IDENTIFYING DATA				
Optoelectronic devices				
Subject	Optoelectronic devices			
Code	V05G300V01922			
Study programme	Degree in Telecommunications Technologies Engineering - In extinction			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Moure Rodríguez, María José			
Lecturers	Cao Paz, Ana María Moure Rodríguez, María José			
E-mail	mjmoure@uvigo.es			
Web	http://faitic.uvigo.es			
General description	This subject deals with the optoelectronic properties of semiconductors and their application in electronic devices for detection, emission, amplification and conversion of optical/electrical signals. Devices include light-emitting diodes, lasers diodes, photodiodes, phototransistors and solar cells. The contents of the course and the laboratory activities coverage the basic operating principles, design considerations, driving circuits and applications of optoelectronic devices. The subject will enable students to apply the physics of optoelectronic devices in optical sensors design and fiber optic communications. Emphasis will also be place on understanding the data sheets of optoelectronic components and their applications to different technologies. Finally integrated optoelectronics, display and image sensor technologies are introduced. Subject of the English Friendly Program. International students can ask teaching staff for: a) teaching materials and bibliographic references in order to follow the subject in English, b) attending office hours in English, c) tests and assessments in English. In addition, all the documentation for this subject has be written in English.			

Competencies	
Code	
B9	CG9: The ability to work in multidisciplinary groups in a Multilanguage environment and to communicate, in writing and orally, knowledge, procedures, results and ideas related with Telecommunications and Electronics.
B12	CG12 The development of discussion ability about technical subjects
B14	CG14 The ability to use software tools to search for information or bibliographical resources.
C60	(CE60/OP3) The ability to design circuits based on optoelectronics devices used in telecommunication systems.
C61	(CE61/OP4) The ability to acquire, condition and process the information obtained from optoelectronic sensors.
D4	CT4 Encourage cooperative work, and skills like communication, organization, planning and acceptance of responsibility in a multilingual and multidisciplinary work environment, which promotes education for equality, peace and respect for fundamental rights.

Learning outcomes		
Expected results from this subject	Training and Learning Results	
To know the fundamentals of different optoelectronic devices.		C61
The capability to analyze the data sheets and to compare different optoelectronic devices.	B12 B14	C61
To know of the applications of electronic devices.		C60
The capability to design basic circuits for driving photoemitter devices.		C60
The capability to design basic circuits for photodetection.		C60 C61
To know different optoelectronic sensors.		C61

To know the architecture and the operating modes of displays.		C60	
To know of the architecture and characteristics of image sensors.		C60 C61	
The ability to select the more suitable devices according to each application.	B12 B14	C60 C61	
To know in depth the applications related to Telecommunications.	B9	C60	D4

Contents

Topic	
Unit 1: Introduction	Fundamentals and classification of optoelectronic devices. Radiometric and photometric units and their relationships.
Unit 2: Light Emitting Diodes	Principles of LED operation. Types of LEDs and properties. Parameters and characteristics. Driving circuits. Basic applications.
Unit 3: Optoelectronic Detectors	Light Dependent Resistors: principles of LDR operation, properties, parameters, driving circuits and applications. Photodiodes: principles of photoconductive detectors, types, parameters, driving circuits and applications. Phototransistor: principles of phototransistor operation, types, parameters, driving circuits and applications. Photodetector comparison.
Unit 4: Solar Cells	Photovoltaic detectors: principles and properties. Manufacture and performance of solar cells, parameters and characteristics. Applications.
Unit 5: Laser Diodes	Principles of Laser operation. Types of lasers. Laser diode operation. Driving circuits and applications.
Unit 6: Image Sensors	Principles of CCD and CMOS operation. Parameters and characteristics. Color detection. Applications.
Unit 7: Optical Sensors	Principles of optical sensing. Internal design, types, parameters and applications of: optocouplers, optical encoders, object sensors, code-bar readers, humidity sensors, color detection, distance sensors, anemometers, temperature sensors and biomedical sensors.
Unit 8: Display Technologies	Principles of Liquid Crytal Display operation. Principles of LED and Organic LED displays. Introduction to plasma, electroluminescence and digital light processor technologies.
Unit 9: Introduction to Fiber Optics	Fiber Optic fundamentals. Classification of fibers. Fiber optic emitters and detectors. Principles of fiber optic communications. Principles of fiber optic sensors.
Laboratory Practices	1. Basic optoelectronic circuits. LEDs and LDRs. Laboratory measurements. 2. Analog optical modulation. Optical detectors based on photodiodes and phototransistors. 3. Optoelectronic sensors for object sensing. 4. Digital communications based on fiber optic. 5. Optical circuits for color measurement. 6. LASER sensor for distance measurement. Measurements using a spectrometer. 7. Other optoelectronic sensors.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	15	30	45
Case studies	4	8	12
Project based learning	6	30	36
Presentation	1	3	4
Laboratory practical	14	9	23
Problem and/or exercise solving	2	24	26
Report of practices, practicum and external practices	0	4	4

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

Methodologies

	Description
Lecturing	The professor explains the theoretical contents of the course, encouraging critical discussion and the student involvement. Reading assignments for each session will be previously available via FaiTIC, and students are expected to come to the theoretical class having completed the assigned reading. In the master sessions the competencies CE60 and CE61 are developed.

