



Universitat de Lleida

DEGREE CURRICULUM  
**CONTROL AND ROBOTICS  
SYSTEMS DESIGN**

Coordination: TRESÁNCHEZ RIBES, MARCEL

Academic year 2018-19

## Subject's general information

<b>Subject name</b>	CONTROL AND ROBOTICS SYSTEMS DESIGN			
<b>Code</b>	102127			
<b>Semester</b>	2nd Q(SEMESTER) CONTINUED EVALUATION			
<b>Typology</b>	<b>Degree</b>	<b>Course</b>	<b>Character</b>	<b>Modality</b>
	Bachelor's Degree in Automation and Industrial Electronic Engineering	3	COMPULSORY	Attendance-based
<b>Course number of credits (ECTS)</b>	6			
<b>Type of activity, credits, and groups</b>	<b>Activity type</b>	PRALAB	PRAULA	TEORIA
	<b>Number of credits</b>	0.4	2.6	3
	<b>Number of groups</b>	4	2	1
<b>Coordination</b>	TRESÁNCHEZ RIBES, MARCEL			
<b>Department</b>	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING			
<b>Teaching load distribution between lectures and independent student work</b>	Total load: 150h - 60h of lectures (40%) - 90h of independent student work (60%)			
<b>Important information on data processing</b>	Consult <a href="#">this link</a> for more information.			
<b>Language</b>	Catalan			
<b>Distribution of credits</b>	4 Credits of lectures and practical examples in big groups (GG) 2 Credits of practical work in small groups (GP)			
<b>Office and hour of attention</b>	Office (2.07) or Robotics Lab (2.04) at the EPS building. Monday 10:00-11:00 AM.			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
TRESÁNCHEZ RIBES, MARCEL	mtresanchez@diei.udl.cat	9,8	

## Subject's extra information

It is recommended to have coursed previously “Senyals i Sistemes” and “Teoria Bàsica del Control” subjects.

It is **COMPULSORY** that the students bring the following elements of individual protection (EPI) to the practices at the laboratory.

- Blue laboratory gown from UdL (unisex)
- Protection glasses
- Mechanical protection gloves

They can be purchased through the shop Údels of the UdL:

C/ Jaume II, 67 baixos  
Centre the Cultures i Cooperació Transfronterera

<http://www.publicacions.udl.cat/>

The use of other elements of protection (for example caps, masks, gloves of chemical or electrical risk, etc.) will depend on the type of practice to be done. In that case, the teacher will inform of the necessity of specific EPI.

Not bringing the EPI's described or not fulfilling the norms of general security that are detailed below imply that the student can not access to the laboratories or have to go out of them. The no realisation of the practices for this reason imply the **consequences in the evaluation** of the subject that are described in this course guide.

### GENERAL NORMS OF SECURITY IN LABORATORY PRACTICES

- Keep the place of realisation of the practices clean and tidy. The table of work has to be free from backpacks, folders, coats...
- No short trousers or short skirts are allowed in the laboratory.
- Closed and covered footwear is compulsory in the laboratory.
- Long hair needs to be tied.
- Keep the laboratory gown laced in order to be protected from spills of chemicals.
- Bangles, pendants or wide sleeves are not allowed as they can be trapped.
- Avoid the use of contact lenses, since the effect of the chemical products is much bigger if they enter between the contact lense and the cornea. Protection over-glasses can be purchased.
- No food or drink is allowed in the laboratory.
- It is forbidden to smoke in the laboratories.
- Wash your hands whenever you have contact with a chemical product and before going out of the laboratory.
- Follow the instructions of the teacher and of the laboratory technicians and ask for any doubt on security.

For further information, you can check the following document of the *Servei de Prevenció de Riscos Laborals de la UdL*: <http://www.sprl.udl.cat/alumnes/index.html>

## Learning objectives

Acquire the ability to design control and industrial automation systems.

Know the working of control systems in robotic systems.

Learn principles and applications of robotic systems

Identify and analyze the different parts of a robot

Understand the operation of a robot and be able to planning their possible application

Learn to develop graphical interfaces to manage control systems.

## Competences

### Cross-disciplinary competences

**EPS1.** Capacity to solve problems and prepare and defence arguments inside the area of studies.

**EPS2.** Capacity to gather and interpret relevant data, within the area of study, to judge and think about relevant subjects of social, scientific and ethical nature.

### Specific competences

**GEEIA25.** Knowledge and capacity for modelling and simulation of systems.

**GEEIA26.** Knowledge of automation and technical regulation of control and his application to the industrial automation.

**GEEIA27.** Knowledge of principles and applications of robotic systems.

**GEEIA29.** Capacity to design systems of industrial automation control.

### Cross-disciplinary competences

**EPS1.** Capacity to solve problems and prepare and defence arguments inside the area of studies.

**EPS2.** Capacity to gather and interpret relevant data, within the area of study, to judge and think about relevant subjects of social, scientific and ethical nature.

