grammars, pushdown automata, etc.), lexical and syntactic analysis
- Computability and complexity (Turing machines, undecidability and complexity, etc.)

BIBLIOGRAPHY

“Michael Sipser — *Introduction to the Theory of Computation* — Cengage Learning
John Hopcroft — *Introduction to Automata Theory, Languages, and Computation* — Pearson”

REQUIREMENTS

System and Network modules and Development modules from previous semesters.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE3-EC3
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 12
Labs : 0
Total : 12

Project :
Personnal work :

ASSESSMENT

Performance tracking and establishment of personal objectives.

TEACHING MATERIALS

Documentation

LANGUAGE

English

CONTACT

This course aims to promote health, well being, and the values of sports through the practice of varied physical activities, while strengthening students' ability to work in teams and push their limits. Through a variety of sports activities and cooperative games, students will be encouraged to develop essential interpersonal skills such as communication, collaboration, and leadership.

UE : UE7-DEV

COURSE : Sports

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Communicate orally, adapting to the technical knowledge level of the interlocutors
- Organize the project according to project management methodologies

PROGRAM

- Physical initiation and preparation
- Team sports and team spirit
- Individual sports and personal development
- Health and prevention

BIBLIOGRAPHY

- Jonny Wilkinson, *The Winning Mind*, 2012
- Mike Horn, *Dare to Touch the Stars*, 2016
- Grégoire Chevnard, *From My Couch to the World's Toughest Race*, 2018

REQUIREMENTS

No prerequisites.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE2-EC1
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 18
Labs : 10
Total : 28

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments, practical work sessions, and a mini embedded project.

TEACHING MATERIALS

Slides, directed work sheets, practical work sheets, embedded platforms (ESP32, STM32).

LANGUAGE

English

CONTACT

Provide theoretical and practical foundations for designing embedded real time applications in the context of the Internet of Things. Students will learn to identify, analyze, and solve issues related to real time constraints, limited resources, and reliability of connected embedded systems.
Modifié le : 14 juillet 2026

UE : UE7-IOT

COURSE : Internet of Things : Embedded and Real-Time Systems

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Apply programming and communication paradigms specific to embedded systems and IoT
- Design secure infrastructure and service solutions tailored for connected objects
- Implement an end-to-end IoT solution by identifying hardware architectures, terminal object networks, and communication with an IoT service platform

PROGRAM

— Real-Time Systems — Fundamentals

- Identify and understand real-time constraints (hard / soft real-time) associated with an embedded IoT application
- Analyze and quantify these constraints; recommend a scheduling solution type (Rate Monotonic, Earliest Deadline First)
- Feasibility analysis of a real-time task set

— Embedded Programming and RTOS

- Creating tasks, synchronization, and inter-process communication on a real-time operating system (FreeRTOS)
- Priority management, semaphores, mutexes, message queues
- Energy management : sleep modes, deep sleep, duty cycling

— Hardware Resources and Peripherals

- Identifying critical hardware and software resources of an IoT node (sensors, actuators, communication interfaces)
- Role and development of device drivers (GPIO, I2C, SPI, UART, ADC)
- Embedded communication buses and low-level protocols

— Design and Tools

- Specification tools and languages for developing embedded real-time applications (sequence diagrams, state machines)
- Cross-compilation toolchain, on-target debugging (JTAG/SWD)
- Sensor-microcontroller-network integration : from sensor to cloud (MQTT, CoAP)

— Practical Work

- Lab 1 : Getting started with FreeRTOS on ESP32 — tasks, priorities, scheduling
- Lab 2 : Inter-task communication and sensor management (I2C/SPI)
- Lab 3 : Energy management and low-power modes

- Lab 4 : Complete integration — sensor acquisition, real-time processing, MQTT transmission

BIBLIOGRAPHY

Jean-Philippe Babau — *Embedded Real-Time Systems* — Hermes/Lavoisier
Richard Barry — *Mastering the FreeRTOS Real Time Kernel* — freertos.org
Kolban — *Kolban's Book on ESP32* — leanpub.com
James F. Kurose and Keith W. Ross — *Computer Networking* — Pearson Education
Phillip A. Laplante et al. — *Real-Time Systems Design and Analysis : Tools for the Practitioner* — Wiley-IEEE Press
Elecia White — *Making Embedded Systems : Design Patterns for Great Software* — O'Reilly Media

REQUIREMENTS

- SR052 : Operating Systems and Command Language
- SR051 : Principles of Networks and IoT
- Basics of C/C++ programming

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE2-EC2
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 2
Total : 6

Project :
Personnal work :

ASSESSMENT

Skills will be assessed based on deliverables provided, in line with the expectations described in the evaluation grids.

TEACHING MATERIALS

All documents used during teaching sessions and resources mobilized by the SAE. IoT hardware platforms (ESP32, Raspberry Pi, sensors).

LANGUAGE

English

CONTACT

Exploit an IoT network, enhance extracted data, and improve network cost and impact. A company specializing in IoT solutions wishes to deploy a network of smart sensors for environmental monitoring (air quality, temperature, humidity, noise) in an urban or agricultural context in La Réunion. The client requests 2026

to end solution : from embedded sensor nodes to a visualization dashboard, including data collection and processing. The engineering team must design, prototype, and demonstrate the feasibility of this solution while considering energy autonomy.

UE7-IOT

IoT SAE

SCOPE OF THE CHALLENGE

WORKING SITUATION

COMPETENCES AND LEVEL ASSESSED

- Apply programming and communication paradigms specific to embedded systems and IoT (1.5)-(1.4)
- Analyze IoT data while integrating edge analytics specificities (1.5)-(1.4)
- Assess project costs and economic viability of a solution (1.5)-(1.4)
- Evaluate the environmental impact of a solution (1.5)-(1.4)
- Manage a project while respecting cost, schedule, and quality constraints (1.5)-(1.4)

EXPECTED OUTPUTS

- A **documented Git repository** containing all source code, technical documentation, architecture diagrams, and README.
- A **framing note** including the roadmap, project methodology, and risk management.
- A **specification document** with detailed requirements, regulatory compliance, and environmental analysis.
- An **architecture document** covering hardware and software with justification of technological choices, autonomy estimation, and costs.
- An **MVP v0** : functional prototype with test log and metrics.
- An **MVP v1** : integrated prototype with market analysis and economic model.
- **Presentation materials** for intermediate and final reviews.
- A **report** and a **demonstration** of the complete solution.

RESOURCES

- Teachers from IoT-related UE courses and engineering tools
- IOT701 : Embedded and Real-Time Systems (co-requisite)
- IOT706 : Data Analysis for IoT (co-requisite)
- Systems and Networks modules and Development modules from previous semesters

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE2-EC3
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 16
Total : 20

Project :
Personnal work :

ASSESSMENT

deliverables and presentations

TEACHING MATERIALS

Mission support, data, guides, reports...

LANGUAGE

English

CONTACT

This course aims to develop students' ability to successfully carry out an innovation project in a group (7 to 12 students), involving problem solving, continuous improvement or the design of new breakthrough solutions, while taking sustainability challenges into account

Modifié le : 14 juillet 2026

UE : UE7-IOT

COURSE : Innovation competition

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

mobilizing and combining tools related to innovation methodology acquired in the resources, learning to learn (completing the tools...), working in a project group (shared reflexivity, autonomy, time and stress management...), communicating and convincing

PROGRAM

Upstream innovation : State of the art, market study, regulations, market immersion, opportunities, defining objectives, starting ideation

BIBLIOGRAPHY

According to the year's project

REQUIREMENTS

Project management, survey management, marketing, creativity methods. These prerequisites are acquired beforehand in the curriculum resources or during the year through autonomous or guided learning.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE2-EC4
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 4
Labs : 8
Total : 16

Project :
Personnal work :

ASSESSMENT

Continuous assessments and lab work evaluation (complete pipeline deployed on target hardware).

TEACHING MATERIALS

Slides, Jupyter notebooks, Edge Impulse platform, ESP32/Arduino Nano 33 BLE Sense boards, practical work sheets.

LANGUAGE

English

CONTACT

Master the complete data analysis pipeline for IoT, from sensor data collection to machine learning model training, deployment, and validation of embedded models on resource constrained devices (edge AI / TinyML).

Modifié le : 14 juillet 2026

UE : UE7-IOT

COURSE : Data Analysis for IoT

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Analyze IoT data by integrating edge analytics (edge computing) specificities
- Apply programming and communication paradigms specific to embedded systems and IoT
- Design infrastructures and service solutions tailored for connected objects

PROGRAM

— Module 1 — IoT Data Collection and Preparation (Lecture : 1h, Tutorial : 1h, Lab : 2h)

- Specificities of IoT data : time series, multi-axis sensor data, sampling, noise
- Collection strategies : on-field labeling, reproducible acquisition protocols
- Preprocessing : cleaning, normalization, windowing, data augmentation
- Handling class imbalances and variable field conditions
- *Lab : Accelerometer/gyroscope data collection on ESP32, labeling and exploration with Python/Pandas*

— Module 2 — Model Training for Embedded Systems (Lecture : 1.5h, Tutorial : 1.5h, Lab : 2h)

- Introduction to TinyML : memory, computation, and energy constraints
- TensorFlow Lite for Microcontrollers : architecture, quantization (int8, float16), model conversion
- Edge Impulse Studio : project creation, data import, impulse design (DSP + classification)
- Suitable architectures : 1D CNN for time series, anomaly detection, light-weight transfer learning
- Trade-offs : accuracy vs. model size vs. inference latency
- *Lab : Training a gesture recognition model on Edge Impulse, exporting to TFLite*

— Module 3 — Embedded Deployment and Inference (Lecture : 1h, Tutorial : 1h, Lab : 2h)

- Deploying TFLite models on microcontrollers (ESP32, Arduino Nano 33 BLE)
- Integration into a real-time loop : acquisition → preprocessing → inference → action
- Memory optimization : arena sizing, operator resolver, flatbuffer model
- Measuring embedded performance : latency, RAM/Flash memory consumption, energy consumption

- *Lab : Deploying the model on target hardware, measuring latency and memory consumption*
- **Module 4 — Field Validation and Robustness (Lecture : 0.5h, Tutorial : 0.5h, Lab : 2h)**
 - Robustness challenges in real-world conditions : sensor drift, environmental variations, aging
 - Field validation vs. laboratory validation : test protocols, performance metrics in situ
 - Data drift and concept drift : detection and update strategies (retraining, feedback loop)
 - Field feedback → retraining loop : incremental data collection, data and model versioning
 - Ethical and reliability considerations for automated decisions at the edge
 - *Lab : Validating the model in real-world conditions, analyzing errors, proposing improvements, iterating*

BIBLIOGRAPHY

Pete Warden & Daniel Situnayake — *TinyML : Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers* — O'Reilly, 2020
Vijay Janapa Reddi et al. — *Widening Access to Applied Machine Learning with TinyML* — Harvard, 2021

Edge Impulse Documentation — docs.edgeimpulse.com

TensorFlow Lite for Microcontrollers Documentation — tensorflow.org/lite/microcontrollers

REQUIREMENTS

- Python and C/C++ programming basics
- Probability and statistics fundamentals (S5-S6)
- IOT701 : Embedded and Real-Time Systems (co-requisite)

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE2-EC5
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 20
Labs : 0
Total : 20

Project :
Personnal work :

ASSESSMENT

deliverables and presentations

TEACHING MATERIALS

Mission support, data, guides, reports...

