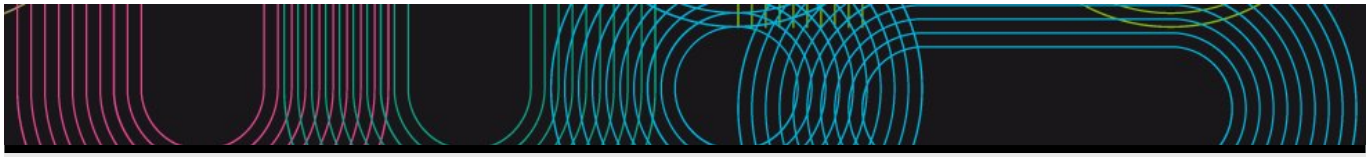

IDENTIFYING DATA				
Microwave and Millimetre Wave Circuit Design and CAD				
Subject	Microwave and Millimetre Wave Circuit Design and CAD			
Code	V05M145V01317			
Study programme	Telecommunication Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	Fernández Barciela, Mónica			
Lecturers	Fernández Barciela, Mónica			
E-mail	monica.barciela@uvigo.es			
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General description	Communications systems are at the mercy of the available technology to fabricate their transceivers. To understand the complexities of modern communications transceivers, their performance requirements and limitations, especially in the microwave and mm-wave frequency bands, it is mandatory to have a closer look to their underlying electronics and fabrication methods. And this look requires not only a theoretical background in active devices and circuit design methodologies or fabrications methods, but most importantly, a practical background in circuit design, fabrication, measurement and performance evaluation. The student has already acquired this theoretical background through previous subjects. The present subject aim to provide the student with some practical background by fully designing, fabricating in hybrid integrated technology and characterizing a circuit prototype, in fact one of the analogue building components of modern transceivers for working in the microwave bands (power amplifier, oscillator or mixer). Most of the presential hours of the course and personal work of the student will be devoted to the design and fabrication of this prototype. Besides this practical work, some presential hours will be devoted to describe the design rules and methodologies of advanced transceiver circuit modules working in microwave and mm-wave bands. Among others, we may mention issues related to the design of efficient power amplifiers or the use of X-parameters to characterize and model these nonlinear components. The subject will be taught fully in english, both in oral and written communications with the students, and in provided technical documents and reports.			

Competencies	
Code	
B1	CG1 Ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C32	CE38/OP8 Ability to design, manufacture (in hybrid technology) and characterize the analog components of transceivers of communications in microwave and millimeter-wave bands

Learning outcomes	
Expected results from this subject	Training and Learning Results
Learn to design analogue advanced active circuits (linear and nonlinear) for emitters and receivers for communications in the microwave and milimeter wave frequency bands.	B1 B4 C32

Learn to design high frequency circuits for the optoelectronic interface in optical communications systems.	B1 B4 C32
Learn the fabrication techniques of integrated circuits (hybrid and monolithic) for communications in the high frequency bands. Learn how to apply one of these techniques in circuit prototype fabrication.	B1 B4 B8 C32
Learn to characterize and asses the performance of microwave circuits for communication transceivers.	B1 C32

Contents

Topic	
1. Advanced circuit design for communication transceivers in the microwave and millimeter wave bands.	a. Linear and Nonlinear Circuit Design Techniques. -CAD-based design and component models. -Measurement-based design. - S-parameters vs X-parameters b. Advanced Low Noise Amplifier Design c. High Eficiency Power Amplifier Design d. High Frequency Oscillator Design e. Frequency Converter Design
2. High frequency circuit design for optoelectronic transceivers in optical communications systems.	Broadband Amplifier Design Techniques
3. Fabrication techniques for Hybrid and Monolithic Microwave Integrated Circuits	Hybrid MIC processing techniques MMIC technologies and foundry processing techniques.
4. Advanced linear and nonlinear characterization techniques, and corresponding instrumentation, to guide design and evaluate performance.	Device linear characterization techniques and instruments: VNAs. Device nonlinear characterization techniques and instruments: NVNAs, VSAs, etc.
5. A Case Study: CAD-based prototype design, fabrication and performance evaluation.	Prototype Design using ADS simulator Prototype fabrication in Hybrid-MIC technology using microstrip transmission lines Prototype characterization to evaluate performance.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	5	10	15
Practices through ICT	14	56	70
Laboratory practical	4	0	4
Mentored work	0	22	22
Mentored work	2	12	14

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

Methodologies

	Description
Lecturing	It will be given in a classroom with the aid of a slate board and a video projector. Main concepts in the relevant Chapters will be described. The student will have available in Faitic support documentation. Note: the last Chapter it is an application work (case study) to be performed by the student, as part of a tutored work. Besides, some of the Topics/sections in the Subject will be individually worked and presented by the students, as part of another tutored work. These lessons are oriented to the acquisition of the competencies: CG1,4,8 and CE38/OP8.
Practices through ICT	During these classes, with the aid of a commercial microwave circuits simulator, the student will design a circuit prototype, among those described in the subject. This work will also continue at home hours through tutorized personal work. The student will have available in Faitic support documentation and files. He/she will be able to obtain a circuit simulator student licence for his/her PC, thanks to an agreement between UVIGO and the simulator provider company. These classes are designed to aid in adquiring competencies: CG1,4,8 and CE38/OP8.

