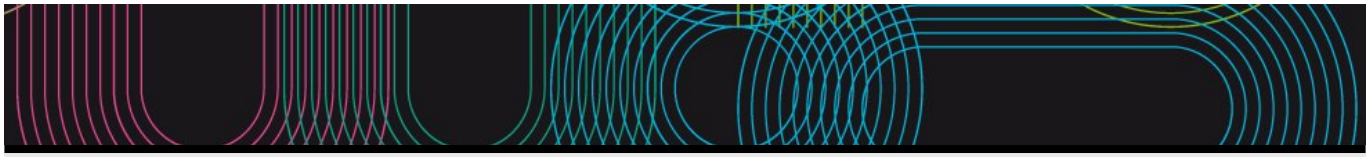

IDENTIFYING DATA				
Automation and control fundamentals				
Subject	Automation and control fundamentals			
Code	V12G320V01405			
Study programme	Grado en Ingeniería Eléctrica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Fernández Silva, Celso Armesto Quiroga, José Ignacio			
Lecturers	Fernández Silva, Celso Moares Crespo, José María			
E-mail	armesto@uvigo.es csilva@uvigo.es			
Web				
General description	This matter presents the basic concepts of the systems of industrial automation and of the methods of control, considering like central elements of the same the programmable automaton and the industrial regulator, respectively.			

Training and Learning Results	
Code	
B3	CG3 Knowledge in basic and technological subjects that will enable students to learn new methods and theories, and provide them the versatility to adapt to new situations.
C12	CE12 Know the fundamentals of automation and control methods.
D2	CT2 Problems resolution.
D6	CT6 Application of computer science in the field of study.
D9	CT9 Apply knowledge.
D17	CT17 Working as a team.
D20	CT20 Ability to communicate with people not expert in the field.

Expected results from this subject	Training and Learning Results		
Obtain a detailed and realistic vision of the current state of control and industrial automation systems.	B3	C12	D6 D9
Know which are the elements that constitute an industrial automation system, how they work and how the are dimensioned.	B3	C12	
Capacity to design and project a complete automation system.		C12	D2 D6 D9 D17 D20
Understand the fundamentals of programmable logic controllers and their application in automating different types of industrial plants.		C12	D2 D6 D9

Contents
Topic

1. Types of control systems and methods (10C)	Introduce the student to the basic concepts regarding the automatic control of continuous linear systems 1.1 Conceptual Introduction 1.1.1 On/Off control 1.1.2 Open loop control 1.1.3 Closed loop control 1.2 Modelling physical systems 1.2.1 Modelling using differential equations 1.3.2 Laplace Transform 1.3.3 Modelling using transfer functions 1.4 Transitory and permanent response 1.4.1 First order systems 1.4.2 Second order systems 1.5 Continuous linear controllers 1.5.1 PID regulators 1.5.2 Open-loop tuning 1.5.3 Closed-loop tuning 1.6 Examples and Exercises
2. Introduction to industrial automation(2.5C)	Introduce the student to the basic concepts regarding industrial automation, as well as their economic and soclal relevance. 2.1 Why are industrial processes automated? 2.2 Historical evolution of automation: from controlling simple movements to supply chain management 2.3 Economic and social aspects 2.4 Role of the Electrical Engineer 2.5 Types of automation and examples
3. Elements and devices for automation (2.5 C)	Introduce the student to the elements that are commonly used for industrial automation 3.1 Sensors 3.1.1 Presence 3.1.2 Rotation and speed 3.1.3 Traslation 3.1.4 Encoder 3.1.4 Others: temperature, pressure, etc. 3.2 Simple actuators 3.2.1 Electrical engines 3.2.2 Cylinders 3.2.3 Pumps 3.2.4 Valves 3.2.5 Contactors 3.3 Complex actuators 3.3.1 Guides 3.3.2 Tables 3.3.3 Conveyors 3.3.4 Cranes 3.3.5 Robots and manipulators 3.3.6 Plant transport systems 3.3.7 Plant storage systems 3.4 Plant control elements 3.4.1 Industrial regulator 3.4.2 Frequency variator 3.4.3 Programmable Logic Controller 3.4.4 Control by PC 3.4.5 industrial Communications 3.5 Monitorization and management Systems 3.5.1 SCADA 3.5.2 MES

