



Teaching Guide				
Identifying Data				2022/23
Subject (*)	Power and Analogue Electronics	Code	631G02363	
Study programme	Grao en Tecnoloxías Mariñas			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Third	Optional	6
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría de ComputadoresEnxeñaría Industrial			
Coordinador	Bregains Rodriguez, Julio Claudio	E-mail	julio.bregains@udc.es	
Lecturers	Bregains Rodriguez, Julio Claudio Perez Castelo, Francisco Javier	E-mail	julio.bregains@udc.es francisco.javier.perez.castelo@udc.es	
Web	moodle.udc.es			
General description	The knowledge and competences that allow the student to analyze, detect and supervise the fundamental analog and power electronic equipments and systems of ships are acquired in this subject.			

Study programme competences / results	
Code	Study programme competences / results
A1	CE1 - Capacidade para a realización de inspeccións, medicións, valoracións, taxacións, peritacións, estudos, informes, planos de labores e certificacións nas instalacións do ámbito da súa especialidade.
A2	CE2 - Capacidade para a dirección, organización e operación das actividades obxecto das instalacións marítimas no ámbito da súa especialidade.
A3	CE3 - Capacidade para o manexo de especificacións, regulamentos e normas de obrigado cumprimento.
A8	CE8 - Capacidade para realizar actividades inspectoras de acordo co establecido na normativa europea referente ao control polo estado do porto.
A17	CE17 - Modelizar situacións e resolver problemas con técnicas ou ferramentas físico-matemáticas.
A18	CE18 - Redacción e interpretación de documentación técnica.
A48	CE33 - Vigilar el cumplimiento de las prescripciones legislativas.
A62	CE52 - Exercer como oficial ETO da Mariña Mercante, logo de superados os requerimentos esixidos pola Administración Marítima
A63	CE53 - Supervisar o funcionamento dos sistemas eléctricos, electrónicos e de control
A65	CE55 - Facer funcionar os sistemas xeneradores e os sistemas de distribución
A68	CE58 - Manter e reparar o equipo eléctrico e electrónico
A69	CE59 - Manter e reparar os sistemas de control automático da máquina propulsora principal e das máquinas auxiliares
A70	CE60 - Manter e reparar os equipos de navegación da ponte e dos sistemas de comunicación do buque
A71	CE61 - Manter e reparar os sistemas eléctricos, electrónicos e automáticos de control da maquinaria de cuberta e do equipo de manipulación da carga
A72	CE62 - Manter e reparar os sistemas de control e seguridade do equipo de fonda
B1	CT1 - Capacidad para gestionar los propios conocimientos y utilizar de forma eficiente técnicas de trabajo intelectual
B2	CT2 - Resolver problemas de forma efectiva.
B3	CT3 - Comunicarse de xeito efectivo nun ámbito de traballo.
B4	CT4 - Traballar de forma autónoma con iniciativa.
B5	CT5 - Traballar de forma colaboradora.
B6	CT6 - Comportarse con ética e responsabilidade social como cidadán e como profesional.
B9	CT9 - Capacidade para a aprendizaxe de novos métodos e teorías, que lle doten dunha gran versatilidade para adaptarse a novas situacións.
C1	C1 - Expresarse correctamente, tanto de forma oral coma escrita, nas linguas oficiais da comunidade autónoma.
C2	C2 - Dominar a expresión e a comprensión de forma oral e escrita dun idioma estranxeiro.



C3	C3 - Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C4	C4 - Desenvolverse para o exercicio dunha cidadanía aberta, culta, crítica, comprometida, democrática e solidaria, capaz de analizar a realidade, diagnosticar problemas, formular e implantar solucións baseadas no coñecemento e orientadas ao ben común.
C5	C5 - Entender a importancia da cultura emprendedora e coñecer os medios ao alcance das persoas emprendedoras.
C10	CB2 - Aplicar os coñecementos no seu traballo ou vocación dunha forma profesional e poseer competencias demostrables por medio da elaboración e defensa de argumentos e resolución de problemas dentro da área dos seus estudos
C11	CB3 - Ter a capacidade de reunir e interpretar datos relevantes para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
C12	CB4 - Poder transmitir información, ideas, problemas e solucións a un público tanto especializado como non especializado.
C13	CB5 - Ter desenvolvido aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores con un alto grao de autonomía.