Laboratory practical	The previously designed prototype by the student, during the practices in computer rooms and his/her personal work, will be fabricated in hybrid MIC technology and characterized using adequate instrumentation. These classes are designed to help in adquiring competencies: CG1,4,8 and CE38/OP8.
Mentored work	With the aid of the hours of practice in computer rooms, and through his/her personal work, the student will be guided to fully design - working individually- a circuit prototype. Then, he/her will fabricate this prototype and evaluate its performance during the laboratory practices. The student will write a final report of his/her work. This work with require most of the student effort in the subject. These classes are designed to help in adquiring competencies: CG1,4,8 and CE38/OP8.
Mentored work	Each student will prepare - working individually- a short writen report about one of the topics covered in the subject. This work will also be assesed by an oral presentation in which he/she will answer questions about the work. These classes are designed to help in adquiring competencies: CG1,4,8 y CE38/OP8.

Personalized assistance

Methodologies	Description
Lecturing	The student will be able to consult his doubts, about the different topics described in the master lessons, during the lecturer office hours.
Practices through ICT	During these classes, students -individually- will perform the assigned tasks related to CAD design with the aid and personalized guidance of the lecturer.
Laboratory practical	During these classes, students -individually- will perform the assigned tasks related to prototyping and measurements with the aid and personalized guidance of the lecturer.
Mentored work	The student will be able to consult his doubts and request suggestions in the realization of his work of design/manufacture and measure of the prototype using the lecturer office hours.
Mentored work	The student will be able to consult his doubts and request suggestions in the realization of the work/presentation of a topic, related to the Subject, during the lecturer office hours.

Assessment

	Description	Qualification	Training and Learning Results	
Mentored work	The student -individually- will design, fabricate in Hybrid Technology and evaluate the performance of a microwave circuit prototype. The assesment will be performed through the circuit design, the quality of the fabricated prototype, the final measured prototype performance and a written report. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	90	B1 B4 B8	C32
Mentored work	The student -individually, will write a report about a topic related to the subject. The assesment will be performed taking into account the quality of the report and the answers to short questions during the oral presentation of the work. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	10	B1 B4 B8	C32

Other comments on the Evaluation

The subject will be taught fully in English, both in oral and written communications with the students, and in provided technical documents and reports.

A) First Call: The student work in the subject will be evaluated through the development of the two mentored works:

1. The circuit prototype: design, fabrication in hybrid integrated technology, performance evaluation (simulated and experimental), and written report (90% of the total subject qualification).

2. The written report and its presentation, about a given topic, and his/her answers to the presented questions. (10% of the total subject qualification).

B) Second Call:
Those students who have been present at least in 80% of the presential hours will have the opportunity to re-design his/her previous prototype design and also improve the written report of the topic. Each of these tasks will be assigned the same qualification percentage as in the first call Those students who have not been present in at least 80% of the presential hours, or did not opt for improving their previous works, will have four weeks to design, fabricate, measure, evaluate performance and write a report of a circuit prototype chosen by the lecturer. The assessment of this work will be 100% of the subject qualification.
In the End-of-Program Call, evaluations will be similar to the Second Call.

In case of plagiarism detection in any of the student works, the grade obtained by the student in this course will be a failing grade (0) and the course lecturer/s will communicate this issue to the school Board of Directors so they may take those measures deemed appropriate.

Sources of information

Basic Bibliography

Guillermo Gonzalez, **Microwave Transistor Amplifiers: Analysis and Design**, 2,

Complementary Bibliography

Technical papers (journals, application notes, data sheets,...),

Instrumentation and simulator manuals,

Steve C. Cripps, **Advanced Techniques in RF Power Amplifier Design**, 1,

Guillermo Gonzalez, **Foundations of Oscillator Circuit Design**,

D. Root, **X-Parameters: Characterization, Modeling, and Design of Nonlinear RF and Microwave Components**, 1,

Recommendations

Subjects that it is recommended to have taken before

Electronics and Photonics for Communications/V05M145V01202

Contingency plan

Description

Teaching Group A: Lectures will be online (synchronous or asynchronous).

Teaching Group A: On-line classes (synchronous or asynchronous) will provide the students with descriptions/explanations of the work to be done and aid him to solve his/her doubts, so that, beside the provided supporting documentation and files, as well as the simulator license and online office hours, he/she can performed the assigned work autonomously at home.

The mentored work corresponding to the design of an electronic prototype will not include those parts related to the manufacture and measurement of this prototype. This experimental work will be replaced by the development of an additional report, on another subject topic, or the design of another circuit. The prototype work will correspond in this case to 75% of the subject grade, the extra report/design to 15%.

Evaluation:

First Call:

The mentored works will be evaluated through the delivered written reports, the designs simulations results (prototype or additional circuit) and the oral presentations, which will be performed on-line during the classes of groups B.

Second and End-of-Program Call:

Those students who have been present at least in 80% of the presential hours will have the opportunity to improve their previous deliverables (mentored works). Each of these tasks will be assigned the same qualification percentage as in the First Call.

Otherwise, the student will have 4 weeks to: design, with the aid of the simulator, evaluate performance through simulations and deliver a written report of circuit prototype, suggested by the professor. This work grades up to 80% of the total subject grade. For the remaining 20%, the student will have to deliver a written report on a subject related with one of the subject topics. For performing this report the student will have 1 week.