



## Teaching Guide

Teaching Guide				
Identifying Data				2019/20
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		E-mail	julio.bregains@udc.es
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Web	moodle.udc.es			
General description	The knowledge and competences that allow the student to analyze, detect and supervise the fundamental 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 xuícios 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.



PROBLEMS SOLVING.	<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>
LABORATORY PRACTICALS.	<p>PRACTICAL 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 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 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 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>



ITC PRACTICALS.	<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>
SUPERVISED PROJECTS.	<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	21	52.5	73.5
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	7	12.6	19.6
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	7	12.6	19.6
Supervised projects	A1 A3 A8 A17 A18 A48 A65 A69 A72 B1 B2 B3 B4 B6 C1 C3 C11 C12	2	4	6
Speaking test	B2 B3 B4 B6 C1 C4 C5 C10 C11 C12	0.25	0.75	1
Problem solving	A17 A63 B1 B2 B4 B9 C2 C10 C11 C13	7	16.8	23.8
Mixed objective/subjective test	A3 A17 A18 A63 B1 B2 B4 B6 B9 C1 C11 C12 C13	3	0	3
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 -with the help of slides and blackboard- 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.
Laboratory practice	The students will develop a series of practicals in the Electronics Laboratory, working with proper devices (circuits) and the available measurements material. 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 (PSpice).
Supervised projects	The students will have to develop, independently, a project proposed by the professor of practicals using the ITC electronic circuits simulation software tool PSpice. Besides, at the end of the course, those students who passed the subject will be able to request to perform an additional project (independently) in order to opt to raise the score (see assessment section). The theme of such a project will be proposed by the professor and it will be related to some of the contents of the subject.
Speaking test	Presentation and speaking defense by the student of the practice project proposed by the professor.
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.

Personalized attention	
Methodologies	Description
Problem solving Speaking test Guest lecture / keynote speech Supervised projects 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 practice: listen to and solve questions from the students in relation to the practices proposed or realized in the laboratory.</p> <p>ITC practicals: 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>Supervised projects: listen to and solve questions from the students in relation to the independent realization of a project proposed by the professor of practices.</p> <p>Speaking test: reasoning with the student the results of the supervised project proposed by the practices professor, with the aim of verifying the comprehension of it and determine both the degree of exploitation of the practices performed in the Electronics Laboratory and the capacity of the student for the critical analysis in problems solving.</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	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.  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.	20
Speaking test	B2 B3 B4 B6 C1 C4 C5 C10 C11 C12	At the date established by the professor, an evaluation of the defense -in an oral session- of a supervised project of practices will be performed. The articulation when presenting the results and the critical analysis of them will be mainly assessed.	2
Mixed objective/subjective test	A3 A17 A18 A63 B1 B2 B4 B6 B9 C1 C11 C12 C13	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.  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.	60
Supervised projects	A1 A3 A8 A17 A18 A48 A65 A69 A72 B1 B2 B3 B4 B6 C1 C3 C11 C12	It will consist of the evaluation of a project proposed and advised by the professor, and related to any of the chapters of the subject. Those students that passed the subject (see assessment comments below) may request an additional supervised project (see Step 5: Methodologies), whose maximum mark will be 1 point.	3
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	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.  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.	7.5
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	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.  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.	7.5
Others			

## Assessment comments



Description of the scoring  
obtained in the exam.

The student may obtain:

## A) UP TO 6 POINTS OBTAINED

IN THE MIXED TEST, WITH A MINIMUM OF 3 (IN THIS SECTION) TO PASS THE SUBJECT.

THE MAXIMUM TIME LAPSE OF EACH MID-COURSE EXAM (SEE NEXT PARAGRAPH) WILL BE 2 HOURS. THE MAXIMUM TIME LAPSE OF THE FINAL EXAM WILL BE 3 HOURS.

The mixed test will consist of two exams of theory and problems solving in correspondence with the contents of the subject developed over the quarter.

