Teaching Guide				
Identifying Data				2019/20
Subject (*)	Kinematics and Dynamics of Industrial Robots		Code	730497228
Study programme	Mestrado Universitario en Enxeñaría Industrial (plan 2018)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	Second	Optional	3
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Naval e Industrial			
Coordinador	Ramil Rego, Alberto	E-mail	alberto.ramil@udc.es	
Lecturers	Ramil Rego, Alberto	E-mail	alberto.ramil@udc.es	
Web				
General description	Acquire the basic knowledge that allows a kinematics and dynamics of robotic manipulators. Develop applications using computer tools.			

Study programme competences	
Code	Study programme competences
B1	CB6 - Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context.
B2	CB7 - That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of ??study.
B6	G1 - Have adequate knowledge of the scientific and technological aspects in Industrial Engineering.
B13	G8 - Apply the knowledge acquired and solve problems in new or unfamiliar environments within broader and multidisciplinary contexts.
C1	ABET (a) - An ability to apply knowledge of mathematics, science, and engineering.
C3	ABET (c) - An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
C8	ABET (h) - The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
C11	ABET (k) - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Learning outcomes			
Learning outcomes	Study programme competences		
Acquire the basic knowledge that allows a kinematics and dynamics of robotic manipulators.		BJ1 BJ2 BJ6 BJ13	CJ1 CJ11
Develop applications using computer tools.		BJ2 BJ13	CJ3 CJ8 CJ11

Contents	
Topic	Sub-topic

1. Introduction	1.1 Introduction 1.2 Classification of manipulators 1.3 Rotation matrices. Representation by means of axis-angle; Angles (Roll-Pitch-YaW); Euler angles and quaternions. 1.4 Homogeneous transformations. 1.5 Composition of transformations
2. Direct Kinematics	2.1 Direct Kinematics. 2.2 Denavit-Hartenberg Convention. 2.3 Obtaining transformation matrices. 2.4 Speeds and rotations. 2.5 Jacobian of the manipulator. 2.6 Singularities.
3. Manipulator Dynamics	3.1 Dynamics of the manipulator. 3.2 Newton-Euler and Euler-Lagrange equations. 3.3 Movement control.
4. Reverse Kinematics.	4.1 Reverse Kinematics. 4.2 Ambiguities. 4.3 Application to an arm with 6 DOF.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	B6 C1 C8 C11	8	16	24
Problem solving	B13 B6 C11 C1	4	14	18
ICT practicals	B1 B2 B13 C3 C11	6	24	30
Mixed objective/subjective test	B6 C11 C1	3	0	3
Personalized attention		0	0	0
(*)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 complemented with the use of audiovisual media to develop the program of the subject and make explanations and examples that allow the understanding of the principles of the subject to be able to apply them to practical examples.
Problem solving	Resolution of problems corresponding to the different subjects of the program in order to understand the theoretical principles and know their practical application, comparing different methods highlighting the advantages of each.
ICT practicals	Application of various computer applications to facilitate calculations in solving problems and illustrate the results with simulations of movements of different manipulators.
Mixed objective/subjective test	It is a written test consisting of 2 parts (theory and problems) of approximately 1 and 2 hours, with a maximum total duration of 3 hours. The theory test will have 5 to 10 questions of diverse amplitude and degree of concretion on the contents of the program. The practical type test will consist of the resolution of 1 to 10 problems of varying complexity on the contents of the program.

Personalized attention	
Methodologies	Description

Guest lecture / keynote speech Problem solving ICT practicals Mixed objective/subjective test	It is recommended that all students attend tutorials to clarify issues related to the session as well as the solution of problems and practices.

Assessment			
Methodologies	Competencies	Description	Qualification
Problem solving	B13 B6 C11 C1	Orally and/or written presentation of problems proposed.	20
ICT practicals	B1 B2 B13 C3 C11	Orally and/or written presentation of problems and simulations made with the computer.	10
Mixed objective/subjective test	B6 C11 C1	The mixed test consists of two parts: theory and problems. In the theory part the knowledge of the contents of the subject is valued as well as the reasoned exposition of the theoretical developments. In the part of problems will be assessed both the approach and the development applied to the specific case to obtain the solution. The dates of these tests will be those that appear in the exam calendar and course planning published by the center.	70

Assessment comments
Only students who do not participate in mixed tests will be rated as NOT PRESENTED. Academic dispensation in this matter is not admitted. The evaluation criteria of the 2nd opportunity are the same as those of the 1st opportunity.

Sources of information	
Basic	- Carl D. Crane III and Joseph Duffy (1998). Kinematic analysis of robot manipulators. Cambridge University Press - Mark W. Spong, M. Vidyasagar (1989). Robot dynamics and control. John Wiley & Sons. New York
Complementary	- Tadej Bajd, Matjaz Mihelj, Marko Munih (2013). Introduction to robotics. Dordrecht: Springer - Siciliano, Bruno; Khatib, Oussama (2008). Springer handbook of robotics. Berlin: Springer - Craig, John J. (2005). Introduction to robotics: mechanics and control. Pearson Educacion Internacional - Asada, Haruhiko; Slotine, Jean-Jacques E. (1986). Robot analysis and control. New York: John Wiley and sons - Thomas R. Kurfess (2004). Robotics and Automation Handbook 1st Edition. CRC Press

Recommendations
Subjects that it is recommended to have taken before
Biomechanics/730497227
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
It must make a sustainable use of resources and the prevention of negative impacts on the natural environment.

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.