



IDENTIFYING DATA

Automation and control fundamentals

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|---------------------|--|-----------|------|------------|
| Subject | Automation and control fundamentals | | | |
| Code | V12G340V01403 | | | |
| Study programme | Grado en Ingeniería en Organización Industrial | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2nd | 1st |
| Teaching language | Spanish English | | | |
| Department | | | | |
| Coordinator | Espada Seoane, Angel Manuel Rodríguez Diéguez, Amador | | | |
| Lecturers | Manzanedo García, Antonio Rodríguez Diéguez, Amador | | | |
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| General description | In this matter present the basic concepts of the systems of industrial automation and of the methods of control, considering like central elements of the same the programmable programmable logic controller and the industrial controller, respectively. | | | |

Skills

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|------|--|
| Code | |
| B3 | CG 3. Knowledge in basic and technological subjects that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations. |
| C12 | CE12 Know the fundamentals of automation and control methods. |
| D2 | CT2 Problems resolution. |
| D3 | CT3 Oral and written knowledge communication. |
| D6 | CT6 Application of computer science in the field of study. |
| D9 | CT9 Apply knowledge. |
| D16 | CT16 Critical thinking. |
| D17 | CT17 Working as a team. |
| D20 | CT20 Ability to communicate with people not expert in the field. |

Learning outcomes

| Expected results from this subject | Training and Learning Results | | |
|---|-------------------------------|-----|------------------------------|
| Purchase a global and realistic vision of the current scope of industrial automation systems. | B3 | C12 | D17 D20 |
| Know which are the constitutive elements of an industrial automation system, its sizing and as they work. | B3 | C12 | D2 D6 D20 |
| Knowledge applied on the programmable logic controllers, its programming and its application to industrial automation systems. | B3 | C12 | D2 D6 D9 D16 D17 |
| General knowledge on the continuous control of dynamic systems, of the main tools of simulation of continuous systems and of the main devices of process control with greater interest to industrial level. | B3 | C12 | D3 D6 D17 D20 |

Contents

| Topic | |
|--|---|
| 1. Introducción to industrial automation and elements of automation. | 1.1 Introducción to automation of tasks. 1.2 Types of control. 1.3 The programmable logic controller. 1.4 Diagrama of blocks. Elements of the PLC. 1.5 Cycle of operation of the PLC. Time of cycle. 1.6 Ways of operation. |
| 2. Languages and programming technics of programmable logic controllers. | 2.1 Binary, octal, hexadecimal, BCD systems. Real numbers. 2.2 Access and adressing to periphery. 2.3 Instructions, variables and operating. 2.4 Forms of representation of a program. 2.5 Types of modules of program. 2.6 linear Programming and estructurada. 2.7 Variables binarias. Entrances, exits and memory. 2.8 Binary combinations. 2.9 Operations of allocation. 2.10 Timers and counters. 2.11 Operations aritméticas. |
| 3. Tools for sequential systems modelling. | 3.1 Basic principles. Modelling technics. 3.2 Modelling by means of Petri Networks. 3.2.1 Definition of stages and transitions. Rules of evolution. 3.2.2 Conditional election between several alternatives. 3.2.3 Simultaneous sequences. Concurrence. Resource shared. 3.3 Implementation of Petri Networks. 3.3.1 Direct implementation. 3.3.2 Normalised implementation (Grafcet). 3.4 Examples. |
| 4. Control systems introduction. | 4.1 Systems of regulation in open loop and closed loop. 4.2 Control typical loop. Nomenclature and definitions. |
| 5. Representation, modelling and simulation of continuous dynamic systems. | 5.1 Physical systems and mathematical models. 5.2.1 Mechanical systems. 5.2.2 Electrical systems. 5.2.3 Others. 5.3 Modelling in state space. 5.4 Modelling in transfer function. Laplace transform. Properties. Examples. 5.5 Blocks diagrams. |
| 6. Analysis of continous dynamical systems. | 6.1 Stability. 6.2 Transient response. 6.2.1 First order systems. Differential equation and transfer function. Examples. 6.2.2 Second order systems. Differential equation and transfer function. Examples. 6.2.3 Effect of the addition of poles and zeros. 6.3 Systems reduction. 6.4 Steady-state response. 6.4.1 Steady-state errors. 6.4.2 Input signals and system type. 6.4.3 Error constants. |
| 7. PID controller. Parameters tuning of industrial controllers. | 7.1 Basic control actions. Proportional effects, integral and derivative. 7.2 PID controller. 7.3 Empirical methods of tuning of industrial controllers. 7.3.1 Open loop tuning: Ziegler-Nichols and others. 7.3.2 Closed loop tuning: Ziegler-Nichols and others. 7.4 Controllers design state space. Pole assigment. |
| P1. Introduction to STEP7. | Introduction to the program STEP7, that allows to create and modify programs for the Siemens PLC S7-300 and S7-400. |
| P2. Programming in STEP7. | Modelling of simple automation system and implementation in STEP7 using binary operations. |
| P3. Implementation of PN in STEP7. | Petri Networks modelling of simple automation system and introduction to the implementation of the same in STEP7. |
| P4. PN Modelling and implementation in STEP7. | Petri Networks modelling of complex automation system and implementation of the same in STEP7. |

P5. GRAFCET modelling and implementation with Petri Networks normalised modelling and implementation with S7-Graph.

