Major	Industrial Engineering		
Master's programme	CYBER-PHYSICAL SYSTEMS ENGINEERING		
Master's Code	CPSE		
Qualification awarded	**Master's degree in Industrial Engineering**		
Programme director	**Prof. Jean-Philippe PERNOT (jean-philippe.pernot@ensam.eu)**		
Mode of study	*Level of qualification*	*Field of study*	*Language of study*
Full time	**Master ISCED 7**	**Engineering ISCED-F-07**	**English**
ECTS	*Campus*	*Length of programme*	*Specific arrangements for recognition of prior learning*
60	**Aix-en-Provence**	**1 year (from September to September)**	**Yes (VAE or VAP)**
Keywords	**Cyber-Physical Systems, Industry 4.0, Factory of the Future, Digital Twins, Digital Thread, Digital Mock-Up, Reverse Engineering, Rapid Prototyping, Artificial Intelligence, Data analytics, Smart Product, Smart Manufacturing, Decision Making, CPS supervision and control, Fault-Detection, Robotics**		

Admission requirements

Type	Level	Way
French proficiency	**Level B2**	**Certificate**
English proficiency	**Level B2**	**Certificate**
Previous degree	**First-year of Master's (M1) minimum, or equivalent, in Engineering**	**Certificate of achievement**

Applicants interested in the CPSE programme must follow the online procedure and adhere to the schedule.

https://artsetmetiers.fr/en/formation/master-admissions

Overall objectives

The CPSE programme aims at training future engineers and researchers to evolve in complex multi-disciplinary industrial environments embedding Cyber-Physical Systems as well as other mainstream Industry 4.0 concepts, technologies and processes:

- To explore the concepts, methods, models and tools used to design, simulate, manufacture and control Cyber-Physical Systems (CPS) in the scope of Industry 4.0;
- To train future engineers and researchers to evolve in complex multi-disciplinary industrial environments embedding CPS as well as other mainstream Industry 4.0 technologies and processes.

Programme learning goals

The table below details the abilities to be acquired and the expected proficiency levels according to the following grading scale:

1) To have experienced or been exposed to the current and future challenges for Cyber-Physical Systems (CPS) engineering and Industry 4.0 applications.
2) To be able to participate in and contribute to develop a transversal approach coupling design, simulation, manufacturing and control of CPS in the scope of the Industry 4.0.
3) To be able to understand, explain and manipulate the concepts, methods, models and tools for CPS engineering.
4) To be skilled in the practice or implementation of methods, models and tools i) to optimize the design of CPS, ii) to simulate their behaviour, iii) to manufacture them.
5) To be able to lead or innovate in the scope of the Industry 4.0 paradigm and within a multi-disciplinary industrial environment.

Sets of expected abilities	***Expected abilities***	***Expected proficiency level***
		R&D
Disciplinary knowledge and reasoning	**1.1 Knowledge of underlying mathematics and science**	**4**
	1.2 Core fundamental knowledge of engineering	**4**
	1.3 Advanced engineering fundamental knowledge, methods and tools	**4**
Personal and professional skills attributes	**2.1 Analytical reasoning and problem solving**	**4**
	2.2 Experimentation, investigation and knowledge discovery	**4**
	2.3 System thinking	**3**
	2.4 Ethics, though and learning	**4**
	2.5 Ethics, equity and other responsibilities	**4**
Interpersonal skills: Teamwork and communication	**3.1 Teamwork**	**4**
	3.2 Communications	**4**
	3.3 Communications in foreign language	**3**
Conceiving, Designing, implementing, operating, innovating and entrepreneurship in the context of Corporate Social Responsibility	**4.1 External, societal and environmental context**	**3**
	4.2 Enterprise and business context	**3**
	4.3 Conceiving, systems engineering and management	**3**
	4.4 Designing	**4**
	4.5 Implementing	**3**
	4.6 Operating	**3**
	4.7 Leading engineering endeavours	**4**
	4.8 Engineering entrepreneurship	**3**

More specifically, the **key strengths** of the CPSE programme are as follows:

- Deep theoretical knowledge on the mainstream concepts, methods, models and tools involved in CPS engineering and Industry 4.0 technologies and processes;
- Extended practical skills for the definition of multi-disciplinary technical solutions for CPS engineering;
- Deep understanding of the overall value chain, the strategic and supply chain management and the associated concepts with a particular focus on Industry 4.0 issues;
- Structured research methodology to be used as a template to address a wide range of Industry 4.0 related research challenges;
- Transversal adaptation, integration, analysis, critical thinking, self-learning, communication, valorisation and organizational skills gained when confronting to both academic and industrial multi-disciplinary projects;
- International exposure through the courses taught in English and exchanges with other foreign students.

Programme structure

Learning outcomes are reached through a well-balanced training program that combines theoretical and practical learning sequences, during which students are placed in both academic and real-life industrial configurations, in order to develop multiple transversal skills.

