Universidad Carlos III de Madrid

COURSE: Industrial Robotics		
GRADO: Ingeniería Industrial Electrónics and Automation Engineering	YEAR:3	TERM:2nd

WEEKLY PROGRAMMING

SELECTURES LECTURES WEEK	SE-SSION	DESCRIPTION	GROUPS		Special room for session (computer classroom, audio-visual classroom…)	IS IT A SESSION WITH TWO PROFESSORS (*)	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURES	SEMINAR			DESCRIPTION	CLASS HOURS	HOMEWORK HOURS Maximum 7 H
1	1	Course guidelines and methodology introduction Robotics introductory preliminary lecture 1. Methodology explanation 2. Evaluation procedures and criteria 3. Basic concept 4. Ethical issues and basis rules	X			No	Personal work about lesson. Proposed exercises. Discussion	1,5	3
1	2	Definitions (Industrial and service robotics) Historical perspective (robotic generations) Modern Robot markets and trends. - Industrial Robotics - Service robotics		X		No	Personal work about lesson. Proposed exercises. Discussion	1,5	
2	3	Robotics Morphology : electro-mechanical issues 1. Structure 2. Classical configurations 3. Mechanical Sub-system 4. End effectors	X			No	Personal work about lesson. Proposed exercises. Discussion	1,5	3

2	4	Solution of proposed exercises. Mechanical structure exercises. Several analysis from structural point of view would be done, to clarify concepts and be able to identify common electromechanical configurations, morphological recognition, and develop skills to select optimal structure for each application dependent requisites.		X		No	Personal work about lesson. Proposed exercises. Discussion	1,5	
3	5	Robot Morphological Analysis: mechatronics focusing 1. Actuators 2. Position and speed sensors 3. Homing sensors and homing procedures, switch limits (end of travel indicators) sensors. 4. Safety specific sensors 5. External sensors	X			No	Personal work about lesson. Proposed exercises. Discussion and conceptual review: industrial robotics core components: Actuators and internal sensors, Distributed I/O.	1,5	3
3	6	Solution of proposed exercises. Actuators selection , design of sensory system, internal (propio) and external sensor design. Signal types and requirements		X		No	Personal work about lesson. Proposed exercises for discussion and conceptual review: Internal and internal safety assurance strategies, failure modes recognition anomaly working modes,...	1,5	
4	7	Control architectures: typical configurations analysis: Hardware and Software approaches 1. Basic architectures : main functionalities 2. Multiprocessor Architectures 3. Communications and meta-controllers	X			No	Personal work about lesson. Proposed exercises: Control Unit, modern architectures characterization, performance analysis , real time requisites, distribute control policies.	1,5	3
4	8	Exercises for best control architecture selection		X		No	Personal work about lesson. Proposed exercises	1,5	
5	9	Control system Structures: interfaces 1. basic concepts 2. Man-machine Interfaces 3. Safety levels and assurance 4. External Communications	X			No	Personal work about lesson. Proposed exercises	1,5	3
5	10	Exercises for selection of Man-machine Interfaces Moderns trends and usability analysis		X		No	Personal work about lesson. Proposed exercises	1,5	
6	11	Industrial applications: technological approach 1. Classification 2. Practical Cases 3. Main characteristics a. Working area	X			No	Personal work about lesson. Proposed exercises	1,5	3

