CentraleSupélec

Course catalogue

Computer Science Engineer

First year

Metz Campus of CentraleSupélec

last update: January 25, 2026

Semester 5

ISP-INF-S05-01		**Mathematics S05**	**12 ECTS**
SPM-MAT-001	3	Mathematics for Engineers	36.0 h
SPM-PHY-001	2	Quantum Physics 1	22.5 h
SPM-MAT-002	3	Probability	24.0 h
SPM-SIC-001	3	Signals and Systems	36.0 h
SPM-NCL-001	1	Introduction to Research 1	12.0 h

ISP-INF-S05-02		**Computer Science S05**	**10 ECTS**
SPM-INF-005	3	Computer architecture	36.0 h
SPM-INF-001	1	Free Softwares for Engineers	13.5 h
SPM-INF-003	4	Introduction to C/C++ Programming	39.0 h
SPM-INF-002	2	Python for Scientists	21.0 h

ISP-INF-S05-21		**HEP S05**	**4 ECTS**
SPM-HEP-008	1	Project Management	15.0 h
SPM-HEP-001	1	Oral and written communication	15.0 h
SPM-HEP-003	1	Engineer, Environment and Society	12.0 h
SPM-HEP-002	1	Scientific Dissemination Project 1	12.0 h
1SL9000	P/F	Sport S05	21.0 h

ISP-INF-S05-15		**Foreign Language S05**	**4 ECTS**
LV1S05	1	Foreign Languages and Culture 1	21.0 h
LV2S05	1	Foreign Languages and Culture 2	21.0 h

Semester 6

ISP-INF-S06-04		**Computer Engineering S06**	**12 ECTS**
SPM-INF-007	3	C++ programming	42.0 h
SPM-INF-010	3	Operating Systems	32.0 h
SPM-INF-008	2.5	Computer Networking	26.5 h
SPM-INF-006	2	Relational Databases	18.0 h
SPM-PRJ-002	1.5	C++ programming project	18.0 h

ISP-INF-S06-03		**Engineering Sciences S06**	**9 ECTS**
SPM-MAT-003	2	Statistics	25.5 h
SPM-AUT-001	3	Systems and Models	36.0 h
SPM-INF-009	4	Data structures and algorithms	44.5 h
SPM-NCL-002	P/F	Introduction to Research 2	15.0 h

ISP-INF-S06-22		**HEP S06**	**5 ECTS**
SPM-HEP-005	1	Economic, Industrial and Financial Systems	18.0 h
SPM-HEP-009	1	Scientific Dissemination Project 2	14.0 h
SPM-HEP-006	1	Commons	12.0 h
SPM-HEP-023	1	Job Application Preparation	15.0 h
1SL9000	P/F	Sport S06	21.0 h
SPM-STA-001	P/F	Execution Internship	0.0 h

ISP-INF-S06-16		**Foreign Language S06**	**4 ECTS**
LV1S06	1	Foreign Languages and Culture 1	21.0 h
LV2S06	1	Foreign Languages and Culture 2	21.0 h

Mathematics for Engineers

Course supervisor: Michel Barret

Total: 36.0 h **CM:** 18.0 h, **TD:** 15.0 h

SPM-MAT-001 *back*

Description: In this course, students are expected to acquire and master the formalisms, concepts, and mathematical results used in modeling physical systems or phenomena and engineering sciences. This particularly includes an advanced level in linear algebra and a thorough understanding of measure theory, Lebesgue integration, Fourier transform, and differential calculus.

Learning outcomes: By the end of this course, students will master the formalisms, concepts, and mathematical results used in modeling physical systems or phenomena and engineering sciences. They will have an advanced level in linear algebra and a thorough knowledge of measure theory, Lebesgue integration, Fourier transform, and differential calculus.

Evaluation methods: 3h written test, can be retaken.

CM:

1. Théorie de la mesure, intégrale de Lebesgue 1/2 (1.5 h)
2. Théorie de la mesure, intégrale de Lebesgue 2/2 (1.5 h)
3. Mesures sur des espaces produits (1/2) (1.5 h)
4. Mesures sur des espaces produits (2/2) (1.5 h)
5. Espaces vectoriels normés 1/2 (1.5 h)
6. Espaces vectoriels normés 2/2 (1.5 h)
7. Transformation de Fourier 1/2 (1.5 h)
8. Transformation de Fourier 2/2 (1.5 h)
9. Rappels et compléments d'algèbre linéaire 1/2 (1.5 h)
10. Rappels et compléments d'algèbre linéaire 2/2 (1.5 h)
11. Calcul différentiel 1/2 (1.5 h)
12. Calcul différentiel 2/2 (1.5 h)

TD:

1. Théorie de la mesure, intégrale de Lebesgue 1/2 (1.5 h)
2. Théorie de la mesure, intégrale de Lebesgue 2/2 (1.5 h)
3. Mesures sur des espaces produits (1/2) (1.5 h)
4. Mesures sur des espaces produits (2/2) (1.5 h)
5. Espaces vectoriels normés (1.5 h)
6. Transformation de Fourier 1/2 (1.5 h)
7. Transformation de Fourier 2/2 (1.5 h)
8. Rappels et compléments d'algèbre linéaire 1/2 (1.5 h)
9. Rappels et compléments d'algèbre linéaire 2/2 (1.5 h)
10. Calcul différentiel (1.5 h)

Quantum Physics 1

Course supervisor: Damien Rontani

Total: 22.5 h **CM:** 13.5 h, **TD:** 7.5 h

SPM-PHY-001 *back*

Description: Quantum Physics 1, offered in the first-year common core curriculum, aims to introduce the fundamental concepts of wave physics as well as the modern mathematical formalism of quantum physics, notably the Schrödinger equation. Students will develop a solid understanding of essential quantum phenomena and learn to use the mathematical tools specific to quantum mechanics, including operator algebra and its properties. The course will be based on key experiments that laid the foundation of quantum theory (double-slit experiment, photoelectric effect, Stern-Gerlach experiment) to present the fundamental postulates of quantum mechanics and justify the transition from classical to quantum formalism. The notions of orbital angular momentum quantization and spin will be covered, along with their use in the study of two-level systems and a first description of the hydrogen atom. Finally, several practical applications will be examined to illustrate the relevance of these concepts, including the MASER, atomic clocks, and Nuclear Magnetic Resonance (NMR). This course provides an essential foundation for understanding quantum systems and prepares students for advanced courses in physics, photonics, nanotechnologies, or quantum engineering.