LANGUAGE

English

CONTACT

This course aims to develop students' ability to successfully carry out, in groups (7 to 12 students), an innovation project related to problem solving, continuous improvement, or the design of new breakthrough solutions, while considering sustainability issues

Modifié le : 14 juillet 2026

UE : UE7-IOT

COURSE : Digital Innovation

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

mobilize and combine tools related to innovation methodology acquired in the resources, learn to learn (completing tools...), work in a project group (collective reflexivity, autonomy, time and stress management...), communicate and convince

PROGRAM

Upstream innovation : State of the art, market study, regulations, market immersion, opportunities, defining objectives, starting ideation

BIBLIOGRAPHY

According to the year-long project

REQUIREMENTS

Project management, survey management, marketing, creativity methods. These prerequisites are acquired beforehand in the curriculum resources or during the year through autonomous or guided learning.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE1-EC1
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 6
Total : 20

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides, practical work sheets.

LANGUAGE

English

CONTACT

Understand and implement information system supervision mechanisms for maintenance and security purposes.

Modifié le : 14 juillet 2026

UE : UE7-SYSRES

COURSE : Computer Networks : Administration, Supervision and Management

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Monitor an information system
- Implement mechanisms and software for data collection and analysis for preventive maintenance and detection of anomalies in the information system

PROGRAM

- Typical architectures for network management, including management consoles, aggregators, and device agents.
- Data collection and types : log files, metrics, traces.
- Structure of Management Information (SMI), Management Information Base (MIB), SNMP administration protocol.
- Tools for supervision and administration through collection tools and dashboards.
- Alert and incident management.
- Supervision of modern environments : cloud, containers.

BIBLIOGRAPHY

REQUIREMENTS

The Systems and Networks modules from previous semesters.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S7-UE1-EC2
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 6
Total : 20

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides, practical work sheets.

LANGUAGE

English

CONTACT

Master modern tools and practices for deploying, orchestrating, and automating information systems. This course trains students in containerizing applications with Docker, orchestrating them at scale with Kubernetes, and automating system administration with Ansible. It also covers essential infrastructure services for deploying an IS (LDAP directory, DNS, messaging) and cloud paradigms, enabling students to design, deploy, and maintain a complete information system while respecting security and availability constraints.

UE : UE7-SYSRES

COURSE : System Administration : Orchestration, Containers and Automation

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

- Design, deploy, and maintain essential information system infrastructure services (directory, DNS, messaging) while respecting security constraints
- Containerize an application using Docker and manage its lifecycle : building images, composing multi-container services, image registries
- Deploy and administer a Kubernetes cluster : managing workloads, services, persistent volumes, scaling, and continuous updates
- Automate system infrastructure configuration and deployment using Ansible : playbooks, roles, dynamic inventories
- Design, deploy, maintain, and evolve cloud services by distinguishing IaaS, PaaS, and SaaS models, and evaluating the advantages and limitations of each approach
- Implement data collection and analysis mechanisms for preventive maintenance and anomaly detection in the information system

PROGRAM

- **Information system infrastructure services :**
 - Authentication directory : LDAP protocol — structure, schema, deployment, and integration into an IS.
 - DNS hierarchy : zones, records, recursive and authoritative resolution.
 - Installing and securing a DNS server : DNSSEC, signed zone management.
 - Configuring a mail server : SMTP, IMAP protocols, anti-spam, DKIM, SPF, DMARC.
 - Centralized identity management : LDAP integration with IS services (DNS, mail, SSH).
- **Containerization with Docker :**
 - Recap of virtualization and positioning of containers : namespaces, cgroups, image layers.
 - Building Docker images : Dockerfile, best practices, layer optimization, multi-stage builds.
 - Managing the lifecycle of containers : Docker networks, persistent volumes, environment variables.
 - Composing services with Docker Compose : defining multi-container stacks, dependencies, health checks.
 - Image registries : Docker Hub, private registry (Harbor); versioning and security policies.
 - Container security : non-root user, vulnerability scanning (Trivy), signed content policy.
- **Orchestration with Kubernetes :**

- Kubernetes architecture : control plane (API server, etcd, scheduler, controller manager), worker nodes.
- Core objects : Pod, Deployment, ReplicaSet, Service, ConfigMap, Secret, Namespace.
- Managing persistent storage : PersistentVolume, PersistentVolumeClaim, StorageClass.
- Scaling and continuous updates : *rolling update, rollback, Horizontal Pod Autoscaler*.
- Exposing services : Ingress, LoadBalancer, TLS certificate management (cert-manager).
- Security in Kubernetes : RBAC, NetworkPolicies, Pod Security Standards, secret management.
- Deployment tools : Helm (Kubernetes package manager) ; introduction to GitOps (ArgoCD).
- **Automation with Ansible :**
 - Automation principles : idempotence, infrastructure as code, configuration management.
 - Ansible architecture : inventories (static and dynamic), modules, playbooks, variables, and facts.
 - Structuring Ansible projects : roles, collections, Ansible Galaxy.
 - Automating administration tasks : service deployment, user management, updates.
 - Integrating Ansible into a CI/CD pipeline : automatic triggering, secret management (Ansible Vault).
- **Cloud deployment of containerized applications :**
 - Cloud-native vs internal applications : design differences, scalability, resilience.
 - Deploying a containerized application on a managed Kubernetes service (AKS, GKE, or EKS).
 - DevOps and CI/CD principles : continuous integration and deployment pipeline (GitLab CI, GitHub Actions).
 - *IaaS/PaaS/SaaS paradigms and cloud architecture choices are covered in depth in SR802.*
- **Observability in a containerized environment (introduction) :**
 - Observability challenges in Kubernetes : metrics, logs, traces.
 - Application and system metrics : exposure via Prometheus, visualization with Grafana — basic concepts.
 - Logging in Kubernetes : stdout/stderr, log aggregation with Loki.
 - *These tools will be covered in depth in SR802 — System Administration : Storage and Monitoring.*

BIBLIOGRAPHY

- Evi Nemeth et al. - *UNIX and Linux System Administration Handbook* - Addison-Wesley, 5th ed., 2017

- Kelsey Hightower et al. - *Kubernetes : Up and Running* - O'Reilly, 3rd ed., 2022
- Jeff Nickoloff & Stephen Kuenzli - *Docker in Action* - Manning, 2nd ed., 2019
- Lorin Hochstein - *Ansible : Up and Running* - O'Reilly, 3rd ed., 2022
- Kubernetes Documentation : <https://kubernetes.io/docs/>
- Docker Documentation : <https://docs.docker.com>
- Ansible Documentation : <https://docs.ansible.com>
- Helm Documentation : <https://helm.sh/docs/>
- ANSSI - *Security recommendations for Docker container deployment* : <https://www.ssi.gouv.fr/guide/>

REQUIREMENTS

- **SR051 - Networking and IoT Principles (S5)** : OSI model, TCP/IP, routing, DNS — essential for understanding Docker and Kubernetes networks.
- **SR052 - Operating System and Command Language (S5)** : Linux administration, process management, permissions, Bash scripting — foundation for all system administration.
- **SR062 - System Administration 1 (S6)** : system services (systemd), user management, introduction to network services — direct prerequisite for LDAP, DNS, and messaging.
- **SR603 - Virtual Environments and Collaboration Practices (S6)** : introduction to containers, collaboration tools, version control — foundations of containerization and GitOps.
- **Expected cross-disciplinary skills :**
 - Common Linux administration : service management, networking, permissions, text editors (vim/nano)
 - Basic Bash scripting : loops, conditions, file management
 - Git proficiency : clone, commit, push, branches
 - Basic knowledge of YAML and JSON for DevOps tool configuration
 - Ability to read technical documentation in English

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE1-EC3
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 2
Total : 6

Project :
Personnal work :

ASSESSMENT

Skills will be assessed based on the deliverables provided, details of which will be communicated to students in advance.

TEACHING MATERIALS

All documents used during teaching sessions or resources mobilized. If necessary, additional documentary references will be provided.

LANGUAGE

English

CONTACT

Designing infrastructures tailored to company needs, automating server and service deployment, and deploying tools to maintain operational status.

Modifié le : 14 juillet 2026

UE7-SYSRES

SAE Systems and Networks

SCOPE OF THE CHALLENGE

WORKING SITUATION

COMPETENCES AND LEVEL ASSESSED

Designing a secure information system architecture

EXPECTED OUTPUTS

- A **technical report** covering the entire project.
- A **20-minute oral presentation** to a jury, including a live demonstration.

The SAE will be assessed based on the following criteria, in addition to the technical aspects specified in the expected level description :

- Justification of solution and technology choices tailored to the client's needs
- Analysis and performance measurement for continuous SI improvement
- Integration of fundamental security principles
- Documentation of the work carried out
- Robustness and scalability of the infrastructure to meet the client's operational requirements

RESOURCES

- Systems and Networks lecturer(s)
- Cybersecurity lecturer(s)
- Communication lecturer

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-
S7-UE1-EC4
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 10
Labs : 6
Total : 20

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides, directed work sheets, and practical work sheets.

LANGUAGE

English

CONTACT

This course will enable students to understand local area network technologies in order to manage and/or design a company's communication infrastructure, and to know, implement, and evaluate the main routing protocols to create a multi site infrastructure using an operator network's

modèle le : 14 juillet 2026

UE : UE7-SYSRES

COURSE : Interconnection of Networks : Theories and Protocols

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

— Design a multi-site connection via an operator network

PROGRAM

- Inter-domain routing : BGP.
- Route announcement principles, eBGP and iBGP duality. Internal routing/external routing synchronization and route redistribution.
- Internet Exchange Points (GIX), transit, and peering.
- Traffic engineering in the Internet. BGP traffic analysis, study of BGP announcement oscillations. Internet connectivity analysis, principles of metrology. Active and passive measurement tools.
- Label switching : MPLS.
- VRFs and MPLS/BGP VPNs.

BIBLIOGRAPHY

James F. KUROSE and Keith W. ROSS - Computer Networking - Pearson Editions

REQUIREMENTS

Systems and Networks modules and Cybersecurity from previous semesters.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE4-EC1
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 8
Labs : 12
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, guided and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-CYBER

COURSE : Cybersecurity : Exfiltration, Evasion and Malware

SCOPE OF THE COURSE

OBJECTIVES

Understand offensive mechanisms of data exfiltration, evasion of defenses, and malware operation to enable malware analysis, detection of suspicious behaviors, and strengthening of an information system's defensive posture.