4. Programmable Logic Controllers (2,5C)	Introduce basic concepts relative to the design and development of automation systems based on Programmable Logic Controllers (PLC) 4.1 Basic concepts 4.1.1 Physical and logical architecture 4.1.2 Numbering systems 4.1.3 Program cycle 4.1.4 Set-up 4.1.5 Modular programming 4.2 Basic elements 4.2.1 Inputs 4.2.2 Outputs 4.2.3 Memory 4.2.4 Counters 4.2.5 Timers 4.3 Operations 4.3.1 Memory transfer 4.3.2 Combinatorial logic 4.3.3 Arithmetic 4.4 Low level languages 4.5 High level languages 4.6 Advanced functions
5. Introduction to the lenguajes and techniques for programming PLCs (5C)	Students learn to develop binary automation systems using a contact diagram language 5.1 Contact diagrams concepts 5.2 Binary variables 5.3 Combinatory systems 5.4 Sequential systems 5.5 Arithmetic operations 5.6 Counters 5.7 Timers 5.8 Examples
6. Design of basic industrial automatisms (10C)	Students learn to model binary automation systems using Petri Nets and Grafcet. 5.1 Basic principles. Modeling techniques. 5.2 Modeling using Petri Nets. 5.2.1 Definition of stages and transitions. Rules of evolution. 5.2.2 Conditional selection of alternatives. 5.2.3 Simultaneous sequences. Concurrence. Shared resource. 5.3 Implementation of Petri Nets. 5.3.1 Direct implementation 5.3.2 Normalized implementation (Grafcet) 5.4 Design of basic industrial automation systems. 5.5 Examples.
P1. Introduction to the design of systems of control with Matlab/Simulink (2L)	Explain the basic elements of the Matlab/Simulink program as well as the specific control blocks. Analyse and simulate the temporal response of first and second order continuous systems.
P2. Analysis and control of systems with Matlab and Simulink (2L)	Analysis and simulation of linear control systems with Matlab/Simulink.
P3. Industrial regulator tuning (2L)	Determination of the parameters of a PID regulator using the methods studied in class. Implementation in an industrial regulator connected to a personal computer where the plant model is simulated.
P4. Implementation of a combinational system in a PLC (2L)	Description of the PLC programming environment. Creation of projects, hardware configuration and program editing. Implementation of a simple combinational system using a low level lenguaje (contacts).
P5. Implementation of a sequential system in a PLC (2L)	Implementation of a simple sequential system using a low level language (contacts).
P6. Analyse a complex plant for its automation (2L)	The student will study the operation of a complex electro-pneumatic plant and will create an input/output table. Due to the fact that the plant is connected to a distributed periphery module, she will learn to configure it.
P7. Modelling an industrial automation system with Petri Nets (2L)	Design a Petri Net for automating the plant analysed in the previous practice.
P8. Implementation of an industrial automation system (2L)	Implementation of the Petri Net modelled in the previous practice using a graphical language (Grafcet-like).
P9. Set up of an industrial automation system (2L)	Set up and validation of the system implemented in the previous practice.

Planning			
	Class hours	Hours outside the classroom	Total hours
Problem solving	0	10	10
Laboratory practical	18	27	45
Lecturing	32.5	32.5	65
Essay questions exam	3	27	30

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Problem solving	The profesor will solve problems and exercises in the classroom and the students will have to resolve similar exercises to obtain the necessary skills
Laboratory practical	Concepts explained in the classroom are applied to specific situations and solved using tools commonly found in the workplace
Lecturing	Exhibition by part of the professor of the contents of the matter

