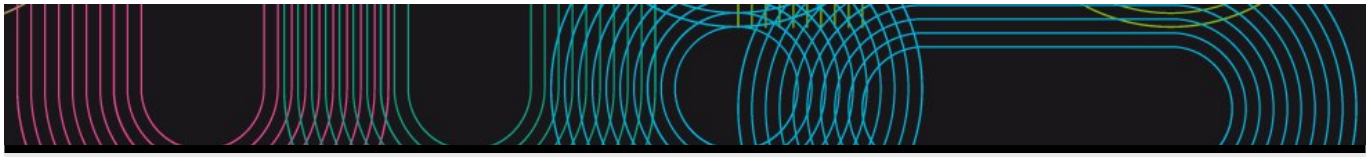

IDENTIFYING DATA				
Microwave Circuits				
Subject	Microwave Circuits			
Code	V05G306V01322			
Study programme	Bachelor Degree in Telecommunication Technologies Engineering (BTTE)			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Fernández Barciela, Mónica			
Lecturers	Fernández Barciela, Mónica Rodríguez Rodríguez, José Luis			
E-mail	monica.barciela@uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	This subject provides the student with the basic tools to analyze components and analog subsystems (active and passive) that operate in the band of the microwaves, as well as to evaluate his specifications and performance. The microwave subsystems are part, among others, of the modern communications systems transceivers (cellular telephony, wireless networks, satellite communications, and so on), thus the importance for the student to get some knowledge and background about these components. On the other hand, this subject complements the knowledge the student has, due to previous subjects, in electronics for communications, since when working in the microwave range, we need to use different tools for an accurate circuit analysis and design. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
B3	CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
B5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
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.
C23	CE23/ST3 The ability to analyze the components and their specifications for guided and non-guided communications systems
C24	CE24/ST4 The ability to select circuits, subsystems and systems of radiofrequency, microwaves, broadcasting, radio link and radio determination.
C25	CE25/ST5 The ability to select transmission antennas, equipment and systems, propagation of guided and non-guided waves, with electromagnetic, radiofrequency and optical media, and their corresponding radio electric spectrum management and frequency designation.
D2	CT2 Understanding Engineering within a framework of sustainable development.
D3	CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc.
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.

Expected results from this subject	Training and Learning Results		
To learn how to analyze microwave active and passive circuits and components, and to evaluate their specifications and performance. The student will learn how to use S-parameters, electronic instrumentation for measurements in the microwave range and circuit simulators for that purpose.	B3 B5	C23	
To learn how to solve exercises, how to perform measurements, how to elaborate and present reports, how to work in a technical team and to transfer knowledge in the field. To learn how to handle technical documentation and scientific bibliography, both in English.	B4 B5 B9	C24 C25	D3 D4
To learn how to select, analyze and apply semiconductor active devices in circuits for microwave communications subsystems.	B5	C23 C24 C25	
To learn how to analyze and select microwave circuits for optical transmitters and receivers.	B5	C23 C25	
To learn how to evaluate and select microwave subsystems. To propose solutions for applications at the different frequency bands for guided (coaxial cable, waveguide) and wireless transmissions.	B3 B5	C24 C25	D2

Contents	
Topic	
1.Introduction to microwave circuits.	A. Microwaves and their advantages for communications. B. Microwave Subsystems. Solutions for applications in the different frequency bands for wave guided and wireless transmissions. C. Integrated technologies for high frequencies. MICs.
2. Basic concepts.	A. Transmission Lines Theory. Travelling waves, characteristic impedance and reflection coefficient. B. Smith Chart. C. Coaxial cable and planar transmission lines.
3. S-parameters.	A. Definition and properties. B. Signal Flow Charts. C. Power and Gain. D. Stability.
4. Impedance Matching.	Basic matching networks (discreet and distributed) for narrowband applications.
5. Microwave passive components.	Filters, couplers, phase shifters and resonators.
6. Microwave active devices for integrated circuits.	A. Semiconductors for microwave active devices. Heterostructures. B. High Frequency Diodes c. Bipolar and FET Transistor technologies for high frequencies.
7. Circuits for microwave transceivers.	A. Linear microwave amplifiers. B. Circuits for optical receivers and transmitters.
8. Linear analysis of microwave active and passive components, and circuits with a commercial simulator.	a. Practice to analyze basic microwave components: microwave transistor equivalent circuit, matching networks, etc. b. Practice to analyze attenuators and various types of couplers. c. Practice to analyze linear amplifiers.
9. RF measurements of microwave devices and circuits. Microwave lab instruments.	a. Coaxial wires and adapters. b. Vector Network Analyzer. Calibration. c. RF measurements using a Vector Network Analyzer. d. Analysis of the RF performance of various microwave components

