



## IDENTIFYING DATA

### Electronic technology

|                     |                                                                                                                                                                                                                                                                  |           |      |            |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|------------|
| Subject             | Electronic technology                                                                                                                                                                                                                                            |           |      |            |
| Code                | V12G350V01402                                                                                                                                                                                                                                                    |           |      |            |
| Study programme     | Degree in Industrial Chemical Engineering                                                                                                                                                                                                                        |           |      |            |
| Descriptors         | ECTS Credits                                                                                                                                                                                                                                                     | Choose    | Year | Quadmester |
|                     | 6                                                                                                                                                                                                                                                                | Mandatory | 2nd  | 2nd        |
| Teaching language   | Spanish<br>Galician                                                                                                                                                                                                                                              |           |      |            |
| Department          | Electronics Technology                                                                                                                                                                                                                                           |           |      |            |
| Coordinator         | Verdugo Mates, Rafael                                                                                                                                                                                                                                            |           |      |            |
| Lecturers           | Rodríguez Castro, Francisco<br>Verdugo Mates, Rafael                                                                                                                                                                                                             |           |      |            |
| E-mail              | rverdugo@uvigo.es                                                                                                                                                                                                                                                |           |      |            |
| Web                 | <a href="http://fatic.uvigo.es">http://fatic.uvigo.es</a>                                                                                                                                                                                                        |           |      |            |
| General description | The objective of this course is to provide the students with the theoretical and practical fundamental knowledge in electronics' five main areas: analog electronics, digital electronics, industrial sensors, power electronics and communications electronics. |           |      |            |

In case of any discrepancy between this translation of the guide and the Spanish version, the valid one is the Spanish version.

## Competencies

|      |                                                                                                                                                                             |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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. |
| C11  | CE10 Knowledge and use of the principles of circuit theory and electrical machines.                                                                                         |
| D2   | CT2 Problems resolution.                                                                                                                                                    |
| D9   | CT9 Apply knowledge.                                                                                                                                                        |
| D10  | CT10 Self learning and work.                                                                                                                                                |
| D17  | CT17 Working as a team.                                                                                                                                                     |

## Learning outcomes

| Expected results from this subject                                   | Training and Learning Results |     |     |     |
|----------------------------------------------------------------------|-------------------------------|-----|-----|-----|
| Know the operation of the electronic devices.                        | B3                            | C11 | D1  |     |
|                                                                      | B4                            | C24 | D2  |     |
|                                                                      | B6                            | C26 | D2  |     |
|                                                                      | B10                           | C27 | D9  |     |
|                                                                      | B12                           | C29 | D10 |     |
|                                                                      | B17                           |     | D17 |     |
| Know the electronic systems of conditioning and acquisition of data. | A1                            | B1  | C2  | D1  |
|                                                                      | A5                            | B4  | C8  | D3  |
|                                                                      |                               |     | C11 | D10 |
|                                                                      |                               |     | C14 |     |
| Identify the different types of industrial sensors.                  | A1                            | B2  | C1  | D1  |
|                                                                      |                               |     | C32 | D3  |
|                                                                      |                               |     |     | D4  |
|                                                                      |                               |     |     | D5  |
|                                                                      |                               |     |     | D6  |
|                                                                      |                               |     |     | D8  |
|                                                                      |                               |     |     | D10 |

Know the digital electronic systems basic.

C11 D2

D9

D17

Know the electronic circuits for the communication of information.