The CPSE programme is a one-year Master programme that spreads on two semesters

- **First semester (S3): From September to January**
  This semester is composed of 4 professionalizing modules of 12h each, 6 scientific modules of 24h each, 1 language module of 24h, 1 long research project of 128h, for a total of 30 ECTS.
- **Second semester (S4): From February to September**
  The second semester is dedicated to the Master thesis of 6 months and 30 ECTS. The internship will be made in a research structure (laboratory or company) in France or abroad.

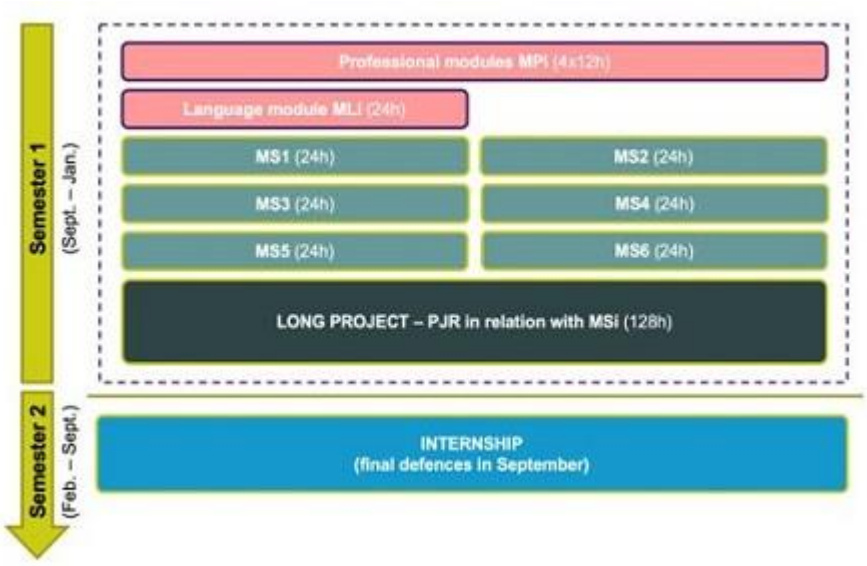

Figure 1 : Structure of the CPSE programme.

Code	Title	Sem.	Year	ECTS	Hours	Compulsory/ Optional	Teaching modalities
MP1	Research methodology	S3	M2	2	12	Compulsory	Course/Exercises/Project
MP2	Artificial intelligence and data analytics	S3	M2	2	12	Compulsory	Course/Exercises/Project

Code	Title	Sem.	Year	ECTS	Hours	Compulsory/ Optional	Teaching modalities
MP3	Industry 4.0 : concept, survey and future trends	S3	M2	2	12	Compulsory	Course/Exercises/Project
MP4	Digital factory and supply chain	S3	M2	2	12	Compulsory	Course/Exercises/Project
MS1	Digital mock-up for CPS modelling and advanced engineering	S3	M2	3	24	Compulsory	Course/Exercises/Project
MS2	Reverse Engineering and rapid prototyping for CPS	S3	M2	3	24	Compulsory	Course/Exercises/Project
MS3	Digital chain for CPS engineering in a heterogeneous context	S3	M2	3	24	Compulsory	Course/Exercises/Project
MS4	Supervision of CPS during the engineering and exploitation phases	S3	M2	3	24	Compulsory	Course/Exercises/Project
MS5	Advanced robotics	S3	M2	3	24	Compulsory	Course/Exercises/Project
MS6	Mechatronics, advanced control, identification and fault-detection for CPS	S3	M2	3	24	Compulsory	Course/Exercises/Project
ML1	Advanced technical English	S3	M2	2	24	Compulsory	Course/Exercises/Project
PRJ	Research project	S3	M2	2	128	Compulsory	Long project
MTI	Master thesis	S4	M2	30	NA	Compulsory	Internship

Table 1 : Detail of the modules of the CPSE programme over the two semesters.

Study and assessment rules

Each module can be evaluated by means of practical works, projects, reports, oral presentations, exams and the assessment rules are explained at the beginning of the programme. Each module is evaluated between 0 and 20.

For professional and language modules (MPi and MLi):

- The final mark of each professional/language module must be ≥ 10, and there is no compensation between the modules

For scientific modules (MSi):

- The final mark of each scientific module must be ≥ 10, and there is no compensation between the modules

For long research project (PJR):

- The final mark of the PJR must be ≥ 10

For master thesis (MTI)

- The final mark of the master thesis must be ≥ 10

Retake exams are organized at the beginning of the second semester.

Graduation requirements

To be graduated, students need to comply with the following rules:

Master 2

- Validate 30 ECTS during the first semester;
- Validate 30 ECTS during the second semester.

At the end of the CPSE programme, the final average is calculated based on the ECTS distribution, and honours are awarded (very good, good, fair, satisfactory).

Careers of graduates and access to further studies

Depending on their results and professional expectations, graduate students can continue their professional careers as a:

- PhD student in a field related to Industry 4.0 and CPS, in academia or in industry (CIFRE), to become a recognized expert in an area of the Industry 4.0
- R&D engineer/researcher in large companies or start-ups, in numerous sectors (manufacturing, construction, services, consultancy, etc.) and fields (automotive, aerospace, health, IoT, etc.) in an area of the Industry 4.0