COURSE SYLLABUS
2018-19

GENERAL INFORMATION

Course Information	
Name	Industrial Automation and Robotics
Code	DEA-IND-511
Degree	Master's Degree in Smart Industry (MIC)
Year	1st
Semester	1st (Fall)
ECTS credits	6
Type	Compulsory
Department	Electronics, Automation and Communications
Coordinator	Sergio Luis Asenjo Vegue

Instructor	
Name	Sergio Luis Asenjo Vegue
Department	Electronics, Automation and Communications
Office	Department Common Office - (Alberto Aguilera, 25)
e-mail	sasenjo@comillas.edu
Phone	+34 629 88 35 81
Office hours	Arrange an appointment through email.
Instructor (Laboratory)	
Name	Sergio Luis Asenjo Vegue
Department	Electronics, Automation and Communications
Office	Department Common Office - (Alberto Aguilera, 25)
e-mail	sasenjo@comillas.edu
Office hours	Arrange an appointment through email.

DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

In the professional profile of the Master of Smart Industry, this subject aims to train students in the technologies and methodologies that allow a production system to work automatically, under the point of view of industrial automation.

The subject has a laboratory with practices that deal with process automation and robotics. There are different elements reviewed such as programmable PLCs, HMI systems, identification systems, quality control systems, robots and integration in an automated system, by means of a scale copy of a typical automatic production system.

Prerrequisites

Basic knowledge of programming, mechanics, electrical engineering and electronics.

CONTENTS

Theory
It is covering all the fundamental concepts for the automation of production systems
Unit 1: INTRODUCTION
Introduction. Importance of the automation of an industrial system. Basic concepts: plant, control, operator, sensors, drives, open loop control, closed loop control, continuous processes, discrete processes, mixed processes, batch processing.
Unit 2: ARQUITECTURE OF AN AUTOMATION SYSTEM
Functional and physical architecture of the control of a system. Automation pyramid. Function of each level. Technological elements of each level: sensor networks, fieldbuses, controllers (PLCs), instrumentation, drives, robots, plant buses, RTUs, local area networks and control centers. OSI communications model. Control types: centralized, distributed. Real time control.
Unit 3: METODOLOGÍES FOR DISCRETE PROCESSES CONTROL
Classic methods: Boole's algebra, Grafcet and Gemma.
Unit 4: WIRED LOGIC
Definitions. Simple projects. IEC 81346. Typical devices used. Sequential and Combinational logic.
Unit 5: PLC PROGRAMMING
Execution models. Main parts of a PLC. IEC 61131 languages. Ladder diagram language. Instruction language. Functional block language. Structure text language. Grafcet.
Unit 6: INDUSTRIAL COMMUNICATIONS
Network types. OSI model. Sensor networks. Device networks. Fieldbus networks. Industrial standards. Industrial examples.
Unit 7: IOT IN AUTOMATION SYSTEMS
Definitions. Models. Design considerations. Architectures. Risk and Security.
Unit 8: CONTROL CENTERS
Communication systems, supervision and control systems (SCADA). Functions. Basic models of organization. Integration with other systems. Web Technology. Man/machine interface design. Information model.
Unit 9: EXAMPLES OF AUTOMATION SYSTEMS
Case study: energy systems, industrial plants, intelligent management of buildings, home automation and security systems. Design strategies and implementation.
Unit 10: RELIABILITY OF AN AUTOMATION SYSTEM
Definitions. Architectures. Reliability analysis. SIL levels. Standardization: IEC 61508, national standards.

Laboratory
It is about laboratory practices to fix theoretical concepts
Lab 1: Wired logic
Main uses of combinational and sequential logic for wired systems
Lab 2: PLC programming
Basic and advanced programing on TIA portal by Siemens
Lab 3: HMI
Basic and advanced programming of HMI panel for process interfacing
Lab 4: Grafcet
Programming of GRAPH language under TIA portal by Siemens
Lab 5: Artificial vision
Basic and advanced functionality of artificial vision system
Lab 6: RFID
Basic and advanced applications of RFID identification systems
Lab 7: Robot
Basic programming and integration of robot IRB 129 by ABB
Lab 8: Factory
By means of small scale factory model elaborate integration projects of the different technologies of former labs

Competences and learning outcomes

Competences

General competences

CG1. Have acquired advanced knowledge and demonstrated, in a research and technological or highly specialized context, a detailed and well-founded understanding of the theoretical and practical aspects, as well as of the work methodology in one or more fields of study.