B3

D10

## Contents

| Topic                                    |                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Introduction                             | <ul style="list-style-type: none"> <li>- Control and supervision of industrial systems by means of electronics</li> <li>- Some representative cases</li> </ul>                                                                                                                                                                                   |
| Electronic devices, circuits and systems | <ul style="list-style-type: none"> <li>- Electronics components and devices</li> <li>- Active and passive electronic devices</li> <li>- Analog and digital electronic circuits</li> <li>- Electronic systems</li> </ul>                                                                                                                          |
| Diodes and rectification                 | <ul style="list-style-type: none"> <li>- The diode</li> <li>- Operation modes and characteristics</li> <li>- Diodes types</li> <li>- Operation Models</li> <li>- Analysis of circuits with diodes</li> <li>- Rectifier circuits</li> <li>- Filtering for rectifier circuits</li> <li>- Thyristors</li> </ul>                                     |
| Transistors                              | <ul style="list-style-type: none"> <li>- The Bipolar Junction Transistor (BJT.) Operation principles and characteristic curves</li> <li>- Work zones</li> <li>- Quiescent point design</li> <li>- The transistor operating as a switch</li> <li>- The transistor operating as an amplifier</li> <li>- Field Effect Transistors (FET).</li> </ul> |
| Amplification                            | <ul style="list-style-type: none"> <li>- Amplification concept</li> <li>- Feedback concept</li> <li>- The Operational Amplifier (OA)</li> <li>- Basic circuits with OA</li> <li>- The Instrumentation Amplifier</li> </ul>                                                                                                                       |
| Digital Electronics I                    | <ul style="list-style-type: none"> <li>- Numbering Systems</li> <li>- Boolean Algebra</li> <li>- Combinatorial logic functions. Analysis, synthesis and reduction</li> </ul>                                                                                                                                                                     |
| Digital electronics II                   | <ul style="list-style-type: none"> <li>- Flip-flops</li> <li>- Sequential logic circuits</li> <li>- Programmable Systems</li> <li>- Microprocessors</li> <li>- Memories</li> </ul>                                                                                                                                                               |
| Electronic Sensors                       | <ul style="list-style-type: none"> <li>- Sensors</li> <li>- Types of sensors as function of the measuring magnitude</li> <li>- Some sensors of special interest in industry applications</li> <li>- Electrical model of some common sensors</li> <li>- Study of some examples of coupling sensors and CAD system</li> </ul>                      |
| Analog - Digital Converters              | <ul style="list-style-type: none"> <li>- The Analog and Digital Signals.</li> <li>- The Analog to Digital Converter (ADC)</li> <li>- Sampling, quantification and digitization</li> <li>- More important ADC characteristics: number of bits, sampling speed, conversion range and cost</li> </ul>                                               |
| Industrial Communications                | <ul style="list-style-type: none"> <li>- Introduction to Industrial Communications</li> <li>- Industrial data buses.</li> </ul>                                                                                                                                                                                                                  |
| Power Electronics                        | <ul style="list-style-type: none"> <li>- Circuits for Power Conversion</li> <li>- Rectifiers</li> <li>- Lineal and Switched Power Sources</li> </ul>                                                                                                                                                                                             |

## Planning

|                            | Class hours | Hours outside the classroom | Total hours |
|----------------------------|-------------|-----------------------------|-------------|
| Lecturing                  | 25          | 0                           | 25          |
| Problem solving            | 8           | 0                           | 8           |
| Previous studies           | 0           | 49                          | 49          |
| Autonomous problem solving | 0           | 46                          | 46          |
| Laboratory practices       | 18          | 0                           | 18          |
| Objective questions exam   | 1           | 0                           | 1           |
| Essay questions exam       | 3           | 0                           | 3           |

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

| Methodologies              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Lecturing                  | These sessions will be held in the rooms and dates fixed by the direction of the school. They will consist in an oral explanation by the professor of the most important parts of the course, all related with the materials that the student had to work previously. This is intended to favor the active participation of the students, that will have occasion to rise doubts and questions during the sessions. Active participation is desired during all the sessions.                                                                                                                                                                                                                                                                                                                                            |
| Problem solving            | During these sessions, in the classroom, interleaved with the lectures, the professor will proceed to solve examples and/or exercises that properly illustrate the problems to solve. As long as the number of participants in the classroom allows, active participation will be promoted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Previous studies           | <p>Previous preparation of the theoretical sessions:<br/>Prior to the start of the theoretical sessions, the students will have available a series of materials that have to prepare, as the sessions will relay on them.</p> <p>Previous preparation of the laboratory sessions:<br/>It is mandatory that the students make all the assigned previous tasks prior to access the laboratory. These task are intended to greatly improve the laboratory knowledge acquisition. The achieved report will be taken into account when the laboratory session is to be evaluated.</p>                                                                                                                                                                                                                                        |
| Autonomous problem solving | <p>Self study and review of the theoretical sessions for knowledge consolidation:<br/>The student must study, in a systematic time schedule, after each lecture session, in order to dissipate any doubts. Any doubts or unsolved questions will have to be expose to the professor as soon as possible in order to enhance the feedback of the learning process.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Laboratory practices       | <p>Laboratory sessions will be held in the time schedule established by the school's head teacher. Students will work in groups of two students each. The sessions will be supervised by a professor, who will control the assistance and will also evaluate the harnessing of it. During the laboratory sessionsthe students will make activities of the following kinds:</p> <ul style="list-style-type: none"> <li>- Assembling electronics circuits</li> <li>- Use of electronic instrumentation</li> <li>- Measure of physical variables on circuits</li> <li>- Do calculations related to the circuit and/or the measurements</li> <li>- Collect data and represent it (diagrams, charts, tables)</li> </ul> <p>At the end of each laboratory session each group will deliver the corresponding score sheets.</p> |