Planning	Class hours	Hours outside the classroom	Total hours
Laboratory practical	7	14	21
Practices through ICT	12	36	48
Introductory activities	0	7	7
Lecturing	19	38	57
Problem and/or exercise solving	1	3	4
Problem and/or exercise solving	1.5	5	6.5
Problem and/or exercise solving	1.5	5	6.5

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

Methodologies	
	Description

Laboratory practical	The work will be performed individually or in pairs of students. With the aid of different microwave measurement instruments/components, there will be analyzed passive and active microwave devices / circuits mostly in microstrip technology. It will be defined and evaluated different figures of merit and other tools that will be used in the experimental characterization of these components. An introduction to Vector Network Analyzers with be provided to the student, besides description of their use and calibration procedure . Students will find in Moovi support documentation. These practises are designed to aid in adquiring competencies CG3, CG4, CG5, CG9, CE23, CE24, CE25, CT2, CT3 y CT4.
Practices through ICT	The work will be performed individually or in small teams of 2 students. With the aid of a commercial microwave circuits simulator, there will be analyzed different passive components (matching networks, filters, couplers, etc.) and active semiconductor devices (diodes and transistors), and simple amplifier circuits, in agreement with Chapter 8. There will be defined and evaluated diverse figures of merit and other tools that will be in used in the analysis of these components. Also, exercise resolution will be described, to complete the one described in the lectures. Students will find in Moovi support documentation and files. Besides, they will have available a procedure to obtain a simulator licence for their PCs, through an agreement between UVIGO and the simulator provider. These practises are designed to help in adquiring competencies: CG3, CG5, CE23, CE24 y CE25.
Introductory activities	The student will have available documents about concepts from previous subjects that the student need to recall.
Lecturing	It will be given in a classroom with the aid of a slate board and a video projector. Most of the concepts in the subject Topics will be described in detail and explained. Application of these concepts will be supplied through exercises resolution, during lectures, and in the practices (ICT and laboratory). Students will find in Moovi support documentation. These sessions are designed to help in adquiring competencies CG3, CG5, CG4, CE23, CE24 y CE25.

Personalized assistance

Methodologies	Description
Lecturing	During master sessions, the professor will answer the questions addressed by the students regarding the content of the subject or the assessment tests. Besides, in office hours, the professor will also be available to the students, providing answers to their questions in a more personalized way. Office hours appointement: https://moovi.uvigo.gal/user/profile.php?id=11321
Laboratory practical	During laboratory practises, the professor will guide the work of each student, and answer those questions he/she may ask regarding the work and the assessment test/s. Office hours appointment: https://moovi.uvigo.gal/user/view.php?id=11322&course=9898
Practices through ICT	During practises, the professor will guide the work of each student, and answer those questions he/she may ask regarding the work and the assessment test/s. Office hours appointement: https://moovi.uvigo.gal/user/profile.php?id=11321

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	In the case of Continuous Assessment: During or outside the designated time for experimental practices, the student will perform one or several short examinations, individually (or in small groups), involving short questions/exercises and/or circuit implementations. This evaluation may involve a team presentation of the work performed. Besides, in the short exam 3, the work performed in theses practices may be also evaluated, through questions/exercises. In the case of Exam-only Assessment, the work performed in these practices may also be evaluated, though questions/exercises and/or some experimental implementation/test.	10	B3 C23 D2 B4 C24 D3 B5 C25 D4 B9

