IDENTIFYING DATA				
Electronic technology				
Subject	Electronic technology			
Code	P52G381V01301			
Study programme	(*)Grao en Enxeñaría Mecánica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Falcón Oubiña, Pablo			
Lecturers	Falcón Oubiña, Pablo Gómez Pérez, Paula			
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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	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	Knowledge of the fundamentals of electronics.
D2	Problems resolution.
D9	Apply knowledge.
D10	Self learning and work.
D17	Working as a team.

Learning outcomes			
Expected results from this subject	Training and Learning Results		
To know of the operation of electronic devices.	B3	C11	D2 D9 D10 D17
Know conditioning and data acquisition electronic systems and devices.		C11	D10
To identify different types of industrial sensors.		C11	D10
To know the basics of a digital electronic system.		C11	D2 D9 D10 D17
To know basic electronic circuits for data communications.	B3	C11	D9 D10
ENAEE LEARNING OUTCOME: KNOWLEDGE AND UNDERSTANDING LO 1.3 Be aware of the multidisciplinary context of engineering. (level of development of this sub-learning outcome: Basic (1))		C11	

ENAEE LEARNING OUTCOME: ENGINEERING ANALYSIS LO 2.2 Ability to identify, formulate and solve engineering problems within an specialty; choose and apply properly analytical methodologies; recognize the importance of social, health and safety, environmental, economic and industrial restrictions. (Medium (2))	D2 D9
ENAEE LEARNING OUTCOME: COMMUNICATION AND TEAMWORK LO 7.2 Ability to operate properly within national and international contexts, both individually and as a team, and cooperate with engineers and/or people from other disciplines. (Medium (2))	D10 D17
ENAEE LEARNING OUTCOME: CONTINUOUS EDUCATION LO 8.1 Ability to realize the need for continuous training and undertake this activity throughout their professional life on their own. (Medium (2))	D10
ENAEE LEARNING OUTCOME: CONTINUOUS EDUCATION LO 8.2 Ability to stay up-to-date on science and technology. (Basic (1))	D10

Contents

Topic	
Digital Electronics	- Basic concepts - Logical values: positive and negative logic - Logical families: TTL, ECL, CMOS - Binary functions and basic logic blocks - Truth table - Karnaugh maps - Basic integrated circuits - Design of basic combinational digital systems
Operational Amplifiers	- Basic concepts - Differential amplifier and operational amplifier - The op. amp.: terminals, feedback, virtual shortcut - Op-Amp circuits with closed-loop and negative feedback: inverting and non-inverting amplifiers, summing amplifier, differential amplifier, integrator, differentiator,... - Design of analog systems based on operational amplifiers
The diode	- Basic concepts - Semiconductors - The diode - The zener diode - Other diodes: LED, photodiode, etc. - Applications
The Bipolar Junction Transistor (BJT)	- Structure - BJT operation - Polarization, load line analysis and operating point (Q) - Applications
Field-Effect Transistor (JFET)	- Structure - Families of FET transistors - Polarization - Applications
Small-Signal Amplifiers	- Amplifier gain: voltage amplifier, current amplifier - Input impedance - Output impedance - Small-signal model for BJT - Small-signal model for JFET
Applications	- Data acquiring systems - Sensors and actuators - Analog to digital converter - Design of digital and analogical electronic systems - Industrial communications
Practice 1: Digital Electronics	This practice introduces the student to digital combinational circuits by assembling basic circuits within a protoboard.
Practice 2: Operational Amplifiers	The goal of this practice is introducing the closed-loop operation of these types of amplifiers, by assembling different circuits within a protoboard.
Practice 3: Simulation of digital and analog circuits	The goal of this practice is to introduce the simulation software PSIM and "Digital Electronic Simulator" to the student, in order to understand the importance of a proper simulation.

Practice 4: Basic electronic circuits with diodes	This practice shows the student different circuits for diodes (rectifiers, trimmers, ...), by assembling them in a protoboard and testing them with different input signals.
Practice 5: Basic electronic circuits with transistors	This practice shows basic circuits with transistors (mainly BJT) in order to show the polarization concepts shown in theory.
Practice 6: Simulation of electronic circuits with diodes and transistors	With this practice the student will learn to solve different circuits conformed by diodes and/or transistors with the simulation software PSIM.
Practice 7: Multistage amplifier design	This practice tries to merge all the concepts learned during the course for analog devices by designing a simple multistage amplifiers conformed by a small-signal amplifiers followed by one (or more) stages of high power amplifiers (wit op-amps).