### Personalized attention

| Methodologies        | Description                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Laboratory practices | Tutoring Sessions: During the established schedule of each professor, students will be able to speak freely about course issues with the professor. Also the will receive orientation and academic support, if needed. Email: The students also will be able to request orientation and support by means of email to the professors of the course. This way of attention is advisable for indications and short doubts of punctual type. |

### Assessment

|                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Qualification | Training and Learning Results |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------|
| Laboratory practices | <p>Assessment of the laboratory sessions:</p> <p>The laboratory sessions will be evaluated in a continuous way, on each session.<br/>The applied criteria are:</p> <ul style="list-style-type: none"> <li>- A minimum attendance of 80%</li> <li>- Punctuality</li> <li>- Previous task preparation of the sessions</li> <li>- Make the most of the session</li> </ul> <p>The practical sessions will be held in groups of two students. The documents of the practices will be available prior to the sessions.<br/>The students will fill report, that will be delivered when the session ends. This report serves to justify both the attendance and how they have done the work asked for.</p> | 20            | C11 D9<br>D10<br>D17          |

|                          |                                                                                                                                                                                                                                                                                                                                                                                                      |    |                  |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|------------------|
| Objective questions exam | Evaluation of Blocks of Topics: This part is intended to emphasize the self learning process and provide feedback to the students. It's main aim is to provide honest and objective information about the learning process. These individual exams will be held by electronics means, if possible. It can consists on a wide set of test questions, short answers and analytical numerical problems. | 20 | B3 C11 D2 D9 D10 |
| Essay questions exam     | Individual Exam: It will consist on an individual written exam near the end of the semester, in the dates established by the head teachers. The exam will be a combination of any of the following types of exercises:<br>- Test Questions<br>- Short Answer Questions<br>- Analysis Problems<br>- Practical Cases                                                                                   | 60 | B3 C11 D2 D9 D10 |

### Other comments on the Evaluation

Evaluation:

All the students will be evaluated of continuous way by means of the following procedure:

Along the semester the students will realise several partial proofs and will obtain a note by each proof. The note of partial (NP) will obtain of the average of the notes of the proofs.

Also the long of the semester the students will do practices of laboratory and will obtain a note by each practice. The sessions without assistance will be marked with a zero. The note of laboratory (NL) will obtain of the average of the notes of the practices, with the following exceptions:

- a) If the assistance to the sessions of practices is inferior to 80% the total note of the same (NL) will be zero.
- b) If the average of the notes obtained in the partial proofs (\*NP) is inferior to 3,33, the note of laboratory (NL) will be zero.

Also along the semester partial exams will be made. Each partial exam will have a grade. The grade of these exams (NP) is the average of the grades in each one.

The qualification of continuous evaluation (CC) procedure will be calculated with this formula:

$$CC = 0,8 \times NP + 0,2 \times NL$$

The students can opt to that qualification CC becomes the qualification in records (CA), without need to take any additional exam, as long as they fulfil all the following requirements:

- a) The average grade of the partial exams (NP) must be great or equal than 6,25 points.
- b) The grade obtained in all the partial exams must be at least 3,75 points.
- c) Obtain a laboratory grade (NL) great or equal to 7 points.

A final exam (EF) will be held in scheduled dates in June and July.

The grades in records (CA) for those students that do not want to or can not opt to the note of continuous qualification method will be obtained with arrangement to the following formula:

$$CA = 0,2 \times NP + 0,2 \times NL + 0,6 \times EF$$

For the present academic year, grades NL and NP obtained in the previous two academic courses are still valid with the following exceptions:

- Those students that want to use the previous NL grade with less than 7 points can not apply for the continuous evaluation procedure, and must pass the final exam (EF)
- Those student that want to use the previous NP grade can not apply for the continuous evaluation procedure, and must pass the final exam (EF)

Those students granted with an exemption from the school direction not to take part on the continuous evaluation process, will be evaluated at the same day and time established by the school direction board, in the following way:

- A two part test

1- A written exam identical to the final examination, with a weight of 70% on the final grade and lasting a maximum of two hours.

2- A specific laboratory test, with a weight of 30% on the final grade and lasting a maximum of two hours. This take will take place immediately after the written exam in the laboratories of the same school.

In the final year examination, students will take a written exam that will weigh 70% on the final grade. The remaining 30% will be obtained from the qualification of a laboratory test.

