

**1. General information****Course:** PROGRAMMING MOBILE ROBOTS**Type:** ELECTIVE**Degree:** 416 - UNDERGRADUATE DEGREE PROGRAMME IN INDUSTRIAL ELECTRONICS AND AUTOMATION ENG**Center:** 605 - SCHOOL OF INDUSTRIAL ENGINEERS. AB**Year:** 4**Main language:** English**Use of additional languages:****Web site:****Code:** 56345**ECTS credits:** 6**Academic year:** 2023-24**Group(s):** 11**Duration:** C2**Second language:****English Friendly:** N**Bilingual:** Y**Lecturer:** ANTONIO FERNANDEZ CABALLERO - Group(s): 11

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2. Pre-Requisites**Pre-requisites**

The student must have prior basic knowledge of computers and programming.

Therefore, and to properly follow this course, it is recommended that students have previously studied the subjects 'Computer Fundamentals' and 'Industrial Informatics'.

3. Justification in the curriculum, relation to other subjects and to the profession**Justification in the study plan, and relation with other courses and the profession**

The concepts and skills provided in this course are part of the reference MECHATRONICS and thus complement the fourth year electives called 'Pneumatic Systems', 'Sensors and Actuators', 'Virtual Instrumentation' and 'Mechanics of Robots and Manipulators'.

The course is initially based on the programming concepts learned in the subjects of 'Computer Basics' and 'Industrial Informatics' as well as some of Robotics concepts seen on the subject 'Industrial Robotics'.

This course provides the concepts and basic skills that an Industrial Engineer specializing in Industrial Electronics and Automation requires in relation to the programming of sensors, actuators and control of mobile robots.

4. Degree competences achieved in this course**Course competences**

Code	Description
CEO12	Knowledge of the fundamentals of mobile robotics and its reasoning models in order to know how to use specific techniques depending on the problem to be solved.
CG03	Knowledge of basic and technological subjects to facilitate learning of new methods and theories, and provide versatility to adapt to new situations.
CT02	Knowledge and application of information and communication technology.

5. Objectives or Learning Outcomes**Course learning outcomes****Description**

Ability to program a simulator for mobile robots and some real mobile robots, mainly in aspects related to autonomous navigation.

Additional outcomes

Knowledge of the internal workings of mobile robots (sensors, actuators and control).

Ability in the handling of computer libraries.

Ability in oral and written communication.

Ability in teamwork.

6. Units / Contents**Unit 1: Mobile Robots****Unit 2: Mobile Robot Architectures****Unit 3: Robot Behaviours****Unit 4: Robot Locomotion****Unit 5: Robot Sensing****Unit 6: Robot Vision**

Unit 7: Motion Planning
Unit 8: Localisation and Mapping
Unit 9: Robot Navigation
Unit 10: Learning in Mobile Robots
Unit 11: Multi-Robot Systems
Unit 12: Human-Robot Interaction

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	CEO12 CG03	1.2	30	Y	N	The teacher will focus on the topic and explain its fundamental contents.
Computer room practice [ON-SITE]	Practical or hands-on activities	CEO12 CT02	0.48	12	Y	N	It consists in the realization, in small groups, of practical exercises and simulations with specific software.
Problem solving and/or case studies [ON-SITE]	Problem solving and exercises	CEO12 CG03 CT02	0.48	12	Y	N	It will consist of the exposition of the works carried out in the practices.
Final test [ON-SITE]	Assessment tests	CEO12 CG03 CT02	0.08	2	Y	Y	It will deal with the whole subject evaluating its theoretical and practical aspects.
Mid-term test [ON-SITE]	Assessment tests	CEO12 CG03	0.16	4	Y	N	
Study and Exam Preparation [OFF-SITE]	Self-study		3.6	90	N	-	
Total:			6	150			
Total credits of in-class work: 2.4			Total class time hours: 60				
Total credits of out of class work: 3.6			Total hours of out of class work: 90				

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Assessment of activities done in the computer labs	25.00%	25.00%	The work carried out by the student during the practices will be valued on the basis of a demonstration of the functioning of the programs and the documentation delivered in the written reports.
Practicum and practical activities reports assessment	15.00%	15.00%	Both the content of the work presented and the clarity of the written expression will be valued.
Mid-term tests	60.00%	60.00%	
Total:	100.00%	100.00%	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject, an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

The final exam that includes all the subjects not passed during the course.

Non-continuous evaluation:

Evaluation criteria not defined

Specifications for the resit/retake exam:

The retake exam consists of a final exam that covers the whole subject.

No note is kept of the activities carried out during the course.

Specifications for the second resit / retake exam:

The second retake exam consists of a final exam that covers the whole subject.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents	
Hours	hours
Computer room practice [PRESENCIAL][Practical or hands-on activities]	12
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	12
Final test [PRESENCIAL][Assessment tests]	2
Mid-term test [PRESENCIAL][Assessment tests]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Unit 1 (de 12): Mobile Robots	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 2 (de 12): Mobile Robot Architectures	
Activities	Hours

Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 3 (de 12): Robot Behaviours	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 4 (de 12): Robot Locomotion	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 5 (de 12): Robot Sensing	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 6 (de 12): Robot Vision	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 7 (de 12): Motion Planning	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 8 (de 12): Localisation and Mapping	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 9 (de 12): Robot Navigation	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 10 (de 12): Learning in Mobile Robots	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 11 (de 12): Multi-Robot Systems	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Unit 12 (de 12): Human-Robot Interaction	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Global activity	
Activities	hours
Final test [PRESENCIAL][Assessment tests]	2
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	12
Computer room practice [PRESENCIAL][Practical or hands-on activities]	12
Class Attendance (theory) [PRESENCIAL][Lectures]	30
Mid-term test [PRESENCIAL][Assessment tests]	4
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Total horas: 150	

10. Bibliography and Sources						
Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
F. Torres, J. Pomares, P. Gil, S.T. Puente, R. Aracil	Robots y Sistemas Sensoriales http://journalfieldrobotics.org/Home.html http://www.elsevier.com/wps/find/journaldescription.cws_home/505622/description	Prentice Hall		84-205-3574-5	2002	Chapters 6-7, 11 and 14
S. Thrun, W. Burgard, D. Fox	Probabilistic Robotics	The MIT Press		978-0-262-20162-9	2005	Chapters 2 and 7-12
R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza	Introduction to Autonomous Mobile Robots, Second Edition	The MIT Press		978-0-262-01535-6	2011	
F. Fahimi	Autonomous Robots: Modeling, Path Planning, and Control	Springer		978-0-387-09537-0	2009	Chapter 6
H. Choset, K.M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L.E. Kavraki, S. Thrun	Principles of Robot Motion: Theory, Algorithms, and Implementations	The MIT Press		978-0-272-03327-5	2005	
A. Ollero	Robótica: Manipuladores y Robots Móviles	Marcombo		978-8-426-71313-1	2005	Chapters 2 and 7-12
B. Siciliano, L. Scavico, L. Villani, G. Oriolo	Robotics: Modelling, Planning and Control	Springer		978-1-84628-641-4	2009	Chapters 5 and 11-12