

SHAKE THE FUTURE.



# MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

## INDUSTRIAL ENGINEERING

### SMART AND CONNECTED ENTERPRISE

#### YEAR 2 AUTUMN SEMESTER

PROGRAMME SUPERVISOR:  
ALAIN BERNARD

# ENTERPRISE MODELLING (2)

INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE

YEAR 2 - AUTUMN SEMESTER

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LEAD PROFESSOR: Farouk Belkadi, [farouk.belkadi@ec-nantes.fr](mailto:farouk.belkadi@ec-nantes.fr)

## Objectives

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At the end of the course, students will be able to understand the main concepts, business paradigms and technologies behind the paradigm of enterprise of the future. They will be able to analyze and understand research work on the topic. The ontology concept is explored as an extension of modelling methods learned in Enterprise Modelling (1) for knowledge representation and classification.

## Course contents

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This course presents an overview of current research work in industry and scientific literature. Lessons learned from recent projects are also summarized in order to explain what are the current challenges for enterprises and scientific problems in the new era of the enterprise of the future. The key elements introduced in this course are as follows:

- Business and managerial issues within the paradigm of enterprise of the future
  - Evolution of industrial practices in modern enterprise
  - New business paradigms: Product-Service system, circular economy, frugality, etc.
- Human factor at the heart of enterprise of the future
  - Knowledge management and transfer,
  - Decision-making systems,
- Knowledge representation
  - Knowledge classification and representation with ontology
  - Knowledge representation with meta-models
- New challenges and applications of technology in the enterprise
  - Data collection and interpretation,
  - Applications of virtual and augmented reality tools, etc.
- Energy efficient systems and sustainability challenges
  - What is environmental impact?
  - Lifecycle analysis.
- Research work analysis
  - Overview of some research projects
  - Analysis of scientific articles

The major part of the learning process will be conducted through the analysis of scientific papers and the completion of mini projects around innovative ideas on enterprise of the future.

## Keywords

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Knowledge modelling, Enterprise of the future, Technology 4.0, New industrial practices, IoT

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	8 hrs	0 hrs	0 hrs	20 hrs	4 hrs

# DESIGN OF ENTERPRISE INFORMATION SYSTEMS

## INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE

### YEAR 2 - AUTUMN SEMESTER

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LEAD PROFESSOR: Farouk Belkadi, [farouk.belkadi@ec-nantes.fr](mailto:farouk.belkadi@ec-nantes.fr)

#### Objectives

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

- Understand the current architecture of enterprise information systems (EIS)
- Understand the main steps of the development project of Enterprise Information System
- Collect and analyze a list of requirements for the information system of interest
- Define the functional and technical specification of any information system
- Understand the main mechanisms of customization and configuration of information systems

#### Course contents

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This course aims to present the main methods and tools used in the development projects of an enterprise information system and how such development projects are managed. To do so, a first step consists in introducing the main components of any information system, the principle functions and their role in the enterprise. After this introduction, the following items will be presented in detail:

- Introduction to Information System Architecture
- Development project of EIS:
  - Key steps
  - Needs expression and stakeholders
  - Milestones and deliverables
- Collection and management of EIS requirements
  - types of requirements, types of stakeholders,
  - collection methods,
  - traceability and validation
- Design of data base
  - Relational model and sql,
  - Graphic oriented model
- Functional specification with UML
  - Overview of UML diagrams
  - Structural view: Class and objects diagrams,
  - Behaviour: Activity, sequence, state-transition and collaboration diagrams
  - Functional view: use case diagram
  - Physical implementation: component and deployment diagrams
- Service-Oriented Architecture design with Archimate
  - Core concepts of Archimate modelling language
  - Business layer modelling
  - Application layer modelling
  - Technology layer modelling

Practical exercises and homework will help students to apply the learned modelling languages in several case studies. A mini-project is also planned as a collaborative development project of information system dealing with real industrial use cases.

