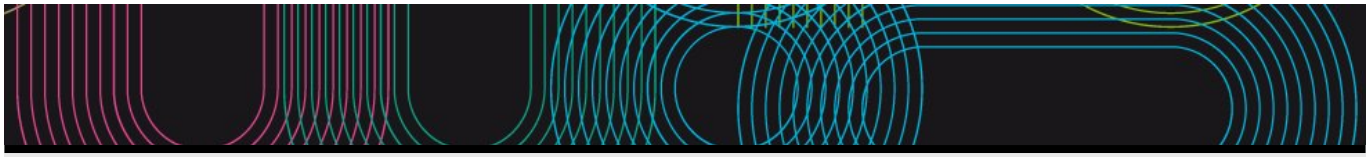

IDENTIFYING DATA				
Microwave and Millimetre Wave Circuit Design and CAD				
Subject	Microwave and Millimetre Wave Circuit Design and CAD			
Code	V05M145V01317			
Study programme	Telecommunication Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	5	Optional	2nd	1st
Teaching language	English			
Department				
Coordinator	Fernández Barciela, Mónica			
Lecturers	Fernández Barciela, Mónica			
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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 band (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 The ability to project, calculate and design products, processes and facilities in telecommunication engineering areas.
B4	CG4 The 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 The 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
Master Session	5	10	15
Practice in computer rooms	14	0	14
Laboratory practises	4	0	4
Tutored works	0	78	78
Tutored works	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
Master Session	It will be given in a classroom with the aid of a slate board and a video projector. Main concepts in the Chapters will be described, with the exception of the last Chapter that it will not be covered here, since it is an application work (case study) by the student. These classes are designed to aid in adquiring competencies: CG1,4,8 and CE38/OP8.
Practice in computer rooms	During these classes, with the aid of a commercial microwave circuits simulator, it will be designed by the student a circuit prototype, among those described in the subject. This work will be completed with through tutorized personal work by the student. These classes are designed to aid in adquiring competencies: CG1,4,8 and CE38/OP8.
Laboratory practises	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.

Tutored works	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 project 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.
Tutored works	Each student will prepare - working individually- a short writen report about one of the topics covered in the subject. This work will by assesed by an oral presentation in which he/she will answer short questions about the work. These classes are designed to help in adquiring competencies: CG1,4,8 y CE38/OP8.

Personalized attention

Methodologies	Description
Practice in computer rooms	During these classes, students -individually- will perform the assigned tasks related to CAD design with the aid and personalized guidance of the lecturer.
Laboratory practises	During these classes, students -individually- will perform the assigned tasks related to prototyping and measurements with the aid and personalized guidance of the lecturer.

Assessment

	Description	Qualification	Training and Learning Results	
Tutored works	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 competencess CG1, CG4, CG8 and CE32.	90	B1 B4 B8	C32
Tutored works	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 competencess 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 summons : The work of the student in the subject will be evaluated through the development of the two tutorized works:

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

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

If the student does not obtain the minimum qualification to pass the subject in the first summons and has been present at least in 80% of the presential hours, the lecturer will suggest changes/improvements to the prototype design and written report about the topic, for the second summons.

B) The second summons: 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 improve the written report of the topic. Each of these tasks will be assigned the same qualification percentage as in the first summons Those students who have not been present in at least 80% of the presential hours, will have two 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 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

Artículos técnicos (revistas científicas, notas de aplicación, información fabricante componentes,...),
Manuais dos equipos e simulador,
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,

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

Recommendations

Subjects that it is recommended to have taken before

Electronics and Photonics for Communications/V05M145V01202