## Subject contents

### 1. Introduction to robotics

1.1. Robots classification

1.2. Sensors and actuators

1.3. Stepper motors and DC motors

1.4. Electronic solutions for motor controlling

1.5. Examples of robotics systems

### 2. Robot control

2.1. Direct kinematics model

2.2. Methodology of Hartenberg-Denavit

## 2.3. Inverse kinematics model

## 3. Graphical design of control systems

### 3.1. Graphical interfaces

### 3.2. Development of discrete controllers

### 3.3. Programming of graphical environments for control

### 3.4. Examples of applied control

## 4. Control based on artificial vision

### 4.1. Global processing operations

### 4.2. Filters and convolutions

### 4.2. Image processing techniques

## 3. Applications

### 3.1. Programming of robots in industry

### 3.2. Feedback control of robots using image processing

## Methodology

The development of the subject will be based on the practical work performed at different laboratories of the university.

The contents and description of the practical work will be available at the web.

The development of the practical work will be based on the MATLAB programming environment.

There will be a final work about the control of a cartesian robot with vision system. This practical work will be done in small groups (GP) during the period for perform the practices 6 and 7 specified on the development plan.

## Development plan

Week	Description	Classroom Activity	Classroom Hours	Student workload Hours
1	Presentation	masterclass	2	0
	Lesson 1: Lecture	masterclass	2	4
2	Lesson 1: Lecture	masterclass	2	4
	Lesson 2: Lecture	masterclass	2	4
	Lesson 2: Experimental	Experimentation	2	5

Week	Description	Classroom Activity	Classroom Hours	Student workload Hours
3	Lesson 3: Lecture	masterclass	2	12
4	Lesson 3: Exercices	Practical exercise 1	2	0
	Lesson 3.1: Experimental	Experimentation	2	8
5	Lesson 3.1: Practices	Practical exercise 2	4	0
6	Lesson 3.2: Experimental	Experimentation	4	8
7	Lesson 3.2: Practices	Practical exercise 3	2	0
	Lesson 3.3 i 3.4: Lecture	Experimentation	2	10
8	Lesson 3.3: Practices	Practical exercise 4	4	3
9	Evaluation exam 1	Practices doubts	2	5
10	Lesson 4: Lecture	Experimentation	4	10
11	Lesson 4: Exercices	Practical exercise 5	2	0
11-12	Lesson 4: Practices	Practical exercise 6	4	2
12	Lesson 5: Lecture	Experimentation	2	3
13-14	Lesson 5: Final project	Practical exercise 7	8	1
15-16	Evaluation exam 2	Validation exam	2	5
17	Tutorials	Tutorials	2	0
18	make-up exam	Evaluation	2	6

During the last part of the course of artificial vision and cartesian robot (10, 11, 12, 13 and 14 weeks) the sessions will be done in small groups of students (GP). The rest of sessions, if are space enough and licenses, will be done in big groups of students (GG).

## Evaluation

The evaluation is based on the weighted practical work performed during the course.

$$NC = ( NP1 \cdot P1 + NP2 \cdot P2 + NP3 \cdot P3 + \dots + NPx \cdot P7 )$$

To compute continuous assessment (NC) is mandatory to submit all proposed practices. Otherwise, **NC = 0**.

A practice presented out of deadline will score **Px = 0**.

In June, there will be a validation exam of the practices. The result would be Pass / Fail. If pass, the final mark (**NF**) will be the NC. If fails, the final mark will be  $NF = NC \cdot 0.5$ .

If **NC** is lower than 5.0 there will be an optional remedial exam (**NR**). Then, the final mark will be the highest score between NF and NR without exceed 6.9 (approved).

## Bibliography

- Notes from the subject.

- Philip J. McKerrow, Addison-Wesley: **Introduction to Robotics**. ISBN 0-534- 914370-5.
- A. Barrientos, L.F. Peñín, C. Balaguer, R. Aracil: **Fundamentos de robótica**, McGraw Hill, 1997. ISBN: 8448108159.
- K.S. Fu, R.C. González, C.S.G. Lee. McGraw-Hill: **Robótica: Control, Detección, Visión e Inteligencia**. ISBN 84-7615-214-0
- P. M. Taylor, Eds. Ceac: **Control Robótico**. ISBN 0-333043821-3
- Reyes Cortés, Fernando, Robótica: **Control de robots manipuladores**. Barcelona: México: Marcombo: Alfaomega 2011. ISBN: 9788426717450.
- Craig, John J.: **Robótica**. 3a ed. México: Pearson Educacion, 2006. ISBN: 9702607728.