Industrial Robotics

Academic Year: (2024 / 2025) **Review date: 06-09-2023**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: GONZALEZ VICTORES, JUAN CARLOS

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Algebra
Computer programming

LEARNING OUTCOMES

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.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

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 perform 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, doubts solving 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).

- Lectures, doubts solving 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 (assigments, laboratory, practicals…):	40

The continuous evaluation will be based on the two partial assessment tests (30% + 30%) and the qualification of a programming exercise (40%) . To habilitate the computation of the programming work score a minimum of 4 point 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 programming work; The programming work assignment is taken into account for extraordinary call if presented during the continuous evaluation.

BASIC BIBLIOGRAPHY

- A. Barrientos, L.F. Peñin, C. Balaguer, R. Aracil Fundamentos de Robotica (2ª edicion), 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