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| P6. Control systems analysis with MATLAB. | Introduction to the control systems instructions of the program MATLAB. |
| P7. Introduction to SIMULINK. | Introduction to SIMULINK program, an extension of MATLAB for dynamic systems simulation. |
| P8. Modelling and transient response in SIMULINK. | Modelling and simulation of control systems with SIMULINK. |
| P9. Empirical tuning of an industrial controller. | Parameters tuning of a PID controller by the methods studied and implementation of the control calculated in an industrial controller. |

Planning

| | Class hours | Hours outside the classroom | Total hours |
|----------------------|-------------|-----------------------------|-------------|
| Laboratory practical | 18 | 30 | 48 |
| Problem solving | 0 | 15 | 15 |
| Lecturing | 32.5 | 32.5 | 65 |
| Essay questions exam | 3 | 19 | 22 |

*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 | Different activities aimed to apply the concepts learned during the lectures. |
| Problem solving | The professor is going to solve in class some problems and exercises. The students need to solve similar exercises on their own to obtain the capabilities needed. |
| Lecturing | Include the professor lectures about the contents of the subject. |

Personalized assistance

| Methodologies | Description |
|----------------------|---|
| Lecturing | For a effective use of the dedication of the student body, the faculty will attend personally the doubts and queries of the same. Said attention will take place so much in the classes of theory, problems and laboratory as in the tutorials (in a schedule prefixed). For all teaching modalities, the tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. |
| Laboratory practical | For a effective use of the dedication of the student body, the faculty will attend personally the doubts and queries of the same. Said attention will take place so much in the classes of theory, problems and laboratory as in the tutorials (in a schedule prefixed). For all teaching modalities, the tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. |
| Problem solving | For a effective use of the dedication of the student body, the faculty will attend personally the doubts and queries of the same. Said attention will take place so much in the classes of theory, problems and laboratory as in the tutorials (in a schedule prefixed). For all teaching modalities, the tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. |
| Tests | Description |
| Essay questions exam | For a effective use of the dedication of the student body, the faculty will attend personally the doubts and queries of the same. Said attention will take place so much in the classes of theory, problems and laboratory as in the tutorials (in a schedule prefixed). For all teaching modalities, the tutoring sessions may be carried out by telematic means (email, videoconference, FAITIC forums, ...) under the modality of prior agreement. |

Assessment

| | Description | Qualification | Training and Learning Results |
|----------------------|---|---------------|--|
| Laboratory practical | It will evaluate each practice of laboratory between 0 and 10 points, in function of the fulfillment of the aims fixed in the billed of the same and of the previous preparation and the attitude of the students. Each practical will be able to have distinct weight in the total note. | 20 | B3 C12 D3 D6 D9 D16 D17 D20 |
| Essay questions exam | Final examination of the contents of the matter, that will be able to include problems and exercises, with a punctuation between 0 and 10 points. | 80 | B3 C12 D2 D3 D16 |

Other comments on the Evaluation

- Continuous Assessment of student work practices along established laboratory sessions will be held in the semester, with the assistance to them mandatory. In the case of not overcome, a review of practices, conditioned to having passed the script test, will take place in the second call, on a date after the script test, in one or more sessions and including the contents not passed in ordinary practice sessions.
 - The assessment of the practices for students who officially renounces Continuous Assessment will be carried out in a review of practices, conditioned to having passed the script test, in the two calls, on a date after the script test, in one or more sessions and including the same contents of the ordinary practice sessions..
 - It may demand previous requirements to the realisation of each practice in the laboratory, so that they limit the maximum qualification to obtain.
 - It must pass both tests (script and practices) to pass the matter, give the total score at the rate indicated above. In case of no longer than two or one test, scaling may be applied to partial notes that the total does not exceed 4.5.
 - In the final exam may establish a minimum score on a set of issues to overcome.
 - In the second call of the the same course, students should examine the tests (script and/or practices) not passed in the first one, with the same criteria of that.
 - According to the Rule of Continuous Assessment, the subject students to Continuous Assessment that present to some activity evaluable collected in the Teaching Guide of the matter, will be considered like "presented".
 - Ethical commitment: student is expected to present an adequate ethical behavior. If you detect unethical behavior (copying, plagiarism, unauthorized use of electronic devices, and another ones), it follows that the student does not meet the requirements for passing the subject. In this case the global qualification in the present academic course will be of suspense (0.0).
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Sources of information**Basic Bibliography**

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

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

R. C. DORF, R. H. BISHOP, **Sistemas de Control Moderno**, 10ª, 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, Paraninfo, 2002

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

OGATA, KATSUIKO, **Ingeniería de Control Moderna**, 5ª, Pearson, 2010

Recommendations**Subjects that continue the syllabus**

Product design and communication, and automation of plant elements/V12G380V01931

Subjects that are recommended to be taken simultaneously

Electronic technology/V12G380V01404

Subjects that it is recommended to have taken before

Computer science: Computing for engineering/V12G380V01203

Mathematics: Calculus II and differential equations/V12G380V01204

Fundamentals of electrical engineering/V12G380V01303

Other comments

- Requirements: To enrol in this subject is necessary to had surpassed or well be enrolled of all the subjects of the inferior courses to the course in the that is summoned this subject.
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