COURSE DATA

Data Subject	
Code	46796
Name	Control de sistemas robóticos
Cycle	Master's degree
ECTS Credits	4.5
Academic year	2024 - 2025

Study (s)

Degree	Center	Acad. year	Period
2269 - Master's Degree in Electronic Engineering	School of Engineering	1	Annual

Subject-matter

Degree	Subject-matter	Character
2269 - Master's Degree in Electronic Engineering	2 - Electrónica Industrial	Obligatory

Coordination

Name	Department
ESPI HUERTA, JOSE MIGUEL	242 - Electronic Engineering
GIRBES JUAN, VICENT	242 - Electronic Engineering

SUMMARY

This subject aims to provide students with the necessary knowledge on the design and resolution of multivariable control systems (MIMO), with specific application in robotic systems. The main sensors and actuators used in autonomous robot navigation and control applications will also be introduced. Throughout the course, different practical problems will be raised that the students will have to solve individually, progressively increasing their complexity. Theoretically obtained designs must be subsequently verified by computer-aided simulation. Specifically, the following contents will be the main basis of the course:

- Design of controllers in state feedback.
- Design of observers.
- Modeling and simulation of robotic systems.
- Design of control algorithms and autonomous navigation of robots.

The study and analysis of the theoretical concepts studied as well as their verification and subsequent practical implementation make the subject very interesting, offering students the ability to solve complex control problems that can be presented in companies and in any field of industry, especially in robotic applications.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

For the normal teaching development of the subject, it is advisable for the student to have prior knowledge of mathematics and classical control systems.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

The learning results correspond to the following contents (CON) and skills (HAB), established in the syllabus:

Con1 - Know advanced energy conversion techniques, electromagnetic compatibility and system control in the field of industrial electronics.

Hab1 - Identify, formulate and solve problems in the field of Electronic Engineering and related multidisciplinary fields.

Hab2 - Model and simulate mathematically in the field of Electronic Engineering and related multidisciplinary fields.

Hab4 - Handle specialized software and hardware, as well as design, simulation and programming environments in the field of Electronic Engineering and related multidisciplinary fields.

Hab5 - Design systems and processes that meet specifications from different points of view: electronic, regulatory, economic, social, ethical and environmental.

DESCRIPTION OF CONTENTS

1. Multivariable control

1. Description of linear systems with state equations
1.1 Definition of state space equation
1.1.1 Continuous state space equation
1.1.2 Discrete state space equation
1.2 Solution of the state space equation
1.3 Stability of MIMO systems
1.4 Transfer Matrices
1.5 Discretization of continuous systems in the state space
1.6 Problems
2. Design of state space controllers
2.1 Introduction
2.1.1 State space feedback
2.1.2 Homogeneous feedback
2.2 Allocation of state feedback poles
2.2.1 Method of identifying coefficients
2.2.2 General method for pole assignment
2.3 Proportional control
2.3.1 Analog implementation
2.3.2 Digital implementation
2.4 Integral Control
2.4.1 Analog implementation
2.4.2 Digital implementation
3. Design of observers systems
3.1 Introduction
3.2 Complete observers
3.2.1 Analog implementation
3.2.2 Digital implementation
3.2.3 Analysis of the inner loop with complete observer
3.2.4 Principle of separation with complete observer
4. Laboratory practices
Session 1: Introduction
Session 2: Homogeneous control
Session 3: Proportional control
Session 4: Integral control
Session 5: Homogeneous control with observer
Session 6: Proportional control with observer
Session 7: Integral control with observar
Session 8: Application to a real inverted pendulum

2. Robotic systems

1. Modeling of robotic systems
1.1 Introduction
1.2 Kinematic modeling of robots
1.3 Dynamic modeling of robots
1.4 Simulation of robotic systems
1.5 Problems
2. Control of robotic systems
2.1 Introduction
2.2 Kinematic control
2.3 Dynamic control
2.4 Control by path tracking
2.5 Control by tracking trajectory
2.6 Problems
3. Sensors and actuators in applications
3.1 Introduction
3.2 Sensors
3.2.1 Proprioceptive sensors
3.2.3 Exteroceptive sensors
3.3 Actuators
3.3.1 Linear actuators
3.3.2 Rotary actuators
3.4 Problems
4. Laboratory practices
Session 1: Introduction to dynamic robot simulation
Session 2: Modeling mobile robots
Session 3: Control of mobile robots by path tracking
Session 4: Control of mobile robots by trajectory tracking
Session 5: Sensors in robotic applications
Session 6: Actuators in robotic applications
Session 7: Autonomous navigation of robots

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	25,00	100
Laboratory practices	20,00	100
Development of group work	5,00	0
Development of individual work	7,50	0
Study and independent work	20,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	5,00	0
Preparation of practical classes and problem	5,00	0
Resolution of case studies	10,00	0
TOTAL	**112,50**	

TEACHING METHODOLOGY

THEORY CLASSES: The theory classes will be taught in a masterly manner. Different questions will be asked by the teacher before the class to determine the level of knowledge acquired by the students in the previous preparation work for each of the subjects. Theory and problem classes will be held in a classroom with computer equipment. The student will have access to the teaching material related to the contents of the subject (transparencies, articles, web addresses, references for extension, etc.), through the Virtual Classroom, an application developed by the University of Valencia that facilitates easy and guided access to different types of teaching and/or administrative resources.

LABORATORY CLASSES: Laboratory classes will be taught in the Center's laboratories. The teacher will assess the students on the knowledge and understanding of the practice. This assessment will be carried out using a computer.

EVALUATION

Both in the first and second call, the grade for the subject will be the result of:

1. (SE1) The completion of a written test on the dates indicated in the official calendar. The exam will consist of various questions with difficulty similar to the questions and problems asked in class.

2. (SE2) The evaluation of the practical sessions will be carried out by solving a practical case in the laboratory.

Copying or plagiarism of any activity that is part of the evaluation will result in the impossibility of passing the course, and the student will then be subject to the appropriate disciplinary procedures indicated in the ACTION PROTOCOL FOR FRAUDULENT PRACTICES AT THE UNIVERSITY OF VALENCIA (ACGUV 123/2020).

In any case, the system of evaluation will be ruled by the established in the Regulation of Evaluation and Qualification of the University of Valencia for Degrees and Masters. (https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?accion=inicio&idEdictoSeleccionado=5639).

REFERENCES

Basic

- Graham C. Goodwin, Stefan F. Graebe, Mario E. Salgado. Control System Design
- Sigurd Skogestad, Ian Postlethwaite. Multivariable Feedback Control: Analysis and Design
- Siegwart, R., Nourbakhsh, I. R., Scaramuzza, D. (2011). Introduction to autonomous mobile robots. MIT press.
- Siciliano, B., Khatib, O. (2016). Handbook of Robotics. Springer