# UNIVERSIDAD DE CASTILLA - LA MANCHA
## GUÍA DOCENTE

## 1. General information

**Course:** PROGRAMMING MOBILE ROBOTS

**Type:** ELECTIVE

**Degree:** 352 - UNDERGRADUATE DEGREE PROGRAMME IN MECHANICAL ENGINEERING (AB)

**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**

| Building/Office | Department | Phone number | Email | Office hours |
|---|---|---|---|---|
| Escuela Técnica Superior de Ingenieros Industriales / 1.C.3 | SISTEMAS INFORMÁTICOS | 2406 | antonio.fdez@uclm.es | |

## 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 subject 'Computer Fundamentals'.

## 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 subject of 'Computer Basics' 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 Mechanics 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 |
|---|---|
| A07 | Knowledge of Information Technology and Communication (ITC). |
| A12 | Knowledge of basic materials and technologies that assist the learning of new methods and theories and enable versatility to adapt to new situations. |
| F25 | Knowledge of the fundamentals of mobile robotics and their models of reasoning with the objective of knowing how to use specific techniques in terms of the problem to be resolved. |

## 5. Objectives or Learning Outcomes

**Course learning outcomes**

Description

Programming of a simulator for mobile robots and a real mobile robot, fundamentally in the 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 | A07 A12 F25 | 0.96 | 24 | Y | N | The teacher will focus on the topic and explain its fundamental contents. |
| Computer room practice [ON-SITE] | Practical or hands-on activities | A07 A12 F25 | 0.48 | 12 | Y | N | It consists in the realization, in small groups, of practical exercises and simulations with specific software. |
| Project or Topic Presentations [ON-SITE] | Group Work | A07 A12 F25 | 0.24 | 6 | Y | N | It will consist of the exposition of the works carried out in the practices. |
| Progress test [ON-SITE] | Assessment tests | A07 A12 F25 | 0.4 | 10 | Y | N | They will consist of tests related to both theoretical aspects and practical application. |
| Final test [ON-SITE] | Assessment tests | A07 A12 F25 | 0.16 | 4 | Y | Y | It will deal with the whole subject evaluating its theoretical and practical aspects. |
| Workshops or seminars [ON-SITE] | Workshops and Seminars | A07 A12 F25 | 0.16 | 4 | Y | N | It will consist of two simnars for describing the software tools necessary to undertake the practices. |
| Study and Exam Preparation [OFF-SITE] | Self-study | A07 A12 F25 | 3.6 | 90 | Y | 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 |
|---|---|---|---|
| Oral presentations assessment | 10.00% | 10.00% | The effort made by the student in exhibiting the work done in the internship will be valued. |
| 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. |
| Test | 50.00% | 50.00% | Up to four progress tests will be taken. Each of these progress tests must be passed with at least 4 out of 10. It is essential to obtain an average of 4 out of 10 or more in all the progress tests. |
| **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 includes all the subjects not passed during the course.
    **Non-continuous evaluation:**
        The final exam includes all the subjects of the course.
**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.
No note is kept of the activities carried out during any previous course.

## 9. Assignments, course calendar and important dates

| Not related to the syllabus/contents | |
|---|---|
| **Hours** | **hours** |

| Activities | Hours |
|---|---|
| Computer room practice [PRESENCIAL][Practical or hands-on activities] | 12 |
| Project or Topic Presentations [PRESENCIAL][Group Work] | 6 |
| Progress test [PRESENCIAL][Assessment tests] | 10 |
| Final test [PRESENCIAL][Assessment tests] | 4 |
| Workshops or seminars [PRESENCIAL][Workshops and Seminars] | 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 |

**Unit 6 (de 12): Robot Vision**

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Lectures] | 2 |

**Unit 7 (de 12): Motion Planning**

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Lectures] | 2 |

**Unit 8 (de 12): Localisation and Mapping**

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Lectures] | 2 |

**Unit 9 (de 12): Robot Navigation**

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Lectures] | 2 |

**Unit 10 (de 12): Learning in Mobile Robots**

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Lectures] | 2 |

**Unit 11 (de 12): Multi-Robot Systems**

| Activities | Hours |
|---|---|
| Class Attendance (theory) [PRESENCIAL][Lectures] | 2 |

**Global activity**

| Activities | hours |
|---|---|
| Workshops or seminars [PRESENCIAL][Workshops and Seminars] | 4 |
| Final test [PRESENCIAL][Assessment tests] | 4 |
| Project or Topic Presentations [PRESENCIAL][Group Work] | 6 |
| Computer room practice [PRESENCIAL][Practical or hands-on activities] | 12 |
| Progress test [PRESENCIAL][Assessment tests] | 10 |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 24 |
| Study and Exam Preparation [AUTÓNOMA][Self-study] | 90 |

**Total horas:** 150

## 10. Bibliography and Sources

| Author(s) | Title/Link | Publishing house | City | ISBN | Year | Description |
|---|---|---|---|---|---|---|
| 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. Scavicco, L. Villani, G. Oriolo | Robotics: Modelling, Planning and Control | Springer | | 978-1-84628-641-4 | 2009 | Chapters 5 and 11-12 |
| F. Fahimi | Autonomous Robots: Modeling, Path Planning, and Control | Springer | | 978-0-387-09537-0 | 2009 | Chapter 6 |
| F. Torres, J. Pomares, P. Gil, S.T. Puente, R. Aracil | Robots y Sistemas Sensoriales | Prentice Hall | | 84-205-3574-5 | 2002 | Chapters 6-7, 11 and 14 |
| | http://journalfieldrobotics.org/Home.html | | | | | |
| | http://www.elsevier.com/wps/find/journaldescription.cws_home/505622/description | | | | | |
| S. Thrun, W. Burghard, 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 | |