Course guide
230745 - MPTH - Microwave Photonics and Terahertz Research and Applications

Last modified: 21/06/2024

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: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here:

Others: Consultar aquí / See here:

PRIOR SKILLS

Electromagnetic Theory. Propagation of plane waves in free space, polarization, incidence, losses. Guided wave propagation.
Microwave circuits, S-parameters, and transmission lines.
Fundamentals of wave transmission through fiber optics. Optical modulation systems.
Lasers and optical detectors.
Semiconductor material physics. Energy bands and electrical conduction. Charge carriers (electrons and holes). Generation, recombination and charge transport.
methods for the generation and detection of electromagnetic waves at Terahertz frequencies. Photoconductive antennas and electro-optic cristals. Spectroscopic system in both the time and in the frequency domains.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic
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.
8. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.

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 practical work

LEARNING OBJECTIVES OF THE SUBJECT

Concepts and methods for the analysis of radiofrequency, microwave, photonics, and Terahertz systems, and the study of technology and applications.

Propagation of radio signals over fiber. Analog photonics.

Radiofrequency applications assisted by photonic systems: filters, true time delay networks for beamforming and steering in phased antenna arrays, analog-to-digital and digital-to-analog converters, remote sensing (radar), and satellite applications.

Terahertz frequency systems. Applications in non-invasive sensing systems and threat security. Time-domain and frequency-domain spectroscopy.

STUDY LOAD

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

Total learning time: 125 h

CONTENTS

Microwave Photonics

Description:
Concepts and methods for the analysis of radiofrequency, microwave, photonics, and Terahertz systems, and the study of technology and applications.

Propagation of radio signals over fiber. Analog photonics.

Radiofrequency applications assisted by photonic systems: filters, true time delay networks for beamforming and steering in phased antenna arrays, analog-to-digital and digital-to-analog converters, remote sensing (radar), and satellite applications.

Related competencies :
CE2. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
CE3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
CE13. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic
CT3. 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.

CT4. 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.

CT5. 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.

Full-or-part-time: 1h
Theory classes: 1h

Terahertz

Description:
Terahertz frequency systems. Applications in non-invasive sensing systems and threat security. Time-domain and frequency-domain spectroscopy.

Related competencies :
CE2. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
CE3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
CE13. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic
CE15. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.
CT3. 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.

CT4. 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.

CT5. 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.

Full-or-part-time: 1h
Theory classes: 1h

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

exam and online tests: 30%.
Tasks and projects: 70%.

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.