Teaching Guide				
Identifying Data				2023/24
Subject (*)	Mobile Robotics		Code	770538020
Study programme	Máster Universitario en Informática Industrial e Robótica			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Optional	3
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Ciencias da Computación e Tecnoloxías da InformaciónEnxeñaría IndustrialEnxeñaría Naval e Industrial			
Coordinador	Bellas Bouza, Francisco Javier	E-mail	francisco.bellas@udc.es	
Lecturers	Bellas Bouza, Francisco Javier Prieto Garcia, Abraham Quintián Pardo, Héctor	E-mail	francisco.bellas@udc.es abraham.prieto@udc.es hector.quintian@udc.es	
Web				
General description	The aim of the course is to provide a global vision of the problems to be dealt with and the existing solutions in the operation of mobile robots in industry, focusing on their autonomous operation. The course has a clearly practical focus, and the theoretical concepts will be worked on in a practical way through the programming of rolling robots, both real and simulated.			

Study programme competences	
Code	Study programme competences
A1	CE01 - Capacidad para aplicar técnicas de análisis de datos y técnicas inteligentes en robótica y/o informática industrial
A4	CE04 - Capacidad para uso y desarrollo de código y librerías que permitan captar el entorno y actuar sobre él en sistemas robóticos y/o industriales
B2	CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio
B5	CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.
B9	CG4 - Extraer, interpretar y procesar información, procedente de diferentes fuentes, para su empleo en el estudio y análisis
B10	CG5 - Capacidad para proponer nuevas soluciones en proyectos, productos o servicios
B14	CG9 - Aplicar conocimientos de ciencias y tecnologías avanzadas a la práctica profesional o investigadora
C1	CT01 - Adquirir la terminología y nomenclatura científico-técnica para exponer argumentos y fundamentar conclusiones
C3	CT03 - Aplicar una metodología que fomente el aprendizaje y el trabajo autónomo

Learning outcomes			
Learning outcomes	Study programme competences		
Knowledge of the particularities of mobile robots in the context of industrial robotics, and in particular of autonomous mobile robots.	AC1 AC4	BC2 BC5 BC9 BC10 BC14	CC1 CC3
Knowledge of the physical principles of sensors used in autonomous robot navigation, and their application contexts.	AC1 AC4	BC9 BC14	CC1 CC3
Knowledge of the problems and main solutions in trajectory planning and autonomous navigation.	AC1 AC4	BC9 BC14	CC1 CC3
Knowledge of the main static and dynamic modelling techniques of the environment in which robots move.	AC1 AC4	BC9 BC14	CC1 CC3

Knowledge of the problems and the main existing solutions in localisation and mapping.	AC1 AC4	BC9 BC14	CC1 CC3

Contents	
Topic	**Sub-topic**
Introduction to mobile robotics	Kinematics of mobile robots Locomotion: - Motors - Degrees of freedom - Legs - Wheels - Other effectors
Perception in mobile robotics	- Types of sensors - Sensors in mobile robotics -- Contact -- Distance -- Computer vision -- IMU -- GPS - Control architectures -- Deliberative -- Reactive -- Hybrid -- Communications
Movement control	- Position control system
Localization and mapping	- Navigation: -- Topological -- Metric - Simultaneous localisation and mapping -- Localisation (odometry, beacons) -- Visual SLAM
Trajectory planning and navigation	- Graph search - Wavefront-based planning

Planning				
Methodologies / tests	**Competencies**	**Ordinary class hours**	**Student?s personal work hours**	**Total hours**
Guest lecture / keynote speech	B5 B9 C3 C1	10.5	4.5	15
ICT practicals	B2 B5 B9 B10 B14 C1 C3	10	10	20
Oral presentation	A1 A4 B9 B10 B14	0.5	6.5	7
Supervised projects	A1 A4 B2 B10 B14 C1 C3	0	30	30
Personalized attention		3	0	3
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**

Guest lecture / keynote speech	Oral presentation of the theoretical syllabus by the teachers of the course.
ICT practicals	Face-to-face sessions with the computer in which teachers will explain the use and programming of the mobile robotics techniques seen in theory, so that students acquire sufficient skills to use them autonomously. Real and/or simulated robots will be used.
Oral presentation	Theory paper(s) on a topic proposed by the teachers of the course, which must be presented in front of classmates and also handed in in writing.
Supervised projects	Carrying out work/projects outside the classroom in which different programmes related to the topics seen in practical classes will be implemented through ICT, using real or simulated robots selected by the subject teachers. These projects will be carried out autonomously by the students and their progress will be supervised by the lecturers.