CG2. Know how to apply and integrate their knowledge, understanding, scientific rationale, and problem-solving skills to new and imprecisely defined environments, including highly specialized multidisciplinary research and professional contexts.

CG5. Be able to transmit in a clear and unambiguous manner, to specialist and non-specialist audiences, results from scientific and technological research or state-of-the-art innovation, as well as the most relevant foundations that support them.

CG6. Have developed sufficient autonomy to participate in research projects and scientific or technological collaborations within their thematic area, in interdisciplinary contexts and, where appropriate, with a high knowledge transfer component.

CG7. Being able to take responsibility for their own professional development and their specialization in one or more fields of study.

Specific Competences

CE1. To Have an overview of the connected industry. Be able to explain in which areas substantial improvements can be obtained through the application of digital technologies and techniques.

CE2. Being able to design intelligent systems, gives direct application in the new context of the connected industry.

CE3. Be able to design and train systems that learn automatically, mastering both supervised and unsupervised learning techniques. Understand the application potential of these systems in the improvement of industrial processes, relationship with customers, etc.

CE8. To know the techniques of automation of industrial processes.

Learning outcomes

By the end of the course students should:

RA1. To identify in an industrial system the different levels of a hierarchical automation.

RA2. To know and choose for each level the most appropriate control strategies and the necessary technological elements.

RA3. To assess the risks in each level and to know the standards to apply.

RA4. To design with adequate tools the automation of non-trivial system in different areas such as energy, automated production systems, smart buildings and security facilities.

RA5. To present and defend, either orally or in writing, the most appropriate automation solutions.

TEACHING METHODOLOGY

General methodological aspects

In order to achieve the acquisition of the proposed competences, the subject will be developed taking into account the activity of the student as a priority factor. This will imply that both face-to-face and non-face-to-face sessions will promote the active involvement of students in learning activities.

In-class activities	Competences
1. **Lectures**: The lecturer will introduce the fundamental concepts of each unit, along with some practical recommendations, and will go through worked examples to support the explanation. Active participation will be encouraged by raising open questions to foster discussion and by proposing online quizzes and short application exercises to be solved in class either on paper or using a software package **(20 hours)**.	**CG1, CG6, CG7, CE1, CE2, CE3, CE8**
2. **Resolution of practical problems.** Resolution of problems to support the fixation of the theory by the students. The resolution will be done by the instructor and students in a collaborative way **(8 hours)**.	**CG1, CG2, CG6, CG7, CE1, CE2, CE3**
3. **Lab sessions** Under the instructor's supervision, students, divided in small groups, will apply the concepts and techniques covered in the lectures to simulated versions of commercial robots. **(28 hours).**	**CG1, CG2, CG5, CG6, CE1, CE2, CE3, CE8**
4. **Tutoring** for groups or individual students will be organized upon request.	

Out-of-class activities	Competences
1. The main target is to understand the theoretical concepts as well as to put in practice all knowledge acquired to solve all different types of problems.	**CG1, CG2, CG5, CG6, CG7, CE1, CE2, CE3, CE8**
2. **Individual study of the material to be discussed in later sessions and exam preparation**: Activity carried out individually by the student when analyzing, searching and internalizing the information provided by the subject and which will be discussed with his classmates and the instructor in later classes **(60 hours)**.	**CG1, CG2, CG5, CE1, CE2, CE3, CE8**
3. **Resolution of practical problems to be solved outside the class schedule by the student:** The student must use and internalize the knowledge provided in the subject. The correction with the whole class will be made by one of the students or the teacher according to the cases. The individualized correction of each exercise will be carried out by the student or another classmate according to the cases (exchange method) **(30 hours)**.	**CG1, CG2, CG6, CG7, CE1, CE2, CE3**
4. **Preparation of Labs**. This work includes the corresponding to the project for those students who have chosen to do it **(30 horas)**.	**CG1, CG2, CG6, CG7, CE1, CE2, CE3, CE8**

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
• Final exam or equivalent Project.	- Understanding of the theoretical concepts. - Application of these concepts to problem-solving. - Critical analysis of numerical exercises' results.	40%
• Follow up test	- Understanding of the theoretical concepts. - Application of these concepts to problem-solving. - Critical analysis of numerical exercises' results.	20%
• Lab evaluations	- Understanding of the theoretical concepts. - Application of concepts to solve practical problems in the laboratory. - Analysis and interpretation of the results obtained in the solved problems. - Ability to work in groups. - Presentation and written communication.	40%

Grading

Those students with an average mark in the follow-up tests greater than 7.5 and a cumulative score in the laboratory greater than 8, may substitute the final theory exam by an automation project of medium complexity.

