Course guide
295918 - IR - Intelligent Robotics

Last modified: 30/06/2026

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

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: PEDRO PONSA ASENSIO

Others: Primer quadrimestre:
PEDRO PONSA ASENSIO - Grup: T11
SEBASTIAN TORNIL SIN - Grup: T11
ELENA VILLALBA AGUILERA - Grup: T11, Grup: T12

PRIOR SKILLS

- industrial robotics
- Electronic instrumentation (sensors, electric actuators, communications networks)
- Programming (Python, MATLAB)

REQUIREMENTS

It is recommended to have passed the subjects Industrial Robotics and Computer Vision (RIVC) and Automatic Regulation (REGA)

TEACHING METHODOLOGY

- written exam
- exercises
- case study
- project-based learning
- oral presentation
- team work
- laboratory practices
- simulation scenario

LEARNING OBJECTIVES OF THE SUBJECT

- Introduce students to the classification of robots (industrial, collaborative, intelligent).
- To know and apply the basic methods of artificial intelligence to robotics.
- To design, develop and program autonomous robotic systems.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	50.00
Hours small group	30,0	50.00

Total learning time: 60 h

CONTENTS

1. Introduction

Description:
1.1. Context. Intelligent robotics definition
1.2. Robotic systems architecture
1.3. Brief history
1.4. Field application: industry, space
1.5. Vehicles: Robotino, jetracer, rover
1.6. Python libraries

Specific objectives:
Introduce the context of robots with cognitive capabilities and their applications.

Related activities:
Written exam
Exercises

Full-or-part-time: 6h
Theory classes: 2h
Guided activities: 2h
Self study : 2h

2. AI methods applied to robotics

Description:
2.1. Decision trees
2.2. Reinforcement learning
2.3. Neural networks and classification. Deep Learning
2.4. Study case: Jetson nano and Jetracer in laboratory track
2.5. Study case: Jetracer training for autonomous driving

Specific objectives:
Know the relevant AI methods and Python libraries (Keras, TensorFlow, Numpy) to apply to robotics.

Related activities:
Written exam
Exercises

Full-or-part-time: 24h
Theory classes: 10h
Guided activities: 4h
Self study : 10h

3. Interacting with robots

Description:
3.1. Interaction model (physical, cognitive) for human-robot systems.
3.2. Design of cognitive assistants for human-robot tasks in an industrial environment.
3.3. Interfaces (commands by voice or gesture, human tracking by vision techniques, force measurement)
3.4. Industrial Case study

Specific objectives:
Assess the interaction between a human and an artificial agent.

Related activities:
Written exam
Exercises

Full-or-part-time: 16h
Theory classes: 6h
Guided activities: 4h
Self study : 6h

4. Autonomous mobile robots

Description:
4.1. Introduction
4.2. Wheels-based robots
4.3. Perception
4.4. Localization
4.5. Planning
4.6. Autonomous robot project

Specific objectives:
To know the diversity of mobile robots in the industry and to design new prototypes.
Project-based challenges is used in the project development.

Related activities:
Project
Autonomous navigation in simulation scerario. çrover moving inside a maze, using LiDAR simulated sensor and PID motion control strategies

Full-or-part-time: 44h
Theory classes: 12h
Guided activities: 20h
Self study : 12h

5. Practice activities

Description:
5.1. Working system: Ubuntu, VSCode, Python scripts
5.2. Modelling and simulation of the JPL rover: URDF, RViz, Gazebo
5.3. Rover simulated teleoperation
5.4. Functionalities of ROS for autonomous navigation

Specific objectives:
Develop advanced programming and system integration skills

Related activities:
Laboratory Practices

Full-or-part-time: 60h
Laboratory classes: 30h
Self study : 30h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

Project (PBL) 20%
Practices report (P) 30%
Written exam (E) 30%
Oral presentation (OP) 20%

Final mark: 0,2*PBL + 0,3*P + 0,3*E + 0,2*OP (continuous evaluation)

EXAMINATION RULES.

1. There will be evaluation of directed activities (face-to-face or non-face-to-face) corresponding to the completion of proposed work (type AP) and the completion of Practices report (type P). These may be individual or in groups, according to the criteria of each professor.
2. There will be a partial exam (PE) lasting a maximum of 2 hours, which will consist of questions related to theoretical knowledge of the subject matter of the course and aimed at assessing the learning objectives of the student.

There will be no re-evaluation exam in this subject.

BIBLIOGRAPHY

Basic:
- Siegwart, Roland; Nourbakhsh, Illah Reza; Scaramuzza, Davide. Introduction to autonomous mobile robots [on line]. 2nd ed. Cambridge: MIT Press, cop. 2011 [Consultation: 14/07/2025]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3339191. ISBN 9780262015356.
- Govers, Francis X. Artificial intelligence for robotics: build intelligent robots using ROS 2, Python, OpenCV, and AI/ML techniques for real-world tasks [on line]. Second edition. Birmingham, England: Packt Publishing, 2024Available on: https://github.com/PacktPublishing/Artificial-Intelligence-for-Robotics-2e/. ISBN 9781805129592.

Complementary:
- Angulo Bahón, Cecilio; Ponsa Asensio, Pere. Cognitive assistant supported human-robot collaboration [on line]. London: Elsevier,

2024Available on: https://www.sciencedirect.com/book/monograph/9780443221354/cognitive-assistant-supported-human-robot-collaboration. ISBN 9780443221354.
- Cangelosi, Angelo and Asada, Minoru. Cognitive robotics [on line]. Cambridge: The MIT Press, 2022Available on: https://direct.mit.edu/books/oa-edited-volume/5331/Cognitive-Robotics. ISBN 9780262046831.

RESOURCES

Other resources:
Robots in laboratory A5.4: Robotino 4, Jetracer and JPL Rover (re-designed with the collaboration of PUCRA Association)
https://pucra.upc.edu/ />
How design and build a rover following the instructions of the NASA JPL
https://jplopensourcerover.com/#!/signup />
MATLAB and SIMULINK tools related to European Rover Challenge competition
https://se.mathworks.com/academia/student-competitions/european-rover.html