COMPETENCE AND SKILLS

- Statically and dynamically analyze malware to understand its behavior and indicators of compromise
- Identify and counter data exfiltration techniques (hidden channels, DNS tunneling, C2) and evasion of detection mechanisms
- Design, develop, and implement mechanisms to protect data, software, networks, and cloud environments
- Select and administer tools for detecting and correlating security incidents in response to malware threats
- Write a technical analysis report in French and English, including indicators of compromise (IoC) and remediation recommendations

PROGRAM

- **Malware taxonomy** : viruses, worms, Trojans, ransomware, spyware, rootkits, bootkits — infection and propagation mechanisms
- **Data exfiltration techniques** : hidden channels, DNS tunneling, exfiltration via HTTP/HTTPS, command and control (C2) protocols, *beaconing*
- **Defense evasion techniques** : obfuscation, *packing*, payload encryption, antivirus and EDR bypass, *living off the land* (LOLBins)
- **Static malware analysis** : metadata extraction, disassembly (Ghidra, IDA Free), string extraction, analysis of imports/exports
- **Dynamic malware analysis** : sandboxing, system call monitoring, network analysis (Wireshark, FakeNet-NG), *hooking*
- **Countermeasures and remediation** : containment, eradication, restoration, system hardening, threat intelligence
- **Report writing** : structure, IoC, criticality scoring, technical and organizational recommendations

BIBLIOGRAPHY

- Michael Sikorski & Andrew Honig - *Practical Malware Analysis* - No Starch Press, 2012
- Chris Eagle - *The IDA Pro Book* - No Starch Press, 2nd ed., 2011
- Bruce Dang et al. - *Practical Reverse Engineering* - Wiley, 2014
- Solange Ghernaoui - *Sécurité informatique et réseaux* - Éditions Dunod
- MITRE ATT&CK - Exfiltration and evasion tactics : <https://attack.mitre.org>
- ANY.RUN - Dynamic analysis sandbox : <https://any.run>
- VirusTotal - File and URL analysis : <https://www.virustotal.com>

- MalwareBazaar - Malware sample database : <https://bazaar.abuse.ch>
- ANSSI - Guides and recommendations : <https://www.ssi.gouv.fr/guide/>
- NIST SP 800-83 - *Guide to Malware Incident Prevention and Handling* : <https://csrc.nist.gov/publications/detail/sp/800-83/rev-1/final>

REQUIREMENTS

- **SEC502 - Cybersecurity : Principles, Practices and Threats** : CIA model, threat classification, malware introduction and defenses
- **SEC602 - Cryptography and Applications** : encryption, PKI, TLS/SSL — necessary to understand obfuscation techniques and encrypted C2 channels
- **SEC702 - Cybersecurity : Offensive Security Methodologies** : pentest phases, vulnerability exploitation, post-exploitation — direct basis for understanding malicious behaviors
- **SEC701 - Secure Architecture and Infrastructure** : networks, firewalls, DMZ, segmentation — essential for analyzing malicious communications
- **SYSRES 501 - Network and IoT Principles** : TCP/IP protocols, DNS, HTTP — essential for analyzing malicious network traffic
- **SYSRES 502 - Operating Systems and Command Languages** : Linux/Windows administration, processes, registry, file systems — foundation for behavioral analysis
- **Expected cross-disciplinary skills** :
 - Linux terminal and Windows environment proficiency
 - Scripting basics (Bash, Python)
 - Ability to read technical documentation in English
 - Use of virtual machines and isolated environments

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE4-EC2
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 2
Total : 6

Project :
Personnal work :

ASSESSMENT

Competence will be assessed based on the deliverables provided, using a criterion-based grid presented to engineering students in advance.

TEACHING MATERIALS

All documents used during teaching sessions. If necessary, additional documentary references may be consulted.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE8-CYBER

Cybersecurity SAE

SCOPE OF THE CHALLENGE

WORKING SITUATION

Design, deploy, and/or audit a security policy and document the work.

COMPETENCES AND LEVEL ASSESSED

Managing the security of an information system

EXPECTED OUTPUTS

- The **commented source code** of the developed malware (ransomware + ex-filtration module), stored in a private Git repository.
- A **comprehensive technical report** including :
 - Description of the malware architecture and technical choices
 - Evasion techniques implemented and their justification
 - Generated indicators of compromise (IoC)
 - Limitations and recommended countermeasures
- A **20-minute oral presentation** to a jury, with a *live* demonstration in a virtualized environment.

In addition to the technical aspects specified in the expected level description, the SAE will be assessed based on the following criteria :

- Compliance with national and international legal frameworks
- Continuous scientific and technological monitoring
- Communication with stakeholders, both written and oral, in French and English
- Continuous reduction of cyberattack risks and impacts

RESOURCES

- Mathematics and cryptography instructor
- Cybersecurity specialist, particularly in regulatory aspects
- English instructor

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE4-EC3
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 12
Labs : 4
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, directed work sheets and practical work sheets.

LANGUAGE

English

CONTACT

Tahiry RAZAFINDRALAMBO
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Modifié le : 14 juillet 2026

UE : UE8-CYBER

COURSE : Cybersecurity : Risks, Incidents and Compliance

SCOPE OF THE COURSE

OBJECTIVES

Master the risk management, incident response and regulatory compliance approaches for an information system. Through a methodological and practical approach, students will learn to identify and qualify cyber risks, manage security incident response, and implement the requirements of current standards and regulations (GDPR, NIS2, ISO 27001).

COMPETENCE AND SKILLS

- Conduct a comprehensive risk analysis using a recognized methodology (EBIOS Risk Manager, ISO 27005) and applicable regulatory framework
- Design and implement data, network and cloud protection mechanisms in line with identified security requirements
- Define and apply an Information System Security Policy (ISSP) tailored to the organization's risks and constraints
- Manage the detection, analysis and response to a security incident using correlation tools (SIEM) and formalized procedures
- Identify legal and regulatory obligations (GDPR, NIS2, LPM) and derive the necessary compliance measures
- Draft technical and organizational documents (ISSP, incident response plan, risk analysis report) in French and English

PROGRAM

- **Introduction to cyber risk management** : fundamental concepts (threat, vulnerability, impact, likelihood), risk lifecycle, relationship between risk and security policy
- **Risk analysis methodologies** : EBIOS Risk Manager (ANSSI), ISO/IEC 27005, comparison with MEHARI and OCTAVE; risk modeling workshops
- **Information System Security Policy (ISSP)** : development, governance, monitoring indicators, integration into the company's strategy
- **Regulatory and normative framework** : GDPR (obligations, DPO role, breach notifications), NIS2 directive, Military Programming Law (LPM), ISO/IEC 27001 and 27002
- **Security incident management** : incident lifecycle (detection, containment, eradication, recovery), response procedures, role of SOC and CERT
- **Business continuity and resilience** : Business Continuity Plan (BCP), Disaster Recovery Plan (DRP), crisis exercises (*tabletop exercises*)
- **Audit and compliance** : internal security audit, ANSSI frameworks (SecNum-Cloud, security visa), implementation of an ISMS according to ISO 27001
- **Deliverables drafting** : risk analysis report, ISSP, CNIL/ANSSI incident notification form, risk treatment plan

BIBLIOGRAPHY

- Laurent Bloch & Christophe Wolfhugel - *Sécurité informatique — Principes et méthodes* - Eyrolles, 3rd ed., 2013

- Solange Ghernaouti - *Sécurité informatique et réseaux* - Dunod Editions
- Alexandre Fernandez-Toro - *Management de la sécurité de l'information — Implémentation ISO 27001* - Eyrolles, 2012
- ANSSI - *La méthode EBIOS Risk Manager* : <https://www.ssi.gouv.fr/guide/ebios-risk-manager/>
- ANSSI - *Référentiel d'exigences pour les OIV/OSE* : <https://www.ssi.gouv.fr>
- ISO/IEC 27001 :2022 - *Information security management systems*
- ISO/IEC 27005 :2022 - *Information security risk management*
- CNIL - *RGPD Guide for Developers and DPOs* : <https://www.cnil.fr/fr/rgpd-de-quoi-parle-t-on>
- NIST SP 800-61 - *Computer Security Incident Handling Guide* : <https://csrc.nist.gov/publications/detail/sp/800-61/rev-2/final>
- MITRE ATT&CK - *Tactics and techniques matrix* : <https://attack.mitre.org>

REQUIREMENTS

- **SEC502 - Cybersecurity : Principles, Practices and Threats** : CIA model, threat classification, introduction to security policies
- **SEC602 - Cryptography and Applications** : encryption, PKI, TLS/SSL — foundations of data protection mechanisms required by standards
- **SEC701 - Secure Architecture and Infrastructure** : design of secure architectures, firewalls, DMZ — technical context for risk analysis
- **SEC702 - Cybersecurity : Offensive Security Methodologies** : knowledge of attack techniques and vulnerabilities — essential for assessing risk likelihood
- **SEC801 - Exfiltration, Evasion and Malware** : malware analysis, IoC, evasion techniques — necessary for qualifying and handling security incidents
- **SYSRES 501 - Principles of Networks and IoT** : network protocols, addressing — basis for understanding system perimeters and mapping
- **Expected cross-disciplinary skills** :
 - Ability to draft structured technical and organizational documents
 - Reading and understanding standards and regulatory texts in French and English
 - Analytical and synthesis skills for risk modeling
 - Project management and teamwork skills

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE4-EC4
ECTS : 2

DURATION

Lectures : 0
Tutorial classes : 20
Labs : 10
Total : 30

Project :
Personnal work :

ASSESSMENT

Internal assessment : Situational tasks on professional skills, at least 2 assessments per semester
External assessment : TOEIC (Semesters 8/9)

TEACHING MATERIALS

General English : Current affairs topics, press, Internet
Specialized English : Technical and scientific resources
Professional English : CV, cover letter, emails
TOEIC past papers

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-CYBER

COURSE : English

SCOPE OF THE COURSE

OBJECTIVES

This English-language course aims to develop pragmatic, sociocultural, and linguistic CEFR competencies in the four language skills through varied teaching methods in interactive lectures, tutorials, and practical sessions. Activities include listening and reading comprehension, written productions (essays, summaries, memos, internship reports), and oral productions (presentations, group projects, improvisations, discussions, and debates) to prepare students for professional English use while fostering critical thinking.

COMPETENCE AND SKILLS

- Understand spoken and written English
- Express oneself in writing and speaking (continuous and interactive production)
- Use technical and professional documents
- Prepare for the TOEIC : Level 4 (B2.2)

PROGRAM

- Comprehension of written and spoken documents : scientific and technical documents, study of scientific publications
- Writing the internship report (Level 2)
- Technical and professional presentations with slides (Level 2)
- Grammar correction – argumentative structure, nuanced viewpoints
- Work on authentic accents (British / American English)
- Formal and scientific register : Level 3

BIBLIOGRAPHY

- Authentic written and oral documents, Internet, TV resources, foreign press, digital tools, linguistic tools
- Global Exam, British Council, BBC Learning English, VoA, monolingual dictionaries
- TOEIC past papers
- Websites of international and European organizations (general and specific) :
 - General : UN, WHO, WEF, IMF, WTO, World Bank...
 - Specific : IEEE, IETF, NIST, ENISA, NCSC...