## Course material

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- Pierre-Alain Muller ; Modélisation Objet avec UML ; Editions Eyrolles (2003)
- Pascal Roques ; UML 2 par la pratique ; Editions Eyrolles (2009)
- J. Rumbaugh, et al. The Unified Modeling Language: Reference Manual, Addison-Wesley 2004
- An Introduction to the ArchiMate® 2 Modeling Language <http://www.opengroup.org/archimate>
- Integrating value modeling into ArchiMate. University of Twente
- Archi – Archimate Modelling, User guide 1.3
- Requirements Engineering - Fundamentals, Principles, and Techniques Springer-Verlag (2010)

## Keywords

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Information Systems architecture, Specification, Requirement, UML, Archimate

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

# COLLABORATIVE INFORMATION SYSTEMS IN ENTERPRISE

INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE  
YEAR 2 - AUTUMN SEMESTER

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LEAD PROFESSOR: Farouk Belkadi, [farouk.belkadi@ec-nantes.fr](mailto:farouk.belkadi@ec-nantes.fr)

## Objectives

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

- Understand the role of information systems (EIS) in the enterprise and their main functions
- Design simple data bases with query (Microsoft Access/Excel)
- Manipulate the main functions of ERP systems (Enterprise Resources Planning)
- Manipulate the main functions of PLM systems (Product Lifecycle Management)
- Manipulate the main mechanisms of customization and administration of collaborative EIS

## Course contents

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This course aims to present the main functions of collaborative enterprise information systems (EIS), classified according to the main business processes of the enterprise. An overview of the main commercial ERP/PLM tools is provided to clarify the scope of these tools. After this introduction, the following items will be presented in detail:

- Introduction to enterprise information systems
  - Concepts related to enterprise information systems
  - Types of enterprise information system
- Main functions of ERP
  - Marketing and sales
  - Supply chain management
  - Production Management
  - Introduction to OpenERP and Sage ERP tools
- Main Functions of PLM
  - Product configuration (eBOM)
  - Data-file management (volt, check-in, check-out, version, iteration)
  - Notion of Lifecycles and workflows
  - Notion of Workspace and collaborative functions (notification, viewer, etc.)
  - Data searching, where use function, connection to CAO
  - Introduction to Audros and Windchill PLM tools
- Administration of PLM
  - Management of organization, team, users and roles
  - Creation of customized workflows and lifecycles
  - Customization of data model with Audros Model Shape

A simple use case will be conducted during the tutorials to show how different processes and data will be managed and implemented in different tools.

## Course material

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- Product Lifecycle Management, Mariusz Cholewa, Wrocław University of Technology  
[http://www.studia.pwr.wroc.pl/p/skrypty/14\\_Production%20Management%20%20W-10/03\\_Product%20Lifecycle%20Management.pdf](http://www.studia.pwr.wroc.pl/p/skrypty/14_Production%20Management%20%20W-10/03_Product%20Lifecycle%20Management.pdf)
- Enterprise Resource Planning: Foundations  
[http://www3.unipv.it/ingegneria/copisteria\\_virtuale/motta/doss/13-PV-DoES-03-ERP-v1.pdf](http://www3.unipv.it/ingegneria/copisteria_virtuale/motta/doss/13-PV-DoES-03-ERP-v1.pdf)
- Open ERP user guide
- Windchill user guide
- Audros user guide

## Keywords

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Information Systems, PLM, ERP

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	12 hrs	0 hrs	18 hrs	0 hrs	2 hrs

# INTEGRATED DESIGN ENGINEERING OF PRODUCT-SERVICE SYSTEMS

INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE  
YEAR 2 - AUTUMN SEMESTER

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LEAD PROFESSOR: Alain Bernard, [alain.bernard@ec-nantes.fr](mailto:alain.bernard@ec-nantes.fr)

## Objectives

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At the end of the course, the students will be able to understand the main concepts and methods of integrated design engineering applied to new approaches related to product service systems

## Course contents

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This course proposes six modules related to integrated design engineering methods:

- Methods and tools of engineering design
- Definition of Product-Service system
- Innovation methods for product-service systems design
- Managing complexity in integrated design engineering
- Knowledge management and knowledge-based engineering applied to decision making
- Product-service systems lifecycle management based on an integrated platform

## Keywords

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Integrated design, Product-service system, knowledge management, decision making

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	16 hrs	14 hrs	0 hrs	0 hrs	2 hrs

# MULTICRITERIA DECISION MAKING AND DECISION SUPPORT

INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE  
YEAR 2 - AUTUMN SEMESTER

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LEAD PROFESSOR: Raphaël Chenouard, [raphael.chenouard@ec-nantes.fr](mailto:raphael.chenouard@ec-nantes.fr)

## Objectives

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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

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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, ELECTRE)
- Multi-objective optimization

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

## Course material

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

## Keywords

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Decision Theory, Pareto dominance, AHP

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	8 hrs	8 hrs	8 hrs	6 hrs	2 hrs



# INFORMATION SYSTEMS INTER-OPERABILITY

## INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE

### YEAR 2 - AUTUMN SEMESTER

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**LEAD PROFESSOR:** Florent Laroche, [florent.laroche@ec-nantes.fr](mailto:florent.laroche@ec-nantes.fr)

#### Objectives

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At the end of the course (30 hours including seminars + personal work) the students will understand the key concepts and technologies supporting the communication between information systems throughout the digital chain of the company.