Bibliography:

- Ref. [1] : C. Cohen-Tannoudji, F. Laloë, B.Diu, Mecanique Quantique – Tome 1, EDP Science CNRS Edition (2018)
- Ref. [2] : J.-L. Basdevant, J. Dalibard, Mécanique Quantique, Ellipse Edition (2006)

Learning outcomes: At the end of this course, students will be able to: AA1: Understand and implement the fundamental postulates of quantum mechanics – AA2: Understand and apply the theory of angular momentum – AA3: Solve a wave physics problem by applying the Schrödinger equation – AA4: Apply the quantum formalism to simple quantum systems – AA5: Explain the foundational experiments of quantum mechanics

Evaluation methods: 1h30 written test, can be retaken.

CM:

1. Introduction à la Mécanique Quantique et rappels de physique ondulatoire (3.0 h)
2. Introduction à la Mécanique Quantique et rappels de physique ondulatoire (1.5 h)
3. Postulats de la Mécanique Quantique (1.5 h)
4. Algèbre d'Opérateurs - Commutation des Observables (1.5 h)
5. Quantification du moment cinétique (3.0 h)
6. Moment cinétique de Spin - Systèmes à deux niveaux (3.0 h)

TD:

1. Introduction à la Mécanique Quantique et rappels de physique ondulatoire (1.5 h)
2. Postulats de la Mécanique Quantique (1.5 h)
3. Algèbre d'Opérateurs - Commutation des Observables (1.5 h)
4. Quantification du moment cinétique (1.5 h)
5. Moment cinétique de Spin - Systèmes à deux niveaux (1.5 h)

Probability

Course supervisor: Michel Barret

Total: 24.0 h **CM:** 12.0 h, **TD:** 10.5 h

SPM-MAT-002 *back*

Description: By the end of the core curriculum course in probability, students will have mastered the concepts of random experiments, probability spaces, probability distributions, random variables (RVs), conditioning, and independence of RVs. They will be able to construct an appropriate probability space for a given random experiment (and vice versa), compute and use moments of real or complex RVs, recognize and utilize the Hilbert space structure of second-order complex RVs, and identify and apply various representations of probability distributions (cumulative distribution function, probability density function, characteristic functions, etc.). They will be able to recognize and apply common probability distribution models (Bernoulli, binomial, Poisson, Gaussian, etc.), as well as understand and use the different modes of convergence for sequences of random variables. Finally, they will be able to justify and apply the fundamental theorems of probability theory (Central Limit Theorem, Law of Large Numbers, etc.), and understand and use the concept of conditional expectation.

Learning outcomes: By the end of this course, students will be able to: use the concepts of random experiments, probability spaces, probability distributions, random variables (RVs), conditioning, and independence of RVs; construct an appropriate probability space for a given random experiment and vice versa; compute and use moments of real or complex RVs; recognize and utilize the Hilbert space structure of second-order complex RVs; identify and apply different representations of probability distributions (cumulative distribution function, probability density function, characteristic functions, etc.); identify common probability distribution models (Bernoulli, binomial, Poisson, Gaussian, etc.); recognize and use the different types of convergence for sequences of RVs; justify and apply the fundamental theorems of probability theory (Central Limit Theorem, Law of Large Numbers, etc.); and understand and apply the concept of conditional expectation.

Evaluation methods: 1h30 written test, can be retaken.

CM:

1. Introdution aux espaces probabilisés 1/2 (1.5 h)
2. Introdution aux espaces probabilisés 2/2 (1.5 h)
3. Moments des variables aléatoires 1/2 (1.5 h)
4. Moments des variables aléatoires 2/2 (1.5 h)
5. Fonctions caractéristiques et suites de VA indépendantes 1/2 (1.5 h)
6. Fonctions caractéristiques et suites de VA indépendantes 2/2 (1.5 h)
7. Loi et espérance conditionnelle 1/2 (1.5 h)
8. Loi et espérance conditionnelle 2/2 (1.5 h)

TD:

1. Introdution aux espaces probabilisés (1.5 h)
2. Moments des variables aléatoires 1/2 (1.5 h)
3. Moments des variables aléatoires 2/2 (1.5 h)
4. Fonctions caractéristiques et suites de VA indépendantes 1/2 (1.5 h)
5. Fonctions caractéristiques et suites de VA indépendantes 2/2 (1.5 h)
6. Loi et espérance conditionnelle 1/2 (1.5 h)
7. Loi et espérance conditionnelle 2/2 (1.5 h)

Signals and Systems

Course supervisor: Stéphane Rossignol

Total: 36.0 h **CM:** 18.0 h, **TD:** 6.0 h, **TP:** 12.0 h

SPM-SIC-001 *back*

Description: The digital world generates large volumes of diverse data (audio, images, video, physical measurements) associated with human activities in fields as varied as healthcare, telecommunications, industry, and the environment. Extracting meaningful information from these signals is increasingly essential for: decision-making (e.g., medical diagnosis), information encoding (e.g., data compression), analysis of physical phenomena (e.g., detection of mechanical faults), and signal restoration (e.g., removing noise from an audio signal). The course will begin by introducing fundamental concepts of signals (in particular, regarding distributions) and linear time-invariant systems (convolution, etc.). It will then address energy-related aspects (correlations, signal-to-noise ratio). This will lead to the study of the Fourier transform for analog signals and the spectral representations used in analog systems (e.g., for filtering). The course will then explore what happens when signals are discretized and digital systems are considered (Shannon, Gabor; discrete-time Fourier transform; Fast Fourier Transform). Finally, it will examine the reverse transition—from digital back to analog—as well as sampling rate conversion.

Bibliography:

- Ref. [1] : A.V. Oppenheim and R.W. Schafer, Discrete Time Signal Processing, Prentice Hall, 3rd Ed. (2009)

Learning outcomes: By the end of this first-year course, students will be able to understand and apply signal processing methods to solve various problems in information science, such as information transmission, signal denoising, physical parameter estimation, and spectral analysis. These problems arise in a wide range of applications, including automatic speech recognition, music recording identification, radar source localization, climate data analysis, medical image reconstruction in MRI, gravitational wave detection in astrophysics, and the development of next-generation cellular networks (5G, IoT).