Case studies	The study and analysis of actual technological solutions completes the theoretical presentations. This activity includes the study of different alternatives, commercial devices or systems, cost and power estimation, environmental impact and performance analysis. Through the case studies the competencies CE60, CE61 and CG12 are developed.
Project based learning	This activity focuses on applying the techniques described in the lecture classes and the skills developed at laboratory to a project implementation. These sessions are developed in a laboratory with skilled equipment. Students should obtain well founded solutions, choosing appropriate methods and devices. These projects are planned and tutored in small size groups. In the projects the competencies CG9, CG12, CG14 and CT4 are mainly developed.
Presentation	The project developed by the students must be oral presented by the authors. Through the oral presentations the competencies CG9 and CG12 are developed.
Laboratory practical	During laboratory sessions the student learns the design, hardware implementation, verification and measurement of basic optoelectronics circuits. All the sessions are guided and supervised by the professor. In the laboratory practices, the competencies CE60, CE61 and CG14 are developed.

Personalized assistance

Methodologies	Description
Lecturing	Students have the opportunity to solve doubts in personalized attention sessions. The appointment with the corresponding professor should be required and agreed by e-mail, preferably in the hours which are published in the faculty website.
Laboratory practical	Students have the opportunity to solve doubts in personalized attention sessions. The appointment with the corresponding professor should be required and agreed by e-mail, preferably in the hours which are published in the faculty website.
Project based learning	Each group of students developing a project will attend periodic follow-up meetings.

Assessment

	Description	Qualification	Training and Learning Results		
Project based learning	The students should present a tutored project which deserves the 40% of the final qualification. The progress of this job will be supervised from continuous assessment but the final work should be oral presented by the authors.	40	B9 B12 B14	C60 C61	D4
Problem and/or exercise solving	The student must pass a short answer test which covers all of the contents taught in the theoretical classes or laboratory practices. This test will deserve the 30% of the final qualification.	30		C60 C61	
Report of practices, practicum and external practices	The assistance to the laboratory practices is mandatory: at least the student should complete 6 of the 7 sessions. The implementation of the circuits described in the practice guidelines and the reports submitted at the end on each session will deserve the 30% of the final qualification.	30	B9 B12 B14	C60 C61	D4

Other comments on the Evaluation

1. Continuous assessment

The course can be passed with full marks from continuous assessment, with no need to sit the final exam. If the students assist to more than 2 laboratory sessions means that they follow the continuous assessment.

The weighting and content of each continuous assessment part are as follows:

1.1 Test (NTest):

- It consists on a short answer questionnaire carried out preferably using the FaiTic platform.
- It covers all of the contents taught in the theoretical classes or laboratory practices.
- The date will be approved by the Academic Commission of the Grade and it will be published at the beginning of the course.
- The student pass this part if he/she gets a mark greater than or equal to 5.

1.2 Laboratory practices (NPrac):

- The student should complete 6 of the 7 sessions in order to pass this part.
- The student should correctly implement the circuits described in the guidelines of the practice and submit a report corresponding to each laboratory session. The qualification of each practice depends on these achievements.
- It can be developed individually or by groups of 2 students. In this last case and if both attend the practice, the qualification is the same for the 2 students.
- The student will pass this part if he/she gets an average greater than or equal to 5. The weighting of each practice is the same to obtain the NPrac mark.

1.3 Project (NPro):

- It should be oral presented by the authors.
- It can be developed individually or by groups of 2 students. In this last case, the 85% of the qualification is common for both members of the group meanwhile the 15% represents the individual qualification obtained from the oral presentation of each student.
- The student will pass this part if he/she gets a mark greater than or equal to 5.

1.4 Final qualification of continuous assessment (Final_ca)

The final qualification of continuous assessment is obtained as follows:

Final_ca: = (NTest*0.3 + NPrac*0.3 + NPro*0.4) if NTest is greater than or equal to 5 and NPrac is greater than or equal to 5 and NPro is greater than or equal to 5;

Final_ca = min [(NTest*0.3 + NPrac*0.3 + NPro*0.4), 4] in other case;

The student who fails one or more of the parts of continuous assessment has another opportunity to pass any part in the final assessment:

- He/she can make a written long answer exam and this mark replaces NTest.
- He/she student can improve his/her laboratory mark (NPrac) by means of an exam. This exam consists of several problems related to the contents of laboratory practices.
- He/she can complete and present his/her project (NPro) before the date of the final exam.

