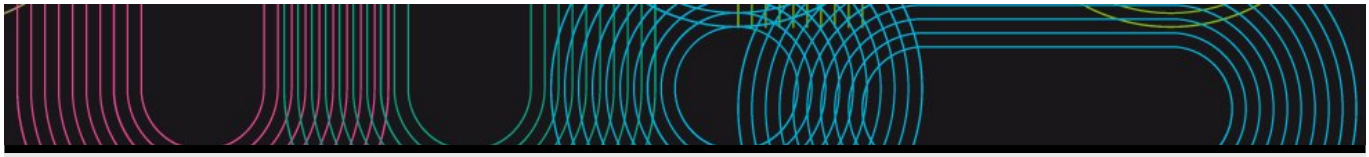

IDENTIFYING DATA				
Systems and Control Engineering				
Subject	Systems and Control Engineering			
Code	V09G291V01301			
Study programme	Grado en Ingeniería de la Energía			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Pereira Martínez, Moisés Nicolás			
Lecturers	Pereira Martínez, Moisés Nicolás			
E-mail	moisnico@yahoo.es			
Web	http://moovi.uvigo.gal			
General description	In this matter, the basic concepts of industrial automation systems and control methods are presented, considering the programmable automaton and the industrial regulator, respectively, as their central elements			

Training and Learning Results	
Code	
A1	That the students demonstrate to possess and understand knowledge in an area of study that is part of the general education (second level), and often found at a level that, although based on advanced textbooks, also includes some aspects that involve knowledge from the avant-garde of the field of study
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A4	That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized audience
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Ability to draw links between the different elements of all the knowledge acquired, understanding them as components of a body of knowledge with a clear structure and strong internal cohesion.
B3	To suggest and develop practical solutions, using the relevant theoretical knowledge, to phenomena and problems-situations of ordinary reality that are specific to engineering, developing appropriate strategies.
B4	To foster collaborative working, communication, organization and planning skills, along with the ability to take responsibilities in a multilingual, multidisciplinary work environment that promotes education for equality, peace and respect for fundamental rights.
B5	To be familiar with the relevant sources of information, including constant updating, in order to practice one□s profession competently, accessing all the present and future tools of information search, constantly adapting to technological and social changes.
C16	Knowledge of the fundamentals of the electrical power system: generation of energy, transportation, distribution and delivery networks, along with the types of lines and conductors. Knowledge of the regulations of high and low tension. Basic knowledge of electronics and control systems.
C38	Knowledge about modelling and simulation of systems.
D1	To be familiar with and to be able to use the legislation applicable in this sector, to be acquainted with the social and business environments and to be able to deal with the relevant administration, integrating this knowledge into the drawing up of engineering projects and into the implementation of every aspect of their professional work.
D2	Ability to organize, understand, assimilate, produce and handle all the relevant information to develop their professional work, using appropriate computing, mathematics, physics tools, etc. when these are required.
D3	Understanding engineering within a framework of sustainable development with environmental awareness.

D4	Understanding the importance of safety issues and being able to foster awareness about safety among people within their environment.
D5	To become aware of the need for continuous training and the constant improvement of quality, developing the values that are characteristic of scientific thinking, showing flexible, open and ethical attitudes in the face of different situations and opinions, particularly as regards non-discrimination on the grounds of gender, race or religion, respect for fundamental rights, accessibility, etc.

Expected results from this subject

Expected results from this subject	Training and Learning Results		
General knowledge about control and simulation of dynamic systems, both continuous and sampled.		C16 C38	
Capacity to design basic systems of regulation and control.		C16 C38	D1 D2 D3 D4 D5
Basic notions of optimum control.		C16 C38	
Skill to conceivimg, developing and modeling automatic systems.	A1 A2 A3 A4 A5	C16 C38	D1 D2 D3 D4 D5
Capacity to analyse the needs of a project of automation and fix its specifications.		C16 C38	D1 D2 D3 D4 D5
Ability to size and select an industrial programmable controller for a specific automation application as well as determine the type and characteristics of the required sensors and actuators.		C16 C38	D1 D2 D3 D4 D5
Being able to integrate different technologies (electronic, electrical, pneumatic, etc.) in a single automation.	B1 B3 B4 B5	C16 C38	D1 D2 D3 D4 D5