To pass the course, in any of the previous cases, it is necessary to achieve a final grade equal or higher than 5 points.

Recommendations:

It is very important that the students keep updated the profile in the FAITIC platform. All communications related with this course will be made through this platform. All individual communications will be made through the email listed in this platform.

The students can solve doubts related with the laboratory previous activities in the personal attention hours (tutoring time), or by any other contact procedure available in FAITIC.

The students must meet the deadlines for all the activities.

All the achieved results must be justified, in any of the exams or activities. None of the achieved results will be taken for good if no explanation is given about the method used to find them. The selected method for solving a problem is considered when grading the solution.

When writing the solutions and answers in reports and tests, avoid spelling mistakes and unreadable symbols.

Exams lacking some of the sheets will not be graded.

Use of cell phones, notes or books is forbidden during exams.

### **Competencies Acquisition and Its Influence on Assessments**

In this subject all the different activities are designed to assess the students in the competencies, and the acquisition of the competencies defines the final mark. Here follows a description of how the competencies and activities are related.

**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.

The acquisition of this competency is provided by the contents of the topics of the subject. All activities of self-assessment, the laboratory sessions and the different test are elaborated to evaluate the knowledge of the technical subjects.

**CE11** Knowledge of the fundamentals of electronics.

This competency is warrant to be acquired along all the lectures, the laboratory sessions, the self-assessment activities and the tests.

**CT2** Problems resolution.

The students will exercise this competency by means of the following activities: self-assessment activities, bulletin of problems and previous theoretical solution of experiments to be made at the laboratory. This competency is also acquired along all the test (for each block and the individual one), as they mainly are composed by problems to be solved.

**CT9** Apply Knowledge

This competency is mainly acquired during the laboratory sessions, where the theoretical knowledge from problems, designs and simulations should match the assembly of circuits and real measures. Laboratory sessions are evaluated one by one, scoring an average of marks, if there is a minimum number of attended sessions with a minimum score.

**CT10** Self learning and work

The self learning process is fundamental to achieve the score to approve the subject. In order to motivate students in the task of acquiring the theoretical knowledge, self-assessment test (on line), lectures based on the remote learning platform (faitic) and bulletins of problems have been created. The self-assessment test also provide feedback to the professors about the main difficulties found by students. On the laboratory sessions, the previous preparation is an explicit method of evaluation. In order to make this preparation, each of the laboratory sessions has its specific documentation and

tutorials.

#### **CT17 Working as a team**

The students exercise this competency at the laboratory sessions, by making teams of two people. Cooperation in most of the sessions is needed to perform the assembly of circuits, make the measurements and take notes. The professor in charge of the laboratory session verifies the previous work and how each session is going along, watching that both members cooperate to achieve the best possible result. Scores for students can be different if the professor detects that one of the team member is not cooperating.

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#### **Sources of information**

##### **Basic Bibliography**

Malvino, Albert; Bates, David J., **Principios de Electrónica**, 7ª,

Boylestad, R. L.; Nashelsky, L., **ELECTRÓNICA: TEORÍA DE CIRCUITOS Y DISPOSITIVOS ELECTRONICOS**, 10ª,

Rashid, M.H., **CIRCUITOS MICROELECTRONICOS: ANALISIS Y DISEÑO**, 2ª,

TOCCI, RONALD J., NEAL S. WIDMER, GREGORY L. MOSS, **Sistemas digitales. Principios y aplicaciones**, 10ª,

Lago Ferreira, A.; Nogueiras Meléndez, A. A., **Dispositivos y Circuitos Electrónicos Analógicos: Aplicación práctica en laboratorio**,

##### **Complementary Bibliography**

Malik N. R., **Electronic Circuits. Analysis, simulation, and design**,

Wait, J.; Huelman, L.; Korn, G., **INTRODUCCION AL AMPLIFICADOR OPERACIONAL**, 4ª,

Pleite Guerra, J.; Vergaz Benito, R.; Ruíz de Marcos, J. M., **Electrónica analógica para ingenieros**,

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#### **Recommendations**

##### **Subjects that are recommended to be taken simultaneously**

Fundamentals of automation/V12G380V01403

##### **Subjects that it is recommended to have taken before**

Physics: Physics I/V12G380V01102

Physics: Physics II/V12G380V01202

Mathematics: Algebra and statistics/V12G380V01103

Mathematics: Calculus I/V12G380V01104

Mathematics: Calculus II and differential equations/V12G380V01204

Fundamentals of electrical engineering/V12G380V01303