REQUIREMENTS

- **CEFR Level B2.1**
- Can understand the essential content of complex topics in a text, including technical discussions in their field.
- Can communicate with a degree of spontaneity and fluency such that conversation with a native speaker involves no tension for either party.

- Can express oneself clearly and in detail on a wide range of subjects, give an opinion on a current topic, and present the advantages and disadvantages of different options.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE4-EC5
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 10
Labs : 0
Total : 10

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and worksheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-CYBER

COURSE : English or L2

SCOPE OF THE COURSE

OBJECTIVES

This course aims to develop students' linguistic, cultural, and communicative skills in a second modern language (Chinese or Spanish). It focuses on acquiring language fundamentals, oral and written fluency, as well as discovering associated cultures, to prepare students for interactions in personal, professional, or academic contexts.

COMPETENCE AND SKILLS

- Communicate with various stakeholders (clients, management, users, IT managers, organizations -CNIL, ANSSI-) in writing and orally
- Ensure appropriate communication with stakeholders, including clients, administrations, citizens, and civil society.

PROGRAM

1. Language initiation

- Basic grammatical structures : present tense, adjectives, pronouns.

2. Oral communication

- Techniques to improve pronunciation and oral fluency.

3. Written comprehension and expression

- Writing simple letters or emails (self-introduction, requests for information).

4. Linguistic and intercultural deepening

- Study of songs, poems, or literary excerpts adapted to the level.

5. Practical project and continuous assessment

- Regular oral and written evaluations to monitor progress.

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE5-EC1
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 18
Labs : 0
Total : 22

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, guided exercises (*travaux dirigés*), and practical work (*travaux pratiques*) handouts.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-DATA

COURSE : Deep Learning

SCOPE OF THE COURSE

OBJECTIVES

Master the architectures and techniques of deep learning to design, train, and deploy neural network models suited to complex data science problems. This course deepens the theoretical foundations of multilayer networks and covers major architectures — convolutional, recurrent, and generative — with a focus on practical challenges specific to large-scale learning : regularization, optimization, interpretability, and scaling on GPU and distributed systems.

COMPETENCE AND SKILLS

- Design and implement deep neural network architectures (feedforward, CNN, RNN, LSTM) suited to the nature and volume of data for a given problem
- Train, regularize, and optimize a deep learning model by applying best practices : initialization, *dropout*, *early stopping*, parameter sharing, hyperparameter tuning
- Define, implement, and evaluate a predictive analysis leveraging massive data using deep learning frameworks executed on GPU or distributed systems
- Apply convolutional (CNN) and recurrent (RNN/LSTM) architectures to multimedia data analysis : image classification, object detection, signal and time series processing
- Select appropriate deep learning tools and frameworks (TensorFlow, PyTorch, Keras) considering constraints of data volume, performance, and interpretability
- Stay informed about the state of the art in deep learning and assess the relevance of advanced architectures (generative models, transformers) for new use cases

PROGRAM

— Foundations of deep neural networks :

- Review of the multilayer perceptron (MLP); hierarchical representation of features.
- Activation functions : ReLU, sigmoid, tanh, softmax — properties and use cases.
- Backpropagation algorithm in a deep *feedforward* network.
- Gradient problems : vanishing and exploding gradients; solutions (batch normalization, weight initialization).
- Regularization : *dropout*, *early stopping*, *weight decay*, parameter sharing.

— Convolutional neural networks (CNN) :

- Convolution principle : local pattern detection (edges, textures); translation invariance.
- Convolution layers, *pooling* layers (max pooling, average pooling), and flattening (*flatten*).

- Reference architectures : LeNet, AlexNet, VGG, ResNet, EfficientNet.
- Transfer learning and *fine-tuning* on limited data.
- Applications : image classification, object detection, semantic segmentation.
- **Recurrent neural networks (RNN / LSTM / GRU) :**
 - RNN architecture ; backpropagation through time (BPTT).
 - Challenge of long-term dependencies ; vanishing gradient problem in RNNs.
 - LSTM (*Long Short-Term Memory*) and GRU (*Gated Recurrent Unit*) : gating mechanisms and use cases.
 - Applications : time series processing, signals, sequence generation.
- **Optimization and scaling :**
 - Optimization algorithms : SGD, Momentum, RMSprop, Adam.
 - Learning rate scheduling.
 - GPU execution : CUDA, tensor computation parallelization.
 - Scaling on distributed systems : data and model parallelism (link with DAT701).
 - Tool selection based on data volume : TensorFlow, PyTorch, Keras, JAX.
- **Interpretability and best practices :**
 - Visualization of activations and convolutional filters ; saliency maps (*Grad-CAM*).
 - Model evaluation : metrics, learning curves, overfitting detection.
 - Deployment of a deep learning model : export, quantization, optimized inference.
- **Advanced topics (subject to availability) :**
 - Generative models : generative adversarial networks (GAN) — architecture, training, applications (image synthesis, data augmentation) ; practical challenges (*mode collapse*, convergence instability).
 - Introduction to Transformers and attention mechanisms ; vision transformers (ViT) and language models (LLM).
 - Self-supervised and contrastive learning ; *foundation models*.

BIBLIOGRAPHY

- Kubat, M. (1999). Neural networks : a comprehensive foundation by Simon Haykin, Macmillan, 1994, ISBN 0-02-352781-7. The Knowledge Engineering Review, 13(4), 409-412.
- Michael A. Nielsen, “Neural Networks and Deep Learning”, Determiation Press, 2015
- Simon Haykin - *Neural Networks and Learning Machines* - Prentice Hall, 3rd ed., 2008
- Michael A. Nielsen - *Neural Networks and Deep Learning* - Determiation Press, 2015 : <http://neuralnetworksanddeeplearning.com>
- Ian Goodfellow, Yoshua Bengio & Aaron Courville - *Deep Learning* - MIT Press, 2016 : <https://www.deeplearningbook.org>

- Aurélien Géron - *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow* - O'Reilly, 3rd ed., 2022
- Kubat, M. - *An Introduction to Machine Learning* - Springer, 3rd ed., 2021
- PyTorch documentation : <https://pytorch.org/docs/stable/>
- TensorFlow / Keras documentation : https://www.tensorflow.org/api_docs
- Papers With Code — State of the art in deep learning : <https://paperswithcode.com>
- Distill.pub — Interactive deep learning visualizations : <https://distill.pub>
- Fast.ai — Practical deep learning courses : <https://www.fast.ai>

REQUIREMENTS

- **Machine Learning (S7)** : classification and regression algorithms, model evaluation, bias/variance trade-off, cross-validation — direct and essential foundation for this course.
- **Massive Data Systems (S7)** : distributed architectures, parallel computing frameworks — necessary for scaling deep learning models.
- **Data Mining (S6)** : data preprocessing, feature extraction, introduction to clustering.
- **Probability and Random Variables (S5)** : probability distributions, expectation, variance — foundations of loss functions and optimization methods.
- **Stochastic Processes (S6)** : sequence and time series modeling — useful for understanding RNNs and LSTMs.
- **Expected cross-disciplinary skills** :
 - Advanced Python programming (numpy, pandas, matplotlib, scikit-learn)
 - Linear algebra : matrix products, decompositions, eigenvalues
 - Differential calculus : partial derivatives, chain rule, gradient
 - Basic knowledge of GPUs and computing environments (Google Colab, Jupyter)
 - Ability to read technical documentation and research papers in English

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE5-EC2
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 16
Labs : 0
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessments and evaluated practical work.

TEACHING MATERIALS

Slides, guided and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-DATA

COURSE : Data Analysis : Methods and Applications

SCOPE OF THE COURSE

OBJECTIVES

Deepen and consolidate data science skills by exploring advanced analysis methods and their practical applications across various domains. Building on machine learning and deep learning foundations, this course emphasizes mastering the entire data project lifecycle — from data collection and preprocessing to result interpretation and production deployment — while integrating ethical, reproducibility, and model explainability considerations.

COMPETENCE AND SKILLS

- Design and manage a complete data analysis project by applying methods suited to the problem's nature, data volume, and quality
- Apply advanced methods for processing and analyzing tabular, temporal, textual, and multimedia data (images, signals) by selecting and justifying methodological choices
- Rigorously evaluate a data analysis model's performance, diagnose its limitations, and propose well-argued improvements
- Ensure reproducibility, traceability, and maintainability of a data analysis pipeline by applying MLOps best practices (versioning, testing, documentation)
- Interpret and explain complex model results using explainability methods (SHAP, LIME, Grad-CAM) and present them clearly to technical or non-technical audiences
- Integrate ethical and regulatory dimensions into data analysis system design : algorithmic biases, fairness, GDPR and RIA compliance

PROGRAM

- **Data project lifecycle and best practices :**
 - Data project scoping : defining objectives, identifying data, feasibility assessment.
 - Data lifecycle management : collection, storage, versioning, governance.
 - Reproducibility and traceability : MLflow, DVC, experiment tracking.
 - Development best practices : unit testing, documentation, CI/CD for data projects.
- **Advanced preprocessing and feature engineering :**
 - Handling missing, outlier, and imbalanced data : advanced strategies (SMOTE, multiple imputation).
 - Feature selection and construction : filter, wrapper, and embedded methods.
 - Encoding high-cardinality categorical variables; adaptive normalization and standardization.
 - Data augmentation for images, text, and time series.
- **Temporal data and signal analysis :**

- Characterization and decomposition of time series : trend, seasonality, residuals.
- Classical models : ARIMA, SARIMA, Prophet.
- Deep learning approaches for time series : LSTM, Temporal Convolutional Networks (TCN), temporal Transformers.
- Anomaly detection in time series.
- Signal analysis : Fourier transform, spectrograms, wavelets.
- **Natural Language Processing (NLP) :**
 - Text representation : bag-of-words, TF-IDF, word embeddings (Word2Vec, GloVe, FastText).
 - Sequence models for NLP : RNN, LSTM, attention mechanisms.
 - Transformers and pre-trained language models : BERT, CamemBERT, GPT — fine-tuning for specific tasks.
 - Applications : text classification, sentiment analysis, information extraction, automatic summarization.
- **Multimedia data analysis (images and signals) :**
 - CNN recap ; advanced architectures : EfficientNet, ViT (*Vision Transformer*).
 - Object detection and segmentation : YOLO, Mask R-CNN.
 - Transfer learning and *few-shot learning* for multimedia data.
 - Audio data analysis : feature extraction (MFCC), sound classification, speech recognition.
- **Explainability and interpretability of models (XAI) :**
 - Challenges of black-box models in deep learning ; *explainable AI* (XAI) concepts.
 - Local methods : LIME, SHAP (*SHapley Additive exPlanations*).
 - Global methods : feature importance, partial dependence plots (PDP).
 - Visualizing CNN decisions : Grad-CAM, activation maps.
- **Ethics, bias, and regulatory compliance :**
 - Sources of bias in data and models : selection bias, confirmation bias, representation bias.
 - Algorithmic fairness metrics : disparate impact, equality of opportunity.
 - Regulatory obligations : GDPR applied to data analysis systems, RIA classification, DPIA.
 - *Responsible AI* principles : transparency, traceability, human oversight.
- **Production and deployment (MLOps) :**
 - Architecture of an ML system in production : *feature store*, *model registry*, monitoring.
 - Model deployment : REST API (FastAPI, Flask), containerization (Docker), orchestration (Kubernetes).
 - Monitoring models in production : data drift, performance degradation.
 - Continuous model updating and retraining.

