Course guide
230608 - MPCE - Microwaves and Photonics for Communications and Earth Observation

Last modified: 25/05/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Background in the fundamentals of electromagnetic wave propagation and Microwave Engineering. Transmission line theory and Scattering (S) parameters.
Basics of photonic generation and detection processes and fiber optics wave propagation.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic
2. Ability to design and manufacture integrated circuits
3. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
4. Ability to implement wired/wireless systems, in both fix and mobile communication environments.

Transversal:
5. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

6. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

7. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

- Lectures
- Application sessions
- Laboratory sessions
- Laboratory practical work
- Group work (distance)
- Individual work (distance)
- Exercises
- Oral presentations
- Other activities: circuit design, fabrication and laboratory measurement
- Extended answer test (Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to train students in the methods for the analysis of circuits and systems at RF, microwave and optical frequencies, as well as the study of the available technology and the electronic and photonic components that are used at these frequencies. The techniques are then applied to the design of prototypes that are characterized in the laboratory.

Learning results of the subject:

- Knowledge of the basic concepts and techniques related to applications of electromagnetic wave propagation at microwave, and photonic frequencies in the fields of communications, satellite and remote sensing.
- Knowledge of the fundamental electronic and photonic components (active and passive), materials and manufacturing processes for these applications and frequency bands.
- Understanding of the basic phenomena involved in the generation, detection, and frequency conversion of electromagnetic waves in these frequency bands.
- Specific techniques for the analysis of circuits and systems at RF, microwave and optical frequencies, and their application to the design of passive and active circuits (transmission lines, waveguides, filters, couplers, splitters, signal sources, amplifiers, detectors, mixers, modulators).
- Specific techniques for the numeric simulation of circuits and systems at RF, microwave and optical frequencies using CAD programs.
- Design and fabrication of circuits and systems (amplifiers, filters, detectors, electromagnetic visualization systems).
- Specific techniques used to measure circuits and systems at these frequencies.
- Experimental characterization of designed prototypes in the laboratory.

STUDY LOAD

Type	Hours	Percentage
Hours large group	39,0	31.20
Self study	86,0	68.80

Total learning time: 125 h

CONTENTS

1. Linear analysis of RF and Microwave circuits

Description:
Planar transmission lines. Analysis, design and simulation of passive circuits (couplers, hybrids, filters) and active circuits (low noise amplifiers). CAD techniques. Techniques for measurement of Microwave circuits in the laboratory. Laboratory characterization techniques, using specific instrumentation, for RF and Microwave systems. Measurements of circuits designed, simulated and fabricated during the course.

Full-or-part-time: 67h
Theory classes: 8h
Practical classes: 4h
Laboratory classes: 9h
Self study : 46h

2. Devices and applications of Microwave Photonics

Description:
Photonic concepts, methods, tools and components for Microwave applications of Photonics. Transmission and distribution of microwave signals through optical fiber- Radio over Fiber. Microwave Photonics use cases: Tunable RF Filters, Antenna Array Beam Steering Networks, Photonic-aided radars. Practical design exercises using numerical simulation and optimization in combnation with experimental work.

Full-or-part-time: 58h
Theory classes: 12h
Practical classes: 2h
Laboratory classes: 4h
Self study : 40h

ACTIVITIES

LABORATORY

Description:
- Laboratory sessions to understand the operation and calibration techniques of specific instruments to characterize RF, Microwave and Photonic circuits.
- Laboratory sessions to experimentally characterize circuits and systems that have been designed, simulated and optimized in a team project.

Full-or-part-time: 4h
Laboratory classes: 4h

EXERCISES

Description:
Exercises to strengthen the theoretical knowledge and CAD techniques for circuit and system simulation.

Full-or-part-time: 6h
Practical classes: 6h

ORAL PRESENTATION

Description:
Presentation of team projects. Comparison between simulated and measured results. Discussion.

Full-or-part-time: 4h
Theory classes: 4h

EXTENDED ANSWER TEST (FINAL EXAMINATION)

Description:
Final examination.

Full-or-part-time: 2h
Theory classes: 2h

GRADING SYSTEM

Final examination: 30%
Individual work: 20%
Group work (including laboratory): 50%

EXAMINATION RULES.

- Open book exam
- Design exercises and multiple choice questions

BIBLIOGRAPHY

Basic:
- Lee, Yun-Shik. Principles of terahertz science and technology [on line]. New York: Springer, 2009 [Consultation: 13/05/2020]. Available on: http://dx.doi.org/10.1007/978-0-387-09540-0. ISBN 9780387095394.
- Cox III, C.H. Analog optical links: theory and practice. New York: Cambridge University Press, 2004. ISBN 0521621631.
- Pozar, D.M. Microwave engineering [on line]. 4th ed. Hoboken: Wiley, 2012 [Consultation: 09/04/2021]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=2064708. ISBN 9780470631553.
- Lee, C.H. Microwave photonics [on line]. 2nd ed. Boca Raton: CRC, 2017 [Consultation: 22/06/2017]. Available on: http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10666204. ISBN 9781466502871.

Complementary:
- Weber, R.J. Introduction to microwave circuits: radio frequency and design applications. New York: IEEE Press, 2000. ISBN 0-7803-4704-8.
- Iezekiel, S. Microwave photonics : devices and applications [on line]. Chichester: Wiley & Sons, 2009 [Consultation: 12/05/2015]. Available on: http://onlinelibrary.wiley.com/book/10.1002/9780470744857. ISBN 9780470744857.