Personalized assistance	
Methodologies	**Description**
Lecturing	The professor will promote the participation of students in class, reserving time to resolve the topics being discussed, as well as the previous subjects. In the case that a student requires a more personalised attention, he should direct his doubts to the professor by sending him an e-mail (fvazquez@uvigo.es) clearing describing his doubt and indicating his schedule preferences for an eventual tutoring session The professor will try to resolve the doubt by e-mail and, in the case that the answer was satisfactory for the student, will publish the doubt and the answer in Faitic (Wiki section). If the doubt cannot be resolved by e-mail, the professor will summon to the student to a tutoring session at a specific date/hour.
Problem solving	The professor will promote the participation of students in class, reserving time to resolve the topics being discussed, as well as the previous subjects. In the case that a student requires a more personalised attention, he should direct his doubts to the professor by sending him an e-mail (fvazquez@uvigo.es) clearing describing his doubt and indicating his schedule preferences for an eventual tutoring session The professor will try to resolve the doubt by e-mail and, in the case that the answer was satisfactory for the student, will publish the doubt and the answer in Faitic (Wiki section). If the doubt cannot be resolved by e-mail, the professor will summon to the student to a tutoring session at a specific date/hour.
Laboratory practical	The professor will promote the participation of students in class, reserving time to resolve the topics being discussed, as well as the previous subjects. In the case that a student requires a more personalised attention, he should direct his doubts to the professor by sending him an e-mail (fvazquez@uvigo.es) clearing describing his doubt and indicating his schedule preferences for an eventual tutoring session The professor will try to resolve the doubt by e-mail and, in the case that the answer was satisfactory for the student, will publish the doubt and the answer in Faitic (Wiki section). If the doubt cannot be resolved by e-mail, the professor will summon to the student to a tutoring session at a specific date/hour.

Assessment					
	Description	Qualification	Training and Learning Results		
Laboratory practical	Continuous evaluation of each student's work will be assed during a total of 9 lab sessions, scoring each session between 0 and 10 points, including the practice report.	25		C12	D2 D6 D9 D17 D20
Essay questions exam	Each final examination will include a test covering conceptual aspects, an exercise on automatic control and a problem on Petri Nets.	75	B3	C12	D2 D9

Other comments on the Evaluation

For each practice session the profesor will establish specific targets/deliverables, that will include numerical results, graphics and working solutions.The **practice report** will an Exercise on Faitic or a paper form that the student will have to complete during the practice.

Evaluation of the practical sessions:

- Assistance: 3 points
- Participation: 2 points

- Approach of the problem and of the solution: 2 points
- Correct solution: 3 points

The grade of the practices will be the weighted average of the grades obtained in all the sessions and will be saved for the second evaluation if the student has passed then and does not decline continuous evaluation.It is not saved for other course years.
Students that have passed the practices during the continuous evaluation will be able to pass the subject if their score in the exam is of at least 4 points and the total is at least 5 points.
Students that have not passed the practices during the continuous evaluation or decline, will have to pass a practical examination if they pass the final examination (5 points over 10) in any one of the two final course evaluations.

Ethical commitment: It is expected an adequate ethical behaviour of the student. In case of detecting unethical behaviour (copying, plagiarism, unauthorized use of electronic devices, etc.) shall be deemed that the student does not meet the requirements for passing the subject. In this case, the overall rating in the current academic year will be Fail (0.0).

Sources of information

Basic Bibliography

E.MANDADO, J.MARCOS, CELSO FERNANDEZ, J.I.ARMESTO, **Autómatas Programables y Sistemas de Automatización**, Marcombo, 2009

MANUEL SILVA, **Las Redes de Petri en la Automática y la Informática**, Editorial AC,

DORF, BISHOP, **Sistemas de control modernos**, Ed. Addison-Wesley,

Complementary Bibliography

Ogata, K., **Ingeniería de control moderna**, Ed. Prentice-hall,

Barrientos, **Control de sistemas continuos. Problemas resueltos**, Ed. Mcgraw-Hill,

Recommendations

Other comments

Requirements: To register for this module the student must have passed or be registered for all the modules of the previous year.