CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2024-2025

YEAR 2

INDUSTRIAL ENGINEERING

SMART AND CONNECTED ENTERPRISE

PROGRAMME SUPERVISOR(S):
Catherine DA CUNHA

YEAR 2 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
CPPS	Integrated Design and Implementation of CPPS	4
DATASCIENCE	Artificial Intelligence for Decision Making in Industrial Engineering	4
IS4PLM	Advanced IS within PLM approach	4
KBS	Knowledge-based systems	5
MBSE4PSS	Model-based system engineering for product service systems	4
MDMDS	Multicriteria Decision Making and Decision Support	4
PROJT	Project	3

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE3	Cultural and Communication English	2
ESP3	Spanish Language	2
FLE3	French Language	2

YEAR 2 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
THESIS	Master Thesis or Internship	30

Integrated Design and Implementation of CPPS [CPPS]

LEAD PROFESSOR(S): Catherine DA CUNHA / Olivier CARDIN

Requirements

Basic of informations systems
Basic of production management

Objectives

At the end of the course (30 hours + personal work) the students will be able to:
- Express the main characteristics and benefits of cyber-physical production systems
- Model a heterarchical manufacturing control architecture
- Integrate the basics of holonic paradigms
- Implement a cyber-physical production system using multi-agent technologies

This course contributes to the Sustainable Development Goal 12 "Responsible consumption and production" by increasing the knowledge of the students about cyber-physical production systems and their impacts on the environmental and social KPI.

Course contents

The lectures aim to introduce the following concepts:
- Systems of cyber-physical production systems;
- Heterarchical manufacturing control;
- Holonic manufacturing systems;
- Emerging behavior and bio-inspired systems;
- Cloud Manufacturing.

After an introduction lecture, practical classes will lead to a development project in full autonomy using an automated, robotized and emulated manufacturing system.

Course material

- Trentesaux, D., 2009. Distributed control of production systems. Engineering Applications of Artificial Intelligence, Distributed Control of Production Systems 22, 971–978.
- Cardin, O., Ounnar, F., Thomas, A., Trentesaux, D., 2017. Future Industrial Systems: Best Practices of the Intelligent Manufacturing and Services Systems (IMS2) French Research Group. IEEE Transactions on Industrial Informatics 13, 704–713.
- Multiagent Systems, 2013. G. Weiss, 2nd ed. MIT Press, Cambridge, MA, USA.
- Monostori, L., 2014. Cyber-physical Production Systems: Roots, Expectations and R&D Challenges. Procedia CIRP, Variety Management in Manufacturing Proceedings of the 47th CIRP Conference on Manufacturing Systems 17, 9–13.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	8 hrs	12 hrs	8 hrs	4 hrs	0 hrs

Artificial Intelligence for Decision Making in Industrial Engineering [DATASCIENCE]

LEAD PROFESSOR(S): Catherine DA CUNHA

Requirements

Basic of statistics
Basic of programming

Objectives

At the end of the course, the students will be able to understand the meaning of the tryptic: data, information and knowledge, and how these concepts are integrated and managed to support various business and technical paradigms behind the enterprise of the future.
This course contributes to the Sustainable Development Goal 12 "responsible consumption and production". Using the knowledge acquired in this class, the students will be able to use the data describing the behavior of a system (a machine, a factory,...) to improve it: reduce the energy consumption, reduce the waste, increase the lifetime of the tools....

Course contents

This course presents the fundamentals of data and knowledge management and engineering.
The key elements to be introduced in this course are as follows:
▪ Principles of data and knowledge management
o Distinction between data, information and knowledge
o Key processes of knowledge management
▪ Design of databases for data structuring
o Creation of a simple database with Access
o Data search and queries
▪ Knowledge management
o Principle of knowledge management
o Traceability and reuse of experience
▪ Knowledge Engineering
o Concept of ontology (definition, meaning, and objectives)
o Creation of ontology with Protegé tool
o Reasoning on ontology with SPARQL and rules engines
▪ Knowledge-based reasoning for decision-making
o Principles of Fuzzy logic for decision support
o Introduction to case-based reasoning