The student will have two options: whether to pass the mixed test by means of mid-course exams (one with contents related to the first three chapters, and one with contents related to the rest of the subject) or to pass both through the final mixed test (final exam). The first option is particularly suitable for those students registered part time and with academic dispensation of exemption attendance. To pass the subject it will be required to obtain 3 points of 6 as a minimum in each of the two mixed tests that compose the exam. The final score will be the average of the scores obtained in each mid-term exam. The student that passed one of the mid-term exams will just have to pass the remaining one.

## B) UP TO 2 POINTS OBTAINED

IN THE PROBLEMS SOLVING CONTINUOUS ASSESSMENT, WITH A MINIMUM OF 1 (IN THIS SECTION) TO PASS THE SUBJECT. IF THE STUDENT DOES NOT PASS THE PROBLEM SOLVING (SEE DETAILS BELOW) IT WILL BE NECESSARY TO PASS AN ADDITIONAL FINAL PROBLEM-SOLVING EXAM (WHICH WILL BE INCLUDED WITHIN THE SAME TIME FRAME OF THE FINAL EXAM).

Attending the problems solving lectures is not mandatory. The continuous evaluation will consist of problem solving grouped in tests (consisting of 2 problems to solve and one reasoned question), which may be solved at dates previously specified. The maximum time lapse for each test will be 10 minutes. Those students that do not pass more than 3 tests, or those that do not obtain at least 1 point in the final score of this section, will have to pass an additional final problem-solving exam on dates specified for the final mixed exam. Such additional exam will consist of 3 problems with the highest difficulty, though within the level of the problems solved in the corresponding problem-solving lectures. In such a case, the student will pass such an additional exam only if 1 out of 2 points is obtained. This option is particularly suitable for those students registered part time and with academic dispensation of exemption attendance.

## C) UP TO 2 POINTS OBTAINED

IN THE LABORATORY MEASUREMENTS PRACTICES AND ITC PRACTICALS CONTINUOUS ASSESSMENT, TOGETHER WITH THE SUPERVISED PROYECT (WHOSE SCORE IS, AT MOST, 0.5 POINTS), WITH 1 POINT AS A MINIMUM TO PASS THE SUBJECT. IF THE STUDENT DOES NOT PASS THE PRACTICES (SEE DETAILS BELOW), THEN HE/SHE WILL HAVE TO PASS AN ADDITIONAL LAB-AND-ITC THEORETICAL-PRACTICAL EXAM (WHICH WILL BE PERFORMED AFTER FINISHING THE FINAL MIXED EXAM, AND WHOSE MAXIMUM DURATION WILL BE 1 HOUR).

In the evaluation of the practices it will be compulsory to have 1 out of 2 points from the scorings of the laboratory practices, ITC practicals and the supervised project, delivered to the professor through laboratory guides correspondingly completed by each student. 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. To pass the subject, the student will not have to fail more than 3 of such tests. Those students that do not pass this section (practices) will have to pass an additional lab-and-ITC theoretical-practical exam on dates matching those of the final mixed exam. This option

is particularly suitable for those students registered part time and with academic dispensation of exemption attendance. Such an exam will consist of a set of questions related with the practices developed in the classes, together with questions related to the equipment handling. A minimum of 1 point out of 2 will be required to pass such an exam.

#### D) UP TO 1 (ADDITINAL) POINT

FOR ATTENDING THE LECTURE CLASSES AND/OR PERFORMING A PROJECT SUGGESTED BY THE PROFESSOR.

Attending the lecture classes

will not be mandatory. At the discretion of the teacher, attending the classes and a positive attitude of the student may be assessed positively with 1 additional point added to the global score. As an alternative to this option, the student will have the opportunity of presenting a written project related to any of the subject chapters, and whose contents and length will be specified by the professor (though the length will not exceed 30 DINA4 pages, simple line spacing, New Roman 10pt font type -or similar- with 2 cm margins to both sides of the sheet).

#### E) THE TOTAL SCORE OF THE

SUBJECT WILL BE THE SUM OF THE POINTS SPECIFIED ABOVE, UP TO 10 POINTS.

The evaluation criteria

under table A-III/6 of STCW code, and included in the Quality Assurance System, will be taken into account when designing and performing 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. Horowitz (). 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>
<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>

## 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.

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