Course guide
240IAU11 - 240IAU11 - Fundamentals of Robotics

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Spanish

LECTURER

Coordinating lecturer: Sanfeliu Cortes, Alberto

Others: Bolea Monte, Yolanda

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEAUT5. Design, project and program robotic systems for industrial and service applications.
CEMEI08. Ability to design and project automatic production systems and advanced control processes.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Basic:
CB 7. (ENG) Que els estudiants sàpiguen aplicar els coneixements adquirits i la seva capacitat de resolució de problemes en entorns nous o poc coneguts dintre de contextos més amplis (o multidisciplinars) relacionats amb la seva àrea d'estudi.
CB 8. (ENG) Que els estudiants siguin capaços de d'integrar coneixements i enfrentar-se a la complexitat de formular judicis a partir d'una informació que, essent incompleta o limitada, inclogui reflexions sobre les responsabilitats socials i ètiques vinculades a l'aplicació del seus conexicements i judicis.
CB 9. (ENG) Que els estudiants sàpiguen comunicar les seves conclusions i coneixements (i darrers raonaments que els sostentin), a públics especialitzats i no especialitzats de manera clara i sense ambigüitats.
CB10. (ENG) Que els estudiants poseeixin les habilitats d'aprenentatge qur els permetin continuar estudiant d'una manera d'una forma que haurà de ser en gran mesura autodirigit o autonònom

TEACHING METHODOLOGY

Methodology

The methodology of the course will be through master classes of 2 h/session, where the teacher will explain the theory and will introduce exercises to improve the understanding of the subject. Moreover there will be laboratory classes of 2 h/session, where the student will program an industrial robot. The student will also solve exercises that will be delivered through the course.

LEARNING OBJECTIVES OF THE SUBJECT

The Fundaments de Robòtica subject goal is to teach to the students the basic principles of design and control of robots, as well as how to apply them in industrial environments. It will be explained by one side the cinematic models, dynamic models, control and robot programing, and by the other side how to design industrial applications. The theoretical issues will be combined with lab practices in the department robotic lab, in order that the students learn a robot programing language, and how to design an application with industrial robots.

STUDY LOAD

Type	Hours	Percentage
Hours large group	27,0	24.00
Hours small group	13,5	12.00
Self study	72,0	64.00

Total learning time: 112.5 h

CONTENTS

1. Introduction

Description:
An introduction to robotics

Specific objectives:
1.1 Historical robotics evolution
1.2 Definition and classification of robots
1.3 Robot applications

Full-or-part-time: 4h
Theory classes: 2h
Self study : 2h

2. Robot morphology

Description:
Description of the robot morphology, the architectures and basic components

Specific objectives:
2.1 Basic robot architectures
2.2 Robot features
2.3 Mechanical structure
2.4 Transmission
2.5 Actuators
2.6 Sensors
2.7 Control subsystem
2.8 Terminal components

Full-or-part-time: 7h
Theory classes: 3h
Self study : 4h

3. Kinematic model

Description:
Description of the robot kinematic models

Specific objectives:
3.1 Geometric representation of point in 3d space
3.2 Direct kinematic model
3.3 Inverse kinematic model
3.4 Differential model. Jacobian

Full-or-part-time: 23h
Theory classes: 7h
Self study : 16h

4. Dynamic model

Description:
Description of the robot dynamic models

Specific objectives:
4.1 Lagrange-Euler model
4.2 Newton-Euler model
4.3 Dynamic model of the actuators

Full-or-part-time: 11h
Theory classes: 3h
Self study : 8h

5. Control

Description:
Description of the different robot control levels, joint path generation and control techniques of a joint.

Specific objectives:
5.1 Control levels
5.2 Joint path generation
5.3 Control at joint level
5.4 Control techniques

Related activities:
Master class, problem solving and independent learning through exercises

Full-or-part-time: 15h
Theory classes: 5h
Self study : 10h

6. Robot programing

Description:
Description of the different robot programing languages and robot lab practices

Specific objectives:
6.1 Programing methods
6.2 System requirements for programing robots
6.3 Programing languages

Related activities:
Lab practices

Full-or-part-time: 38h
Theory classes: 4h
Practical classes: 18h
Self study : 16h

7. Environment robot interaction and teleoperation

Description:
Description of how the robot interact with the environment using sensors and teleoperation

Specific objectives:
7.1 Robot environment
7.2 Environment data acquisition
7.3 Teleoperation

Full-or-part-time: 12h
Theory classes: 4h
Self study : 8h

8. System implementation issues for an industrial robot

Description:
It is described the system requirements for a robotic cell, what are the important robot features for an industrial application, the safety issues and the standard procedures to be taken into account for industrial robot applications

Specific objectives:
8.1 Design and control of a robotic cell
8.2 Features to be consider in the selection of an industrial robot
8.3 Robot safety issues
8.4 Standard norms for industrial robots

Related activities:
Master class, problem solving and independent learning through exercises

Full-or-part-time: 10h 30m
Theory classes: 4h
Self study : 6h 30m

GRADING SYSTEM

Grading

There will be a continuous evaluation system. The evaluation will consist of two exams, a short one in the middle of the course and a final one at the end of the course and some exercises to be done at home. Moreover, there will be a lab practice exam.

For this course 2020-2021, due to the impact of the Convid-19 at the teaching of the subject and his evaluation, the evaluation will modify of the following form.â□¨â□¨

The final note will compound from four partial notes:â□¨â□¨

- Evaluation of the laboratory exercises of practices: 25% of the noteâ□¨
- Evaluation of the class exercises: 15% of the note
- Evaluation of the first exam: 20% of the note
- Evaluation of the final exam: 40% of the note

EXAMINATION RULES.

The exam will have two parts, one of theoretical concepts and the second one of exercises.

For this course 2020-2021, because of the impact that is having the Convid-19 at the teaching of the subject and his evaluation, the final examination will be of the following form:â□¨â□¨

- The first and the final examination will consist of a combination of conceptual questions and exercises

BIBLIOGRAPHY

Basic:
- Fu, K. S ; González, Rafael C ; Lee, C.S.G. Robótica : Control, detección, visión e inteligencia. Madrid: McGraw-Hill, 1988. ISBN 8476152140.
- Barrientos, Antonio. Fundamentos de robótica. 2ª ed. Madrid: McGraw-Hill, cop. 2007. ISBN 9788448156367.

Complementary:
- Craig, John J. Introduction to robotics : mechanics and control. 4th ed. Harlow: Pearson, 2022. ISBN 9781292164939.

RESOURCES

Other resources:
Industrial robots