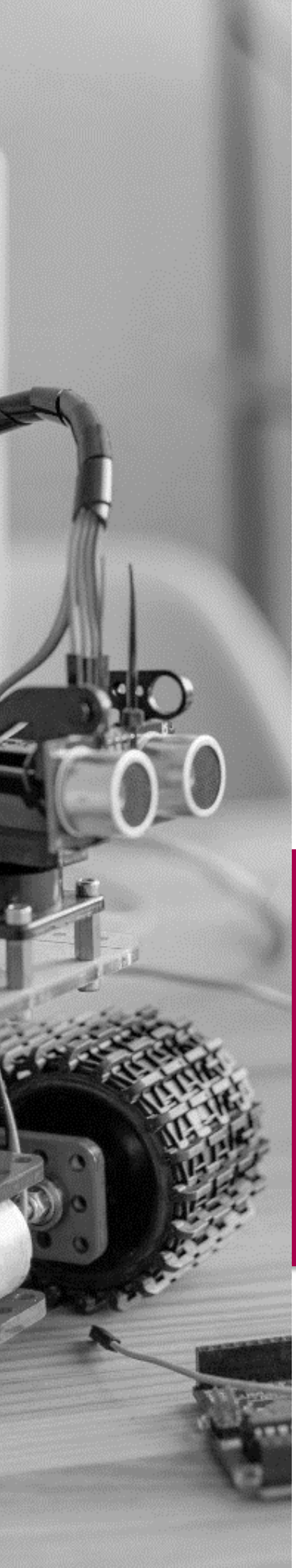

ENSEA

Beyond Engineering

Mechatronics

Graduate/Master Program

ENSEA – Semester 9 MSC - French-Taught

Edition 2023

Mechatronics
ENSEA - MSC 3rd Year Academic Track

Level	**Second year of Master's Degree/Graduate/Semester 9**		
Period	Fall semester (September to January)		
Language of tuition	French		
ECTS	30		
Courses	Code	Course	ECTS
	MSC_1	**Mechatronic systems control [Composed of:]**	**6**
	MSC_3805	Acquisition and control systems	
	MSC_3812	Digital control of actuators	
	MSC_2	**Embedded systems for mechatronics [Composed of:]**	**6**
	MSC_3809	Electromagnetic compatibility	
	MSC_3807	Bus and Network	
	MSC_3810	Sensors and measurement chain	
	MSC_3806	Real-time kernel	
	MSC_3	**Design and dimensioning of mechanical systems [Composed of]**	**4**
	MSC_3802	Design and dimensioning of mechanical systems	
	MSC_4	**Robotics [Composed of:]**	**4**
	MSC_3851	Robotics	
	MSC_5	**Project [Composed of:]**	**5**
	MSC_3837	Mini Project	
	MSC_3850	Conferences	
	SH-3EME	**Humanities [Composed of:]**	**5**
	DSH_3000	Responsible and sustainable management of human resources in a complex environment	
	DSH_3060	English	
	DSH_3061	FLE (French for foreigners) or Spanish or German	

Mechatronics
ENSEA - MSC 3rd Year Academic Track

MSC_1 Mechatronic systems control (6 ECTS)

MSC_3805 Acquisition and control systems (Lectures: 10h / Tutorial classes: 10h / Lab: 28h)

This course provides knowledge in microcontroller-based system design associated with an electric actuator for digital control.
- Microcontroller-based systems. Choice, design, development, C language
- Study of a STM32 microcontroller and its peripherals (UART, DMA, Timer, PWM, Encoder interface, ADC).
- Different types of electrical machines.
- Modelling of electric actuators.
- Study of a direct digital control system of electric actuators with STM32 microcontroller

MSC_3812 Digital control of actuators (Lectures: 12h / Tutorial classes: 8h / Lab: 12h)
This course aims at studying the modelling and digital control of dynamic systems, in order to provide the theoretical and practical basis for the development and implementation of algorithms for control and observation in a sampled context.
- Dynamic modeling, linearization of a representation of non-linear state.
- Sampling and z-transformation for digital control. Specifications.
- Synthesis of digital correctors (PID, RST, Smith's Predictor, ...) and structuring of the patterns of control.
- Control by state feedback and observer (Luenberger) : continuous and sampled linear state representation, controllability, observability, pole placement.
The Labs are focused on the identification of models (SBPA, least-squares), dynamic systems modelling, automatic code generation (fast prototyping with a DSP target) applied to motor control.

MSC_2 Embedded systems for mechatronics (6 ECTS)

MSC_3809 Electromagnetic compatibility (Lectures: 8h / Tutorial classes: -h / Lab: -h)
The aim is to make students aware of the practical aspects involved in complying with EMC standards on the design of power electronics devices and of their control. This module therefore aims to complement the EMC basics, with a focus on applications specific to Mechatronics.

MSC_3807 Bus and Network (Lectures: 6h / Tutorial classes: -h / Lab: 4h)
The aim of this course is to study the connections allowing systems to communicate. This is not an exhaustive description of the different links, but a presentation of the basic concepts through some examples, such as the CAN network for a fieldbus.
- Token ring, Profibus, Modbus.
- Fieldbus, I2C bus, CAN, LIN networks, MOST, FlexRay, application examples.