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	35	63
Laboratory practical	14	4	18
Seminars	22	0	22
Problem and/or exercise solving	9	15	24
Problem and/or exercise solving	1.5	2	3.5
Problem and/or exercise solving	1.5	2	3.5
Laboratory practice	3	0	3
Essay	2	11	13

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

Methodologies

	Description
Lecturing	They will consist in an oral explanation by the lecturer 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.
Laboratory practical	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.
Seminars	Previous preparation of the theoretical sessions: 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. Previous preparation of the laboratory sessions: 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. This section includes the intensive course designed for preparing the extraordinary exam.

Personalized assistance

Methodologies	Description
Seminars	In the scope of tutorial action, academic tutoring actions and personalized tutoring are distinguished. Within the first option, students will have tutoring hours where they can consult questions related to the subject contents, organization and/or planning. In personalized tutoring hours, each student, individually, can discuss with the teacher any problem regarding his/her understanding of the subject. Both tutorial actions aim to compensate the different learning rhythms through attention to diversity. The teachers of the subject will personally attend to the doubts and queries of the students, in person, according to the schedule that will be published on the website of the center, such as through telematic means (email, videoconference, FAITIC forums, etc.) under the modality of previous appointment.

Assessment

	Description	Qualification	Training and Learning Results		
Problem and/or exercise solving	Final exam to evaluate the global knowledge acquired of the subject, due at the end of the semester.	40	B3	C11	D2 D9 D10
Problem and/or exercise solving	First assessable test of the knowledge acquired up to that moment (due date: around the 5th week of the semester).	15	B3	C11	D2 D9 D10

Problem and/or exercise solving	Second assessable test, corresponding to themes 4, 5 and 6 (approximate date: 9th week of the semester).	15	B3	C11	D2 D9 D10
Laboratory practice	Laboratory exam where the ability to understand, ensemble and simulate basic electronic circuits are tested (due date: at the end of the semester).	15	B3	C11	D2 D9 D10 D17
Essay	Group work corresponding to the first part of the practical evaluation (approximate date: 10th week of the semester).	15	B3	C11	D2 D9 D10 D17

Other comments on the Evaluation

The student evaluation and qualification criteria proposed for this subject are set out. Given the peculiarities of the Centro Universitario de la Defensa, where this subject will be taught, and taking into account that the students are in a boarding school, only evaluation criteria for assistants are proposed.

Ordinary call:

Continuous evaluation

In the ordinary call, a process of continuous evaluation is carried out in which the weight of the different parts in which the subject is structured over the final mark is as follows:

- Knowledge of theory (T): 70%
- Practical knowledge (L): 30%

Knowledge of theory:
The theory knowledge part is evaluated by combining two scoring tests and a final exam as follows:

- Partial exam 1 (P1):
    - A test of approximately 1 hour and a half in length and preferably located at the end of themes 1 and 2 of the subject.
    - Weight: 15% of the continuous assessment score (NEC).
    - It is qualified with 10 points.
    - Made individually.
    - It can take the form of a multiple choice questionnaire, short answer questionnaire, problem solving or some combination of the above.
    - There is no minimum qualification.
- Partial Exam 2 (P2):
    - A test of approximately 1 hour and a half, preferably located at the end of themes 3 and 4 of the course.
    - Weight: 15% of the continuous assessment score (NEC).
    - It is qualified with 10 points.
    - Made individually.
    - It can take the form of a multiple choice questionnaire, short answer questionnaire, problem solving or some combination of the above.
    - There is no minimum qualification.
- Final exam (EF):
    - Exam to be taken on the evaluation dates.
    - Weight: 40% of the continuous assessment score (NEC).
    - It is qualified with 10 points.
    - Made individually.
    - They can be in the form of a multiple choice questionnaire, short answer questionnaire, problem solving or

    - some combination of the above.
    - A minimum qualification of 4.0 is required.

Practical knowledge:

The practical part of the course is assessed by means of group work and a practical laboratory test, as follows:

- Group work (L1):
    - Design and simulation of an electronic system for the solution of an engineering problem.
    - The work proposal will be approved by the teachers to check that it meets the minimum milestones of the task.
    - If the students do not propose a work within the deadline set by the teachers at the beginning of the course, a a generic work will be assigned to them with the necessary requirements.
    - Weight: 15% of the continuous evaluation score (NEC).
    - A minimum score of 4.0 points is required.

- Practical laboratory exam (L2):
    - This is a test to evaluate the ability acquired by the student to assemble electronic circuits and to check their operation with the instruments used in the practices.
    - The realization of the test is individual.
    - Weight: 15% of the continuous evaluation score (NEC).
    - It is qualified with 10 points.
    - A minimum score of 4.0 points is required.