Learning outcomes			
Learning outcomes	Study programme competences / results		
To know the basic schemes of the electronic circuits related to the communications, handling and control systems of ships. To be able to supervise the functioning of the equipment and electronic systems of ships.	A1	B1	C5
	A2	B2	
	A3	B5	
	A8	B6	
	A17	B9	
	A48		
	A62		
	A63		
	A65		
	A69		
A72			
To acquire the fundamental concepts with the aim of analyzing and detecting faults and failures in electronic systems linked to the processes of navigation and control of ships.	A1	B1	C1
	A2	B2	C3
	A3	B3	C4
	A8	B5	C5
	A17	B6	C10
	A18	B9	C11
	A62		C12
	A63		C13
	A65		
	A68		
	A69		
	A70		
A71			
A72			
To know the basic electronic components used in different ship systems. To know the basic circuits that can be configured with the above-mentioned devices.	A3	B1	C1
	A17	B2	C2
	A18	B4	C3
	A62	B5	C10
	A63	B9	C11



To know how to handle, repair and start the equipment and electronic systems of ships.	A1	B1	C5
	A2	B2	
	A3	B3	
	A8	B5	
	A17	B6	
	A48	B9	
	A62		
	A63		
	A65		
	A69		
	A72		

Contents	
Topic	Sub-topic
CHAPTER 1: ELECTRONIC COMPONENTS.	1.1. The diode. Basic terms of periodic functions: mean and effective values. 1.1.1. Basic circuits with diodes: half wave rectifiers and full wave rectifiers. Circuits with capacitor filters. 1.2. The BJT transistor. States of the transistor. 1.2.1. Basic circuits with BJTs: common emitter, common base and common collector configurations. 1.3. The unipolar MOSFET transistor. 1.3.1. Basic circuits with MOSFETs: common source configurations.
CHAPTER 2: AMPLIFIERS.	2.1. Generalities: Voltage, current and power gains. 2.2. Voltage amplifiers. Feedback. 2.3. The operational amplifier. 2.3.1. Linear applications of OAs. 2.3.2. Non-linear applications of OAs.
CHAPTER 3: CIRCUITS WITH TRANSISTORS.	3.1. Oscillators. 3.2. Active and passive filters. 3.3. RF and microwave circuits. 3.4. Tuned amplifiers. 3.5. Multipliers. 3.6. Mixers.
CHAPTER 4: FOUNDATIONS OF POWER ELECTRONICS.	4.1. Power terms. Power factor. 4.2. Methods for analyzing power circuits. 4.3. Power electronic devices. Thyristors, transistors and diodes. 4.3.1. Operating principles. 4.3.2. Control, limitations and dissipation.
CHAPTER 5: AC-DC AND AC-AC CONVERTERS.	5.1. Controlled rectifiers. 5.2. AC regulators. 5.3. Cycloconverters. 5.4. Motors control.
CHAPTER 6. DC-DC CONVERTERS. SWITCHED FEEDING SOURCES AND DC-AC CONVERTERS.	6.1. Buck, boost and buck-boost converters. 6.2. Flyback, forward and push-pull converters. 6.3. Full bridge inverter. 6.4. Resonant inverters and PWM. 6.5. Motors control.