Practices through ICT	In the case of Continuous Assessment: During or outside practice hours, the student will have one/several examinations in which will answer/solve individually some proposed questions/exercises with the aid of the simulator. Besides, in the short exam 3, the work performed in the practices may be similarly evaluated. In the case of Exam-only Assessment, the work performed in the practices may be evaluated in the Exam through questions/exercises with the aid of the simulator.	10	B3 C23 B5 C24 C25
Problem and/or exercise solving	Continuous Assessment: There will be one short partial examination (Exam 1), containing exercises resolution. Moreover, it may contain a set of short questions related to the master sessions. In the case of Exam-only Assessment, problem/exercise solving will be an important part of the Exam.	15	B3 C23 B4 C24 B5 C25
Problem and/or exercise solving	Continuous Assessment: There will be one short partial examination (Exam 2), containing exercises resolution. Moreover, it may contain a set of short questions related to the master sessions. In the case of Exam-only Assessment, problem/exercise solving will be an important part of the Exam.	25	B3 C23 B4 C24 B5 C25
Problem and/or exercise solving	Continuous Assessment: There will be one (almost global) examination (Exam 3), containing exercises resolution. Moreover, it may contain a set of short questions related to the master sessions and the practices, both experimental or CAD-based. In the case of Exam-only Assessment, problem/exercise solving will be an important part of the Exam.	40	B3 C23 B4 C24 B5 C25

Other comments on the Evaluation

It is convenient that all students participate in the practices, both experimental and computer aided ones, to acquire all the required skills of this subject.

A) If the student selects Continuous Assessment (CA):

The schedule of the different assessments events will be approved by the Grade Academic Commission (CAG) and it will be available at the Term beginning. These assessments tests will not have available second chance ones.

1. In order that his/her work in the practices (computer aided and/or experimental) is evaluated, his/her presence in at least 80% of the corresponding practices will be mandatory. Besides, he/she must perform all the assessment events scheduled related to these practices. The maximum grade the student might obtain in the joint evaluation of all these types of practices is 20 % of the Total Available Course Grade (TACG).

2. The rest of the student work will be evaluated by means of 3 Short Examinations that will mainly contain exercises resolution, but may also include short questions. These 3 short examinations, as a whole, add up to 80% of the TACG.

The First and Second Short Examinations may last around 1 hour; the First corresponds to 15% of the TACG and the Second to the 25% of the TACG.

It is assumed that students performing the Second and/or Third Short Examination do choose Continuous Evaluation. In this case, the final grade cannot be "Not Presented".

The Third Short Examination will take place simultaneously with the Final Examination, performed by those students who do not follow CA. This short examination is the most important one, it involves all or almost all of the subject Topics and corresponds to a 40 % of the TACG.

B) In the case of the students who choose E*xam-only Assessment*, the Final (extended) Examination corresponds to 100% of the TACG. In this examination it will be evaluated exercises resolution, with and without the aid of the simulator, answers to short questions related to the course theoretical and experimental parts (Lab) and computer/simulator aided practices (ICT practices). In this Exam, the weight of Topics 8 and 9 will be in total of 20% of TACG.

Extraordinary Exam:

In it the students who have previously failed must perform a similar Final Examination than in option B, with similar characteristics as the ones described previously.

In particular, those students who followed CA in the first call may opt now between option B and option A.

If they choose option A, all their grades in the first call, with respect to the First and Second short Examinations, and the practices (both experimental and computer aided) will be preserved; hence, it will add up as a whole to 60% of the TACG.

Moreover, these students must solve an exam similar to the Third one in option A (corresponding to 40 % of the TACG). A few days before this Examination takes place, the student will send a written communication to the course coordinator about his/her decision with respect to the desired type of evaluation (A or B).

In the End-of-Program Exam, evaluations will be similar to the Extraordinary Exam.

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

Sources of information

Basic Bibliography

D.M. Pozar, **Microwave Engineering**, 3,

J.M. Miranda y otros, **Ingeniería de Microondas**, 1,

Guillermo González, **Microwave Transistor Amplifiers: Analysis and Design**, 1,

Enrique Sánchez, **Introducción a los dispositivos y circuitos semiconductores de microondas**, 1,

Complementary Bibliography

R.E. Collin, **Foundations for Microwave Engineering**, 2,

P.A. Rizzi, **Microwave Engineering, Passive Circuits**, 1,

S. Y. Liao, **Microwave Devices and Circuits**, 3,

Recommendations

Subjects that it is recommended to have taken before

Physics: Analysis of Linear Circuits/V05G301V01108
Physics: Fundamentals of electronics/V05G301V01201
Electronic technology/V05G301V01206
Electromagnetic Transmission/V05G301V01207