UNIVERSIDADE DA CORUÑA

Teaching Guide			
Identifying Data			**2022/23**
Subject (*)	Robotics	**Code**	614G01098
Study programme	Grao en Enxeñaría Informática		

Descriptors				
Cycle	**Period**	**Year**	**Type**	**Credits**
Graduate	2nd four-month period	Fourth	Optional	6

Language	Spanish		
Teaching method	Face-to-face		
Prerequisites			
Department	Ciencias da Computación e Tecnoloxías da InformaciónComputación		
Coordinador	Santos Reyes, Jose	**E-mail**	jose.santos@udc.es
Lecturers	Becerra Permuy, Jose Antonio Bellas Bouza, Francisco Javier Paz López, Alejandro Santos Reyes, Jose	**E-mail**	jose.antonio.becerra.permuy@udc.es francisco.bellas@udc.es alejandro.paz.lopez@udc.es jose.santos@udc.es
Web			
General description	This course is focused in the main concepts of autonomous robotics, emphasizing the automatic design of control strategies. The specific contents range from the classical control approaches to the newest based on computational intelligence principles, like artificial neural networks, evolutionary algorithms and reinforcement learning.		

Study programme competences	
Code	**Study programme competences**
A43	Capacidade para adquirir, obter, formalizar e representar o coñecemento humano nunha forma computable para a resolución de problemas mediante un sistema informático en calquera ámbito de aplicación, particularmente os relacionados con aspectos de computación, percepción e actuación en ambientes ou contornos intelixentes.
B1	Capacidade de resolución de problemas
B3	Capacidade de análise e síntese
B9	Capacidade para xerar novas ideas (creatividade)
C6	Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C8	Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

Learning outcomes			
Learning outcomes	**Study programme competences**		
Develop an autonomous control system for its operation in a real environment	A43	B1	C6
Know the non-resolved problems in autonomous robotics	A43	B1 B9	C6 C8
Know the problems of sensing and actuation in systems that operate in the real world and real time	A43	B1	C6
Know the problems of knowledge representation in autonomous robotics	A43	B1 B9	C6
Know the problems to tackle when an autonomous robotic control system is developed	A43	B1 B3 B9	C6 C8

Contents	
Topic	**Sub-topic**

Introduction to autonomous robotics	¿What is an autonomous robot? History Sensors and actuators Behaviors Planning Learning and evolution
Elements of a robotic system	Robotic system Actuators and effectors Sensors Control architectures
Behavior-based robotics	Antecedents Classical control architectures Control architectures
Knowledge-based robotics	Knowledge Traditional deliberative robotics Navigation
Hybrid approximations	Main hybrid architectures Cognitive robotics
Evolutionary robotics	Evolutionary algorithms Application to robotics
Learning in autonomous robotics	Learning in classifier systems Reinforcement learning: Q-learning Combination of reinforcement and connectionist learning

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Laboratory practice	A43 B1 B9	21	21	42
Supervised projects	B1 B3 B9 C6 C8	0	30	30
Guest lecture / keynote speech	C6 C8	20	20	40
Objective test	B3 C6	1	0	1
Oral presentation	B3 B9 C8	4	28	32
Personalized attention		5	0	5
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Laboratory practice	Lab. sessions in which the teachers will explain the robotic platform and its development software in detail. Moreover, in these programming exercises must be developed, using the selected robotic platform, some of the techniques taught in theory classes. These exercises will be carried out in an autonomous way and their progress will be supervised by the teachers.
Supervised projects	Theory work or works on a topic proposed by the teachers of the subject that must be developed by the students, individually or in groups, as determined by the teachers and with the indicated delivery dates. The most important work is the development (in a group) of a topic throughout the course, of which a final memory will have to be delivered, in addition to a final presentation (presentation that is part of the test or final exam).
Guest lecture / keynote speech	Oral presentation of the theoretical themes by the teachers of the subject.

Objective test	Multiple choice test or multiple choice questionnaire that is done online at the end of the theory sessions, in order to assess the degree of participation, attention and understanding of the concepts explained by the teacher. Moodle, Microsoft Forms, Kahoot or other similar tools can be used.
Oral presentation	Theory work or works on a topic proposed by the teachers of the subject that must be presented in front of the classmates and also delivered in writing.