The qualification in the extraordinary call of the subject will be obtained in the same way as in the ordinary call by substituting the grade of the final exam for that obtained in the extraordinary test.

Class attendance is mandatory, according to article 93 of the Academic rules of the Escuela Técnica Superior de Ingeniería (ICAI). The attendance requirements will be applied independently for theory and laboratory sessions.

- In the case of theory sessions, failure to comply with this rule may prevent students to be presented to the exams in the ordinary session.

- In the case of laboratory sessions, failure to comply with this rule may prevent them from being examined in the ordinary and extraordinary sessions. In any case, not justified faults to laboratory sessions will be penalized in the evaluation.

WORK PLAN AND SCHEDULE

In and out-of-class activities	Date/Periodicity	Deadline
• Follow up test	Week 4 or 5	
• Final exam	After the lecture period	
• Lab sessions	Weekly starting 3 weeks later after start	
• Reading and study of theory	After class session	
• Resolution of problems resolved	Weekly	
• Preparation of the follow up test or final exam	Within lectures	
• Preparation of lab sessions	Weekly	
• Ellaboration of lab reports		At the end of lab session

STUDENT WORK-TIME SUMMARY			
IN-CLASS HOURS			
Lectures	**Problem resolution**	**Lab sessions**	**Evaluation**
20	8	28	4
HORAS NO PRESENCIALES			
Self study on theory topics	**Self study of practical problems**	**Realization of collaborative works**	**Self Study**
30	30	30	30
		ECTS credits	**6 (180 hours)**

BIBLIOGRAPHY

Basic bibliography
• Slides prepared by the lecturer (available in Moodle rooms).
Complementary bibliography
Books
• Operation manuals of equipment to be used (PLC, robot, camera, etc. available in Moodle rooms)

	In-class activities				Out-of-class activities				Learning outcomes
Week	**Time [h]**	**Lecture**	**Laboratory**	**Assessment**	**Time [h]**	**Self-study**	**Lab preparation and report writing**	**Other activities**	**Code**
1	**2**	Introduction. Automation System Architecture			**4**	Review and self-study			RA1, RA2, RA5
	2	Wired logic			**4**	Review and self-study			RA1, RA2, RA3, RA4, RA5
2	**4**	Programable automation			**8**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
									RA1, RA2, RA3, RA4, RA5
3	**2**	Grafcet			**6**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		Wired logic	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
4	**2**	Grafcet			**6**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		PLC introduction	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
5	**2**	Example of basic automated systems			**6**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		HMI 1	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
6	**2**	Industrial communications			**6**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		HMI 2	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
7	**2**	IOT at Automation systems			**8**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		Artificial vision	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
8	**2**	ISA Architecture			**8**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		RFID	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
9	**2**	Control Centers and SCADA			**8**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		Integration 1	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
10	**2**	Example of Complex systems			**8**	Review and self-study		Resolution of problems	RA1, RA2, RA3, RA4, RA5
	2		Integration 2	Evaluation of lab report by end of the session	**2**		Lab preparation		RA2, RA3, RA4, RA5
11	**4**	Design Methodologies			**8**	Review and self-study or Project preparation		Resolution of problems or	RA1, RA2, RA3, RA4, RA5

								Project preparation	
12	4	Reliability of Automation systems			8	Review and self-study or Project preparation		Resolution of problems or Project preparation	RA1, RA2, RA3, RA4, RA5
13	4	Exam preparation			8	Review and self-study or Project preparation		Resolution of problems or Project preparation	RA1, RA2, RA3, RA4, RA5
14	4	Exam preparation			8	Review and self-study or Project preparation		Resolution of problems or Project preparation	RA1, RA2, RA3, RA4, RA5