Course material

Mikut, R., & Reischl, M. (2011). Data mining tools. Wiley interdisciplinary reviews: data mining and knowledge discovery, 1(5), 431-443.
Knowledge-based multi-level aggregation for decision aid in the machining industry
Ritou, M., Belkadi, F., Yahouni, Z., Da Cunha, C., Laroche, F., & Furet, B. (2019). Knowledge-based multi-level aggregation for decision aid in the machining industry. CIRP Annals, 68(1), 475-478.
Ferhat, M., Ritou, M., Leray, P., & Le Du, N. (2021). Incremental discovery of new defects: application to screwing process monitoring. CIRP Annals, 70(1), 369-372.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	14 hrs	8 hrs	8 hrs	2 hrs	0 hrs

Advanced IS within PLM approach [IS4PLM]

LEAD PROFESSOR(S): Catherine DA CUNHA

Requirements

Objectives

At the end of the course (32 hours + personal work) the students will be able to:
- Understand the main categories and architectures of Enterprise Information Systems
- Manipulate the main functions of PLM systems
- Manipulate some advanced function of ERP systems and MES

This course contributes to the Sustainable Development Goal 9 "Industry, Innovation, and infrastructure" by explaining to the students how digitalization can contribute to the optimization of industrial processes and resources.

Course contents

- Introduction to PLM (Product Lifecycle management)
  - o Difference between PLM approach and PLM tool
  - o Key functions of PLM
    - Notion of Workspace and collaborative design (notification, viewer, etc.)
    - Product configuration (eBOM - mBOM) and variant management
    - Data and files management (volt, check-in, check-out, version, iteration)
    - Notion of Lifecycles and workflows
    - Introduction to administration tools (team management, roles, access rights)
  - o Overview of main commercial PLM solutions

- Manipulation of a PLM
  - o Overview of Dassault 3DX solution
  - o Collaborative Design and EBOM creation of a simple cell phone prototype
  - o Product customization and variant configuration
  - o MBOM and manufacturing planning
  - o Lifecycle management and validation workflows

- Manipulation of ERP (Enterprise Resources Planning)
  - o Recall of basic functions of ERP (SAGE tool)
  - o Introduction to advanced functions of ERP (SAGE and SAP) : business intelligence, data analytics, customer and supplier relationships.
- Introduction to MES
- Design of information systems
  - o Design of Service Oriented software architectures (SOA)
  - o New Challenges of interoperability

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	6 hrs	8 hrs	16 hrs	2 hrs	0 hrs

Knowledge-based systems [KBS]

LEAD PROFESSOR(S): Catherine DA CUNHA

Requirements

Objectives

At the end of the course, the students will be able to understand the meaning of the tryptic data, information and knowledge, and how these concepts are integrated and managed to support various decision making processes in the enterprise.

This course contributes to the Sustainable Development Goal 9 "Industry, Innovation, and infrastructure" and goal 12 “responsible consumption and production” by emphasizing the importance of human knowledge and its efficient management to solve daily problems in the company.

Course contents

- Principles of data and knowledge management
  - o Distinction of Data, information and knowledge
  - o Types of knowledge
- Recall of data management principles
  - o Creation of a simple data base with Access tool
  - o Data searching and queries
- Knowledge management
  - o Principle of knowledge management
  - o Traceability and Reuse of experience
- Knowledge Engineering
  - o Concept of ontology (definition, meaning, and objectives)
  - o Creation of ontology with Protegé tool
  - o Reasoning on ontology for decision aid with SPARQL and rules engines
- Knowledge based reasoning for decision making
  - o Principles of Fuzzy logic
  - o Use of fuzzy logic for decision aid in socio-economic context

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	12 hrs	4 hrs	12 hrs	4 hrs	0 hrs

Model-based system engineering for product service systems [MBSE4PSS]

LEAD PROFESSOR(S): Catherine DA CUNHA

Requirements

Objectives

The aim of this course is to show how new ICT technologies and collaborative models can contribute to the creation of new business paradigms within a sustainable perspective. Lessons learned from recent projects are summarized in order to explain the current challenges of socio-economic sustainability in both industrial and scientific fields, in the new era of enterprise of the future.

At the end of this course, the students will be able to understand the main concepts and methods of integrated design and development of product service systems (PSS), from business, organizational, engineering and technological perspectives. There will be a focus on system engineering principles and model-based design methods and tools to build innovative PSS offers.

