Universitat de Lleida

DEGREE CURRICULUM

CONTROL AND ROBOTICS SYSTEMS DESIGN

Coordination: TRESÁNCHEZ RIBES, MARCEL

Academic year 2019-20

CONTROL AND ROBOTICS SYSTEMS DESIGN 2019-20

Subject's general information

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

Typology:

Degree	Course	Character	Modality
Bachelor's Degree in Automation and Industrial Electronic Engineering	3	COMPULSORY	Attendance-based

Type of activity, credits, and groups:

Activity type	PRALAB	PRAULA	TEORIA
Number of credits	0.4	2.6	3
Number of groups	4	2	1

CONTROL AND ROBOTICS SYSTEMS DESIGN 2019-20

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

Subject's extra information

It is recomended 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 laboratoy 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 developement 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*P1 + NP2*P2 + NP3*P3 + ... + NPx*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 * 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, Fernado, Robótica: **Control de robots manipuladores**. Barcelona: México: Marcombo: Alfaomega 2011. ISBN: 9788426717450.

- Craig, John J.: **Robótica**. 3a ed. México: Pearson Educacion, 2006. ISBN: 9702607728.

Adaptations to the methodology due to COVID-19

All content will be online.

The subject will continue to be developed through the implementation of practical work initially planned. Although the purpose of the activities will be the same, their content will be adapted so that they can be performed entirely from home.

The scheduled face-to-face sessions will be transformed into recorded virtual sessions which will be available following the initial schedule.

The work environment will remain the MATLAB software. A campus license is available that allows students to work from home.

There will be joint live follow-up tutorials through video conferencing on Tuesdays and Thursdays from 5:00 p.m. to 6:00 p.m.

The forum tool, organized by subject stages, will also be available where the students will be able to create topics to discuss each other and and with the teacher (as a moderator).

Adaptations to the development plan due to COVID-19

The expected development plan is as following:

Week	***Day***	***Expected content***
10	14/04 – 19/04	**Online content 4**. Artificial vision and image processing.
11	20/04 – 26/04	**Online content 5**. Practice 5 presentation. Images analysis.
12	27/04 – 03/05	**Online content 6.** Practice 6 presentation. Real-time image processing.
13	04/05 – 10/05	Time for ending active student workload.
14	11/05 – 17/05	**Online content 7**. Practice 7 presentation. Control a Cartesian robot by means of G-Code instructions.
15	18/05 – 25/05	Time for ending active student workload.
16	27/05	Validation test exam
19	16/06	Make-up exam

Adaptations to the evaluation due to COVID-19

The evaluation will not be affected; it will remain the same as planned from the beginning: working doing practical exercises. However, because we do not have the laboratory materials and equipment, there will be changes in the content of the activities and their respective weighting.

In the case of the image processing practice, the school's USB cameras will be replaced by a set of previously captured recordings. In the case of the final activity, practice 7, we will replace the school’s Cartesian Robot for a virtual robotic platform simulating the behavior of a cartesian robot where its control will be worked by reading G-Codes. Because this activity will not have as much impact on the subject as the work with the real platform, the weighting of the activities will be affected as follows:

Practice 1: Programming in M language (exercises) - 0.5 pts

Practice 2: Simulation and analysis of a probability problem - 1 pt

Practice 3: Simulation of the behavior of a MEMS - 1 pt

Practice 4: Interface design (SCADA) and process control - 2.5 pts

Practice 5: Detection of events with image processing - 1 pt

Practice 6: Control applications with artificial vision (by means of recordings) - 2 pts

Practice 7: Control of a Cartesian robot by reading G-Codes - 2 pts