BIBLIOGRAPHY

- Aurélien Géron - *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow* - O'Reilly, 3rd ed., 2022
- Ian Goodfellow, Yoshua Bengio & Aaron Courville - *Deep Learning* - MIT Press, 2016 : <https://www.deeplearningbook.org>
- Chip Huyen - *Designing Machine Learning Systems* - O'Reilly, 2022
- Jacob Devlin et al. - *BERT : Pre-training of Deep Bidirectional Transformers for Language Understanding* - arXiv, 2018 : <https://arxiv.org/abs/1810.04805>
- Scott Lundberg & Su-In Lee - *A Unified Approach to Interpreting Model Predictions (SHAP)* : <https://arxiv.org/abs/1705.07874>
- Hugging Face Transformers documentation : <https://huggingface.co/docs/transformers>
- MLflow documentation : <https://mlflow.org/docs/latest/>
- FastAPI documentation : <https://fastapi.tiangolo.com>
- Papers With Code — State of the art by task : <https://paperswithcode.com>
- CNIL - *Recommendations on AI systems and GDPR* : <https://www.cnil.fr/en/artificial-intelligence>

REQUIREMENTS

- **DAT801 - Deep Learning (S8)** : CNN architectures, RNN, LSTM, optimization mechanisms, TensorFlow/PyTorch frameworks — direct and essential prerequisite for the entire course.
- **DAT701 - Machine Learning (S7)** : supervised and unsupervised algorithms, model evaluation, scikit-learn pipelines.
- **DAT701 - Massive Data Systems (S7)** : distributed architectures, Spark — required for large-scale processing pipelines.
- **Data Mining (S6)** : preprocessing, pattern extraction, introduction to clustering.
- **SHS704 - Law and Ethics in Computer Engineering (S7)** : GDPR, RIA, algorithmic biases — applied in the ethics and compliance section of the course.
- **Expected cross-disciplinary skills** :
 - Advanced Python programming : numpy, pandas, scikit-learn, PyTorch or TensorFlow
 - Proficiency in Git and code/data versioning tools
 - Basic knowledge of containerization (Docker) and application deployment
 - Ability to read and synthesize research papers in English
 - Scientific rigor : reproducibility, documentation, objective evaluation

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE3-EC1
ECTS : 1

DURATION

Lectures : 4
Tutorial classes : 8
Labs : 6
Total : 18

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-DEV

COURSE : Quality Management and Eco-Design of Software

SCOPE OF THE COURSE

OBJECTIVES

This module aims to provide students with knowledge, understanding, and the ability to use Software Engineering (SE) methodological elements complementary to those presented in the 3rd and 4th years. This course also aims to demonstrate that many current SE techniques are extended and synthesized by knowledge representation techniques (often in a more formal way, thus more automatable). This enables students to compare different SE techniques (short-, medium-, or long-term) and choose among them based on various criteria.

COMPETENCE AND SKILLS

PROGRAM

BIBLIOGRAPHY

Laure Cailloce, *Digital : The Great Energy Waste*
Olivier Le Goaer, Adel Noureddine, Franck Barbier, Romain Rouvoy, Florence Maraninchi. *Towards Eco-Responsible Software : Software Engineering Facing the Challenge of Ecological Sobriety*. 2021.

REQUIREMENTS

Software Modeling and Design

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE3-EC2
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 8
Labs : 6
Total : 18

Project :
Personnal work :

ASSESSMENT

At least two continuous assessments.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-DEV

COURSE : Server-side Programming

SCOPE OF THE COURSE

OBJECTIVES

Design and management of dynamic web and intranet applications based on technologies currently known under the Anglo-Saxon term Web Services.

COMPETENCE AND SKILLS

- Integrate technical constraints and systems of an environment
- Apply integration engineering
- Produce comprehensive documentation

PROGRAM

- Review of web application requirements and key components for development in open, interoperable architectures.
- Basic elements of application interoperability management : persistence of web applications, reading and writing cookies, managing application state with sessions.
- Development of Web Services : deployment, registration, discovery, and invocation of Web Services ; inter-service communication and interoperability of web applications ; system integration.
- Development of rich-client applications. Multimedia components for content presentation. Exchange of complex structured data with the server.

BIBLIOGRAPHY

Neil Gray : Web Server Programming Mario Casciaro, Luciano Mammino : Node.js Design Patterns - Second Edition David Flanagan : JavaScript : The Definitive Guide

REQUIREMENTS

- Basics of descriptive web technologies,
- Software Engineering,
- Object-oriented and event-driven programming,
- Databases : models and systems,
- Network principles.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE3-EC3
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 0
Labs : 2
Total : 6

Project :
Personnal work :

ASSESSMENT

The skills will be assessed based on the elements provided in the deliverable, which will be specified in advance to the engineering students.

TEACHING MATERIALS

All documents used during teaching sessions, along with the resources mobilized. If necessary, additional documentary references will be provided.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE8-DEV

Software Engineering SAE

SCOPE OF THE CHALLENGE

WORKING SITUATION

Design and develop a cross-platform application (for mobile and desktop) within an ecosystem involving multiple components (client, server, API).

COMPETENCES AND LEVEL ASSESSED

Design and develop software

EXPECTED OUTPUTS

Task 1 : Functional specifications + Domain analysis documents Task 2 : Design documents and diagrams Task 3 : Code Task 4 : Application, demonstration and documentation

In addition to the technical aspects specified in the expected level description, the SAE will be assessed based on the following criteria :

- Compliance with constraints, standards and legal framework
- Consideration of digital, environmental and societal challenges
- Effective organization and mobilization of available material and human resources
- Continuous scientific and technological monitoring
- Justification of technology, tool and solution choices
- Adapted response to the specifications in interaction with users and commissioning parties

RESOURCES

- Software development instructor
- Instructor specializing in eco-design
- Project management instructor

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE3-EC4
ECTS : 0

DURATION

Lectures : 0
Tutorial classes : 0
Labs : 2
Total : 2

Project :
Personnal work :

ASSESSMENT

Regular individual interviews with a designated tutor teacher

TEACHING MATERIALS

Competency reference framework for the specialty Deliverables from SAEs Computer tool supporting the portfolio

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-DEV

COURSE : Individual follow-up / Portfolio

SCOPE OF THE COURSE

OBJECTIVES

The objective of this course is to support the engineering student in building their competency portfolio throughout their studies at the school, in order to develop their profile in line with their professional project.

COMPETENCE AND SKILLS

Develop the ability to know oneself, self-assess, manage one's skills (particularly with a view to lifelong learning), and make professional choices

PROGRAM

- Understanding the competency approach and the portfolio tool
- Importing evidence elements (traces) justifying the validation of first-year engineering cycle competency levels
- Reflection on the professional project : in which competency(ies) does the engineering student wish to build their career
- Potential valorization of extracurricular activities
- Consolidation of the professional project, in line with the English-speaking internship subject and the academic mobility semester

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE3-EC5
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 12
Labs : 0
Total : 12

Project :
Personnal work :

ASSESSMENT

Minimum 1 continuous assessment

TEACHING MATERIALS

N/A

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-DEV

COURSE : Sports

SCOPE OF THE COURSE

OBJECTIVES

- Develop and improve one's HEALTH
 - Engage in effort (intensity/duration)
 - Analyze and understand the causes and effects of an action
- Get to know oneself better
 - Discover one's physical and mental resources and abilities
 - Improve self-confidence by working on self-esteem

COMPETENCE AND SKILLS

- Develop and mobilize one's resources (emotional/physical) to enhance motor skills, make them effective, and promote success
- Develop method skills for organization, risk management, and safety related to practices
- Develop leadership skills (managing a group, justifying decisions, kindness, fostering a climate of trust and collaboration)
- Improve HEALTH and understand key principles to manage one's physical, mental, and social life throughout life.

PROGRAM

- Racket sports : learning and improvement in badminton
- Artistic activities : discovery and hands-on experience in Acrosport
- Team sports : training and coaching in Volleyball, Beach Volleyball, or Basketball
- Water sports : initiation and improvement in Kayaking
- Physical fitness activities : introduction to general physical preparation and weight training
- Outdoor sports : initiation and improvement in Orienteering (CO) or climbing

BIBLIOGRAPHY

REQUIREMENTS

No prerequisites

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE2-EC1
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 12
Labs : 0
Total : 12

Project :
Personnal work :

ASSESSMENT

Continuous assessment : written exams, oral presentations, case studies.

TEACHING MATERIALS

Slides, industrial case studies, field experience feedback.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-IOT

COURSE : Internet of Things : Design Project

SCOPE OF THE COURSE

OBJECTIVES

Provide engineering students with the methodology and tools needed to carry out an IoT project from specifications to a deployable prototype. This course combines methodological input (lectures), case studies and sizing (tutorials), and hands-on practice through a complete design project.

COMPETENCE AND SKILLS

- Apply embedded and IoT-specific programming and communication paradigms
- Evaluate a project's cost and the economic viability of a solution
- Assess the environmental impact of a solution
- Manage a project while respecting cost, schedule, and quality constraints

PROGRAM

— Lecture — IoT Design Methodology (4h)

- IoT product design cycle : ideation, specification, prototyping, validation, industrialization
- End-to-end system architecture : sensor node, gateway, network, cloud/edge platform, application
- Architecture choices : edge vs. fog vs. cloud — decision criteria (latency, bandwidth, autonomy, cost)
- From breadboard to PCB : hardware design principles for production (component selection, BOM, DFM)
- Regulations and certification : CE marking, RED/RoHS/WEEE directives, ISM bands, radio approval
- Security by design : secure boot, secure OTA, key management, threat modeling (STRIDE, PASTA)
- Scaling up : fleet management, provisioning, monitoring, remote updates (FOTA/SOTA)
- Eco-design : life cycle assessment (LCA), digital sobriety, cost estimation (BOM, NRE, TCO)

— Tutorials — Case studies and sizing (12h)

- Tutorial 1 (3h) : Architecture analysis — Dissect a commercial IoT product : identify hardware and software components, evaluate technical choices and trade-offs
- Tutorial 2 (3h) : Energy budget — Size the power supply for a sensor node (consumption profile, duty cycle, energy harvesting), estimate autonomy, and propose optimizations
- Tutorial 3 (3h) : Robustness and security — Conduct a threat model (STRIDE, PASTA) on an IoT architecture, define countermeasures (secure boot, encryption, OTA), assess field robustness (IP, temperature, MTBF)

- Tutorial 4 (3h) : Costing and eco-design — Build a BOM, estimate unit cost and TCO at different scales, perform a simplified life cycle assessment (LCA), justify component choices
- **Design Project (20h + 10h self-study)**
 - In teams of 3-4 students, carry out a complete IoT design project on a given or proposed topic
 - Expected deliverables :
 - Functional and technical specifications
 - Architecture report (system diagram, justified hardware/software choices)
 - Energy budget and autonomy estimation
 - Security analysis (threat model) and mitigation plan
 - Costing (BOM, unit cost, TCO) and eco-design analysis
 - Functional prototype (proof of concept)
 - Project presentation

BIBLIOGRAPHY

Olivier Hersent, David Boswarthick, Omar Elloumi — *The Internet of Things : Key Applications and Protocols* — Wiley, 2012
Jan Holler et al. — *From Machine-to-Machine to the Internet of Things* — Academic Press, 2014
Perry Lea — *IoT and Edge Computing for Architects* — Packt, 2020
Espressif Documentation — *ESP-IDF Programming Guide* — docs.espressif.com

REQUIREMENTS

- IOT701 : Embedded and Real-Time Systems
- IOT706 : Data Analysis for IoT
- IOT601 : Prototyping (S6)

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE2-EC2
ECTS : 1

DURATION

Lectures : 10
Tutorial classes : 36
Labs : 0
Total : 46

Project :
Personnal work :

ASSESSMENT

Continuous assessment : written assignments, oral presentations, case studies.

