Teaching Guide				
Identifying Data				2020/21
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.			
Contingency plan	1. Modifications to the contents - No changes 2. Methodologies *Teaching methodologies that are maintained - Master session (using the remote training tools available at the UDC) - Troubleshooting (using the remote training tools available at the UDC) - Practices through ICT (using the remote formation and videoconference tools available at the UDC) * Teaching methodologies that are modified - No changes 3. Mechanisms for personalized attention to students - Tutorials by TEAMS weekly - Email: weekly 4. Modifications in the evaluation - No changes *Evaluation observations: - None 5. Modifications to the bibliography or webgraphy - None			

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 C1 C11	4	14	18
ICT practicals	B1 B2 B13 C3 C11	6	12	18
Supervised projects	B1 B2 B13 B6 C1 C3 C11	3	12	15
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.
Supervised projects	Objective test of resolution of a practical case of development of an application with the robot that allows a continuous evaluation of the degree of acquisition of the different competences including theoretical knowledge and the use of different computer applications. The student must follow a series of steps that will be supervised by the teacher, delivering each of them in electronic format.

Personalized attention	
Methodologies	**Description**
Supervised projects Guest lecture / keynote speech Problem solving ICT practicals	It is recommended that all students attend tutorials to clarify issues related to the session as well as the solution of problems and supervised project.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Supervised projects	B1 B2 B13 B6 C1 C3 C11	Delivery in electronic format of the solution of the different steps of the practical work.	80
Problem solving	B13 B6 C1 C11	Orally and/or written presentation of problems proposed.	20

Assessment comments
Only students who do not deliver the supervised work will be classified as NOT PRESENTED. Academic dispensation is not allowed in this matter. The evaluation criteria for the 2nd chance are the same as for the 1st chance. The evaluation criteria of the advanced call will be the same as those of the 1st opportunity. The fraudulent performance of the tests or evaluation activities will directly imply the qualification of failure 0 in the matter in the corresponding call, thus invalidating any qualification obtained in all the evaluation activities for the extraordinary call

Sources of information	
Basic	- Mark W. Spong, M. Vidyasagar (2006). Robot dynamics and control. John Wiley & Sons. New York - Corke, Peter. (2017). Robotics, vision and control : fundamental algorithms in MATLAB. Springer - Siciliano, Bruno; et al. (2010). Robotics : modelling, planning and control. Advanced textbooks in control and signal processing (Springer) - Kevin Lynch, Frank C. Park (2017). Modern robotics : mechanics, planning, and control. Cambridge University Press - Carl D. Crane III and Joseph Duffy (1998). Kinematic analysis of robot manipulators. Cambridge University Press
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.