

Academic Year: (2024 / 2025)

Review date: 04-02-2025

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: GONZALEZ VICTORES, JUAN CARLOS

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Algebra
 Computer programming (C or FORTRAN)
 Control Engineering

LEARNING OUTCOMES

RA1.2: A systematic understanding of the key aspects and concepts of their branch of industrial engineering.
 RA1.3: Coherent knowledge of their branch of industrial engineering including some at the forefront of the branch.
 RA2.1: The ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods.
 RA3.1: The ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements.
 RA3.2: An understanding of design methodologies, and an ability to use them.
 RA4.3: Workshop and laboratory skills.
 RA5.1: The ability to select and use appropriate equipment, tools and methods.
 RA5.2: The ability to combine theory and practice to solve engineering problems.
 RA5.3: An understanding of applicable techniques and methods, and of their limitations.
 CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
 CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
 CG1: Ability to resolve problems with initiative, creativity decision-making and critical reasoning skills, and to communicate and transmit knowledge, skills and abilities in the Industrial Engineering area.
 CG3: Capacity to design a system, component or process in the area of electronic and automatic engineering in compliance with required specifications.
 CG9: Knowledge and capacity to apply computational and experimental tools for analysis and quantification of electronic and automatic engineering problems.
 CE9: Knowledge of principles and applications of robotic systems.

OBJECTIVES

By the end of this subject, students will be able to have:

1. Knowledge and understanding of the key aspects and concepts of industrial robotics and control methods
2. Coherent knowledge of their branch of engineering including some at the forefront of the branch in robotics
3. The ability to apply their knowledge and understanding to identify, formulate and solve problems of industrial robotics using established methods.
4. The ability to apply their knowledge and understanding to develop and realise designs of industrial robotics systems to meet defined and specified requirements.
5. An understanding of design methodologies, and an ability to use them in industrial robotics.

6. Technical and laboratory skills.
7. The ability to select and use appropriate equipment, tools and methods in industrial robotics.
8. The ability to combine theory and practice to solve engineering problems of industrial robotics.
9. An understanding of applicable techniques and methods in robotics, and of their limitations.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
 - 1.1 Definitions and terms
 - 1.2 Historical evolution
 - 1.3 Industrial Robot market and regulations
 - 1.4 Statistics and trends in Industrial Robots Market
2. Morphology and robotic technologies
 - 2.1 Structures and basic configurations
 - 2.2 Review of main sub-systems: mechanical
 - 2.3 Review of main sub-systems: actuators and drives
 - 2.4 Review of main sub-systems: sensors
 - 2.5 End effector and tools
3. Control architecture of Industrial controllers
 - 3.1 Control architecture issues
 - 3.2 Man-machine interface and communications
 - 3.3 Controller functionalities
4. Industrial Robotic Applications
 - 4.1 Classification
 - 4.2 Case Studies
5. Kinematic Control
 - 5.1 mathematical tools
 - 5.2 Kinematic modelling
 - 5.3 Direct and inverse kinematic problem formulation and resolution
 - 5.4 Differential modelling
 - 5.6 Trajectories calculus and generation
 - 5.7 Kinematic control of trajectories
6. Dynamic modelling
 - 6.1 Dynamic Control problem formulation
 - 6.2 Euler-Lagrange formulation
 - 6.3 Direct and inverse dynamics main issues
 - 6.2 Dynamic control issues
7. Programming of robots
 - 7.1 Classification and Programming methods
 - 7.2 Programming languages for commercial robots
 - 7.3 Coordinate systems and spatial references
 - 7.4 Advanced programming concepts and methods with RAPID (ABB)
8. Industrial implantation criteria and relevant issues
 - 8.1 Design aspects for Flexible Manufacturing Cells based on industrial robots and trends
 - 8.2 Safety assurance in Industrial robots
 - 8.3 Introduction to Collaborative Robots

LEARNING ACTIVITIES AND METHODOLOGY

- Lectures, classes in small groups, student presentations, tutorials and personal work, oriented towards acquisition of theoretical knowledge (3 ECTS).
- Lab and exercises in small groups, individual tutorials and personal work, especially by final practice proposal related to simulation and programming of a robotised cell; aimed at the acquisition of practical skills related to the program of the course (3 ECTS).

Practical sessions will be performed:

1. Getting started with ABB industrial robot manipulators and controllers.
2. Robot programming by demonstration and by RAPID.
3. Robot programming by means of simulation.
4. Robot programming of a simple flexible manufacturing system by means of simulation.

ASSESSMENT SYSTEM

% end-of-term-examination:	60
% of continuous assessment (assignments, laboratory, practicals...):	40

The continuous evaluation will be based on the two partial assessment tests (30% + 30%) and the qualification of a simulation exercise (40%). To habilitate the computation of the simulation work score a minimum of 4 points for the media of the two partial assessment must be obtained in order to calculate the continuous assessment score.

If the student does not pass the continuous assessment shall be submitted to the final exam with a 60% exam and 40% of the simulation work; The simulation work assignment is taken into account for extraordinary call (if presented in Ordinary call)

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BASIC BIBLIOGRAPHY

- A. Barrientos, L.F. Peñin, C. Balaguer, R. Aracil Fundamentos de Robotica (2ª edición), McGraw Hill, 1997
- A. Ollero Robótica: manipuladores y robots móviles, Marcombo, 2001
- A. Rentería Robótica Industrial. Fundamentos Y Aplicaciones, McGraw Hill, 2000

ADDITIONAL BIBLIOGRAPHY

- Craig, John J. Introduction to robotics : mechanics and control , Pearson Education, 2014
- Engelberger, J.F. Robotics in service, MIT Press, 1989
- Paul, Richard P Robot manipulators, mathematics, programming, and control: the computer control of robot manipulators, MIT Press, 1981