TEACHING MATERIALS

Slides, case studies, field experience feedback.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-IOT

COURSE : Management, Marketing and Entrepreneurship

SCOPE OF THE COURSE

OBJECTIVES

To develop and implement a business creation or takeover project.

COMPETENCE AND SKILLS

- Advance a business creation or takeover project
- Develop entrepreneurial and business management skills
- Enhance teamwork capabilities

PROGRAM

Management :

- Introduction to management
- Management theories and styles
- Developing leadership skills
- Entrepreneurship and business creation
- Steps to launch a start-up
- Case studies on successful businesses and projects
- Project and business plan development
- Role-playing management scenarios
- Creating a business plan for an innovative idea
- Presentation and defence of the entrepreneurial project

Marketing :

- Introduction to marketing and fundamental principles
- Digital marketing and online strategies, including social media
- Market research and analysis of purchasing behaviour
- Interpersonal communication and effective communication techniques
- Teamwork, group dynamics, and collaboration
- Marketing case studies
- Analysis of successful and failed marketing campaigns
- Communication and presentation workshops
- Public speaking exercises
- Group activities to foster team spirit
- Case studies on time management and conflict resolution
- Group marketing projects
- Creating a marketing campaign for a fictional product
- Role-playing and professional scenario simulations
- Time and priority management practice
- Group conflict resolution activities
- Collaborative projects to strengthen team dynamics

BIBLIOGRAPHY REQUIREMENTS

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE2-EC3
ECTS : 1

DURATION

Lectures : 0
Tutorial classes : 4
Labs : 10
Total : 14

Project :
Personnal work :

ASSESSMENT

Deliverables and presentations

TEACHING MATERIALS

Mission support, data, guides, reports...

LANGUAGE

English

CONTACT

Khalid ADDI

Modifié le : 14 juillet 2026

UE : UE8-IOT

COURSE : Innovation competition

SCOPE OF THE COURSE

OBJECTIVES

This course aims to develop students' ability to successfully carry out an innovation project in a group (7 to 12 students), addressing problem-solving, continuous improvement, or the design of breakthrough solutions, while considering sustainability challenges.

COMPETENCE AND SKILLS

Mobilize and combine tools related to innovation methodology acquired in the resources, learn to learn (supplementing tools...), work in a project group (shared reflexivity, autonomy, time and stress management...), communicate and convince

PROGRAM

Downstream innovation : Prototyping, feasibility, launch

BIBLIOGRAPHY

According to the year's project

REQUIREMENTS

Project management, survey management, marketing, creativity methods. These prerequisites are acquired beforehand in the curriculum resources or during the year through self-directed or guided learning.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE2-EC4
ECTS : 3

DURATION

Lectures : 0
Tutorial classes : 0
Labs : 0
Total : 0

Project :
Personnal work :

ASSESSMENT

Report, presentations, project deliverables, completion of the project management tool, grade from the project supervisor.

TEACHING MATERIALS

LANGUAGE

English

CONTACT

Pierre Ugo TOURNOUX
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Modifié le : 14 juillet 2026

UE : UE8-IOT

COURSE : Project-based learning

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to place engineering students in a project-based approach and apply the various concepts studied in the modules of the first year of the engineering cycle.

COMPETENCE AND SKILLS

- Organize the project according to project management methodologies
- Write technical documentation and design presentation materials in French and English
- Apply a methodology and formalism to design and develop an application

PROGRAM

Types of topics

Based on a problem proposed by a partner company or administration of the ESIROI, engineering students must propose a solution addressing the said problem. Students must define a jointly constructed specification with the company, prioritize features, then associate them with tasks, milestones, and deliverables by applying a project management method. Although the existing IS processes of the company must be considered, the proposed topics require the implementation of a complete solution. *E.g.* developing a Moodle QCM plugin is not a topic meeting this criterion, whereas proposing a pervasive object for thermal comfort assessment calls for a much more comprehensive solution including sensor development, data processing, visualization via a web interface, identification of privacy issues, and securing the entire data collection, processing, and storage chain. Thus, students are expected to integrate and articulate elements from each of the domains taught at ESIROI (CYBER, DATA, DEV, SYS/RES, and IOT) and enable the assessment of INF block competencies.

Specification and planning

Based on the specification, students will be able to estimate the cost associated with the development, deployment, and operation of the solution. This cost includes labor (man-months) and materials. The cost may include the carbon footprint across the entire life cycle of the solution according to the methodologies covered in class. The specification and initial cost estimate will be assessed.

Soft skills

Students will interact with the company and must pay particular attention to their communication. In writing, students must ensure the quality of their writing, the clarity of their message, and the use of language appropriate to the professional context. They must also be attentive to the form of their documents, which must be well-presented and structured. Where possible, they will use project tracking tools (e.g., GitLab, GitHub, Jira, etc.) to interact with the company, but they must first adapt to the habits and technical level of the project supervisors. Orally, students must practice presenting their work clearly,

concisely, and convincingly before each meeting. They must also be able to respond to the company's questions in a relevant and professional manner. The student's "soft skills" are assessed throughout the project.

Project management

Students are expected to leverage project management tools to define deadlines, objectives, ongoing tasks, and upcoming tasks. Meetings with partners must be part of well-defined project stages (milestones, features, technical tasks) and have clear objectives, announced in advance, accompanied by documents enabling participants to prepare and be effective during the meeting. The project management tool must be updated following the meeting. Furthermore, each meeting must result in minutes, a clear and concise report, possibly accompanied by detailed technical notes. Students will be assessed on the project management aspect and the quality of their writing in the project management tool.

Group members, roles, and skills

Projects are carried out by groups of first- and second-year engineering students (3A and 4A). Second-year students are expected to take a more leading role in project management. It is their responsibility to act as project manager, although they must still take on technical tasks. First-year students must progressively build their project management skills to eventually become autonomous when second-year students leave 2 to 4 months before the project's end.

Deliverables

Projects are associated with a minimum of four presentations.

- Kick-off presentation (specification, cost estimate, task breakdown, milestones, and schedule)
- Mid-term presentation (mid-December)
- Presentation at the departure of second-year students (end of March)
- Final project presentation (end of May)

These presentations are internal to the ESIROI, but the project supervisor is invited. However, the project supervisor may request additional presentations for the company or a broader audience.

At the end of the project, first-year students must write a report that may be shared within the ESIROI, the company, and, if possible, externally. This report may accompany the student's portfolio.

Support

When concepts necessary for implementing the project have not been covered by previous teaching modules, the teaching team may address this by offering short introductory sessions on the relevant concepts and technologies. The teaching team may also call on external contributors when they are particularly relevant to the use of a tool. The teaching team is not required to address potential technical shortcomings. It is then up to the students to self-train, assess whether they have the time to do so, and, if necessary, evaluate alternatives.

Additionally, students may request support from the teaching team for :

- Technical support

- Support on solution design
- Support on project management
- Support on report writing and presentation materials

The quantity and type of support requested by students will impact the competency levels validated as part of this project.

Competency assessment methods

To be defined.

0.0.1 Workload

An average of 4 hours per week is expected throughout the year. Weeks are identified in the timetable as being predominantly dedicated to projects to minimize context switching between different mandatory or optional activities for students.

BIBLIOGRAPHY

REQUIREMENTS

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IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE1-EC1
ECTS : 2

DURATION

Lectures : 6
Tutorial classes : 4
Labs : 14
Total : 24

Project :
Personnal work :

ASSESSMENT

Continuous assessments.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-SYSRES

COURSE : Next-Generation Networks : Concepts and Innovations

SCOPE OF THE COURSE

OBJECTIVES

To provide a synthetic overview of the new “network virtualization” paradigm such as SDN and its extensions : SD-WAN and SASE.

COMPETENCE AND SKILLS

- Designing a multi-site connection via an operator network
- Determining the challenges and stakes of deploying applications and services

PROGRAM

- Overview of network evolution since the 2000s.
- Network virtualization : Software Defined Network (SDN).
- SDN architectures : decoupling data-plane vs control-plane, abstraction layers (Northbound and Southbound APIs), controllers.
- Coexistence of virtualized and traditional networks.
- Virtualization of network functions (virtual firewalls, load balancers, proxies...) and comparative performance.
- Virtualization of wide-area networks : SD-WAN.
- Evolution of SD-WAN toward security : Secure Access Service Edge (SASE).

BIBLIOGRAPHY

- Software Defined Networks : A Comprehensive Approach. Paul Goransson, Chuck Black, Timothy Culver. Morgan Kaufmann (2016)
- SDN : Software Defined Networks. Thomas Nadeau D., Ken Gray. O'Reilly Media (2013)
- Software-defined networking and security : from theory to practice. Chowdhary, Ankur, Huang, Dijiang, Pisharody, Sandeep. CRC Press Taylor & Francis Group (2018)
- Foundations of Modern Networking : SDN, NFV, QoE, IoT, and Cloud. Stallings, William. Addison-Wesley Professional (2015)

REQUIREMENTS

The Systems and Networks modules from previous semesters.

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE1-EC2
ECTS : 2

DURATION

Lectures : 4
Tutorial classes : 6
Labs : 6
Total : 16

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical session reports.

TEACHING MATERIALS

Slide decks and worksheets for tutorials and practical sessions.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-SYSRES

COURSE : System Administration : Storage and Infrastructure Monitoring

SCOPE OF THE COURSE

OBJECTIVES

Acquire the operational skills necessary for the operation, monitoring, and maintenance of a production system infrastructure. This course covers two complementary areas : the design of high-availability storage architectures (SAN, NAS, distributed storage) and the implementation of comprehensive information system monitoring, enabling proactive anomaly detection and service continuity assurance.