Evaluation methods: Lab reports

CM:

1. Introduction (1.5 h)
2. Notions sur les signaux (distributions) (1.5 h)
3. Notions sur les systèmes (systèmes linéaires et invariants, convolution) (1.5 h)
4. Énergie/(Auto/Inter)Corrélations/Rapport signal sur bruit (1.5 h)
5. Transformée de Fourier (signal analogique) (1.5 h)
6. Représentation spectrale des signaux/Shannon/Gabor (1.5 h)
7. Représentation spectrale des systèmes/Filtrage (1.5 h)
8. Transformée de Fourier (signal discret) (1.5 h)
9. Interpolation et blocage (1.5 h)
10. Réduction de cadence (cadence=fréquence d'échantillonnage) (1.5 h)
11. Élévation de cadence (1.5 h)
12. Analyse spectrale (1.5 h)

TD:

1. Signaux de base (1.5 h)
2. Aspects temporels (1.5 h)
3. Aspects fréquentiels (1.5 h)
4. Intervention Industrielle (1.5 h)

TP:

1. Opérations de base sur les signaux (3.0 h)
2. Classification des signaux (domaine temporel) (3.0 h)
3. Aspects fréquentiels (3.0 h)
4. Application : détection de pitch (3.0 h)

Introduction to Research 1

Course supervisor: Nicolas Marsal

Total: 12.0 h **CM:** 7.5 h, **TD:** 1.5 h, **TP:** 3.0 h

SPM-NCL-001 *back*

Description: The Research Initiation course provides participants with both a practical and theoretical introduction to the fundamental principles of academic research. By exploring the various stages of the research process—from formulating a research question to communicating results—students will acquire essential skills to conduct effective research projects. Through hands-on exercises, case studies, and classroom discussions, participants will become familiar with methods for data collection and analysis, as well as with ethical standards and best research practices. This module provides a solid foundation for those wishing to pursue graduate studies or engage in independent research projects.

Learning outcomes: The learning outcomes of this module include the ability to formulate relevant research questions, design appropriate research methodologies, collect and analyze data rigorously, and interpret and communicate results clearly and coherently. Students will also learn to critically evaluate existing literature, adhere to ethical research standards, and work collaboratively.

Evaluation methods: Specific evaluation method defined by the various instructors

Evaluated skills:
- Research and Development

CM:

1. Le métier de Chercheur-1/2 (1.5 h)
2. Le métier de Chercheur-2/2 (1.5 h)
3. Rédaction scientifique 1/2 (1.5 h)
4. Rédaction scientifique 2/2 (1.5 h)
5. Reviewing d'Article 1/2 (1.5 h)

TD:

1. Reviewing d'Article 2/2 (1.5 h)

TP:

1. Speed meeting (3.0 h)

Computer architecture

Course supervisor: Jérémy Fix

Total: 36.0 h **CM:** 10.5 h, **TD:** 3.5 h, **TP:** 20.0 h

SPM-INF-005 *back*

Description: This course deals with computer architecture, starting with the transitor and gradually building up the various layers of abstraction to finally reach programming. We'll see the building blocks of information routing (multiplexer), memory (flip-flops, registers) and information processing (arithmetic and logic units) enabling the creation of data paths and their sequencing. The course ends with the programming of the architecture built in a language close to assembler and the realization of a mini-game, and ends by opening perspectives towards operating systems. All practical exercises will be carried out in Logisim simulation.

Learning outcomes: At the end of this course, students will have an understanding of how a computer works, based on logic gates and flip-flops. In particular, they will be prepared to make the link between what they write in C/C++ and execution on the machine.

Evaluation methods: 2h written test, can be retaken.

External resources:
- Site du cours

CM:

1. Codage/Décodage et opérations binaires (1.5 h)
2. Couche physique et couche logique (1.5 h)
3. Chemin de données (1.5 h)
4. Couche ISA et séquenceur microprogrammé (1.5 h)
5. Pile (1.5 h)
6. Programmation (1.5 h)
7. Mémoires, périphériques et interruptions (1.5 h)

TD:

1. Architecture ARM (3.5 h)

TP:

1. Séquenceur manuel (4.0 h)
2. Séquenceur microprogrammé (4.0 h)
3. Pile et appel de routines (4.0 h)
4. Interruptions (4.0 h)
5. Programmation assembleur et ordonnancement (4.0 h)

Free Softwares for Engineers

Course supervisor: Jérémy Fix

Total: 13.5 h **CM:** 1.5 h, **TP:** 12.0 h

SPM-INF-001 *back*

Description: This course introduces the main tools of the free software world useful to an engineer. It covers the use of bash to interact with the system, the philosophy behind GNU tools and how to combine them (pipelines, IO redirection, etc.). We'll also take a look at how to combine various tools (git, python, awk, sed, lynx, ffmpeg, make), using them to carry out two projects. Assessment will be based on the practical reports.

Learning outcomes: At the end of this course, students will be able to interact with a Linux computer, invoking and articulating free software tools via a bash-like command interpreter.

Evaluation methods: Labwork report

Evaluated skills:
- Development

External resources:
- Site du cours

CM:

1. Introduction à Linux (1.5 h)

TP:

1. Linux, Shell, GIT (4.0 h)
2. Eruption solaire (4.0 h)
3. Météo (4.0 h)

Introduction to C/C++ Programming

Course supervisor: Hervé Frezza-Buet

Total: 39.0 h **CM:** 10.5 h, **TD:** 4.5 h, **TP:** 24.0 h

SPM-INF-003 *back*

Description: This course covers C programming, focusing on execution threading (loops, function calls, recursive functions), memory manipulation (structured types, pointers, stack and heap, binary representations). The first steps towards object-oriented design (encapsulation without the syntax of an object language like C++). This course also covers the aspecst of separate compilation (headers, external variables, linkage, dynamic libraries, etc.).

Learning outcomes: On completion of this course, students will be able to write, compile and debug C/C++ programs involving the basic elements of the language.

Evaluation methods: Assessment based on participation in experiments and results.

