

[MRC101] ROBOTICS: MECHANICS, MODELLING AND SIMULATION

GENERAL INFORMATION

Studies	Master's Degree in ROBOTICS AND CONTROL SYSTEMS		Subject	?	
Semester	1	Course	1	Mention / Field of specialisation	
Character	COMPULSORY				
Plan	2023	Modality	Face-to-face	Language	CASTELLANO/EUSKARA
Credits	5	Hours/week	0	Total hours	50 class hours + 75 non-class hours = 125 total hours

PROFESSORS

ANDONEGI ARTEGUI, IMANOL
RUIZ GARATE, VIRGINIA

REQUIRED PREVIOUS KNOWLEDGE

Subjects	Knowledge
(No specific previous subjects required)	[!] Algebra lineal

LEARNING RESULTS

LEARNING RESULTS	KC	SK	AB	ECTS
M1R210 - [!] <i>Modelar y simular la cinemática y la dinámica de robots de diferentes tipos en entornos industriales</i>			x	3,8
M1R223 - [!] <i>Capacidad de trabajar en equipos multidisciplinares y en un entorno multilingüe y de comunicar, tanto de forma oral como escrita, conocimientos, procedimientos, resultados e ideas relacionadas con los temas afines al máster</i>		x		0,32
M1R224 - [!] <i>Capacidad para ejercer su profesión con actitud cooperativa y participativa, y con responsabilidad social</i>		x		0,28
M1R229 - To possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous		x		0,6
			Total:	5

KC: Knowledge or Content / SK: Skills / AB: Abilities

CONTENTS

1 Introduction & Course Overview 2 Basic concepts for robotics I Mechanisms Definition Characteristics: payload, reach, precision, repeatability Anatomy of a robotic manipulator: Links, Joints, Actuators / Arm, wrist, end-effector Kinematic chain: serial/parallel, open/closed, planar chains Types of Industrial robots: cartesian/gantry, cylindrical, spherical. SCARA, articulated/anthropomorphic Basic problems of Manipulation: defining FK, IK, VK and Dynamics Refreshment of maths: Cartesian space Vectors and unit vectors Scalar and vector product: rotations Representation of matrices 3 Basic concepts for robotics II Mobility: Grübler-Kutzbach formula Workspace: reachable vs dexterous Joint/configuration space, actuator space and Task/cartesian space: redundant robots 4 Rigid motion and homogeneous transformations I Representing Pose: vectors Right handed coordinate frame Displacement between frames Rotation between frames Rotation matrix: 2D & 3D: dot product and properties Euler angles (ZXZ, ZYZ, ZYX) RPY from homogeneous transformation matrix Quaternions Composition of rotations (fixed vs consecutive frame) 5 Rigid motion and homogeneous transformations II Velocities and accelerations: Linear and angular velocities Accelerations Velocity propagation The Skew-symmetric matrix 6 Rigid motion and homogeneous transformations III Mapping of frames (rot+transl) Homogeneous transformations Inverse transformations Compound transformations (fixed vs consecutive frame) 7 Forward Kinematics I Goal of FK Trigonometric approach Compositions of homogeneous transformation matrices Intro to DH 8 Forward Kinematics II Exponentials formulation Definition 9 Forward Kinematics III Exponentials formulation Screw axes in the base frame Screw axes in the end-effector frame 10 Inverse kinematics I Goal of IK Introducing redundancy and solvability Closed form solutions: analytical à algebraic & geometry Numerical (iterative) solution: Newton-raphson method & pinv (PBL) 11 Inverse kinematics II Jacobian-based solution (intro) 12 Velocity kinematics & Jacobian I Jacobian Differential motion Jacobian: manipulator, space and body Manipulability 13 Velocity kinematics & Jacobian II Singularities Implications Types: boundary and internal Analysis Glympse into statics: Jacobian for Force/Torque relationships 14 Trajectories Path & Trajectory Path selection Trajectory generator Path generation - Joint space Definition Smoothness Polynomial: cubic quintic Linear: parabolic blends Via points: blends, path motion 15 Joint space trajectories Path generation - Cartesian space Joint-interpolated movement Straight-line movement

LEARNING RESOURCES AND BIBLIOGRAPHY

Learning resources	Bibliography
--------------------	--------------

Subject notes

Technical articles

Moodle Platform

Specific Master Software

http://katalogoa.mondragon.edu/janium-bin/janium_login_opac_re_in
k.