

Course Unit	Mechatronics		Field of study	Automation	
Master in	Electrical and Computers Engineering		School	School of Technology and Management	
Academic Year	2023/2024	Year of study	1	Level	2-1
Type	Semestral	Semester	1	ECTS credits	6.0
Code	5070-792-1102-00-23				
Workload (hours)	162	Contact hours	T -	TP 30	PL 30
			TC -	S -	E -
			OT -	O -	

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) João Paulo Coelho, Ines Cristina Vinhas de Seixas

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Draw mechanical objects in CAD software for subsequent 3D printing;
2. Know and be able to use various types of electromechanical actuators in mechatronics applications: DC motors, brushless DC motor, stepper motors and servomotors;
3. Implement electronic devices for motion control of various electromechanical actuators: PWM modulation and H bridge circuits;
4. Know the different types of classical sensors and be able to implement electronic signal conditioning circuits.
5. Use numerical calculation software for modeling and simulation of dynamic systems.
6. Analyze and design PID controllers for mechatronics applications.
7. Programming microcontrollers for control systems.

### Prerequisites

Before the course unit the learner is expected to be able to:

1. Linear algebra and solving differential equations
2. DC and AC circuit analysis;
3. Analysis of systems in the time and frequency domain
4. Interpret and implement circuits composed of analog or mixed electronic devices;
5. Microcontroller programming.

### Course contents

3D modelling using CAD tools; Signal conditioning for active and passive sensors; Electromechanical, pneumatic and hydraulic actuators; Mathematical modelling of mechatronic systems; System identification; Analysis and simulation of closed-loop control systems; Implementation of digital controllers in embedded systems.

### Course contents (extended version)

1. Modelling for prototyping using 3D printing
2. Fundamental concepts of electronic circuits
  - Linear elements. resistors, capacitors and inductors
  - Semiconductor elements: diodes, transistors, triacs, operational amplifiers
  - Fundamental laws and methods for analyzing DC and AC circuits.
3. Sensors and Actuators
  - Sensors and signal conditioning
  - Electromechanical actuators and power interfaces
  - Pneumatic and hydraulic actuators
4. Modeling of LIT mechatronic systems
  - Methods using first principles
  - Systems identification
5. Dynamic systems control
  - Design of control systems in the continuous time domain
  - Sampling and Reconstruction
  - Starred transform and s to Z mapping
  - Design of control systems in the digital domain

### Recommended reading

1. Robert H. Bishop. THE MECHATRONICS HANDBOOK, CRC Press, 2002
2. João P. Coelho. CONTROLO DIGITAL, IPB, 2005
3. João P. Coelho. SENSORES E ATUADORES, IPB, 2003
4. J. Johnson e P- Picton. MECHATRONICS, Butterworth - Heinrmmann, 1995
5. Newton C. Braga. MECHATRONICS FOR THE EVIL GENIUS, McGraw-Hill, 2006

### Teaching and learning methods

Lectures: presentation of the course contents supported on real applications examples, problem-solving and use of simulation software. Laboratory: tutorial demonstrations of available technology to support mechatronics systems development. Development of small servomechanism applications. Non-presential hours: implementation of the practical work and final report writing.

### Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
  - Projects - 50% (80% related to work to be carried out outside face-to-face hours and 20% to practical class scripts)
  - Final Written Exam - 50%
2. Alternative 2 - (Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 100%

### Language of instruction

Portuguese

## Electronic validation

João Paulo Coelho	José Luís Sousa de Magalhaes Lima	Paulo Jorge Pinto Leitão	José Carlos Rufino Amaro
08-10-2023	09-10-2023	26-10-2023	31-10-2023