INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Mechatronics			Field of study	Automation		
Master in	Industrial Engineering - Electrical Engineering			School	School of Technology and Management		
Academic Year	2020/2021	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9572-355-1203-00-20		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

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

Name(s) of lecturer(s): José Luís Sousa de Magalhaes Lima, 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. Perform Laplace and Z transformations for linear and time-invariant systems;
2. Interpret the logic diagram of a digital system and implement logic circuits;
3. Interpret and implement circuits composed of analog or mixed electronic devices;
4. Perform computer programs in C / Matlab.

Course contents

Actuators used in applications in mechatronics: brushless and brushless direct current motors, stepper motors, servo motors; Control circuits for DC motors: PWM modulation and H-bridges; Signal conditioning for active and passive sensors; Analysis and simulation of control systems in closed-loop; Implementation of digital controllers in embedded systems.

Course contents (extended version)

1. Notions of electrotechnics and electronics
2. The DC electric motor:
   - Structure and operating characteristics;
   - Mathematical model and speed control: pulse width modulation (PWM);
   - Control of DC motors with solid state electronic devices - H bridge;
   - Brushless DC motors;
   - Closed-loop position control and servomotors;
   - Open-loop control of DC motors using the ARDUINO development board.
3. Stepper motors:
   - Characteristics and operating principles;
   - Stepper motor drivers;
   - Operating modes: full step, half-step and micro-step;
   - Open-loop servomechanism;
   - Stepper motor control using the ARDUINO development board.
4. Sensors and Transducers
   - Passive sensors: potenciometers, thermistors, strain gauge, LDR and RTD.
   - Reactive sensors: inductive and capacitive proximity switches.
   - Active sensors: thermocouple, Hall effect sensors, photovoltaic and tachometers;
   - Smart-sensors and micro-machined devices (MEMS);
   - Interfacing sensors to the ARDUINO development board.
5. Dynamic behaviour analysis of linear time-invariant systems:
   - System representation by differential equations;
   - Description of systems in the frequency domain: transfer functions;
   - System identification using input/output measured data;
   - Servomechanisms and PID control.
6. Synthesis of PID controllers in embedded systems:
   - Difference equations;
   - Implementation of PID controllers in the ARDUINO platform.

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 - Heinrmann, 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)

Assessment methods

- Projects - 50%
- Final Written Exam - 50%

2. Alternative 2 - (Student Worker) (Final, Supplementary, Special)
- Final Written Exam - 100%

Language of instruction

Portuguese

Electronic validation

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23-02-2021	02-03-2021	02-03-2021	06-03-2021