2. Eventual assessment, second call and end-of-program call

In those cases in which the student decides not to carry out the continuous evaluation tasks, the final qualification is based on:

- A final exam comprising all the topics of the subject. It usually consists of several questions and problems and lasts about 2.5 hours. The pass mark for this exam is 5 out of 10 and deserves 60% of the final qualification (NEx).
- The students should also present a project with the same objectives and complexity of the project developed in continuous assessment. This project deserves 40% of the final qualification (NPro) and should be presented before the date of the final exam.

The final qualification (Final_ex) is obtained as follows:

Final_ex = (NEx*0.6 + NPro*0.4) if NEx is greater than or equal to 5 and NPro is greater than or equal to 5;

Final_ex = min [(NEx*0.6 + NPro*0.4) , 4] in other case.

This assessment system applies as well to the second call and the end-of-program call.

3. Other comments

- The exams will be written in Spanish. The student can use the Spanish, English or Galician for the reports, works or presentations.
- The grades obtained from the continuous assessment and final exams are only valid for the current academic year.
- The use of books, notes or electronic devices such as phones or computers is not permitted in any test or exam. Mobile phones must be turned off and out of reach of the student.
- In the case that plagiarism is detected in any of the tasks/exams done/taken, the final score for the subject will be 'fail' (0) and the teachers will inform the School authorities so that they take the actions that they consider appropiate.

Sources of information

Basic Bibliography

Kasap S.O., **Optoelectronics and Photonics**, 2, Pearson, 2013

Complementary Bibliography

Martin V. D., **Optoelectronics**, PROMPT Publications, 1997

Wilson J., Hawkes J., **Optoelectronics. An introduction**, 3, Prentice-Hall, 1998

Udd E., **Fiber Optic Sensors. An Introduction for Engineers and Scientists**, 2, John Wiley&Sons, 2011

Kasap, Ruda, Boucher, **Cambridge Illustrated Handbook of Optoelectronics and Photonics**, Cambridge University Press, 2009

Yu F.T.S., Yang X., **Introduction to Optical Engineering**, Cambribge University Press, 1997

Uiga E., **Optoelectronics**, Prentice-Hall, 1995

Midwinter J.E., Guo Y.L., **Optoelectronics and Lightwave Technology**, Wiley, 1992

Holst G.C., **CCD Arrays, Cameras and Displays**, Optical Engineering Press, 1998

Carr J. J., **Electro-Optics. Electronic Circuit Guidebook**, Prompt Publications, 1997

Göpel Ed. W., Hesse J., Zemel J.N., **Sensors. A comprehensive Survey**, 1992

Goetzberger A., Knobloch J., Voss B., **Crystalline Silicon Solar Cells**, Wiley, 1998

Watson J., **Optoelectrónica**, Limusa, 1993

Smith S.D., **Optoelectronic Devices**, Prentice Hall, 1995

Theuwissen A.J.P., **Solid-state Imaging with Charge-Coupled Devices**, Kluwer, 1995

Lasky R.C., Österberg U.L., Stigliani D.P., **Optoelectronics for Data Communication**, 1995

Wood D., **Optoelectronic Semiconductors Devices**, Prentice Hall, 1995

Goff D.R., **Fiber Optic Reference Guide. A Practical Guide to Communications Technology**, Focal Press, 2002

Marston R.M., **Circuitos de optoelectrónica**, CEAC, 2000

Moure M.J., **Apuntes de DOE**, 2017

Cao A.M., **Prácticas de DOE**, 2017

Recommendations

Contingency plan

Description

Whenever physical access to the University is not possible, the theoretical classes, personalized attention, assessment processes, explanation and supervision of practices or projects will be carried out using the Campus Remoto tool together with the support of the FaiTic platform and e-mail.

The laboratory practices that can be not developed in the specialized laboratories at the University will be replaced by one or more of the following alternatives:

 Demonstration practices in which the students must attend to them and participate remotely.
 Simulation practices that the students must develop and submit results reports.
 Practices developed with electronic circuits that the students can assembly at home and submit a results report.

In any of the aforementioned cases, the practices maintain the weight of each one in the final grade and their development can be done individually or by groups of 2 students according to the guidelines that the teaching staff which will be published in time.

The project will be replaced by a theoretical and/or experimental work related to the contents of the subject maintaining its weight in the final grade. In this case, it can be done individually or in groups of 2 students according to its characteristics and/or its length. The work and guidelines will be published by the teaching staff well in advance.