Evaluated skills:
- Development

External resources:
- C++ web pages

CM:

1. Fil d'exécution, pile 1/2 (1.5 h)
2. Fil d'exécution, pile 2/2 (1.5 h)
3. Organiser la mémoire 1/2 (1.5 h)
4. Organiser la mémoire 2/2 (1.5 h)
5. Compilation séparée (1.5 h)
6. Définition de types et encapsulation (1.5 h)
7. STL et smart pointers (1.5 h)

TD:

1. Collections 1/2 (1.5 h)
2. Collections 2/2 (1.5 h)
3. Vérification acquis (1.5 h)

TP:

1. Fil d'exécution, pile (4.0 h)
2. Ranges (4.0 h)
3. Simulateur de réseaux de Petri (4.0 h)
4. Rendu graphique de height fields (4.0 h)
5. Rendu graphique de height fields (4.0 h)
6. Finitions des TPs (4.0 h)

Python for Scientists

Course supervisor: Jérémy Fix

Total: 21.0 h **CM:** 3.0 h, **TP:** 18.0 h

SPM-INF-002 *back*

Description: The aim of this teaching unit is to train students in the tools of the Python ecosystem for scientists. It covers the use of specialized libraries for a number of major themes: scientific computing with Numpy, signal processing with Scipy, managing and processing large volumes of data with pandas, formatting results with matplotlib and an introduction to machine learning with scikit-learn.

Learning outcomes: At the end of this course, students will be able to mobilize the tools of the Python ecosystem for the experimental parts of their scientific activities.

Evaluation methods: Practical reports

Evaluated skills:
- Development

External resources:
- Site du cours

CM:

1. Calcul scientifique (1.5 h)
2. Gestion de données, visualisation (1.5 h)

TP:

1. Manipulation des tableaux et calculs matriciels (3.0 h)
2. Interpolation et optimisation (3.0 h)
3. Traitement du signal : Fourier, convolution, corrélation à la ferme aux animaux (4.0 h)
4. Traitement d'une grande base de données géolocalisées avec pandas (4.0 h)
5. Indicateurs de diversité écologique (4.0 h)

Project Management

Course supervisor: Hervé Frezza-Buet, Damien Rontani

Total: 15.0 h **CM:** 12.0 h

SPM-HEP-008 *back*

Description: This course is designed to make students more effective in managing their projects by providing methodological frameworks and practical tools. They will learn to plan, organize, monitor, and lead a project and a team in various contexts. This course is complemented by the "Management" course, which focuses more specifically on the human aspects of managing individuals and groups.

Learning outcomes: By the end of this course, students will have mastered the fundamentals of project management tools and methods, enabling them to effectively lead all phases of a collaborative project.

Evaluation methods: Case study

Evaluated skills:
- Management

CM:

1. Définitions d'un projet (3.0 h)
2. Recueil et analyse des besoins (3.0 h)
3. Conception et réalisation de la solution (3.0 h)
4. Mise en œuvre et déploiement (3.0 h)

Oral and written communication

Course supervisor: Hervé Frezza-Buet, Damien Rontani

Total: 15.0 h **CM:** 4.0 h, **TP:** 11.0 h

SPM-HEP-001 *back*

Description: This course provides essential tools for effective oral and written communication in academic and professional contexts. On the oral side, students will learn how to speak in public, lead meetings and conduct interviews, manage their speaking time, and adapt to videoconferencing situations. On the written side, they will practice drafting various types of documents (technical or scientific reports, meeting minutes, specifications, responses to calls for projects, etc.), focusing on clear structure and content, while using appropriate tools for formatting and presentation.

Learning outcomes: By the end of this course, students will be able to communicate clearly, effectively, and professionally in a variety of situations, both in writing and orally.

Evaluation methods: Assessment based on participation in tutorials/labs and submitted results (including a pitch video recorded in a single take)

Evaluated skills:
- Management

CM:

1. Principes de communication orale (4.0 h)

TP:

1. Communication écrite, Latex (3.0 h)
2. mise en pratique 1 (4.0 h)
3. mise en pratique 2 (4.0 h)

Engineer, Environment and Society

Course supervisor: Julien Colin

Total: 12.0 h **CM:** 6.0 h, **TD:** 2.0 h, **TP:** 4.0 h

SPM-HEP-003 *back*

Description: This course aims at providing students with fundamental knowledge of the life cycles of resources (energy and non-energy: production/extraction, consumption, end-of-life) and their impact on climate and biodiversity, in relation to the demographic and geopolitical challenges of the 21st century.

Learning outcomes: At the end of this course, students will be familiar with the global challenges facing humanity and its environment in the 21st century, and will have an overview of their levers as citizens and engineers.

Evaluation methods: evaluation of involvement (mandatory and controlled attendance) and of a step back note.

CM:

1. Humanité et défis planétaires du 21ème siècle (2.0 h)
2. énergie climat (2.0 h)
3. Exploitation des ressources minérales ou Cycles de l'eau (2 CM en parallèle, au choix des élèves) (2.0 h)

TD:

1. Transition vers une ville durable (2.0 h)

TP:

1. visite à l'extérieur (2 sites en parallèle, selon le choix au cours précédent) (4.0 h)

Scientific Dissemination Project 1

Course supervisor: Hervé Frezza-Buet, Virginie Galtier

Total: 12.0 h **Projet:** 12.0 h

SPM-HEP-002 *back*

Description: Training in oral communication and pedagogy through preparation and hands-on implementation. Students design an educational activity for elementary school pupils on a scientific or technological topic (coding, physics, mathematics, etc.). They develop the teaching materials and deliver the lesson to CM1 or CM2 classes (4th or 5th grade), under the supervision of the classroom teacher. The project may involve the FabLab. In semester 5, students define the content of their lesson, select pedagogical tools, and are assessed based on a detailed lesson plan (including content, required materials, and expected outcomes). This activity is part of the EntreElèves initiative, in collaboration with the Cité Éducative Metz-Borny.

Learning outcomes: At the end of this course, students will have had the experience of having to construct a communication adapted to an audience very different from their own, having made pedagogical choices to successfully get the message across. They will also have had the demanding experience of a real-life communication situation, which implies a certain degree of charisma.

Evaluation methods: Report describing the planned classroom intervention

Evaluated skills:
- Business Intelligence
- Management

Sport S05

Course supervisor: Hervé Frezza-Buet

Total: 21.0 h **TD:** 21.0 h

1SL9000 *back*

Description: Beyond the development of motor skills (physical, technical, and tactical), physical education courses aim to help students develop personal skills related to self-awareness and self-control, as well as interpersonal skills such as teamwork, active listening, communication, and group facilitation.

TD:

1. Cours de sport (21.0 h)

Foreign Languages and Culture 1

Course supervisor: Elisabeth Leuba

Total: 21.0 h **TD:** 21.0 h

LV1S05 *back*

Description: The first foreign language is generally English. Students are divided into level groups ; in class, work is not only focused on the 4 language competences but also on various topics studied in depth according to students' levels. Topics cover a range of fields, such as civilisation, society and the professional world. Limited class size enables active participation and significant improvement in the language. The educational approach is varied: group work, class presentations, specific exercises, research, debates, etc.