Final mark and minimum requirements to pass the course through continuous assessment:

To ensure that the student has acquired the minimum skills in each of the aspects of the subject, students will be required to achieve a minimum score of 4.0 out of 10 in the final exam of theory (EF), and a minimum score of 4.0 out of 10 in the practical part (L1 and L2).

In this way, the final mark in continuous assessment (NEC) is calculated using the following formulas, a minimum mark of 5.0 in the NEC being necessary to pass the course:

NEC = 0.15*P1 + 0.15*P2 + 0.4*EF + 0.15*L1 + 0.15*L2
In the event that the minimum mark required in any of the parts is not reached, the final mark for continuous assessment will be calculated as:

NEC = min(4.0, NEC)
The student who does not pass the course in continuous evaluation must take the ordinary exam.
Ordinary exam

- Knowledge of theory (T): 70%
- Practical knowledge (L): 30%

Theory:

Consists of:

- A single exam, of approximately 3 hours, to be performed within the course calendar.
- It is qualified with 10 points (T).
- Individual.
- It can include tests, short questions and/or problems or a combination of them.

Laboratory:

Consists of:

- A single practical exam, of approximately 45 min, at the laboratory, related to the practical contents of the subject.

- It is qualified with 10 points (L).
- Individual.

Final mark and minimum requirements to pass the subject:

The final mark (NEO) will be computed following the next equation:

NEO = 0.7 * T + 0.3 * L

A minimum of 4.0 out of 10 points are required for the T exam, and a minimum of 4.0 out of 10 points are required for the L exam. Once obtained these minimums, a punctuation equal or higher than 5.0 points over 10 in the total computation of NEO is mandatory to pass the subject.

Extraordinary exam:

The students that did not pass the subject on first convocatory must attend the second convocatory (or extraordinary exam), that will have the same structure, exam duration, percentages and minimum points required than in the ordinary exam.

Code of Honor:During exames, the use of non-allowed electronic devices, notes or books is forbidden.Exams lacking some of the sheets will not be graded.
All the results obtained must be properly justified, in any of the exams or activities. None of the numerical results will be considered if no explanation is given about the methodology used to obtain them.

It is expected that all the students abide to these considerations. If a non-ethical behaviour is detected, the student will automatically be graded with a 0.0 at the current convocatory.

Sources of information

Basic Bibliography

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

E. Mandado, **Sistemas Electrónicos Digitales**, 9ª,

Complementary Bibliography

R. Pallás Areny, **Sensores y acondicionadores de señal**, 4ª,

J. Millman, **Microelectrónica. Circuitos y sistemas analógicos y digitales**, 4ª,

N. R. Malik, **Circuitos Electrónicos. Análisis, simulación y diseño**, 1ª,

T. L. Floyd, **Fundamentos de Sistemas Digitales**, 9ª,

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics 1/P52G381V01102
Physics: Physics II/P52G381V01106
Mathematics: Calculus 1/P52G381V01103
Fundamentals of electrical engineering/P52G381V01205
Mathematics: Calculus II and differential equations/P52G381V01201

Contingency plan

Description

In view of the possible appearance of extraordinary situations involving the suspension of face-to-face teaching activity and the change to a non-presential/online scenario, the following changes will be made:

CONTENTS

Theoretical credits
The teaching of the theoretical contents of the subject should not be affected by the transfer to non-presential/online mode. If the number of hours to be taught is considerably reduced, the contents of each of the subjects will be adapted in such a way as to guarantee the acquisition of the learning results and skills of the subject.

Practical credits
In view of the impossibility of working with the instrumentation equipment present in the laboratories, the corresponding practices will be replaced by equivalents that can be transferred to a virtual scenario. Specifically, the practices will be

carried out as follow:

Practice 1: Introduction to electronic circuit simulation
The aim of this practice is to familiarize the student with the PSIM electronic circuit simulation software, as well as with the digital system simulator to carry out assemblies with analog devices and combinational systems respectively.

Practice 2: Applications with digital electronic devices
The aim of this practice is that the student is able to design, assemble and test a basic digital electronic circuit, based on combinational systems, from an engineering problem. In this practice, a digital circuit simulator will be used to assemble the circuit.

Practice 3: Design with operational amplifiers
This practice aims to further familiarize the student with the PSIM simulation software. In this practice it will be used to introduce the operational amplifiers and to let the student observe the usefulness of these devices to solve engineering problems. For this purpose, different assemblies will be made with these operational amplifiers where the student can check the operation of the operational amplifiers under different conditions. These assemblies will also serve the student to reason how different assemblies should be joined together to obtain a given transfer function, which can be applied in many areas of engineering.