Contents

Topic	
1. Introduction to industrial automation.	1.1 Introduction to tasks automation. 1.2 Types of control. 1.3 The programmable logic controller. 1.4 Blocks diagram. Elements of the programmable logic controller. 1.5 Cycle of operation of the PLC. Cycle time. 1.6 Ways of operation.
2. Introduction to PLC programming.	2.1 Binary, Octal, Hexadecimal and BCD systems. Real numbers. 2.2 Addresing and access to periphery. 2.3 Instructions, variables and operands. 2.4 Forms of representation of one plan. 2.5 Types of modules of program. 2.6 Linear and structured programming.
3. PLC Programming with Inputs/Outputs.	3.1 Binary variables. Inputs, outputs and memory. 3.2 Binary combinations. 3.3 Operations of assignment. 3.4 Creation of simple program. 3.5 Timers and counters. 3.6 Arithmetic operations. 3.7 Examples.

4. Systems modelling for PLC programming.	4.1 Basic principles. Modelling techniques. 4.2 Petri nets modelling. 4.2.1 Definition of places and transitions. Rules of evolution. 4.2.2 Conditional election between varied alternatives. 4.2.3 Simultaneous sequences. Concurrency. Resource shared. 4.3 Petri nets implantation. 4.3.1 Direct implantation. 4.3.2 Normalized implantation (Grafcet). 4.4 Examples.
5. Basic concepts of automatic control. Representation and modelling of continuous systems.	5.1 Control systems in open and closed loop. 5.2 Typical loop of control. Nomenclature and definitions. 5.3 Physical systems and mathematical models. 5.3.1 Mechanical systems. 5.3.2 Electric systems. 5.3.3 Others. 5.4 State space modelling. 5.5 Transfer function modelling. Laplace transform. Properties. Examples.
6. Analysis of dynamic systems.	6.1 Stability. 6.2 Transient response. 6.2.1 First order systems. Differential equation and transfer functions. Examples 6.2.2 Second order systems. Differential equation and transfer functions. Examples 6.2.3 Effect of the addition of poles and zeros. 6.3 Reduction of systems of upper order. 6.4 Permanent response. 6.4.1 Errors. 6.4.2 Input signals and type of a system. 6.4.3 Error constants.
7. Industrial controllers and parameter tuning.	7.1 Basic control actions. Proportional, integral and derivative effects,. 7.2 PID controller. 7.3 Tuning empirical methods. 7.3.1 Open loop tuning: Ziegler-Nichols and others. 7.3.2 Closed loop tuning: Ziegler-Nichols and others. 7.4 State space design. Poles assignment.
P1. STEP7 introduction.	Introduction the program STEP7, that allows to create and modify programs for Siemens PLCs S7-300 and S7-400.
P2. STEP7 programming.	Simple automation problem modelling and implantation in STEP7 using binary operations.
P3. RdP modelling and STEP7 implantation.	RdP modelling of complex automation example and STEP7 implantation.
P4. GRAFCET modelling and S7-Graph implantation.	RdP normalized modelling and automatitation with S7-Graph.
P5. Control systems analysis with MATLAB.	Introduction to the specific instructions of systems of control of MATLAB program.
P6. Introduction to SIMULINK.	Introduction to the program SIMULINK, extension of MATLAB for dynamic systems simulation.
P7. Transient response modelling in SIMULINK.	Modelling and simulation of control systems with SIMULINK.
P8. Empirical tuning of industrial controllers	Determination of the parameters of a PID industrial controller poles methods studied and implantation of the control calculated in an industrial controller.

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	16	30	46
Problem solving	4	10	14
Lecturing	30	25	55
Report of practices, practicum and external practices	0	8	8
Essay questions exam	2.5	24.5	27

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

Methodologies

	Description
Laboratory practical	Activities of application of the knowledge acquired in the theory classes to specific situations that can be developed in the laboratory of the subject
Problem solving	The teacher will solve problems and exercises in the classroom and the students will have to solve similar exercises to acquire the necessary skills

Lecturing	Exposition by the teaching staff of the contents of the subject.