#### Course contents

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- Applications of interoperability in real life
- Semantic interoperability based on models
- Applicative Standards (step, xml, etc.)
- Web service technologies

#### Course material

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- Chen, D., Doumeingts, G., & Vernadat, F. (2008). Architectures for enterprise integration and interoperability: Past, present and future. *Computers in industry*, 59(7), 647-659.
- Patrick Sitek, Sergio Gusmeroli, Marco Conte, Kim Jansson, Iris Karvonen (eds.) *The COIN Book: Enterprise Collaboration and Interoperability*. Auflage 2011, 211 p.
- Panetto H., Molina A. (2008). Enterprise Integration and Interoperability in Manufacturing Systems: trends and issues. In: Special issue on Enterprise Integration and Interoperability in Manufacturing Systems, A. Molina and H. Panetto (Eds). *Computers In Industry*, Vol. 59, N°5.
- Vernadat, F. B. (2010). Technical, semantic and organizational issues of enterprise interoperability and networking. *Annual Reviews in Control*, 34(1), 139-144.

#### Keywords

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Interoperability, standards, STEP, web services

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	8 hrs	8 hrs	8 hrs	6 hrs	2 hrs

# CONFERENCES

## INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE YEAR 2 - AUTUMN SEMESTER

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**LEAD PROFESSOR:** Alain Bernard, [alain.bernard@ec-nantes.fr](mailto:alain.bernard@ec-nantes.fr)

### Objectives

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This course aims to introduce the research context. The students will attend research events: conference sessions, PhD defenses, 'HDR' (Authorisation to supervise research) defenses etc. The students will:

- Understand how research is organised (research structures and funding)
- Learn how to summarise a research presentation

### Course contents

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The exact content of the course will depend on the research events held in Nantes during the course. The topics selected will be in line with those addressed in the other courses of the Master.

### Course material

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- Michaelson, H. B. (1990). How to write & publish Engineering Papers and Reports. Oryx Press, 4041 N. Central at Indian School, Phoenix, AZ 85012.
- Gastel, B., & Day, R. A. (2016). How to write and publish a scientific paper. ABC-CLIO.

### Keywords

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International conference, research methods, research training

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	2	20 hrs	0 hrs	0 hrs	0 hrs	0 hrs

# MODERN LANGUAGES – FRENCH

## INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE

### YEAR 2 – AUTUMN SEMESTER

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**LEAD PROFESSOR:** Silvia Ertl – [silvia.ertl@ec-nantes.fr](mailto:silvia.ertl@ec-nantes.fr)

### Objectives

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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 (2 semesters), 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

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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.

## Course material

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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).

## Keywords

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reception (listening and reading), production (spoken and written), interaction (spoken and written), knowledge, skills, linguistic competence, sociolinguistic competence, pragmatic competence, register, cultural differences, non-verbal communication, business vocabulary

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
French	4	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

# MODERN LANGUAGES – CULTURAL AND COMMUNICATIONAL ENGLISH

## INDUSTRIAL ENGINEERING – SMART AND CONNECTED ENTERPRISE

### YEAR 2 - AUTUMN SEMESTER

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LEAD PROFESSOR: Spencer Hawkrigde- [spencer.hawkrigde@ec-nantes.fr](mailto:spencer.hawkrigde@ec-nantes.fr)

#### Objectives

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Team-building and Communicational English:

- Understand the general concepts of team-building
- Build a team-building project
- Understand and nurture the creative process
- Enhance self-belief and self-empowerment

Behavioral skills in an inter-cultural environment:

- Strengthen self-confidence and capacity for interaction
- Develop active listening and reformulation skills
- Develop networking skills

#### Course contents

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Cultural and Communicational English: exercises to explore in practice the areas of culture and communication

Field-related or inter-cultural project (for example, construct content for inter-cultural team-building activities; example WIOBOX website etc).

#### Course material

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Written and televised press, information and digital tools, general documents business environment and company strategies.

Internet conferences (Ted Talks, etc.), our own educational materials on Hippocampus (Moodle).

#### Keywords

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Culture and communication, inter-cultural environment, team-building, digital tools, etc.

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	14 hrs	16 hrs	0 hrs	0 hrs	2 hrs