Universitat de Lleida

DEGREE CURRICULUM

CONTROL AND ROBOTICS SYSTEMS DESIGN

Coordination: CLOTET BELLMUNT, EDUARD

Academic year 2022-23

CONTROL AND ROBOTICS SYSTEMS DESIGN 2022-23

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	see table below
Coordination	CLOTET BELLMUNT, EDUARD
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)

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	1	2	3
Number of groups	4	1	1

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CLOTET BELLMUNT, EDUARD	eduard.clotet@udl.cat	9	

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

CONTROL AND ROBOTICS SYSTEMS DESIGN 2022-23

Learning objectives

- Acquire the ability to design control and industrial automation systems.
- Learn how control systems work in robots.
- Learn the principles and applications of robotic systems
- Identify and analyze the different parts of a robot
- Understand how robots operate and acquire the ability to plan and design possible applications
- Learn to develop graphical interfaces to manage control systems.
- Learn about the current technologies in the field of depth perception
- Learn how to desing the algorithms used in robots for autonomous navigation

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.

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 the description of the practical work will be available at the virtual campus website.

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

There will be a final work related with the control of a cartesian robot with a computer-vision system. This practical work will be done in small groups (GP) during the designed period allocated for the final project specified in the development plan.

Development plan

Week	Description	Classroom activity	Classroom hours	Student workload hours
1	Presentation	Masterclass	2	0
	Lecture (T1)	Masterclass	2	4
2	Lecture (T1/T2)	Masterclass	2	3
	Practice (P1)	Practical work	2	5
3	Lecture (T3)	Masterclass	2	3
	Practice (P2)	Practical work	2	5
4	Lecture (T4)	Masterclass	2	2
	Practice (P3)	Practical work	2	5

Week	Description	Classroom activity	Classroom hours	Student workload hours
5	Lecture (T5)	Masterclass	2	2
	Practice (P4)	Practical work	2	2
6	Lecture (T6)	Masterclass	2	3
	Practice (P5)	Practical work	2	7
7	Lecture (T7)	Masterclass	2	3
	Practice (P6)	Practical work	2	6
10	Lecture (T8)	Masterclass	2	2
	Practice (P7)	Practical work	2	7
11	Lecture (T9)	Masterclass	2	2
	Practice (P8)	Practical work	2	8
12	Lecture (T10)	Masterclass	2	3
13	Final project	Practical work	2	3
	Final project	Practical work	2	3
14	Final project	Practical work	2	3
	Final project	Practical work	2	3
15	Final project	Practical work	2	3
	Final project	Practical work	2	3

If the laboratory capacity, materials and software licenses are enough, the face-to-face sessions will be in a big student croup (GG), otherwise the face-to-face sessions will be in small groups (GP).

Evaluation

The evaluation is based on the weighted practical work (NPx) performed during the course (NC).

NC = NP1*P1 + NP2*P2 + NP3*P3 + ... + NPx*Px

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**.

An individual practice cannot be recovered.

The submission of practices representing the 50% or more of the subject punctuation (NC) will be considered as presented in the current course call.

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

Main bibliography:

- Apuntess de la assignatura.

- A. Barrientos, L.F. Peñín, C. Balaguer, R. Aracil: **Fundamentos de robótica**, McGraw Hill, 1997. ISBN: 8448108159.

- Reyes Cortés, Fernado, Robótica: **Control de robots manipuladores**. Barcelona: México: Marcombo: Alfaomega 2011. ISBN: 9788426717450.

- Craig, John J.: **Introduction to robotics : mechanics and control**. 3rd ed. Essex: Pearson Educacion Internacional, 2013. ISBN: 9781292040042.

- González, Rafael C ; Woods, Richard E. **Digital image processing**. 4th ed. New York: Pearson Prentice Hall, 2018. ISBN 9781292223049.

- Peter Corke, **Robotics, Vision and Control. Fundamental Algorithms in MATLAB**. Springer, Berlin, Heidelberg, 2011. ISBN: 978-3-642-20143-1.

Complementary bibliography:

- Philip J. McKerrow, Addison-Wesley: **Introduction to Robotics.** ISBN 0-534- 914370-5.

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

- P. M. Taylor, Eds. Ceac: **Control Robótico.** ISBN 0-333043821-3.

- K.S. Fu, R.C. González, C.S.G. Lee. McGraw-Hill: **Robótica: Control, Detección, Visión e Inteligencia.** ISBN 84-7615-214-0

- Sonka, Milan; Hlavac, Vaclav; Boyle, Roger. **Image processing, analysis and machine vision**. 4th ed. Pacific Grove: Cengage, cop. 2015. ISBN 9781133593690.

- Szeliski, Richard. **Computer vision : algorithms and applications**. London: Springer, cop. 2011. ISBN 9781848829343.