Major	Mechanical Engineering		
Master's programme	ADVANCED SYSTEMS AND ROBOTICS		
Master's Code	SAR		
Qualification awarded	Master in mechanical engineering		
Programme director	Prof Nazih MECHBAL Nazih.mechbal@ensam.eu Lab. PIMM – UMR CNRS, Le Cnam		
Mode of study	Level of qualification	Field of study	Language of study
Full time	Master ISCED 7	Engineering ISCED-F-07	French/English
ECTS	Campus	Length of programme	Specific arrangements for recognition of prior learning
60	Paris	1 year (from September to September)	Yes (VAE or VAP)
Keywords	Robotics, Control, Modelling, Intelligent Systems		

Admission requirements

Type	Level	Way
French proficiency	Level B2	Certificate
French proficiency	Level B2	Certificate
Previous degree	First-year of Master's (M1) minimum, or equivalent, in Engineering	Approved by the admission jury

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

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

Overall objectives

The SAR program aims to train specialists in the design of complex robotic systems and/or intelligent systems with the ability to perceive, learn, decide and act in interaction with the environment.

- The Advanced Systems and Robotics (SAR) track focuses more particularly on the aspects of modeling, simulation, and control of these systems, while integrating the multidisciplinary aspect specific to robotic systems such as the perception of the environment, autonomous systems control, artificial intelligence, and interaction with the environment.
- The objective is to prepare students for the functions of international Research & Development engineers in robotic, mechanical or mechatronic systems, interactive systems, embedded systems and intelligent systems.
- The programme focuses on two main areas: robotics and intelligent systems. It provides basic multidisciplinary knowledge in engineering sciences specific to these two fields, as well as the fundamentals for the analysis and modeling of any complex mechanical system with autonomous capabilities, or for the understanding of human interaction and learning.

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 the technologies related to advanced and intelligent autonomous systems.
2) To be able to participate in and contribute to design and develop complex robotic and mechatronic systems.
3) To be able to understand, explain and manipulate the concepts, methods, models and tools for Robotic and mechatronic systems.
4) To be skilled in the practice or implementation of methods, models and tools i) to optimize the design of industrial robots and intelligent mechatronic systems ii) to simulate their behaviour, iii) to control and feed them with autonomous capabilities them.
5) To be able to lead or innovate in the new technologies based on mechatronic, interactive, embedded and intelligent systems.

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 SAR programme are as follows:

Programme structure

- **First semester (S1): From September to January**
  This semester is composed of 4 core courses (21 ECTS) and 4 elective scientific courses (9ECTS) to choose between 4 subtrack, for a total of 30 ECTS.

- **Second semester (S2): 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.

M2 ROBOTICS								
Common Core (mandatory courses) 21 ECTS				Elective courses : select one of the 4 sub-tracks(9 ECTS credits)				
S3 (30 ECTS)	Research conferences (3 ECTS)	Engineering Project (6 ECTS)	Estimation theory & parametric identification (6 ECTS)	Dynamics and control of robotic manipulators (6 ECTS) — Multi-body systems / Robotic manipulator control	Advanced system control	Non-linear control (3 ECTS)	Robust control (3 ECTS)	AI for control (3 ECTS)
					Mobile robotics	Perception for Robotics (3 ECTS)	Planning & decision-making for robotics (3 ECTS)	Modelling & control of mobile robots (3 ECTS)
	AI (refresher course) (3 ECTS)				Social robotics	Learning for human-robot interaction (3 ECTS)	Statistics for Evidence-Based Engineering (3 ECTS)	Multi-modal analysis of human behavior (3 ECTS)
					Collaborative robotics	Control of robots in physical interaction with humans (3 ECTS)	Haptics and teleoperation (3 ECTS) / Muscular systems modeling (3 ECTS)	Wearable robotics (3 ECTS)
S4 (30 ECTS)	English (3 ECTS)	Internships (27 ECTS)						

Figure 1 : Structure of the SAR programme.

Title	Sem.	Year	ECTS	Hours	Compulsory/ Optional	Teaching modalities
AI (refresher course)	S3	M2	3	30	Compulsory	Course/exercise/project
Engineering Project	S3	M2	6	30	Compulsory	Project
Dynamics and control of robotic manipulators	S3	M2	6	30	Compulsory	Course/exercise/project
Estimation and Identification for Robotics	S3	M2	6	30	Compulsory	Course/exercise/project
Non-linear control	S3	M2	6	60	Optional 1	Course/exercise/project

Title	Sem.	Year	ECTS	Hours	Compulsory/ Optional	Teaching modalities
Robust Control	S3	M2	3	30	Optional 1	Course/exercise/project
AI for control	S3	M2	3	30	Optional 1	Course/exercise/project
Planning & decision-making for robotics	S3	M2	3	30	Optional 2	Course/exercise/project
Modelling & control of mobile robots	S3	M2	3	30	Optional 2	Course/exercise/project
Perception for Robotics	S3	M2	3	30	Optional 2	Course/exercise/project
Learning for human-robot interaction	S3	M2	3	30	Optional 3	Course/exercise/project
Statistics for Evidence-Based Engineering	S3	M2	3	30	Optional 3	Course/exercise/project
Multi-modal analysis of human behavior	S3	M2	3	30	Optional 3	Course/exercise/project
Control of robots in physical interaction with humans	S3	M2	3	30	Optional 4	Course/exercise/project
Haptic interfaces	S3	M2	3	30	Optional 4	Course/exercise/project
Wearable robotics	S3	M2	3	30	Optional 4	Course/exercise/project
Muscular systems modelling	S3	M2	3	30	Optional 4	Course/exercise/project
Scientific communication English	S4	M2	3	30	Compulsory	Course/exercise/project
Master Student Thesis	S4	M2	27	6 months	Core	Internship

Table 1 : Detail of the modules of the SAR 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.

The control of knowledge and the evaluation of acquired skills are done 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. Notes acquired in continuous review are not subject to a second session. A catch-up session is organized 15 days after the initial session jury.
- Each teaching unit (TU) is marked from 0 to 20.
- A TU is validated if the final mark is ≥ 10. The control procedures are specified by each TU manager.

- Training, projects, courses, are evaluated both on the basis of continuous monitoring and on the basis of restitution (report and / or defense).
- The first semester is validated if the average of all the compulsory and the optional TUs is ≥ 10, thus there can be compensation between the modules.
- For master thesis (6 months internship), the final mark of 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

- Semester 1: Validation of TU for 30 ECTS
- Semester 2: Validation of master thesis (individual project) for 30 ECTS

Careers of graduates and access to further studies

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

- The SAR Master will allow students to continue in all programs requiring this level of study promoting the pursuit in a PhD thesis in science.