

## Course guide

# 230634 - LTM - Laser, Terahertz and Microwave Research and Applications

Last modified: 25/05/2023

<b>Unit in charge:</b>	Barcelona School of Telecommunications Engineering	
<b>Teaching unit:</b>	739 - TSC - Department of Signal Theory and Communications.	
<b>Degree:</b>	MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject). MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).	
<b>Academic year:</b> 2023	<b>ECTS Credits:</b> 5.0	<b>Languages:</b> English

## LECTURER

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<b>Coordinating lecturer:</b>	Consultar aquí / See here: <a href="https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura">https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura</a>
<b>Others:</b>	Consultar aquí / See here: <a href="https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma">https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma</a>

## PRIOR SKILLS

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- Electromagnetic theory : wave equation, TEM, TE and TM propagation, boundary conditions, concepts of energy and power, lossless and lossy media, good conductor
- Transmission line parameters
- Transmission line analysis under sinusoidal steady-state condition
- Smith Chart applied to the calculation of transmission line impedances/admittances and reflection coefficients
- S parameters
- Optical fiber basics. Optical modulation systems
- Lasers and optical detectors

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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### Specific:

1. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic
2. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
4. 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. 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.
6. 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.

## TEACHING METHODOLOGY

- Individual resolution of theoretical exercises.
- Group project consisting of design, implementation and measure of a microwave circuit/system such as an amplifier, using ADS/Momentum and Bilateral Amplifier Design (da2) software tools.
- Laboratory practice performed by groups.

## LEARNING OBJECTIVES OF THE SUBJECT

- Specific techniques for the analysis of nonlinear microwave circuits (Harmonic Balance)
- Application to active subsystems (oscillators and mixers)
- Advanced software tools (filters design, circuit simulation, electromagnetic simulation)
- Design, implementation (fabrication) and measurement of passive and active circuit examples
- Terahertz technology and applications
- Optical methods for Terahertz generation

## STUDY LOAD

Type	Hours	Percentage
Hours small group	13,0	10.40
Hours large group	26,0	20.80
Self study	86,0	68.80

**Total learning time:** 125 h

## CONTENTS

### 1 Advanced topics in RF and Microwave circuit analysis

#### Description:

Electromagnetic/circuit co-simulation and optimization of planar structures. Advanced design techniques for passive circuits (microwave filters and power combining/dividing circuits). Linear and non-linear analysis of active circuits (amplifiers, mixers, oscillators). Laboratory characterization techniques. Measurements of circuits designed, simulated and fabricated during the course.

**Full-or-part-time:** 42h

Theory classes: 9h

Laboratory classes: 12h

Self study : 21h

### 1.1 Advanced design of microwave filters

#### Description:

Analysis and synthesis of microwave filters with arbitrary transfer function using coupling matrix techniques

**Full-or-part-time:** 20h

Theory classes: 4h

Laboratory classes: 6h

Self study : 10h

## 1.2 Non linear analysis of microwave circuits

### Description:

Theoretical analysis of non linear systems and simulation techniques  
Analysis and design of Mixers and Oscillators and simulation techniques

### Full-or-part-time: 22h

Theory classes: 5h  
Practical classes: 6h  
Self study : 11h

## 2. Terahertz (THz) Photonics

### Description:

Fundamentals of THz technology and applications: time- and frequency-domain spectroscopic systems, and applications to imaging and communications. Basic characteristics of the different methods for THz radiation generation and detection: purely electronic methods such as frequency multiplication, and purely optical methods such as quantum cascade lasers (QCL). In-depth examination of the more ubiquitous photoconductive and optical rectification based systems: focus on quantitative practical examples and experimental setups.

### Full-or-part-time: 44h

Theory classes: 9h  
Laboratory classes: 13h  
Self study : 22h

## GRADING SYSTEM

E1: Written exams: 20%  
E3: Assignments: 80%

## EXAMINATION RULES.

The written exams are done in class and require CAD software tools.  
The assignments require CAD software tools. They include homework exercises and laboratory practices.  
The laboratory practices are performed in teams of 2-3 students

## BIBLIOGRAPHY

### Basic:

- González, G. Microwave transistor amplifiers: analysis and design. 2nd ed. Englewood Cliffs, N.J.: Prentice-Hall, 1997. ISBN 0132543354.
- 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.

### Complementary:

- Bahl, I.; Bhartia, P. Microwave solid state circuit design. 2nd ed. New York: Wiley-Interscience, 2003. ISBN 9780471207559.
- Cameron, R.J.; Kudsia, C.M.; Mansour, R.R. Microwave filters for communication systems: fundamentals, design, and applications. Hoboken, N.J.: Wiley-Interscience, 2007. ISBN 9780471450221.

## RESOURCES

**Other resources:**

Course notes and presentations corresponding to the different topics covered. Individual licenses to simulation software tools. Course notes are delivered to students registered in the course through the UPC Atenea digital campus (<http://atenea.upc.edu:8080/moodle/>)