INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Automation Systems			Field of study	Technological Processes		
Bachelor in	Industrial Management and Engineering			School	School of Technology and Management		
Academic Year	2023/2024	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	1	Code	9104-754-2104-00-23		

Workload (hours)	162	Contact hours	T -	TP 60	PL -	TC -	S -	E -	OT -	O -

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Paulo Jorge Pinto Leitão, Gustavo Silva Funchal

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Understand an automation system as an integrated system supported by several individual and controlled processes cooperating in a distributed architecture.
2. Know the industrial automation technologies and systems, namely programable logic controllers, robotics, numerical control, automatic storage and transport systems, and computer aided tools.
3. Obtain knowledge of industrial robotics, namely in terms of classification, kinematics, sensors and actuators, simulation and typical applications.
4. Operate and program industrial robots.
5. Knowledge about flexible Manufacturing Systems (FMS), Computer Integrated Manufacturing (CIM), and ISA 95 automation control architecture.
6. Obtain knowledge of cyber-physical systems, digital twin, multi-agent systems and RAMI 4. 0 reference architecture.
7. Model and analyze discrete event-driven systems using Petri nets.
8. Design, implement, digitalize and integrate automation equipment, cells or processes at the shop floor level.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Execute operations using Boolean algebra, binary arithmetic and numeration systems.
2. Apply the basic concepts of industrial automation, namely programmable logic controllers.
3. Elaborate computational programs.

Course contents

Introduction to industrial automation systems. Programmable logic controllers. Technologies of industrial automation systems. Computer integrated manufacturing. Integration of manufacturing systems. Industry 4.0 and cyber-physical systems. Modeling discrete event-drive system using Petri nets.

Course contents (extended version)

1. Introduction to industrial automation systems
   - Definition, automation types, production types, production activities and manufacturing functions.
2. Programmable logic controllers (PLC)
   - Architecture and programming using IEC 61131-3 languages.
3. Technologies of industrial automation systems
   - Industrial robotics, numerical control, automatic storage and transport systems.
4. Computer integrated manufacturing
   - Flexible manufacturing systems (FMS), computer integrated manufacturing (CIM).
   - Computational tools to support manufacturing activities (CAD, CAM, CAE, CAPP, etc.).
   - ISA 95 automation control architecture.
5. Integration of manufacturing systems
   - Need for the integration of systems and associated problems.
   - Integration levels. Mechanisms and architectures for integration. Interoperability.
6. Industry 4. 0 and cyber-physical systems
   - Concept, main design principles, benefits and impact.
   - Cyber-physical systems and digital twin.
   - RAMI 4. 0 architecture and digitalization of assets.
7. Modeling discrete event-drive system using Petri nets
   - Modeling analysis and requirements. Modeling languages for discrete event-driven systems.
   - Petri nets: definition, symbology, basic rules and properties.
   - Analysis and validation of Petri nets.
   - Temporized Petri nets. High-level Petri nets.

Recommended reading

1. “Computer integrated manufacturing and engineering”, U. Rembold, B. O. Nnaji, Addison-Wesley, 1993.
2. “Fundamentals of programable logic controllers, sensors and communications”, Jon Stenerson, Regents/Prentice-Hall, 1993.
3. “Industry 4. 0, “The Industrial Internet of Things”, Alasdair Gilchrist, Apress, 2016.
4. “Applications of Petri Nets in Manufacturing Systems. Modelling, Control and Performance Analysis”, Alan A. Desrochers and Robert Y. Al-Jaar, IEEE Press, 1994.
5. “Handbook of Robotics”, B. Siciliano, O. Khatib (eds), Springer, 2nd edition, 2017.

Teaching and learning methods

Theoretical classes: exposition of the proposed topics. Practical classes: realization of exercises and laboratorial works to help to consolidate the expected learning outcomes. Learning complemented with sessions dedicated to research and discussion, to be developed preferentially during the non-presential hours, and which also enhance transversal skills.

Assessment methods

- Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 50% (The approval requires the achievement of a minimum score of 35%.)
  - Laboratory Work - 50% (Considers the results obtained in the laboratory works and the participation in the classrooms.)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Paulo Jorge Pinto Leitão	José Luís Sousa de Magalhaes Lima	António Jorge da Silva Trindade Duarte	José Carlos Rufino Amaro
01-10-2023	11-10-2023	12-10-2023	20-10-2023