MSC_3810 Sensors and measurement chain (Lectures: 12h / Tutorial classes: 12h / Lab: 16h)
The objective of this course is the design of a chain of measurement, from the sensor to the analog to digital converter.
- Measurement chains. The different elements of a measurement chain, characteristics, accuracy of a chain measurement.
- Study of some sensors. Temperature sensors, deformation, force, pressure, speed, acceleration.
- The instrumentation and isolation amplifier. Objectives and realization, common mode rejection, circuits, technological choices.
- Analog to digital conversion. The different types of converters, characteristics, choice of CAN.

MSC_3806 Real-time kernel (Lectures: 12h / Tutorial classes: 4h / Lab: 20h)
This course introduces the principles and implementation of the real-time kernels. Multitasking concepts (objects tasks, semaphores, mailboxes) and input - output mechanisms (interruptions, drivers) are presented within the framework of a real-time operating system (FreeRTOS), and illustrated with examples and sessions of practical work.
- Multitasking systems. Notion of task, allocation of tasks, communication between tasks, synchronization, multitasking cores, interrupts, input-output.
- Implementation on microprocessor platform or DSP.

MSC_3 Design and dimensioning of mechanical systems (4 ECTS)

MSC_3802 Design and dimensioning of mechanical systems (Lectures: 4h / Tutorial classes: 4h / Lab: 48h)

The objective of this module is to explore the different aspects of mechanical design based on a concrete study (for example, the accessory relay for an aircraft engine). This example serves as a guideline and support, throughout the project. Students must therefore create and deliver results at regular intervals:

- Technical documentation justifying the topological choices and technologies selected, SolidWorks model ...
- Functional analysis (Engineering Methodology System, based on the SysML language)
- Kinematic analysis and mechanism theory
- Static study
- Strength of materials
- Sizing of the pivot connections (bearings), the drive shafts (bending-twisting) and key
- Standardized geometry and dimensioning of gears
- Modeling of the system using CAD software (SolidWorks)

MSC_4 Robotics (4 ECTS)

MSC_3851 Robotics (Lectures: 12h / Tutorial classes: 16h / Lab: 20h)
The objectives of this course are to model robotic systems in order to control them. The aim is to provide the theoretical and practical bases necessary for the design and use of industrial robots

- Classification of architectures (serial, parallel)
- Configuration of robots with the objective of their modeling, homogeneous coordinates
- Geometric, kinematic and dynamic models, direct and reverse
- Use of the Modelica language for modeling and simulating real robots with Simscape or OpenModelica.

MSC_ 5 Project (5 ECTS)

MSC_3837 Mini Project (Lectures: -h / Tutorial classes: -h / Lab: 44h)
The objective of this project is to design a system or a part of a mechatronic system, with the application of the theoretical or practical knowledge acquired during the year: quadcopter, drone, robot...

MSC_3850 Conferences (Lectures: 10h / Tutorial classes: h / Lab: h)
The lectures are delivered by engineers or researchers working in the different specialties of the option: mechatronics, system engineering... Topics may vary from one year to the next.
The following are only a sample of possible subjects: avionics, robotics, systems engineering applied to the automotive or space industry...

SH_3EME Humanities (5 ECTS)

DSH_3000 Responsible and sustainable management of human resources in a complex environment

(Lectures: 16h / Tutorial classes: 6h / Lab: -h)

The course presents the evolution of organizations in a complex environment (team management, corporate culture in a multicultural context, professional project through the dynamics and management of evolutions). It emphasizes the strategic role of human resources management in a CSR context (Quality of Life at Work - OHS) in order to prepare engineering students (guided by the 26000 standard) for their role as project managers, project leaders or employees of a project team.

It introduces the notions of labor law that are essential for engineers (employment contracts, expatriation, work environment in the company) by integrating the social and societal concerns of the company.

The practical courses allow, through an edutainment approach (or in the form of a serious game):

- to implement an HRM that values responsibility and ethics (Remuneration, Training, Skills management, Health and Safety at work).
- Identify good practices to implement a CSR policy.

DSH_3060 English (Lectures: -h / Tutorial classes: 24h / Lab: -h)

The objective of the third-year courses is to make the students able to work in English and have a good command of the language.

The goal is achieving a professional use and to reach, at least, a B2 level requested do obtain the degree.

Two third-year options are grouped together for English courses. Level groups can be formed. The students will be able to work on different aspects of life professional (communication in different settings, in the office, abroad, in seminars, through writing, orally, case studies...), by carrying out work groups and putting in practice the knowledge they have acquired throughout their training.

DSH_3061 FLE (French for foreigners) (Lectures: -h / Tutorial classes: 24h / Lab: -h)

The main goal of this class is training the foreign students through communication fundamentals for everyday life, proposing them an introduction to French culture and civilization and more advanced knowledge in order to work in a French company during the final internship period.