<p>PROBLEMS SOLVING.</p>	<p>PROBLEMS GUIDE NOTES 1: Solving problems of Circuits with Diodes.</p> <p>PROBLEMS GUIDE NOTES 2: Solving problems of Circuits with Unipolar and Bipolar Transistors.</p> <p>PROBLEMS GUIDE NOTES 3: Solving problems of Amplifiers and linear applications of OAs.</p> <p>PROBLEMS GUIDE NOTES 4: Solving problems of non-linear applications of OAs.</p> <p>PROBLEMS GUIDE NOTES 5: Solving problems of Circuits with Transistors 1: Oscillators, Filters and RF Circuits.</p> <p>PROBLEMS GUIDE NOTES 6: Solving problems of Circuits with Transistors II: Tuned Amplifiers, Multipliers and Mixers.</p> <p>PROBLEMS GUIDE NOTES 7: Problem solving of Power Circuits Thyristors and Triacs. Control and Converters.</p>
<p>LABORATORY PRACTICES.</p>	<p>PRACTICAL (VIRTUAL) 1: MEASUREMENTS I: Diodes and Transistors.</p> <p>1.1. Functions generator, multimeter and oscilloscope: measurement of voltages with multimeter and oscilloscope.</p> <p>1.2. Measurement of parameters of rectifiers with diodes.</p> <p>1.3. Measurement of parameters of circuits with bipolar transistors.</p> <p>PRACTICAL (VIRTUAL) 2: MEASUREMENTS II: Operational Amplifiers.</p> <p>2.1. Measurements in circuits with OAs: linear applications.</p> <p>2.2. Measurements in circuits with OAs: non-linear applications.</p> <p>PRACTICAL (VIRTUAL) 3: MEASUREMENTS III: Power Electronics I.</p> <p>3.1. Measurements in circuits of controlled rectifiers.</p> <p>3.2. Measurements in circuits of power limiters.</p> <p>PRACTICAL (VIRTUAL) 4: MEASUREMENTS IV: Power Electronics II.</p> <p>4.1. Measurements in circuits of DC-DC and DC-AC converters.</p> <p>4.2. Measurements in circuits of motor controllers.</p>



<p>ITC PRACTICALS.</p>	<p>ITC PRACTICAL 1: SIMULATIONS I: Diodes and Transistors.</p> <p>1.1. Obtaining voltage and current curves in PSpice.</p> <p>1.2. Simulation of parameters of rectifiers with diodes.</p> <p>1.3. Simulation of parameters of circuits with bipolar transistors.</p> <p>ITC PRACTICAL 2: SIMULATIONS II: Operational Amplifiers.</p> <p>2.1. Circuits with OAs simulation: linear applications.</p> <p>2.2. Circuits with OAs simulation: non-linear applications.</p> <p>ITC PRACTICAL 3: SIMULATIONS III: Power Electronics I.</p> <p>3.1. Simulation of controlled rectifiers circuits.</p> <p>3.2. Simulation of power limiters circuits.</p> <p>ITC PRACTICAL 4: SIMULATIONS IV: Power Electronics II.</p> <p>4.1. Simulation of DC-DC and DC-AC converters circuits.</p> <p>4.2. Simulation of circuits with motor controllers.</p>
<p>SUPERVISED PROJECTS.</p>	<p>RECTIFIERS WITH REGULATORS.</p> <p>RCR.1. Full wave rectifier with filter capacitor.</p> <p>RCR.2. Full wave rectifier with regulator of transistor.</p> <p>RCR.3. Operation of electronic equipments in flammable zones.</p>

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A1 A3 A17 A63 A65 A69 A72 B1 B9 C2 C11	30	37.5	67.5
Problem solving	A17 A63 B1 B2 B4 B9 C2 C10 C11 C13	8	28	36
Mixed objective/subjective test	A17 A18 B1 B2 B4 B9 C3 C10	3	0	3
Laboratory practice	A1 A2 A8 A17 A18 A48 A62 A63 A68 A70 A71 B2 B3 B4 B5 B6 C1 C4 C5 C10 C11 C12 C13	8	12	20
ICT practicals	A1 A2 A8 A17 A18 A48 A62 A63 A68 A70 A71 B2 B3 B4 B5 B6 C1 C3 C4 C5 C10 C11 C12 C13	8	12	20
Personalized attention		3.5	0	3.5
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Guest lecture of the theoretical contents of the subject. The active participation of the students will be fostered with questions whose answer will require some kind of reasoning requiring the application of the knowledge acquired until then.



Problem solving	Guest lecture -with the help of slides and blackboard- of the solving of some problems similar to those that will be included in the mixed exam. The student will have to solve, on dates previously specified and with the same methodology of that of an exam, a set of tests proposed by the professor. Each test will consist of two simple problems and a question whose answer will have to be reasonably justified.
Mixed objective/subjective test	Written test containing questions related to theory and problem solving about the contents given during the lecture sessions of the whole course, in which both the comprehension of such contents and their application to problem solving will be assessed.
Laboratory practice	The students will develop a series of practicals for learning the basic electronic instruments. Together with such practicals, the students will have to answer a set of questions related to the subjects to be developed in each case.
ICT practicals	The students will develop a series of computer practicals with an electronic circuits simulation software tool.