Personalized assistance

Methodologies	Description
Lecturing	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.
Laboratory practical	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.
Problem solving	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.
Tests	**Description**
Essay questions exam	For an effective use of the students dedicatio, the teaching staff will personally attend to the doubts and queries of the student. This attention will take place both in the theory, problems and laboratory classes as well as in the tutorials (at a predetermined time). For all teaching modalities, tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the prior agreement modality.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	Each laboratory practice will be evaluated between 0 and 10 points, depending on the fulfillment of the objectives set in the statement of the same and the previous preparation and attitude of the students. Each practice may have different weighting in the total grade. Expected results from this subject: All of them.	25	A1 B1 C16 D1 A2 B3 C38 D2 A3 B4 D3 A4 B5 D4 A5 D5
Report of practices, practicum and external practices	The memories of the selected practices will be evaluated between 0 and 10 points, taking into account the adequate reflection of the results obtained in the execution of the practice, its organization and quality of presentation. Expected results from this subject: All of them.	5	A1 B1 C16 D1 A2 B3 C38 D2 A3 B4 D3 A4 B5 D4 A5 D5
Essay questions exam	Final exam of the contents of the subject, which may include problems and exercises, with a score between 0 and 10 points. Expected results from this subject: All of them.	70	A1 B1 C16 D1 A2 B3 C38 D2 A3 B4 D3 A4 B5 D4 A5 D5

Other comments on the Evaluation

- A Continuous Evaluation of the work of the students in the practices will be carried out throughout the laboratory sessions established in the semester, being the assistance to them of obligatory character. In the case of not passing it, a practice exam will be carried out in the second call.
- Prerequisites may be required to carry out each practice in the laboratory, in such a way that they limit the maximum qualification to be obtained.
- The evaluation of the practices for the students who officially renounce the Continuous Evaluation, will be carried out in a practice exam in the two calls.
- Both tests (written and practical) must be passed to pass the subject, obtaining the total mark according to the percentage indicated above. In the case of not exceeding two or one of the parts, a scaling may be applied to the partial grades so that the total grade does not exceed 4.5.
- In the final exam, a minimum score may be established in a set of questions to pass it.
- In the second call of the same course, students must examine the tests not passed in the

first call, with the same criteria as that.
- According to the Continuous Assessment Regulations, students subject to Continuous Assessment who attend any assessable activity reflected in the Course Teaching Guide will be considered as "presented".

Calendar of examinations:

It can be accessed in the web page of the School of Mining and Energy Engineering:

http://minaseenerxia.uvigo.es/es/docencia/examenes

Sources of information

Basic Bibliography

E.MANDADO, J.MARCOS, C. FERNANDEZ, J.I.ARMESTO, **Autómatas Programables y Sistemas de Automatización**, 1ª Edición, Marcombo, 2009

MANUEL SILVA, **Las Redes de Petri en la Automática y la Informática**, 1ª Edición, AC, 1985

R. C. DORF, R. H. BISHOP, **Sistemas de Control Moderno**, 10ª edición, Prentice Hall, 2005

Complementary Bibliography

PORRAS A., MONTANERO A., **Autómatas programables : fundamento, manejo, instalación y prácticas**, McGraw-Hill, 2003

ROMERA J.P., LORITE J.A., MONTORO S., **Automatización : problemas resueltos con autómatas programables**, 4ª edición, Paraninfo, 2002

BARRIENTOS, ANTONIO, **Control de sistemas continuos: Problemas resueltos**, 1ª Edición, McGraw-Hill, 1997

OGATA, KATSUIKO, **Ingeniería de Control Moderna**, 1ª Edición, Pearson, 2010

Recommendations

Subjects that it is recommended to have taken before

Computing: Computing for Engineering/V09G291V01110
Circuits and Electrical Machines/V09G291V01201