This course contributes to Sustainable Development Goal 9 "Industry, Innovation, and infrastructure" and goal 12 “Responsible consumption and production” by increasing the innovative capacities of the students and helping them to imagine new sustainable offers and business paradigms.

Course contents

- Definition of socio-economic sustainability and related paradigms (circular economy, frugality, Product-Service systems)
- Blueprinting methods for product-service systems design
- Introduction to System Engineering
  - o System analysis foundations with the concept of facet:
    Core features; system lifecycle; business models and system decomposition
    The design process and the concept of facet
  - o Definition of system engineering
  - o Overview of main SE processes
- Requirement management and functional analysis
  - o The concept of requirement?
  - o The requirement engineering and management process
  - o From the requirement engineering to functional analysis
- Design of system architectures:
  - o Concepts of functional, logical, and physical architectures.
  - o Function allocation and design matrix

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	12 hrs	8 hrs	8 hrs	4 hrs	0 hrs

Multicriteria Decision Making and Decision Support [MDMDS]

LEAD PROFESSOR(S): Raphaël CHENOUARD

Requirements

Python programming language

Objectives

At the end of the course (30 hours + personal homework) the students will be able to:

- Understand decision problems
- Use some decision-making methods to choose a solution among others
- Solve multi-objective decision problems

Course contents

These lectures aim to present the main elements of multi-criteria decision making and decision support methods and tools:

- Introduction to decision theory
- Multicriteria decision methods (AHP)
- Design of experiments
- Multi-objective optimization

Practical exercises and homework will help students to apply the learned concepts and methods.

Course material

- Saat. Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process (1994).
- Deb. Multi-Objective Optimization using Evolutionary Algorithms. Wiley, 2001.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	8 hrs	12 hrs	8 hrs	4 hrs	0 hrs

Project [PROJT]

LEAD PROFESSOR(S): Catherine DA CUNHA

Requirements

Objectives

The objectif of this transdisciplinary course is to give the students the opportunity to discover current advances in the era of the enterprise of the future and industry 4.0, within the objective of sustainbility.

Course contents

Students will realize in full autonomy a literature survey on a topic of their interest from both scientific and industrial perspectives. They can based their review on webinars and journal papers.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	0 hrs	0 hrs	24 hrs	0 hrs

Cultural and Communication English [CCE3]

LEAD PROFESSOR(S): David TROYA

Requirements

Objectives

- Understand the fundamental principles of scientific writing and the importance of clarity and precision in communication.
- Structure scientific documents effectively, adhering to genre-specific conventions.
- Employ appropriate language and tone for diverse scientific audiences.
- Integrate and cite sources correctly to support research arguments and findings.
- Edit and revise their writing for coherence, style, and grammatical accuracy.
- Prepare and deliver scientific presentations, both written and oral.

Course contents

Introduction to Scientific Writing

Overview:

This course provides an essential foundation in scientific writing, equipping students with the skills necessary to effectively communicate research findings and scientific concepts. Through a combination of lectures, workshops, and practical assignments, students will learn the conventions of scientific writing, including structure, style, and clarity. The course will cover various types of scientific documents, such as research papers, literature reviews, grant proposals, and poster presentations.

Course Structure:

The course will be organized into weekly sessions that include lectures on theoretical concepts, hands-on writing exercises, peer review workshops, and discussions of exemplary scientific literature. Students will engage in collaborative projects and receive constructive feedback to enhance their writing skills.

Assessment:

Students will be assessed through a combination of assignments, including written documents, peer review participation, and presentations. Active participation in workshops and discussions is also required to foster a collaborative learning environment.

Course material

Hoogenboom BJ, Manske RC. How to write a scientific article. Int J Sports Phys Ther. 2012 Oct;7(5):512-7. PMID: 23091783; PMCID: PMC3474301.