Personalized attention	
Methodologies	**Description**
Supervised projects ICT practicals	During the practical work through ICT, the student will be able to consult the teacher about all the doubts that may arise regarding the programming of the robots. Tutored work: we recommend the use of personalised attention in these activities to resolve conceptual or procedural doubts that may arise during the resolution of practical problems. In addition, personalised attention will also focus on the student's explanation of the proposed solution. Oral presentation: students will have to go to the teachers to resolve any doubts they may have about the preparation of the work to be presented, both in terms of the content and the presentation itself. Students enrolled part-time will have an online personalised communication channel in all the methodologies.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Supervised projects	A1 A4 B2 B10 B14 C1 C3	Several practical tasks will be proposed throughout the course focused on solving mobile robotics problems using real or simulated robots. These tasks will be developed autonomously by the student outside the classroom and must be defended in front of the lecturers.	70
Oral presentation	A1 A4 B9 B10 B14	The oral presentation of the theoretical work/works, the written version of the same and the active participation in the presentations of the classmates have an important weight in the final grade of the course.	20
Guest lecture / keynote speech	B5 B9 C3 C1	During the lectures, in person activities will be carried out to reinforce the comprehension of the theoretical aspects.	10

Assessment comments

In order to obtain a pass in this subject, a minimum mark of 50 must be obtained in all the above methodologies, with a minimum mark of 35 in the Tutored Work and 15 in the Oral Presentation.
If the student does not pass the subject at the first sitting, he/she will have to repeat the necessary activities of the methodology/s that were not passed at the second sitting. As an example, if a student passed the Oral Presentation part but failed the Supervised Assignments, he/she will have to repeat the practical assignments necessary to achieve a pass, normally those that were not passed individually.
Assessment of the extraordinary call: students who opt for this call will have to carry out the tutored work and oral presentation methodologies.
Students must contact their teachers at the beginning of the term (January) in order to have enough time to submit their work.
Students enrolled on a part-time basis must carry out the tutored work and oral presentation methodologies. In case of not being able to do the oral presentation with the rest of the students, they will have to arrange an alternative date with the professors in all the sessions. It is necessary to contact the lecturers at the beginning of the term (January) in order to have a sufficient deadline.
In the case of plagiarism in internships or teaching assignments, article 11, section 4 b) of the UDC Student Disciplinary Regulations will be taken into account:
b) Failure grade in the exam session in which the offence is committed and with respect to the subject in which it is committed: the student will be graded with a "fail" (numerical grade 0) in the corresponding exam session of the academic year, whether the offence is committed on the first or second occasion. To this end, the student's grade will be modified at the first opportunity, if necessary.

Sources of information	
Basic	- Kelly, Alonzo (2013). Mobile robotics: mathematics, models and methods. Cambridge University Press - Nehmzow, Ulrich (2003). Mobile robotics a practical introduction. Springer - ? Siegwart, Roland (2004). Introduction to autonomous mobile robots. MIT Press
Complementary	- Joseph, Lentin (2015). Learning robotics using Python : design, simulate, program, and prototype an interactive autonomous mobile robot from scratch with the help of Python, ROS, and Open-CV. Packt Publishing - Robin R. Murphy (2000). Introduction to AI Robotics. A Bradford Book - Lynch, Kevin (2017). Modern robotics : mechanics, planning, and control. Cambridge University Press

Recommendations
Subjects that it is recommended to have taken before
Autonomous Robotics Applications/770538015 Machine Vision I/770538018 Introduction to Python for Engineers/770538011 Smart Robotics and Autonomous Systems/770538005
Subjects that are recommended to be taken simultaneously
Introduction to Python for Engineers/770538011 Machine Learning I/770538016
Subjects that continue the syllabus
Other comments
-According to the different regulations applicable to university teaching, the gender perspective must be incorporated into this subject.-Work will be done to identify and modify sexist prejudices and attitudes and influence the environment to modify them and promote values of respect and equality.-Situations of gender discrimination should be detected and actions and measures should be proposed to correct them.In order to help achieve a sustainable environment and fulfil the objective of the Green Campus Action Plan, the delivery of the documentary work carried out in this area:- Virtual format or digital support will be requested.- They'll be done on the Virtual Campus without printing them.In case they?re done in paper:- Don't use plastics.- Use double-sided printing.- Use recycled paper.- Avoid printing drafts.