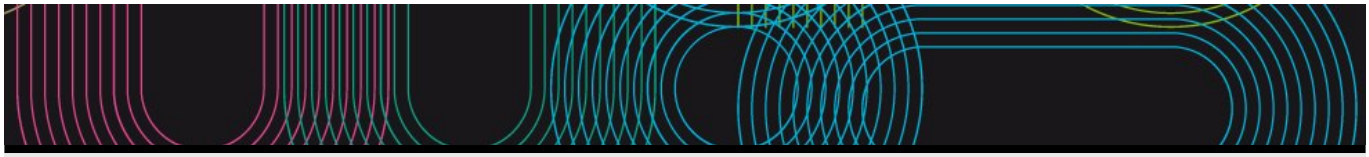

IDENTIFYING DATA				
Microwave and Millimetre Wave Circuit Design and CAD				
Subject	Microwave and Millimetre Wave Circuit Design and CAD			
Code	V05M145V01317			
Study programme	Máster Universitario en Ingeniería de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	Fernández Barciela, Mónica			
Lecturers	Fernández Barciela, Mónica			
E-mail	monica.barciela@uvigo.es			
Web	http://moovi.uvigo.gal/			
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, in several stages that will be independently evaluated. 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.			

Training and Learning Results	
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

Expected results from this subject	
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	5	10
Practices through ICT	15	0	15
Laboratory practical	4	0	4
Mentored work	0	35	35
Mentored work	0	50	50
Mentored work	1	10	11

*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. It will be described the main concepts in the most relevant Topics in the Subject. Students will have available support documentation in Moovi. Note: the last Topic is an application work (case study) to be performed by the student, as part of a tutored work. Besides, some of the Topics/sub-topics in the Subject will be individually worked and presented by the student, 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 Moovi support documentation and files. He/she will be able to obtain a circuit simulator student license for his/her PC, thanks to an agreement between UVIGO and the simulator provider company. These classes are designed to aid in acquiring competencies: CG1,4,8 and CE38/OP8.

Laboratory practical	The previously designed prototype by the student, during the practices with the circuit simulator and his/her personal work, will be fabricated in hybrid MIC technology and characterized using adequate instrumentation. These classes are designed to help in acquiring competencies: CG1,4,8 and CE38/OP8.
Mentored work	With the aid of the hours of practices through ICT, and through his/her personal work, the student will be guided to design - working individually- a circuit prototype using ideal models of the passive components. Then, he/she will implement this design in microstrip hybrid technology, in another mentored work, and evaluate its performance. The student will write a report of the work. These classes are designed to help in acquiring competencies: CG1,4,8 and CE38/OP8.
Mentored work	Each student will prepare - working individually- a short written report about one of the topics covered in the subject. This work will also be assessed by an oral presentation in which he/she will answer questions about the topic. These classes are designed to aid in acquiring competencies: CG1,4,8 y CE38/OP8.
Mentored work	With the aid of the hours of practices through ICT, and through his/her personal work, the student will be guided to design - working individually- a circuit prototype in microstrip hybrid technology. Then, he/she will fabricate this prototype and evaluate its performance during the laboratory practices. The student will write a report of the work. These classes are designed to aid in acquiring 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. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
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. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
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. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Mentored work	The student will be able to consult his/her technical questions and request suggestions, in the realization of his/her work related to the design of an ideal circuit prototype, by using the lecturer office hours. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Mentored work	The student will be able to consult his/her technical questions and request suggestions, to prepare the presentation of a topic related with the Subject, during the lecturer office hours. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321
Mentored work	The student will be able to consult his/her technical questions and request suggestions, in the realization of his/her work related to the design of an hybrid microstrip circuit prototype, by using the lecturer office hours. Office hours appointments: https://moovi.uvigo.gal/user/profile.php?id=11321

Assessment

	Description	Qualification	Training and Learning Results	
Laboratory practical	The student will -individually- fabricate (in Hybrid Technology) and measure the RF performance of a microwave circuit prototype. The assessment will take into account: the assembly of the fabricated prototype, the final measured RF performance and the written report. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	20	B1 B4 B8	C32
Mentored work	The student will -individually- design, with ideal passive components, and simulate the performance of a microwave circuit prototype. The assessment will take into account: the circuit design, the simulated performance and the written report. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	30	B1 B4 B8	C32
Mentored work	The student will -individually- write a report and perform an oral presentation about a topic related to the Subject. The assessment will be performed by taking into account: the quality of the report, the presentation and the discussion (answers to questions) after the presentation. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	10	B1 B4 B8	C32
Mentored work	The student will -individually- design in Hybrid Microstrip Technology and simulate/evaluate the RF performance of a microwave circuit prototype. The assessment will take into account: the circuit layout, the simulated RF performance and the written report. In this work, it will be evaluated competencies CG1, CG4, CG8 and CE32.	40	B1 B4 B8	C32

Other comments on the Evaluation

The subject will be taught and evaluated fully in English. Technical documents, reports, presentations and interactions with the students will be performed in English.

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

1. The microwave circuit prototype: design (ideal and microstrip), fabrication in hybrid integrated technology, RF performance evaluation (simulated/ experimental) and written report. In total, up to 90% of the total Subject qualification.

2. The topic written report and its oral presentation (with discussion). In total, up to 10% of the total subject qualification.

Those students who did opt for Global Evaluation (this decision is always open until 1 month before the date of the global examination), will have four weeks to design, fabricate (mandatory to opt to a grade above 80% of the maximum subject qualification), evaluate performance and write a report of a new circuit prototype, chosen by the lecturer. The assessment of this work will be up to 100% of the subject qualification.

B) Second Call:
Those students who attended at least in 80% of the face-to-face class hours will have the opportunity to re-design his/her previous prototype and also improve the topic written report. 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 face-to-face class hours, or did not opt for improving their previous works, will have four weeks to design, fabricate (mandatory to opt to a grade above 80% of the maximum subject qualification), evaluate performance and write a report of a new circuit prototype, chosen by the lecturer. The assessment of this work will be up to 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