COMPETENCE AND SKILLS

- Design and deploy a storage architecture suited to the performance, availability, and cost constraints of a production infrastructure
- Evaluate and optimize the performance of a high-availability storage network (iSCSI, NFS, SAN) using benchmarking and I/O analysis tools
- Implement a comprehensive monitoring solution for an information system : metric collection, alerting, centralized logging, and dashboards
- Identify and diagnose anomalies in a system infrastructure from collected metrics and logs, and propose corrective actions
- Compare and select a virtualization or containerization solution suited to an operational need, considering the advantages and limitations of each approach
- Understand cloud computing paradigms (IaaS, PaaS, SaaS) and identify use cases justifying a cloud deployment

PROGRAM

— Storage Architectures :

- Overview of storage types : DAS, NAS, SAN — use cases and selection criteria.
- Network storage protocols : iSCSI, NFS, SMB/CIFS, Fibre Channel.
- High-availability storage : RAID, synchronous/asynchronous replication, *failover*.
- Distributed storage : introduction to Ceph and GlusterFS — architecture and use cases.
- Performance evaluation : IOPS, throughput, latency ; benchmarking tools (fio, iotop).
- Backup and restore strategies : 3-2-1 rule, tools (Bacula, Restic, Veeam).

— Virtualization and Containerization — Operational Overview :

- Overview of Type 1 and Type 2 hypervisors ; comparison with containerization.
- Operational advantages and drawbacks of virtualized servers : density, isolation, portability, overhead.
- Comparison of solutions : Proxmox VE, VMware ESXi, KVM, Docker, Kubernetes.

- Selection criteria based on context : security constraints, performance, budget.
- **Cloud Computing Paradigms :**
 - Service models : IaaS, PaaS, SaaS, FaaS — definitions and use cases.
 - Deployment models : public, private, hybrid, multi-cloud.
 - Major cloud providers : AWS, Azure, GCP — overview of services.
 - Shared responsibility model for cloud security.
- **Information System Monitoring and Supervision :**
 - Supervision challenges : availability, performance, security, compliance.
 - System and network metric collection : CPU, memory, disk, bandwidth.
 - Monitoring tools : Prometheus, Grafana, Zabbix, Nagios, Netdata.
 - Alerting : threshold definition, escalation, on-call management (Pager-Duty, Alertmanager).
 - Centralized logging : collection and aggregation of logs (Syslog, journald, ELK Stack, Loki).
 - Operational dashboards : design and best practices.
- **Anomaly Detection and Preventive Maintenance :**
 - Identifying degradation indicators : saturation, abnormal latency, recurring errors.
 - Event correlation and incident diagnosis from logs and metrics.
 - Preventive maintenance : update planning, patch management, load testing.
 - Incident management : escalation procedures, post-mortem, continuous improvement.

BIBLIOGRAPHY

- Evi Nemeth et al. - *UNIX and Linux System Administration Handbook* - Addison-Wesley, 5th ed., 2017
- The SysAdmin Handbook - Simple Talk Publishing, 2010
- Prometheus Documentation : <https://prometheus.io/docs/>
- Grafana Documentation : <https://grafana.com/docs/>
- Zabbix Documentation : <https://www.zabbix.com/documentation/>
- Elastic Stack (ELK) Documentation : <https://www.elastic.co/guide/>
- Ceph Documentation : <https://docs.ceph.com>
- ANSSI - *Recommendations for Logging Information Systems* : <https://www.ssi.gouv.fr/guide/>

REQUIREMENTS

- **SR052 / SYSRES 502 - Operating System and Command Language (S5) :** Linux administration, process management, file systems, Bash scripting.
- **SR062 / SYSRES 602 - System Administration 1 (S6) :** system services, user management, introduction to monitoring.

- **SR702 / SYSRES 702 - System Administration 2 (S7)** : orchestration, containers, cloud services, LDAP, DNS — direct prerequisite.
- **Expected cross-disciplinary skills :**
 - Advanced Linux administration : systemd, networking, storage, LVM
 - Bash and Python scripting for automation
 - Understanding of TCP/IP network architectures
 - Ability to read technical documentation in English

IDENTIFICATION

Course code : ESI-SPI-CI-IN4-S8-UE1-EC3
ECTS : 2

DURATION

Lectures : 6
Tutorial classes : 8
Labs : 6
Total : 20

Project :
Personnal work :

ASSESSMENT

Continuous assessments and practical work reports.

TEACHING MATERIALS

Slides and worksheets for tutorials and practical work.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE8-SYSRES

COURSE : System Administration : Virtualization

SCOPE OF THE COURSE

OBJECTIVES

Master the design, deployment, and administration of complete virtualized infrastructures, with an in-depth focus on hypervisor-level, network, and private cloud virtualization mechanisms. Building on prior knowledge in containerization (SR702) and monitoring (SR802), this course trains students to build robust, secure, and automated production virtualized environments, addressing high availability, security, and Infrastructure as Code challenges.

COMPETENCE AND SKILLS

- Design and deploy a complete virtualized infrastructure (hypervisor, network, storage) tailored to the performance, availability, and security constraints of an information system
- Administer virtual machines in production : lifecycle, templates, snapshots, live migration, high availability, and automatic failover
- Design and implement virtualized network architectures (SDN, VLANs, Vx-LAN, virtual firewalls) while ensuring traffic isolation and security
- Deploy and administer a private cloud (Proxmox VE, OpenStack) and design a hybrid cloud architecture interconnecting on-premises resources with public cloud services
- Automate the provisioning and configuration of virtualized infrastructures using Infrastructure as Code tools (Terraform, Ansible)
- Identify and mitigate attack vectors specific to virtualized environments and apply appropriate hardening measures

PROGRAM

- **Deep dive into virtualization mechanisms :**
 - Review and positioning relative to containers (SR702) and storage (SR802).
 - Hardware-assisted virtualization : Intel VT-x, AMD-V, IOMMU, SR-IOV.
 - Type 1 hypervisors : KVM/QEMU, VMware ESXi, Hyper-V, Proxmox VE — internal architecture and comparison.
 - Resource optimization : CPU/RAM *overcommitment*, NUMA, VM affinity and anti-affinity, balloon driver.
 - High availability : hypervisor clustering, *live migration*, automatic *failover*.
 - Templates, cloning, and automated VM deployment at scale.
- **Advanced network virtualization :**
 - Virtual switches : Open vSwitch (OVS), VMware vSwitch, Linux Bridge.
 - Segmentation and isolation : VLANs, VxLAN, GENEVE — L2 tunneling and extension over L3.
 - SDN (*Software Defined Networking*) : control/data plane separation, Open-Flow, SDN controllers.
 - Virtual firewalls and software routers : pfSense, OPNsense, VyOS — deployment and configuration.

- Micro-segmentation and east-west network security policies.
- QoS in virtualized environments : bandwidth limiting, traffic prioritization.
- **Private and hybrid cloud :**
 - Private cloud architecture : compute, network, storage, identity — the four pillars.
 - Deployment and administration of a Proxmox VE cluster : HA, integrated Ceph storage, resource management.
 - Introduction to OpenStack : Nova, Neutron, Cinder, Glance, Keystone, Horizon components.
 - Hybrid cloud : interconnecting private cloud / public cloud via site-to-site VPN or peering.
 - *Burst* strategies to public cloud : cost and data management.
- **Infrastructure as Code (IaC) :**
 - IaC principles : idempotency, versioning, reproducibility.
 - Terraform : declarative provisioning of VMs and cloud infrastructures (Proxmox, AWS, Azure providers).
 - Ansible : configuration and state management of VMs and hypervisors.
 - CI/CD pipelines for infrastructure : integrating IaC into a GitOps workflow.
 - Managing secrets and credentials in an IaC context (Vault, Ansible Vault).
- **Security of virtualized environments :**
 - Specific attack vectors : *VM escape*, *hyperjacking*, side-channel attacks (Spectre, Meltdown, L1TF).
 - Hypervisor hardening : minimal attack surface, updates, RBAC access control.
 - Enhanced isolation : SELinux/AppArmor for VMs, namespaces, cgroups.
 - Encryption of virtual disks (LUKS) and network storage traffic.
 - Identity management in a virtualized environment : LDAP/Active Directory integration.
 - Auditing and traceability of administrative actions on the hypervisor.

BIBLIOGRAPHY

- Evi Nemeth et al. - *UNIX and Linux System Administration Handbook* - Addison-Wesley, 5th ed., 2017
- James E. Smith & Ravi Nair - *Virtual Machines : Versatile Platforms for Systems and Processes* - Morgan Kaufmann, 2005
- Sameer Naik et al. - *Kubernetes Cookbook : Building Cloud Native Applications* - O'Reilly, 2024
- Proxmox VE Documentation : <https://pve.proxmox.com/pve-docs/>
- OpenStack Documentation : <https://docs.openstack.org>
- Open vSwitch Documentation : <https://docs.openvswitch.org>
- Terraform Documentation : <https://developer.hashicorp.com/terraform/docs>
- Ansible Documentation : <https://docs.ansible.com>

- ANSSI - *Security recommendations for virtualization-based architectures* : <https://www.ssi.gouv.fr/guide/>

REQUIREMENTS

- **SR702 - System Administration : Orchestration, Containers and Automation (S7)** : Docker, Kubernetes, LDAP, DNS, cloud services — direct complement to infrastructure virtualization.
- **SR802 - System Administration : Storage and Monitoring (S8)** : storage architectures, monitoring, cloud paradigms — direct prerequisite.
- **SR062 / SYSRES 602 - System Administration 1 (S6)** : Linux administration, service management, scripting.
- **SR051 - Networking and IoT Principles (S5)** : TCP/IP, routing, switching — essential for network virtualization.
- **Expected cross-disciplinary skills** :
 - Advanced Linux administration : systemd, LVM, networking, firewalls (iptables/nftables)
 - Bash and Python scripting ; basic knowledge of Ansible
 - Experience with virtualization environments (VirtualBox, VMware Workstation, or KVM)
 - Understanding of network architectures : routing, VLANs, firewalls
 - Ability to read technical documentation in English

IDENTIFICATION

Course code : PROJ901
ECTS : 3

DURATION

Lectures : 40
Tutorial classes : 40
Labs : 0
Total : 80

Project :
Personnal work :

ASSESSMENT

Deliverables and evaluation of the method throughout the project.

TEACHING MATERIALS

Resources tailored to the project's application domain.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE9-Projet

Final year project / Individualized SAE

SCOPE OF THE CHALLENGE

WORKING SITUATION

The objective of this course is to implement the knowledge and know-how related to the implementation of software and a set of software and hardware components.

COMPETENCES AND LEVEL ASSESSED

- Model and evaluate the performance of a solution to measure its suitability for the operational environment (2,4)-(2,4)

EXPECTED OUTPUTS

RESOURCES

IDENTIFICATION

Course code : ANG804SEC
ECTS : 2

DURATION

Lectures : 10
Tutorial classes : 0
Labs : 0
Total : 10

Project :
Personnal work :

ASSESSMENT

Deliverables and evaluation of the method throughout the project.