**Personalized attention**

Methodologies	Description
Problem solving Guest lecture / keynote speech ICT practicals Laboratory practice	<p>Guest lecture/keynote speech: listen to and solve questions from the students in relation to the theoretical part of the subject exposed in the corresponding lectures.</p> <p>Laboratory practices: listen to and solve questions from the students in relation to the practices proposed or realized.</p> <p>ITC practices: listen to and solve questions from the students in relation to the practicals proposed or realized with the help of the simulation software tools.</p> <p>Problems solving: listen to and solve questions from the students in relation to the problems solved in class. For the case of the defense of the presented projects, reasoning with the student the results obtained in the problems proposed by the professor, determining his/her judgement and problem solving capacities.</p> <p>In all cases, communication with the students will take place using the individual tutoring hours, through email, or by making use of the corresponding Moodle tools. These two last cases will be particularly adequate for those students with academic dispensation of exemption attendance.</p> <p>For those students registered part-time the timetable the tutoring hours could be adapted according to their needs.</p>

**Assessment**

Methodologies	Competencies / Results	Description	Qualification
Problem solving	A17 A63 B1 B2 B4 B9 C2 C10 C11 C13	<p>It will consist in the evaluation of two (2) brief problems solved by the student, together with one (1) question whose answer will be properly justified. These three (3) points will be proposed by the professor by means of a test. Such tests will be performed at dates previously established by the professor.</p> <p>The students registered part-time and with academic dispensation of exemption attendance will have the option of taking an exam about problem solving at the end of the course.</p>	20



Mixed objective/subjective test	A17 A18 B1 B2 B4 B9 C3 C10	<p>It will consist of an exam composed of a set of questions related to the theory of the subject and a set of problems to be solved by the student, in which both the comprehension of such contents and their application to problem solving will be assessed. The contents will be those developed throughout the course during the lecture sessions.</p> <p>The evaluation criteria and activities for the students registered part time and with academic dispensation of exemption will be the same as those required for the rest of the students.</p>	60
ICT practicals	A1 A2 A8 A17 A18 A48 A62 A63 A68 A70 A71 B2 B3 B4 B5 B6 C1 C3 C4 C5 C10 C11 C12 C13	<p>Attending the practices and performing their corresponding projects will be deemed positive. At the beginning of each ITC practical, the student will have to write the answers to a set of three (3) brief questions (tests) related to the abovementioned practical. If the student does not answer correctly at least two of those questions, the score obtained in the practice will be halved.</p> <p>The students registered part-time and with academic dispensation of exemption attendance will have the option of taking an exam about ITC practicals at the end of the course.</p>	10
Laboratory practice	A1 A2 A8 A17 A18 A48 A62 A63 A68 A70 A71 B2 B3 B4 B5 B6 C1 C4 C5 C10 C11 C12 C13	<p>Attending the practices and performing their corresponding projects will be deemed positive. At the beginning of each practice, the student will have to write the answers to a set of three (3) brief questions (tests) related to the abovementioned practice. If the student does not answer correctly at least two of those questions, the score obtained in the practice will be halved.</p> <p>The students registered part-time and with academic dispensation of exemption attendance will have the option of taking an exam about laboratory practices at the end of the course.</p>	10
Others			

Assessment comments



The mixed test and the problem-solving tests constitute 80% of the grade. The evaluation of laboratory practices and through ICT constitute the remaining 20%.

Description of the evaluation and distribution of points.

## FIRST OPPORTUNITY

### A) MIXED TEST:

It will consist of two midterm exams of 6 points (maximum) each. In order to pass the subject, a minimum of 3 points must be obtained in each one. Once obtained, the grade of the mixed exam will be the average of the grades of both midterm exams.

If any of the midterm exams are not passed, the student will have the opportunity to pass them in the final exam (1st opportunity).

### B) PROBLEM SOLVING:

It will consist of a set of tests with a maximum combined evaluation of 2 points, with a minimum of 1 to pass the course.

In case of not passing the tests, the student will have a problem solving exam on the same date and time as the final exam (see item A). This exam must be passed in order to pass the course.

### C) LABORATORY/TIC PRACTICES:

It will consist of a set of laboratory and computer simulation tasks (ICT) with a maximum joint evaluation of 2 points, with a minimum of 1 to pass the course. At the beginning of each practice, the student must pass a previous test. If the student fails the test, the grade of the corresponding practice will be halved.