Learning outcomes: At the end of the course, students will have improved their ability to communicate in an international professional, academic or personal context.

Evaluation methods: Assessment will be by continuous assessment according to criteria to be determined by each teacher, taking into account personal investment in the course. Each course will be marked out of 20 at the end of the semester.

Evaluated skills:
- Research and Development
- Consulting
- Business Intelligence
- Management

TD:

1. Cours (21.0 h)

Foreign Languages and Culture 2

Course supervisor: Beate Mansanti

Total: 21.0 h **TD:** 21.0 h

LV2S05 *back*

Description: Students are offered a range of second foreign languages at different levels, including for beginners. Students are divided into level groups; in class, work is not only focused on the 4 language competences but also on various topics studied in depth according to students' levels. Topics cover a range of fields, such as civilisation, society and the professional world. Limited class size enables active participation and significant improvement in the language. The educational approach is varied: group work, class presentations, specific exercises, research, debates, etc.

Learning outcomes: At the end of the course, students will have improved their ability to communicate in an international professional, academic or personal context.

Evaluation methods: Assessment will be by continuous assessment according to criteria to be determined by each teacher, taking into account personal investment in the course. Each course will be marked out of 20 at the end of the semester.

Evaluated skills:
- Research and Development
- Consulting
- Business Intelligence
- Management

TD:

1. Cours (21.0 h)

C++ PROGRAMMING

Course supervisor: Hervé Frezza-Buet, Frédéric Pennerath

Total: 42.0 h **CM:** 15.0 h, **TP:** 24.0 h

SPM-INF-007 *back*

Description: The purpose of this course is to cover the main concepts of programming in C++ (C++20 and later). We will introduce the advantages of strong typing, the object-oriented approach (encapsulation and inheritance, operator overloading, etc.), generic programming (templates, concepts), and the functional approach (function manipulation and lambda functions). All of this will be illustrated using the STL (iterators, ranges) during practical work.

Learning outcomes: By the end of this course, students will have acquired more advanced skills in C++, based on object-oriented programming, functional programming, and generic programming, with the various features offered by the latest versions of the language (ranges, concepts, etc.).

Evaluation methods: 3-hour individual computer test, can be retaken.

Evaluated skills:
- Development
- Modelling
- Certification

External resources:
- C++ website

CM:

1. Types et mémoire (1.5 h)
2. Syntaxe (1.5 h)
3. Goodies (1.5 h)
4. Heritage (1.5 h)
5. Fonctions (1.5 h)
6. Exceptions (1.5 h)
7. Templates 1/4 (1.5 h)
8. Templates 2/4 (1.5 h)
9. Templates 3/4 (1.5 h)
10. Templates 4/4 (1.5 h)

TP:

1. Heritage (4.0 h)
2. Fonctions (4.0 h)
3. Finalisation (4.0 h)
4. Templates 1/3 (4.0 h)
5. Templates 2/3 (4.0 h)
6. Templates 3/3 (4.0 h)

Operating Systems

Course supervisor: Michel Ianotto

Total: 32.0 h **CM:** 15.0 h, **TP:** 16.0 h

SPM-INF-010 *back*

Description: This course introduces the concept of operating systems, illustrated through Linux and C++ (using the STL). It covers the main components of operating systems, including process execution management, memory management, hardware management, and user management, as well as the mechanisms used to coordinate them (I/O, inter-process communication, and thread synchronization). The course also addresses containerization and virtualization technologies.

Learning outcomes: At the end of this course, students will have been introduced to the main concepts related to operating systems, enabling them to approach system administration as well as the invocation of system calls in their software development projects.

Evaluation methods: MCQ and evaluation of participation in practical work

Evaluated skills:
- System
- Development

CM:

1. Introductions (1.5 h)
2. Les processus et Threads (1.5 h)
3. Ordonnancement des processus, communication inter-processus (1.5 h)
4. Mémoire (1.5 h)
5. Les fichiers et les entrées-sorties (1.5 h)
6. Communication inter processus (IPC) (1.5 h)
7. Synchronisation de threads 1/2 (1.5 h)
8. Synchronisation de threads 2/2 (1.5 h)
9. Gestion des utilisateurs (1.5 h)
10. Virtualisation/Conteneurisation (1.5 h)

TP:

1. Manipulations du système (4.0 h)
2. Threads 1/2 (4.0 h)
3. Threads 2/2 (4.0 h)
4. Docker (4.0 h)

Computer Networking

Course supervisor: Virginie Galtier

Total: 26.5 h **CM:** 12.0 h, **TD:** 3.0 h, **TP:** 10.5 h

SPM-INF-008 *back*

Description: This course introduces students to the fundamentals of computer networks, with a particular focus on the Internet. It covers key concepts such as protocols and protocol stacks, as well as the various layers involved in network operation. Students will develop an awareness that network security is addressed at every layer. Several protocols (IP, HTTP, POP, etc.) will be explored in greater depth during lab sessions, and students will gain hands-on experience with the Socket API. Finally, seminars will encourage critical thinking on the governance and geopolitical dimensions of modern networks.

Learning outcomes: By the end of this course, students will understand the importance of layered architectures, be familiar with the purpose of each layer in the Internet model, and recognize some of the common solutions implemented at each level.

Evaluation methods: 1h written test, can be retaken.

Evaluated skills:
- System
- Development

CM:

1. concepts fondamentaux 1 (1.5 h)
2. concepts fondamentaux 2 (1.5 h)
3. couche liaison de données (1.5 h)
4. couche réseau (1.5 h)
5. couche transport (1.5 h)
6. couche application (1.5 h)
7. séminaire : aspects géopolitiques du DNS (1.5 h)
8. séminaire : administration d'un réseau (1.5 h)

TD:

1. protocole du bit alterné (1.5 h)
2. adressage (1.5 h)

TP:

1. QoS, analyse de trame (1.5 h)
2. couche liaison de données (1.5 h)
3. routage sur simulateur (1.5 h)
4. couche transport (1.5 h)
5. client/serveur (1.5 h)
6. mail (1.5 h)
7. HTTP (1.5 h)

Relational Databases

Course supervisor: Virginie Galtier

Total: 18.0 h **CM:** 4.5 h, **TD:** 1.5 h, **TP:** 10.5 h

SPM-INF-006 *back*

Description: This course builds on the knowledge acquired in previous years to enable students to design effective database schemas and use relational database management systems (RDBMS). Topics include the entity-relationship model and its translation into the relational model (both systematic and heuristic approaches), functional dependencies, normalization (up to 3NF), SQL (except DCL), practice with 2 RDBMS, transactions, indexes, interacting with a database from within a program, SQL injection and parameterized queries, and an introduction to Object-Relational Mapping (ORM).