		b. Load capacity c. Speed & acceleration. d. Precision, repeatability y resolution							
6	12	Selected exercise resolution about practical approaches using robots.		X		No	Personal work about lesson. Proposed exercises	1,5	
7	13	First evaluation exercise	X			No		1,5	3
7	14	Detailed layout design for specific industries		X		No	Personal work about lesson. Proposed exercises	1,5	
8	15	Kinematics Control intro: mathematical tools 1. Spatial basic concepts 2. Homogeneous matrix 3. Rotation vectors and quaternions	X			No	Personal work about lesson. Proposed exercises	1,5	3
8	16	Selected spatial relationship and matrix exercise resolution		X		No	Personal work about lesson. Proposed exercises.	1,5	
9	17	Kinematics Control: Kinematics model 1. Direct Kinematics 2. Inverse Kinematics	X			No	Personal work about lesson. Proposed exercises	1,5	3
9	18	Proposed exercise of Kinematics relationships.		X		No	Personal work about lesson. Proposed exercises	1,5	
10	19	Kinematics Control: Differential Kinematics model 1. Incremental kinematics model 2. Jacobian kinematics	X			No	Personal work about lesson. Proposed exercises	1,5	3
10	20	Proposed exercise of differential kinematics …		X		No	Personal work about lesson. Proposed exercises	1,5	
11	21	Kinematics Control: trajectory generation methods 1. Articular vs Cartesian 2. Synchronization 3. Polynomial and splines 4. Jacobian based	X			No	Personal work about lesson. Proposed exercises	1,5	3
11	22	Trajectory generation schema's proposed exercises for several robot types		X		No	Personal work about lesson. Proposed exercises.	1,5	
12	23	Dynamic Control approach: 1. Problem statement 2. Euler-Lagrange Formulation 3. Direct and inverse dynamic control problem	X			No	Personal work about lesson. Proposed exercises	1,5	3
12	24	Direct and inverse dynamic exercise resolution for low degrees of freedom robots, mainly planar or simple kinematics models for analytical consideration		X		No	Personal work about lesson. Proposed exercisess.	1,5	

13	25	Robot programing: languages and methodology 1. Classification 2. Programming methods 3. Most used languages	X			No	Personal work about lesson. Proposed exercises.	1,5	3
13	26	RAPID introduction by exercise realization .		X		No	Personal work about lesson. Proposed exercises.	1,5	
14	27	Advanced Programing: I/O, communications ports, external events, external synchronization. Modularization of application.	X			No	Personal work about lesson. Proposed exercises	1,5	3
14	28	Proposed exercise: complete design, setup and programming example for an SCARA robot working on a flexible cell.		X		No	Personal work about lesson. Proposed exercises	1,5	
SUBTOTAL								**42**	**+ 68 = 110**
15		Second evaluation exercise Recoveries, mentoring, job delivery, etc.						3	
16-18		Evaluation work and final statement						3	
TOTAL								**150**	

Experimental LAB scheduling						
Session	**Week**	**SESSION DESCRIPTION**	**Lab room**	**Weekly Student work**		
				DESCRIPTION	**In room hours**	**Weekly hours Máximum 7 H**
1		Practice 1: Handling of an industrial robot, first operation procedures. The students will operate the an ABB industrial robot, to acquire the skills and knowledge about the controller, operating modes, operating states and faults, precautions and safety measures to be considered for programming through guided learning. Different paths will be evaluated by the handler executable commands either from the palette joystick or command line. Identification of relevant information about the positioning, joint and	1.0B06	Review of mechatronics concepts, sensors, control architectures and organization hardware and software applied to industrial robots. (previous activity) Reading Robot's Manual of Operation. Basic data types, methods of problem solving kinematic and dynamic (review). Study of the basic set of instructions in RAPID.	1,5	1,5

		Cartesian coordinate axes and reference systems and expression of the position achieved by the end. Several path and points to store then will be recorded.				
2		Practice 2: Basic programming in RAPID. It tries to make a simple application that allows to develop the knowledge gained in problem sessions Interpreted Programming Language RAPIP for implementation of tasks by interacting directly with the palette of programming: "Teach Pendant" and later editing on your PC. tudents are going to change the parameters of each type of move instruction to verify and discuss the concepts of precision, repeatability, crossing point, reorientation and more.	1.0B06	Review of the organization of application programming, task-level and object level robot (or owner). Modularization and structured programming routines. Review of programming language RAPID ABB. Most frequent instruction execution flow control, motion description, read / write I/ O, communications.	1,5	1,5
3		Lab 3: Advanced Programming RAPID. Students will deepen in the management of the programming high level language RAPID for the setup of typical parts handling applications., including definition of tools and work tools, SDCs. They will use the editing and simulation capabilities of the application ROBOSTUDIO. It must end the practice running an structured routine based application, handling I / O and external interruptions.	1.0B06	Review and expansion of the types of data handled by RAPID. Conversions and forms of storage. Instructions advanced motion control. Routine execution process, function and attention to such interruption.	1,5	1,5
TOTAL						