Personalized attention	
Methodologies	**Description**
Oral presentation Laboratory practice Supervised projects	During the lab practices and tutorials, the student can consult the teacher all the doubts that appear about the realization of the formulated practical problems or about the use of the simulator or the real robot. Supervised projects: It is recommendable the use of a personal assistance in these activities to resolve conceptual doubts or procedures than can appear during the resolution of the practical problems. Also, the personal assistance will be focused on in the explanation, by the student, of the proposed solution. Oral presentation: the students' progress in their theoretical work must be supervised by the teachers, both in terms of contents and format.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Oral presentation	B3 B9 C8	The oral presentation of the theoretical work / papers proposed by the teachers is part of the final exam evaluation. It is necessary to obtain a passing grade in the sum of supervised projects+ oral presentation independently (minimum grade of 5 considering that it is valued from 0 to 10) in order to pass the course.	20
Laboratory practice	A43 B1 B9	One or more practices that will be carried out individually or in groups, as indicated by the teachers. They will span more than a week and may require additional work outside the classroom. It is necessary to obtain a pass grade in this methodology independently (minimum grade of 5 considering that it is valued from 0 to 10) in order to pass the course.	50
Supervised projects	B1 B3 B9 C6 C8	One or more theoretical works will be proposed throughout the course that will be developed autonomously, or in a group, by the student / group outside the classes and that must be defended before the teachers. The main work will be carried out in groups throughout the course, and a final report must be submitted. This work should be presented by the group in class, forming part of the evaluable oral presentation. It is necessary to obtain a passing grade in the sum of supervised projects+ oral presentation independently (minimum grade of 5 considering that it is valued from 0 to 10) in order to pass the course.	20
Objective test	B3 C6	The understanding of the concepts explained by the teacher in the master sessions implies that the students participate actively in the classes, raising doubts and making the most of personal interaction. This understanding is valued in the final grade of the subject through the online questionnaires that are carried out in the final minutes of each magisterial session.	10

Assessment comments

The evaluation of this subject is based on the overcoming of the main methodologies (laboratory practices, supervised projects + oral presentation) independently. The first is focused on the practical demonstration of the knowledge and skills acquired to solve problems in autonomous robotics, and the second on the realization and presentation of works on a specific topic within the theoretical part. Thus, in the event that the student does not pass the subject in the ordinary period, they must repeat all the activities of the method/s that were not passed in the ordinary period. As an example, if a student approved the part of the supervised projects + oral presentation, but failed in laboratory practices, they should repeat the latter. Students enrolled part-time in the subject and those who choose to appear in the early call (December) must perform all methodologies except the objective test. The value of Supervised projects is added to that of laboratory practices, the latter becoming worth 60%. It is necessary for students to contact the teachers at the beginning of the semester to have adequate delivery margins. In accordance with article 14, sections 1 and 3 of the regulations for the evaluation, review and claim of the qualifications of the university degree and master's degree studies, the latest version of which is dated June 29, 2017, the copy or attempted copy (or any improper behavior) during a test will imply the qualification of failure with a 0 in the two opportunities of the annual call. According to article 14, section 4 of the same regulations, plagiarism of any work will imply the qualification of failure with a 0 in that work.

Sources of information	
Basic	- Arkin, R.C. (1998). Behavior Based Robotics. MIT Press - Santos, J., Duro, R.J. (2005). Evolución Artificial y Robótica Autónoma. RA-MA - Mataric, Maja J. (2007). The Robotics Primer. MIT Press - Bekey, A. (2005). Autonomous Robots. MIT Press
Complementary	- Pfeifer, R. and Scheier, C. (1999). Understanding Intelligence. MIT Press - Floreano, D. and Mattiussi, C. (2008). Bio-Inspired Artificial Intelligence. Tema 7. MIT Press - Nolfi, S., Floreano, D. (2000). Evolutionary Robotics. MIT Press - Santos, J. (2007). Vida Artificial. Realizaciones Computacionales. ServicioPublicaciones UDC - Salido, J. (2009). Cibernética aplicada. Robots educativos. Ra-Ma - Sutton, R.S., Burton A.G. (1998). Reinforcement Learning. MIT Press - Thurn, S., Burgard, W., Fox, D. (2005). Probabilistic Robotics. MIT Press

Recommendations
Subjects that it is recommended to have taken before
Intelligent Systems/614G01020 Knowledge Representation and Automatic Reasoning/614G01036 Intelligent Systems Development/614G01037 Machine Learning/614G01038
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
To help achieve a sustainable environment and meet the objective of action number 5: Healthy and sustainable environmental and social teaching and research; Green Campus Ferrol Action Plan; the delivery of the documentary works carried out in this course:1. It will be requested in virtual format and/or computer support.2. It will be done through Moodle, in digital format without the need to print them.3. On paper:- Plastics will not be used;- Double-sided prints will be made.- Recycled paper will be used.- Draft printing will be avoided.