Learning outcomes: By the end of the course, students will be able to model a data system in relational form, implement the model, and manipulate the associated SQL database from within a program.

Evaluation methods: 1h30 written test, can be retaken.

Evaluated skills:
- Modelling
- System
- Development

CM:

1. Modélisation (1.5 h)
2. SQL (1.5 h)
3. ORM (1.5 h)

TD:

1. Modélisation (1.5 h)

TP:

1. SQL (1.5 h)
2. Python (1.5 h)
3. ORM (1.5 h)
4. ouverture (3.0 h)
5. mini projet (3.0 h)

C++ PROGRAMMING PROJECT

Course supervisor: Hervé Frezza-Buet

Total: 18.0 h **Projet:** 18.0 h

SPM-PRJ-002 *back*

Description: Programming project for practical application of the C++ language. The code produced will be versioned using Git.

Learning outcomes: At the end of this course, students will have had their first experience of collaborative development and will have learned how to move from a problem to the appropriate coding choices in C++.

Evaluation methods: Evaluation based on the code produced and uploaded to the git. Evaluation will also be based on ongoing monitoring by the supervisors.

Evaluated skills:
- Modelling
- Development
- Management

Statistics

Course supervisor: Joël Legrand

Total: 25.5 h **CM:** 12.0 h, **TD:** 9.0 h, **TP:** 3.0 h

SPM-MAT-003 *back*

Description: In this course, students will acquire the mathematical, methodological, and computational foundations necessary to perform inference on the underlying probability distribution from observations of a random phenomenon (the data). This will enable them to analyze past phenomena or make forecasts for future events of a similar nature. To achieve this, students will learn the basic formalisms, concepts, and results of mathematical statistics. This includes, in particular, the definition of statistical models, the principles of estimation theory (maximum likelihood estimator, Bayesian estimator, etc.), and hypothesis testing theory (Neyman-Pearson test, chi-squared test, Kolmogorov-Smirnov test, etc.).

Learning outcomes: By the end of this course, students will have acquired a comprehensive set of mathematical, methodological, and computational skills essential for conducting in-depth statistical analyses based on observations of random phenomena (data). They will be able to draw inferences about the underlying probability distribution, enabling them to analyze past events and make forecasts about future events of a similar nature. Participants will have developed a solid understanding of the foundations of mathematical statistics, including the creation and definition of statistical models. They will be familiar with the core principles of estimation theory, using techniques such as the maximum likelihood estimator and the Bayesian estimator. In addition, they will be proficient in applying the principles of hypothesis testing theory, including methods such as the Neyman-Pearson test, the chi-squared test, and the Kolmogorov-Smirnov test. In summary, this course will equip students with the necessary skills to interpret and statistically analyze data, formulate reliable estimates, and carry out rigorous hypothesis tests. These competencies will be essential for making informed decisions based on empirical observations and for contributing meaningfully to problem-solving across a wide range of fields.

Evaluation methods: 1h30 written test, can be retaken.

CM:

1. Introdution et méthodes d'estimation ponctuelle (1.5 h)
2. Comparaison d'estimateurs et propriétés asymptotiques (1.5 h)
3. Intervale de confiance (1.5 h)
4. Estimation bayésienne (1.5 h)
5. Tests d'hypothèses (1.5 h)
6. Tests ANOVA (1.5 h)
7. Régression linéaire (1.5 h)
8. Régression logistique, GLM (1.5 h)

TD:

1. Introdution et méthodes d'estimation ponctuelle (1.5 h)
2. Comparaison d'estimateurs et propriétés asymptotiques (1.5 h)
3. Intervale de confiance (1.5 h)
4. Estimation bayésienne (1.5 h)
5. Tests d'hypothèses (1.5 h)
6. Tests ANOVA (1.5 h)

TP:

1. Régression linéaire (1.5 h)
2. Régression logistique, GLM (1.5 h)

Systems and Models

Course supervisor: Damien Rontani, Jean-Luc Collette

Total: 36.0 h **CM:** 18.0 h, **TD:** 6.0 h, **TP:** 12.0 h

SPM-AUT-001 *back*

Description: The Systems and Modeling course, part of the first-year core curriculum, aims to equip students with the necessary skills to accurately and effectively represent various types of systems using mathematical models. This facilitates the understanding, analysis, and optimization of systems in diverse contexts. The state-space representation—generally nonlinear—provides a highly generic modeling framework, particularly well-suited for numerical simulations of system behavior. However, a linearization step is often required afterward, in order to leverage the extensive set of analytical tools available for linear systems. These tools enable the resolution of differential equations, the assessment of system stability, and the analysis of closed-loop systems. In this context, the connection between time-domain and frequency-domain responses is well established, allowing for controller design via frequency-based methods that meet specific time-response specifications for a controlled system.

Learning outcomes: At the end of this first-year course, the student will be able to develop the mathematical model of a system in order to predict its behavior. They will also have acquired the methods required to perform numerical simulations based on this model. Finally, they will master the design of controllers used in feedback control problems.

Evaluation methods: Labwork evaluation.

Evaluated skills:
- Modelling

CM:

1. Représentation d'état (1.5 h)
2. Choix des variables d'état et simulation (1.5 h)
3. Linéarisation des équations d'état (1.5 h)
4. Résolution des équations d'état (1.5 h)
5. Transformée de Laplace (1.5 h)
6. Transformée en z (1.5 h)
7. Systèmes discrets (1.5 h)
8. Structure générale d'un système asservi (1.5 h)
9. Approche avec fonctions de transfert (1.5 h)
10. Liens entre réponse temporelle et fréquentielle (1.5 h)
11. Cahier des charges et approche fréquentielle (1.5 h)
12. Correction numérique (1.5 h)

TD:

1. TD équation d'état et linéarisation (1.5 h)
2. TD Résolution des équations d'état et transformées (1.5 h)
3. TD diagramme de Nyquist et marges de stabilité (1.5 h)
4. TD correction cascade (1.5 h)

TP:

1. TP commande d'un système électromécanique (3.0 h)
2. TP calcul symbolique et systèmes discrets (3.0 h)

3. TP identification avec réponses fréquentielles et temporelles (3.0 h)
4. TP modélisation et réglage de correcteurs (3.0 h)

Data structures and algorithms

Course supervisor: Nicolas Jozefowiez

Total: 44.5 h **CM:** 19.5 h, **TD:** 6.0 h, **TP:** 16.0 h

SPM-INF-009 *back*

Description: This introductory course presents fundamental algorithms and data structures, as well as generic methods for efficiently solving computational problems. After a general introduction to algorithms and the concept of complexity, certain data structures are presented for their usefulness, such as hash tables, trees (particularly search trees), graphs, heaps, etc. Generic solution methods are then introduced through various examples, such as the divide-and-conquer principle, dynamic programming, and the class of greedy algorithms. Reference algorithms on graphs (Prim, Ford Fulkerson, Dijkstra, etc.) are presented in this context. The rest of the course deals with solving NP-hard problems using exact solution techniques (backtracking, branch-and-bound) and approximate techniques (polynomial time approximation schemes). The course concludes with the NPC class and the P=NP conjecture. The tutorials complement the various chapters of the course, focusing on specific problems. The practical work involves a project to design road navigation software spread over four sessions, drawing on all the chapters of the course.

Learning outcomes: At the end of this course, students will be able to identify the temporal and spatial complexities of an algorithm and place them in a hierarchy of complexity classes in order to evaluate their efficiency. They will be able to implement various generic techniques (dynamic programming, greedy algorithms, divide and conquer, etc.) to design an algorithm that is efficient in terms of complexity. Finally, they will be able to recognize the intrinsic difficulties of NP-hard problems and, where appropriate, use approximation algorithms rather than seeking an exact solution.

Evaluation methods: 3h written test, can be retaken.

Evaluated skills:
- Development
- Modelling

CM:

1. Introduction 1/2 (1.5 h)
2. Introduction 2/2 (1.5 h)
3. Problème de recherche et structures de données associatives 1/2 (1.5 h)
4. Problème de recherche et structures de données associatives 2/2 (1.5 h)
5. Graphes et parcours (1.5 h)
6. Diviser pour régner (1.5 h)
7. Programmation dynamique (1.5 h)
8. Tas binaire et programmation dynamique (suite) (1.5 h)
9. Algorithmes gloutons 1/2 (1.5 h)
10. Algorithmes gloutons 2/2 (1.5 h)
11. Problèmes NP-difficiles 1/2 (1.5 h)
12. Problèmes NP-difficiles 2/2 (1.5 h)
13. Problèmes NP-complets (1.5 h)

TD:

1. Calcul de complexités (1.5 h)
2. Graphes bipartis (1.5 h)
3. Programmation dynamique (1.5 h)
4. Problèmes NPC et algorithme d'approximation (1.5 h)

TP:

1. Implémentation des graphes (4.0 h)
2. Algorithmes géométriques (4.0 h)
3. Plus court chemin dans un graphe (4.0 h)
4. Problème du voyageur du commerce (4.0 h)

Introduction to Research 2

Course supervisor: Nicolas Marsal

Total: 15.0 h **CM:** 9.0 h, **TD:** 4.5 h, **TP:** 1.5 h

SPM-NCL-002 *back*

Description: The Research Initiation course provides participants with both a practical and theoretical introduction to the fundamental principles of academic research. By exploring the various stages of the research process—from formulating a research question to communicating results—students will acquire essential skills to conduct effective research projects. Through hands-on exercises, case studies, and classroom discussions, participants will become familiar with methods for data collection and analysis, as well as with ethical standards and best research practices. This module provides a solid foundation for those wishing to pursue graduate studies or engage in independent research projects.

Learning outcomes: The learning outcomes of this module include the ability to formulate relevant research questions, design appropriate research methodologies, collect and analyze data rigorously, and interpret and communicate results clearly and coherently. Students will also learn to critically evaluate existing literature, adhere to ethical research standards, and work collaboratively.

Evaluation methods: Specific evaluation method defined by the various instructors

Evaluated skills:
- Research and Development
- Business Intelligence

CM:

1. Vulgarisation scientifique (3.0 h)
2. Valorisation de la Recherche-1/2 (3.0 h)
3. Rédaction en anglais (3.0 h)

TD:

1. Analyse de controverse (1.5 h)
2. Capsule Vidéo (1.5 h)
3. Valorisation de la Recherche-2/2 (1.5 h)

TP:

1. Analyse de controverse (1.5 h)

Economic, Industrial and Financial Systems

Course supervisor: Hervé Frezza-Buet, Damien Rontani

Total: 18.0 h **CM:** 18.0 h

SPM-HEP-005 *back*

Description: This course offers a critical examination of contemporary economic, industrial, and financial systems through their origins, dynamics, and impacts. Building on a theoretical foundation, it explores the tensions between economic imperatives and environmental limits. Discussions with field practitioners (elected officials, business leaders) will enrich the reflection by confronting theoretical concepts with industrial and territorial realities.

Learning outcomes: By the end of this course, students will understand the foundations and mechanisms of current economic, industrial, and financial systems. They will be able to analyze their interactions and will gain tools to explore alternative models that align with contemporary social and ecological challenges.

Evaluation methods: The assessment will be based on a report prepared by groups of three students, developed in addition to class hours.

Evaluated skills:

- Business Intelligence

CM:

1. Objet, faits majeurs et théories économiques (1.5 h)
2. Objet, faits majeurs et théories économiques (1.5 h)
3. Croissance, développement, durabilité (1.5 h)
4. Croissance, développement, durabilité (1.5 h)
5. suite + financement de la croissance (1.5 h)
6. suite + financement de la croissance (1.5 h)
7. économie sociale et solidaire (1.5 h)
8. économie sociale et solidaire (1.5 h)
9. Table ronde 1 : Sobriété, réduction de la consommation d'énergie, durabilité, et intérêt général (1.5 h)
10. Table ronde 1 : Sobriété, réduction de la consommation d'énergie, durabilité, et intérêt général (1.5 h)
11. Table ronde 2 : Enjeux économiques, environnementaux et sociaux de l'industrie du 21ème siècle dans un contexte mondialisé (1.5 h)
12. Table ronde 2 : Enjeux économiques, environnementaux et sociaux de l'industrie du 21ème siècle dans un contexte mondialisé (1.5 h)

Scientific Dissemination Project 2

Course supervisor: Hervé Frezza-Buet, Virginie Galtier

Total: 14.0 h **Projet:** 12.0 h

SPM-HEP-009 *back*

Description: Training in oral communication and pedagogy through preparation and hands-on implementation. Students design an educational activity for elementary school pupils on a scientific or technological topic (coding, physics, mathematics, etc.). They develop the teaching materials and deliver the lesson to CM1 or CM2 classes (4th or 5th grade), under the supervision of the classroom teacher. The project may involve the FabLab. In semester 6, students continue and complete the EntreÉlèves science outreach project initiated in semester 5. They finalize their teaching materials and prepare their presentations. Assessment, conducted in collaboration with the classroom teachers, is based on the students' in-class intervention, based on the delivery of the lesson in the classroom (carried out in pairs or groups of three).