Practice 4: Assembly and measurement of basic electronic circuits with diodes
This practice aims at using the PSIM simulation software to mount and measure basic circuits with diodes, such as rectifier circuits (half-wave and full wave), as well as different configurations of signal trimming circuits.

Practice 5: Assembly and measurement of basic electronic circuits with transistors
The fundamental objective of this practice is that the student understands the concepts of the working point of a transistor, and in this way check the zones of operation it works (active, cut-off and saturation). For this purpose, different simple circuits in direct current with bipolar transistors will be carried out in PSIM.

Practice 6: Simulation of electronic circuits with diodes and transistors
The aim of this practice is to familiarize the student with the PSIM electronic circuit simulation software, for the realization of non-linear circuits with diodes and analysis of the working point of bipolar junction and field effect transistors. The small signal amplifiers will also be introduced in the simulator, so that the student understands how they work.

Practice 7: Design of complex analogue systems with amplifiers
The aim of this practice is that the student is able to design, assemble and test a multi-stage amplification circuit, in PSIM, combining different types of amplifiers (small signal and operational), observing the differences between them. For this purpose, the amplifier will be designed and the assembly will be done in an incremental way, incorporating progressively the elements (preampliication, amplification, impedance matching, etc.). In the same way, the student understands the usefulness of this type of amplifier assembly and its interconnection with other engineering concepts such as, for example, signal treatment of different devices and the adapting of the voltage or current levels to operate with them efficiently.

TEACHING METHODOLOGY

A new teaching methodology would be added:

Synchronous online meeting (theory or practical session):
These sessions will be given through a web videoconferencing platform within a virtual classroom. Each virtual classroom will contain various display panels and components, whose design can be customized by the teacher to suit the needs of the class. In the virtual classroom, teachers (and authorized participants) will be able to share their computer screen or files, use a whiteboard, chat, broadcast audio and video, or participate in interactive online activities (surveys, questions, etc.).

LEARNING ASSESSMENT

In a non-presential/online scenario, the evaluation of learning in the online modality will take place combining the FAITIC-Moodle platform with the Campus Remoto tool of the University of Vigo (and/or similar platforms). Below, we show the modifications in the weighting of the tests motivated by the change to the online teaching modality. These changes only affect the continuous assessment of the ordinary call.

Ordinary call

Continuous evaluation

The assessment of theoretical learning will remain unchanged from what was described earlier in this teaching guide in terms of content, weightings, minimum requirements and number of exams.

The assessment of practical learning will be modified by replacing the test that can be assessed in person with a paper. Therefore, the practical part will be evaluated by means of two works whose content and weighting is detailed in the following section.

Practical knowledge:

The laboratory practice part is evaluated by carrying out two group works, as follows:

Group work 1 (L1):
- Design and simulation of a digital circuit that solves a real problem that the students propose according to their particular needs.
- The work proposal will be approved by the teachers to check that it meets the minimum milestones of the task.
- In the event that the students do not propose a work within the deadline set by the teachers at the beginning of the course, a generic work will be assigned to them with the necessary requirements.
- The work will be done in groups of maximum 2 students.
- Weight: 15% of the continuous assessment score (NEC).
- It is qualified with 10 points.
- A minimum score of 4.0 points is required.

Group work 2 (L2):
- Design and simulation of an analogical electronic system for the solution of an engineering problem.
- The work proposal will be approved by the teachers to check that it meets the minimum milestones of the task.
- In the event that students do not propose a work within the deadline set by the teachers at the beginning of the course, a generic work will be assigned to them with the necessary requirements.
- Weight: 15% of the continuous assessment score (NEC).
- It is qualified with 10 points.
- A minimum score of 4.0 points is required.

Final mark and minimum requirements to pass the course through continuous assessment:
To ensure that the student has acquired the minimum skills in each of the aspects of the subject, students will be required to achieve a minimum score of 4.0 out of 10 in the final exam of theory (EF), and a minimum score of 4.0 out of 10 in the practical part (L1 and L2).

In this way, the final mark in continuous assessment (NEC) is calculated using the following formulas, a minimum mark of 5.0 in the NEC being necessary to pass the course:

NEC = 0.15*P1 + 0.15*P2 + 0.4*EF + 0.15*L1 + 0.15*L2

In the event that the minimum mark required in any of the parts is not reached, the final mark for continuous assessment will be calculated as:

NEC = min(4.0, NEC)