TEACHING MATERIALS

Resources tailored to the project's application domain.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE9-Ressources

COURSE : English

SCOPE OF THE COURSE

OBJECTIVES

The objective of this course is to implement the knowledge and know-how necessary for designing a solution in one of the application domains.

COMPETENCE AND SKILLS

- Maintain and use active technological monitoring throughout professional life by relying on scientific training and mastery of innovation processes (1.5)-(1.4)

PROGRAM

Designing the solution's architecture. This project may be linked to a research activity or stem from a company issue.

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : DAT901
ECTS : 3

DURATION

Lectures : 10
Tutorial classes : 8
Labs : 6
Total : 24

Project :
Personnal work :

ASSESSMENT

Deliverables and evaluation of the method throughout the project.

TEACHING MATERIALS

Resources tailored to the project's application domain.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE9-Ressources

COURSE : Advanced Data Science

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to implement the knowledge and know-how required to specify a project and draft a specification sheet.

COMPETENCE AND SKILLS

- Maintain and use active technological watch throughout professional life by relying on scientific training and mastery of innovation processes (1.5)-(1.4)

PROGRAM

- Drafting specification sheets and functional specifications ;
- SWOT analysis of a project ;
- Task sizing and breakdown, and reverse planning ;
- These elements will be adapted to the specific context of the project domain(s) (CSEC, DATA, DEV, IOT, SYSRES).

This project may be linked to a research activity or stem from a company issue.

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : DEV901
ECTS : 3

DURATION

Lectures : 16
Tutorial classes : 8
Labs : 0
Total : 24

Project :
Personnal work :

ASSESSMENT

A knowledge assessment, a lab report, and an oral presentation.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE9-Ressources

COURSE : Introduction to Research

SCOPE OF THE COURSE

OBJECTIVES

- Understand how to create cloud-based applications and use cloud automation tools in the DevOps process.
- Understand the theoretical context of DevOps and cloud automation techniques.
- Demonstrate the application of these techniques to a series of software applications and development scenarios/processes.
- Understand the features offered by popular DevOps and cloud automation tools such as Chef, Puppet, Ansible, and SlipStream.
- Gain practical experience with one of these tools through a project.

COMPETENCE AND SKILLS

- Master fundamental programming paradigms, languages, and algorithms to design and develop applications for any environment (1,4)-(2,4)
- Apply and master integration engineering, interoperability, deployment, and testing (1,4)-(2,4)
- Apply and master methodologies, tools, and formalisms to design, implement, and maintain high-quality and secure software (1,5)-(2,4)

PROGRAM

- Fundamental principles of DevOps, continuous integration, continuous delivery, continuous testing. Relationship with other agile development technologies : Lean, CAMS, and ITSM.
- Organizational impact of DevOps, digital transformation, and DevOps ; structure and operation of the DevOps team, leadership, collaboration, and structured problem-solving ; success factors and key performance indicators.
- Agile software development : Scrum, Kanban, Kaizen ; Scrum Agile process and team management ; role of multidisciplinary teams. Agile Manifesto.
- DevOps tools and processes : CI/CD pipeline ; DevOps Toolchain ; coding, versioning, collaboration, and testing. Version control and team development, Git, automated testing.
- DevOps practices and platforms : Software packaging, containerization. Container technologies, Kubernetes, tools.
- Cloud computing architectures, service and deployment models, Cloud IaaS and Infrastructure as Code, cloud economics.
- Cloud-powered software development : Example and AWS tools.
- Cloud monitoring tools and operational concepts for development.
- Overview of cloud automation : Cloud-based tools (e.g., AWS CloudFormation, Azure ARM) ; multicloud tools such as Chef, Puppet, Ansible, Terraform, others.
- Popular cloud automation tools : Chef, Puppet, Ansible (depending on available platform).
- Cloud security architecture and models, cloud compliance, CSA Consensus Assessment Initiative questionnaire and certification.

- DevSecOps; secure software development lifecycle; cloud-based tools for secure software development.

BIBLIOGRAPHY

Teaching DevOps and Cloud based Software Engineering in University Curricula
P. Bourque and R.E. Fairley, eds., Guide to the Software Engineering Body of Knowledge, Version 3.0, IEEE Computer Society, 2014;
DevOps Institute : The Association for DevOps Professionals [online] <https://devopsinstitute.com/>
DevOps Agile Skills Association (DASA) [online] :
<https://www.devopsagileskills.org/certifications/dasa-devopsfundamentals/>

REQUIREMENTS

Advanced system administration, Software engineering

IDENTIFICATION

Course code : IOT903
ECTS : 3

DURATION

Lectures : 10
Tutorial classes : 8
Labs : 6
Total : 24

Project :
Personnal work :

ASSESSMENT

A knowledge assessment, a lab report, and an oral presentation.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE9-Ressources

COURSE : Internet of Things : Deployment

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to cover advanced concepts in deep learning. It also aims to raise awareness of related issues such as data leakage, privacy protection, and environmental impact.

COMPETENCE AND SKILLS

- Design, develop and use tools and applications integrating data management and their valorization (1.5)-(1.4)
- Define, implement and use descriptive and predictive analysis by exploiting massive data (2.5)-(2.4)
- Apply data analysis methods for multimedia data (images, signals) (2.5)-(2.4)

PROGRAM

Depending on the background of the students present (incoming mobility...), a recap of deep learning concepts may be provided.

The following advanced topics may be covered :

- Autoencoders and their uses ;
- Deep generative models, such as Generative Adversarial Neural Networks (GANNs) and their potential applications ;
- Practical challenges of these approaches, for example : convergence, mode collapse, etc.
- Approaches to address or mitigate the effects of the phenomena described above.

Raising awareness of privacy issues is an additional key element not covered earlier in the program. This may refer both to the problems posed by the datasets used for training and to the results published or even the weights embedded in neural networks that may reveal elements of the training set.

Finally, awareness of the cost of training deep models and their carbon footprint may be addressed, along with ways to limit them.

BIBLIOGRAPHY

Goodfellow, I., Bengio, Y., Courville, A. (2016). Deep learning. MIT press.
Boulemtafes, A., Derhab, A., Challal, Y. (2020). A review of privacy-preserving techniques for deep learning. Neurocomputing, 384, 21-45.
Ligozat, A. L., Luccioni, S. (2021). A Practical Guide to Quantifying Carbon Emissions for Machine Learning Researchers and Practitioners (Doctoral dissertation, MILA ; LISN).

REQUIREMENTS

Following modules :

- “Machine Learning” and “Massive Data Systems” from S7.
- “Data Mining” from S6.
- “Probability and Random Variables” from S5 and “Stochastic Processes” from S6.

IDENTIFICATION

Course code : SEC901
ECTS : 3

DURATION

Lectures : 10
Tutorial classes : 8
Labs : 6
Total : 24

Project :
Personnal work :

ASSESSMENT

A knowledge assessment and a lab report.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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UE : UE9-Ressources

COURSE : Cybersecurity : Reverse Engineering and Exploit Development

SCOPE OF THE COURSE

OBJECTIVES

Apply reverse engineering and forensic techniques to reconstruct the timeline of an attack in the context of a digital forensics investigation.

COMPETENCE AND SKILLS

- Define and implement a security organization and policy tailored to identified risks (1.5)-(3.4)
- Design, develop, and implement mechanisms to protect data, software, networks, and cloud systems (1.5)-(3.4)
- Define and conduct a risk analysis based on documentation, offensive cybersecurity campaigns, and regulatory frameworks (1.5)-(3.4)

PROGRAM

- Apply a forensic investigation technique in a digital forensics scenario.
- Compare commercial and open-source forensic tools.
- Reconstruct a timeline using information extracted from a device under analysis.
- Use forensic tools specific to major mobile operating systems.
- Detect and analyze encrypted content.
- Use a binary analysis tool and/or a disassembler to analyze malware (reverse engineering).
- Laboratory procedures for handling malware.

BIBLIOGRAPHY

REQUIREMENTS

Cybersecurity, systems and networks, and programming modules from previous semesters.

IDENTIFICATION

Course code : SR901
ECTS : 3

DURATION

Lectures : 8
Tutorial classes : 8
Labs : 8
Total : 24

Project :
Personnal work :

ASSESSMENT

A knowledge assessment, a lab report, an oral presentation.

TEACHING MATERIALS

Slides and practical work sheets.

LANGUAGE

English

CONTACT

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Modifié le : 14 juillet 2026

UE : UE9-Ressources

COURSE : Culture DevOps : Continuous Improvement and Collaboration

SCOPE OF THE COURSE

OBJECTIVES

The aim of this course is to provide an overview of infrastructureless networks, suitable algorithms, their properties, and application cases for which these networks are relevant. For the various application domains, it also aims to contextualize the properties of infrastructure-based networks and enable the engineer to select the appropriate method and justify these choices through performance evaluation.

COMPETENCE AND SKILLS

- Design secure infrastructures and service solutions tailored for connected objects (1.5)-(1.4)
- Implement an end-to-end IoT solution by identifying fixed and mobile architectures, the network of terminal objects, remote management of objects, and communication with an IoT service platform (1.5)-(1.4)

PROGRAM

- Differences in constraints and properties between infrastructure-based and infrastructure-less networks ;
- Notion of mobility in networks ;
- Ad hoc networks and MANETs : MESH networks, MANETs, DTN, SPANs, tactical networks ;
- VANETs and comparison with current trends in 5G ;
- Infrastructure-less sensor networks and comparison with current trends in IoT, particularly in 5G ;
- Performance evaluation through modeling and simulation.

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : PROJ100
ECTS :

DURATION

Lectures :
Tutorial classes :
Labs :
Total :

Project :
Personnal work :

ASSESSMENT

TEACHING MATERIALS

LANGUAGE

English

CONTACT

Modifié le : 14 juillet 2026

UE : Stages

COURSE : Technical internship

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

PROGRAM

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : PROJ102
ECTS : 10

DURATION

Lectures : 0
Tutorial classes : 0
Labs : 0
Total : 0

Project :
Personnal work :

ASSESSMENT

TEACHING MATERIALS

LANGUAGE

English

CONTACT

Modifié le : 14 juillet 2026

UE : Stages

COURSE : English-speaking Internship

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

PROGRAM

BIBLIOGRAPHY

REQUIREMENTS

IDENTIFICATION

Course code : PROJ103
ECTS : 20

DURATION

Lectures : 0
Tutorial classes : 0
Labs : 0
Total : 0

Project :
Personnal work :

ASSESSMENT

TEACHING MATERIALS

LANGUAGE

English

CONTACT

Modifié le : 14 juillet 2026

UE : Stages

COURSE : Final Internship

SCOPE OF THE COURSE

OBJECTIVES

COMPETENCE AND SKILLS

PROGRAM

BIBLIOGRAPHY

REQUIREMENTS