Learning outcomes: At the end of this course, students will have had the experience of having to construct a communication adapted to an audience very different from their own, having made pedagogical choices to successfully get the message across. They will also have had the demanding experience of a real-life communication situation, which implies a certain degree of charisma.

Evaluation methods: Evaluation intervention in classroom and deliverables

Evaluated skills:
- Business Intelligence
- Management

Commons

Course supervisor: Hervé Frezza-Buet, Damien Rontani

Total: 12.0 h **CM:** 12.0 h

SPM-HEP-006 *back*

Description: This course offers an introduction to the commons, exploring their conceptual, legal, and economic foundations, as well as their role in the emergence of more open, sustainable, and collaborative production models. The course is structured around three main themes: first, the principles of the commons, their historical development, legal frameworks, and the limits of their implementation; second, the economic models that allow open source and low-tech projects to grow while staying true to their core values; and finally, the challenges related to open data, illustrated through geographic data, with a focus on privacy protection tools, regulatory frameworks, and emerging issues linked to artificial intelligence.

Learning outcomes: At the end of this course, students will be aware of the existence of commons and the free economy; they will understand their potential, challenges, and the tools for implementation, management, and governance.

Evaluation methods: Students will be asked to imagine a project involving open data and to present the potential value it could create, identify the resources to be secured, and anticipate potential challenges.

CM:

1. Les grands principes des communs (4.0 h)
2. Modèles économiques dans l'open-source et low-tech (4.0 h)
3. Enjeux des données ouvertes (4.0 h)

Job Application Preparation

Course supervisor: Hervé Frezza-Buet, Damien Rontani

Total: 15.0 h **CM:** 11.0 h, **TP:** 4.0 h

SPM-HEP-023 *back*

Description: The aim of this course is to develop students' career management skills. It will first help them identify their first job opportunity, go through the recruitment process successfully, and transition into the professional world. Later, these skills will support them when they wish to change positions or switch sectors. Finally, the course will provide insights for the day they find themselves in a recruiting role.

Learning outcomes: By the end of this course, students will be prepared for all stages of the recruitment process — before, during, and after job application.

Evaluation methods: The evaluation will be based on observations of the students' involvement.

CM:

1. opportunités (4.0 h)
2. candidater (4.0 h)
3. international et BigTech (3.0 h)

TP:

1. ateliers pratiques (4.0 h)

Sport S06

Course supervisor: Hervé Frezza-Buet

Total: 21.0 h **TD:** 21.0 h

1SL9000 *back*

Description: Beyond the development of motor skills (physical, technical, and tactical), physical education courses aim to help students develop personal skills related to self-awareness and self-control, as well as interpersonal skills such as teamwork, active listening, communication, and group facilitation.

TD:

1. Cours de sport (21.0 h)

Execution Internship

Course supervisor: Hervé Frezza-Buet, Damien Rontani

SPM-STA-001 *back*

Description: This first internship aims to confront students with the realities of the business world. During this internship, they take on an operational role and participate in various tasks to understand the challenges and difficulties faced by a worker.This internship also offers students the opportunity to grasp how a company functions and how decisions are communicated from the top down through the hierarchy. It helps develop the knowledge necessary for a thorough understanding of the operator's job and its key role as the foundation of any product or service production process. The internship must last at least 5 weeks and take place between semesters S6 and S7. It must be carried out in an environment conducive to acquiring the required knowledge. In particular, this requires the presence of close supervision and integration into a team composed of a sufficient number of operators performing the same type of tasks.

Learning outcomes: At the end of this internship, the student will be able to describe the company structure as perceived by different employees and compare it with the theoretical structure, illustrate the difficulties of operational tasks, observe human relationships in the workplace, and discuss hierarchical relationships within the company.

Evaluation methods: Pass/Fail evaluation based on the submission of an internship report.

Foreign Languages and Culture 1

Course supervisor: Elisabeth Leuba

Total: 21.0 h **TD:** 21.0 h

LV1S06 *back*

Description: The first foreign language is generally English. Students are divided into level groups ; in class, work is not only focused on the 4 language competences but also on various topics studied in depth according to students' levels. Topics cover a range of fields, such as civilisation, society and the professional world. Limited class size enables active participation and significant improvement in the language. The educational approach is varied: group work, class presentations, specific exercises, research, debates, etc.

Learning outcomes: At the end of the course, students will have improved their ability to communicate in an international professional, academic or personal context.

Evaluation methods: Assessment will be by continuous assessment according to criteria to be determined by each teacher, taking into account personal investment in the course. Each course will be marked out of 20 at the end of the semester.

Evaluated skills:
- Research and Development
- Consulting
- Business Intelligence
- Management

TD:

1. Cours (21.0 h)

Foreign Languages and Culture 2

Course supervisor: Beate Mansanti

Total: 21.0 h **TD:** 21.0 h

LV2S06 *back*

Description: Students are offered a range of second foreign languages at different levels, including for beginners. Students are divided into level groups; in class, work is not only focused on the 4 language competences but also on various topics studied in depth according to students' levels. Topics cover a range of fields, such as civilisation, society and the professional world. Limited class size enables active participation and significant improvement in the language. The educational approach is varied: group work, class presentations, specific exercises, research, debates, etc.

Learning outcomes: At the end of the course, students will have improved their ability to communicate in an international professional, academic or personal context.

Evaluation methods: Assessment will be by continuous assessment according to criteria to be determined by each teacher, taking into account personal investment in the course. Each course will be marked out of 20 at the end of the semester.

Evaluated skills:
- Research and Development
- Consulting
- Business Intelligence
- Management

TD:

1. Cours (21.0 h)