Industrial robotics

Academic Year: (2023 / 2024) **Review date: 12/02/2024 12:31:04**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: GONZALEZ VICTORES, JUAN CARLOS

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Algebra
Computer programming (C ,FORTRAN, BASIC)
Control Engineering
Real time computer systems (fundamentals)

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.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE14. Specify and use electronic instrumentation, measurement systems, sensors, techniques and experimental procedures usual and advanced in physics, engineering and biology, including electromechanical and microfluidic microdevices, and design experiments using the scientific method.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.

RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA4. To be able to successfully manage themselves in the complex situations that might arise in their academic or professional fields of study and that might require the development of novel approaches or solutions.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

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. The ability to apply their knowledge and understanding to identify, formulate and solve problems of industrial robotics using established methods.
3. The ability to apply their knowledge and understanding to develop and realise designs of industrial robotics systems to meet defined and specified requirements.
4. An understanding of design methodologies, and an ability to use them in industrial robotics.
5. Technical and laboratory skills.
6. The ability to select and use appropriate equipment, tools and methods in industrial robotics.
7. The ability to combine theory and practice to solve engineering problems of industrial robotics.
8. 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/test:	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 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 edicion), McGraw Hill.

ADDITIONAL BIBLIOGRAPHY

- Craig, John J. Introduction to robotics : mechanics and control , Pearson Education, 2014

- Paul, Richard P Robot manipulators, mathematics, programming, and control: the computer control of robot manipulators, MIT Press, 1981