# Master's Department of Engineering Sciences

**Name of the unit:** Sensors, actuators and transmission

**Lecturer:** Fabien Vérité (fabien.verite@sorbonne-universite.fr)
**Course code:** UM4RBM12
**Student workload:** 18h of lectures, h of tutorial sessions, 40h of lab sessions@
**Credits:** 6 ECTS

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|---|---|---|---|---|
| **Specialization tracks:** | - **E3A** : | ☐ CIMES | ☐ Syscom | ☐ IPS |
| | - **AR** : | ☐ ROBOT | ☐ SI | ☒ MeDH |
| | - **MECA** : | ☐ MS2 | ☐ MF2A | ☐ CompMech |
| | | ☐ ACOU | ☐ EE | ☐ EE APP |

**Semester offered:** ☒ S1 ☐ S2 ☐ S3 ☐ S4
**Language of instruction:** ☒ French ☐ English
**Targeted audience:** ☒ Engineering Sciences students ☐ Other (specify):
**Localization :** ☒ PMC Campus ☐ Other (specify):

## Course Overview

This course offers an in-depth study of classic mechatronic device solutions. Starting with traditional measurement solutions (displacement, deformation, forces, etc.) and human measurement techniques (wearable sensors, motion capture). It also covers actuator systems, especially electric actuators, and their practical applications.
*Keywords:*

## Prerequisites

Students should have previously acquired the following prerequisites to follow this course:

- Knowledge of electronics (CAN, Law of Meshes/Law of Knots, Voltage Divider Bridge)
- Basics of general mechanics

## Intended Learning Outcomes

By the end of this course, students will be able to:

1. Understanding Classic Measurement Solutions: - Gain in-depth knowledge of measurement techniques for displacement, forces, and deformation.
2. Applying Human Measurement Techniques: - Learn about human measurement methods, including wearable sensors, and their applications.
3. Using Motion Capture Systems: - Explore markered and non-marker motion capture systems and their integration with Mediapipe.
4. Implementing Electric Actuator Systems: - Understand in detail electric actuators and their use in servo motor and motor control circuits (MCCs) with and without controllers. - Application-specific sizing and actuator selection
5. Set up and implement low-level feedback loops using electrical actuators of sensors to perform a basic sensorimotor task.
6. Explore Guidance and Transmission Systems: - Study guidance systems, transmission mechanisms and the concept of reversibility, with practical illustrations of friction and other relevant concepts.

## Indicative Teaching Sequence and Methods

| Week | C/TD/TP* | Content | Preparation | Learn. outc. |
|---|---|---|---|---|
| S1/S2/S3 | C1 | Introduction to Classical Measurement Solutions (3x1 hours) - Presentation of displacement, force, and strain measurement techniques - Importance and applications in different fields | | |
| | TP1-TP2-TP3 | Displacement, Forces, and Deformation Measurements (3x3 hours) - Practical application of conventional displacement measurement techniques - Electronic circuits (wheastone bridge, voltage divider bridge, pull-up/down) - Experiments and data analysis | | |
| S4-S5 | C2-C3 | Human Measurement Techniques (2x1 hours) - Wearable sensors to detect intent and movement (IMU, bending sensors, etc.) - Applications and real-world examples | | |
| S4-S5 | TP4-TP5 | Use of Portable Sensors for Motion Detection/Measurement (2x3h): - Installation and use of wearable sensors (flexiforce, bending, IMU) | | |
| S6 | C4-C5 | Course: Motion Capture Systems (2x1h) - Motion Capture Basics - Comparison between systems with and without markers - Integration with Mediapipe | | |
| S7 | TP6 | Lab 4: Motion Capture with Markers (3h) - Configuration and use of a motion capture system with markers (optitrack) - Motion data collection and analysis | | |
| S8 | TP7 | Lab 5: Motion Capture without Markers (3h) - Use of Mediapipe for markerless motion capture - Comparative analysis of the data obtained | | |
| S9 | C6-C7 | Course 4: Electric Actuator Systems (3 hours) - Details of electric actuators and how they work - Servo motor - Stepper - MCC/Brushless - PWM - ServoRC - Chopper/H-Bridge - Stepper Control - System proprioceptive sensor: Encoder / potentiometer - Stepper motor | | |
| S10 | TP8 | Lab 6: Control of Servo Motors and MCC without Controller - Controllerless servo motor and MCC configuration - Performance and Limitations Analysis | | |
| | TP9 | Lab 7: Servo Motor Control and MCC with Controller - Use of controllers (Elmo type) with servo motors and MCC - Experiments on accuracy and responsiveness | | |
| S11 | TP10 | TP 8 : Stepper Motor Control | | |
| S12 | C8 | Course 5: Sensorimotor Feedback Loops (3 hours) - Concept of sensorimotor feedback loops - Implementation and practical applications | | |
| S13-S14 | MinProjet | Implementation of Sensorimotor Feedback Loops. Use a sensor to detect intent and control an actuator. | | |

* C/TD/TP respectively corresponds to lectures, tutorials and lab sessions.

## Indicative Assessment of Intended Learning Outcomes (1st session)

| Week | Individ./group | In-person/remote | Type of exam | Evaluated outcomes | Scale % |
|---|---|---|---|---|---|
| S9 | Individual | In-person | Practical | AAV1 AAV2 AAV3 | 25 % |
| S12 | Individual | In-person | Practical | AAV4 | 25 % |
| S14 | Collective | In-person | Other | AAV5 | 50 % |

## 2nde session of exam

| Session | Individ./group | In-person/remote | Type of exam | Evaluated outcomes | Scale % |
|---|---|---|---|---|---|
| 2 | Individual | In-person | Other | All | 100 % |

**Date of generation of this unit description:** January 14, 2026