In case of not passing the assignments, the student will have a laboratory exam on the same date and time as the final exam (see item A). This exam must be passed in order to pass the course.

**FINAL GRADE:** if the three parts (A, B and C) are passed, the final grade will be the sum of them. In case of failing, the final grade will be half of the sum of these three parts.

**Detection of plagiarism or copying of work:** the fraudulent performance of the tests or evaluation activities will directly imply the qualification of failure '0' in the corresponding opportunity of the subject, thus invalidating any qualification obtained in all the evaluation activities for the second and advanced calls.

## SECOND OPPORTUNITY

For the second opportunity the student may take a mixed test similar in content and difficulty to that of the first opportunity, and must pass both parts. The grade obtained in the mixed test will be added to the laboratory practices, ICT and problem solving grades obtained in the first opportunity. In case of not passing the problem solving or the practicals, the student will have the corresponding exams, within the timetable corresponding to the mixed test. For the calculation of the total grade, the same criteria will be followed as for the first opportunity.

Students enrolled part-time or who have been granted academic dispensation of exemption from attendance, as established by the Rule that regulates the regime of dedication to the study of undergraduate students at UDC (Arts. 2.3; 3.b; 4.3 and 7.5) (04/05/2017), will take the same evaluation tests as students enrolled full-time. He/she will have the option of taking a lab/ICT practicum exam at each opportunity.

The evaluation criteria contemplated in Table A-II/1 of the STCW Code, and collected in the Quality Assurance System, will be taken into account when designing and carrying out the evaluation.

### Sources of information

<b>Basic</b>	<ul style="list-style-type: none"><li>- Profesores de Electrónica Analógica y de Potencia (). Apuntes de la asignatura.</li><li>- R. L. Boylestad y L. Nashelsky (). Electrónica: teoría de circuitos y dispositivos electrónicos. Ed. Prentice Hall</li><li>- J. C. Brégains, P. M. Castro (). Electrónica Básica. Problemas Resueltos. Ed. Starbook</li><li>- P. Horovitz (). The art of Electronics. Cambridge University Press</li><li>- D. W. Hart (). Power Electronics. McGraw-Hill</li><li>- M. H. Rashid (). Electronica de Potencia. Circuitos, Dispositivos y Aplicaciones. Prentice Hall</li></ul>
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<b>Complementary</b>	<ul style="list-style-type: none"><li>- J. A. Edminister (). Circuitos eléctricos (Serie Schaum). Ed. McGraw Hill</li><li>- A. R. Hambley (). Electrónica . Ed Prentice Hall</li><li>- A. P. Malvino (). Principios de electrónica. Ed. McGraw-Hill</li><li>- N. R. Malik (). Circuitos electrónicos. Análisis, simulación y diseño. Ed. Prentice Hall</li><li>- F. J. Martín Pérez y J. Martín Juan (). Apuntes de electricidad aplicada a los buques . Ed. ECU</li><li>- J. C. Brégains, P. M. Castro (). Electricidad Básica. Problemas Resueltos. Ed. Starbook</li><li>- R. L. Boylestad (). Introducción al análisis de circuitos. Ed. Prentice Hall</li><li>- A. Barrado Bautista (). Problemas de Electroónica de Potencia. Ed. Pearson Prentice Hall</li><li>- N. Mohan, T. Undeland, W. Robbins (). Power Electronics.Converters, Applications and Desing. John Wiley &amp; Sons</li><li>- M. Barnes (). Practical variable speed drives and power electronics. Elsevier</li><li>- A. Pigazo López, V. M. Moreno Sáiz (). Sistemas electrónicos de potencia en el buque. Ediciones de la Universidad de Cantabria</li></ul>
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## Recommendations

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

Electrotechnology, Electrical Machinery and Electronic Systems for Vessels/631G02253

### Subjects that are recommended to be taken simultaneously

Digital Electronics/631G02364

### Subjects that continue the syllabus

Electrical Propulsion of Vessels/631G02458

Electronic Systems for Data Acquisition/631G02562

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### Other comments

Basic knowledge about circuits theory: Ohm's law, Kirchhoff laws, Thévenin and Norton theorems, principle of superposition, sources equivalence.

(\*The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.