INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Automation Systems			Field of study	Automation		
Master in	Industrial Engineering - Mechanical Engineering			School	School of Technology and Management		
Academic Year	2022/2023	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	1	Code	9572-356-1105-00-22		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

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, Jose Fernando Lopes Barbosa

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Know the industrial automation technologies and systems, namely robotics, numerical control, automatic storage and transport systems, production and assembly lines, and computer aided tools.
2. Obtain knowledge of industrial robotics, namely in terms of classification, kinematics, sensors and actuators, and typical applications.
3. Operate and program industrial robots.
4. Knowledge about flexible Manufacturing Systems (FMS), Computer Integrated Manufacturing (CIM), and ISA 95 automation control architecture.
5. Obtain knowledge of lean manufacturing techniques.
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. Technologies of industrial automation systems. Computer integrated manufacturing. Integration of manufacturing systems. Lean manufacturing techniques. 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. Technologies of industrial automation systems
   - Industrial robotics, numerical control, automatic storage and transport systems.
3. 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.
   - Manufacturing control systems.
4. Integration of manufacturing systems
   - Need for the integration of systems and associated problems.
   - Integration levels. Mechanisms and architectures for integration. Interoperability.
   - Service-orientated architectures.
5. Lean manufacturing
   - Definition, types of waste, benefits.
   - Analysis of lean techniques, namely Kanban, Poke-Yoke, 5SSs, SMED and Six Sigma.
6. Industry 4. 0 and cyber-physical systems
   - Concept, main design principles, benefits and impact.
   - Cyber-physical systems and digital twin.
   - Digital technologies, namely IoT, artificial intelligence, HMI and collaborative robots.
   - Multi-agent systems.
   - 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. “Automation, Production Systems and CIM”, M. P. Groover , Prentice-Hall, 1987.
2. "Computer Systems for Automation and Control", Gustaf Olsson, G. Piani, Prentice Hall, 1992.
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	José Alexandre de Carvalho Gonçalves	Paulo Alexandre Vara Alves
02-10-2022	16-10-2022	17-10-2022	05-11-2022