Paré G, Kitsiou S. Chapter 9Methods for Literature Reviews. In: Lau F, Kuziemsky C, editors. Handbook of eHealth Evaluation: An Evidence-based Approach [Internet]. Victoria (BC): University of Victoria; 2017 Feb 27. Available from: https://www.ncbi.nlm.nih.gov/books/NBK481583/

How to Create a Research Poster. A guide fo creating a research poster. https://guides.nyu.edu/posters

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Spanish Language [ESP3]

LEAD PROFESSOR(S): Marta HERRERA

Requirements

N/A

Objectives

For beginners:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of vocabulary and linguistic structures
Be able to talk about yourself and those around you
Be able to express oneself during daily activities
Know how to give your opinion

For advanced students:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of specialised vocabulary
Be able to understand the essential content of concrete or abstract subjects including a technical discussion
Be able to communicate spontaneously and fluently
Be able to express oneself in a clear and detailed manner, to express an opinion on a topical subject

Course contents

For beginners:
Personal environment (introduce yourself, express yourself, your tastes, your character, your hobbies, etc.), your surroundings (friends, family, location, climate), your interests (sports, leisure)
Present tense (regular and irregular)
Language patterns to express habit, obligation, "gustar" and its equivalents,
Possessive adjectives
Differences between "es", "está", "hay"
Use of "por" and "para"
Adverbs and frequency patterns
Numeral adjectives

For advanced students:
Knowledge of the Hispanic world (economic, technical, cultural and social environment)
Present tense (regular and irregular)
Imperative
Past tenses
Direct / indirect style
Future tense
Conditional tense
Present and past subjunctive moods

Course material

Preparation manuals, our own tailor-made documents, written and internet press, general civilization documents, digital tools

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
Spanish	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

French Language [FLE3]

LEAD PROFESSOR(S): Silvia ERTL

Requirements

N/A

Objectives

The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with:
- Phonetics
- Self-correcting exercises on our learning platform
- Learning Lab activities
- Project work
- Tutoring

Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources. Students will learn general French, develop language skills of oral and written comprehension and expression.

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture.

At the end of the course, complete beginners can achieve an A1
level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels. Those who already completed the first year of the French course will be prepared for working in a French business environment.

Course contents

Two different tracks are proposed: track 1 for students newly arrived at Centrale Nantes and track 2 for students who have completed the first year of the French course. Track 1:
Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression.
Learners will be able to use the foreign language in a simple way for the following purposes:

1. Giving and obtaining factual information:
- personal information (e.g. name, address, place of origin, date of birth, education, occupation)
- non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.)

2. Establishing and maintaining social and professional contacts, particularly:
- meeting people and making acquaintances
- extending invitations and reacting to being invited
- proposing/arranging a course of action
- exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life

3. Carrying out certain transactions:

- making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities
- making purchases
- ordering food and drink

Track 2:
This track follows on directly from the first-year French course, developing and completing the concepts studied thus far. The main themes are: housing, health and work. These topics will help prepare students for their future work environment. For example, housing is explored in the form of a search for accommodation upon arrival in a new city. Special workshops for CVs and cover letters, elevator pitches and job interviews.

Course material

Preparation manuals, our own tailor-made documents, written and televised press, internet, general civilization documents, digital tools, our own educational materials on Hippocampus (Moodle).

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Master Thesis or Internship [THESIS]

LEAD PROFESSOR(S): Catherine DA CUNHA

Requirements

3 semesters of Industrial Engineering

Objectives

The main goal of the Master thesis is to gain hands-on experience of a real project. Through this project the student will:
- Be exposed to and adapt to an industrial or research environment;
- Put in practice the scientific and technical skills acquired in the previous semesters;
- Strengthen interpersonal and communication skills;
- Be part of or manage a project;
- Organize tasks, analyze results and build deliverables.

Course contents

Students should be pro-active and career-oriented in the search for their thesis/internship.
The topics are approved by the program supervisor to ensure an adequate Master level.
The thesis/internship is evaluated through the submission of a written report and an oral defense.

Course material

- Turabian Kate Larimore, Booth Wayne Clayton, Colomb Gregory G., Williams Joseph M., & University of Chicago press. (2013). A manual for writers of research papers, theses, and dissertations: Chicago style for students and researchers (8th edition.). Chicago (Ill.) London: University of Chicago Press.
- Bui Yvonne N. How to Write a Master's Thesis. 2nd ed. Thousand Oaks, Calif: Sage, 2014.
- Evans David G., Gruba Paul, et Zobel Justin. How to Write a Better Thesis. 3rd edition. Carlton South, Vic: Melbourne University Press, 2011.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	30	0 hrs	0 hrs	0 hrs	0 hrs	0 hrs