Mechatronics
ENSEA - MSC 3rd Year Academic Track

MSC_1 Mechatronic systems control (6 ECTS)

MSC_3805 Acquisition and control systems (Lectures: 18h / Tutorial classes: 18h / Lab: 20h)

This course provides knowledge in microcontroller-based system design associated with an electric actuator for digital control.
- Microcontroller-based systems. Choice, design, development, languages (C, assembler).
- Study of a DSP microcontrollers.
- Different types of electrical machines.
- Modelling of electric actuators.
- Study of a direct digital control system of electric actuators by DSP.

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 analogue 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.
- Analogue to digital conversion. The different types of converters, characteristics, choice of CAN.
- Discovery and use of the Labview software.

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 (VxWorks), 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
- Sizing of the pivot connections (bearings) and the drive shafts (bending-twisting)
- Standardized geometry and dimensioning of gears
- Modeling of the system using CAD software (SolidWorks)

MSC_4 Modeling and simulation of mechatronic systems (4 ECTS)

MSC_3820 Modeling and simulation of mechatronic systems (Lectures: 12h / Tutorial classes: 16h / Lab: 20h)
The objectives of this course are to understand and know how to use theoretical tools and software dedicated to modelling the logical and physical design of a system (RFL design: Requirements, Functional, Logical, Physical). The objective of this modeling is the simulation in order to dimension a complex system.

- Expression of need and functional modelling
- Logical modelling: overview of available languages (Modelica)
- Physical modelling (SolidWorks)
- Simulation of simple mechanism (Segway)

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 Human Resources Management and International Management (Lectures: 16h / Tutorial classes: 6h / Lab: -h)
This transversal training offers:
- an awareness of labor law specifically for the engineer: employment contract, expatriation, working environment in the company
- managerial aspects dealt within a multicultural context such as team management, corporate culture, professional projects…
- accounting aspects: employee cost versus human capital.

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.