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

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2019
Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019).
(Master's degree Optional)
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5
Teaching staff:
Coordinator: Pradell Cara, Lluis
Others: A. Aguasca, I. Corbella, N. Duffo, J. O'Callaghan, J. Mateu, L. Pradell, F. Torres,
Santos Blanco, María Concepción

Prior skills
- 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

Requirements
- Circuit theory (or equivalent)
- Electromagnetic theory (or equivalent)
- Radiation & guided waves (or equivalent)
- Microwave theory (or equivalent)
- Optical Communications (or equivalent)

Degree competences to which the subject contributes
Specific:
1. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic circuitry.
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 fixed 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
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- Introduction to specific techniques for the analysis of microwave circuits (S parameters)
- Application to various passive and active subsystems, such as divider/combiner networks, filters, small-signal, large-signal and broadband amplifiers, oscillators and mixers
- Introduction and application of software tools, such as ADS, to the analysis of microwave circuits.
- Design, implementation (fabrication) and measurement of passive and active circuit examples
- Theory and practical utilisation of basic laboratory instruments: network analyzer, spectrum analyzer and noise analyzer.
- Terahertz technology and applications
- Optical methods for Terahertz generation

Learning objectives of the subject

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 da2 software tools.
- Laboratory practice performed by groups.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 26h</th>
<th>20.80%</th>
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<tbody>
<tr>
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<td>Hours small group: 13h</td>
<td>10.40%</td>
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<tr>
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<td>Self study: 86h</td>
<td>68.80%</td>
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### Content

<table>
<thead>
<tr>
<th>1 Advanced topics in RF and Microwave circuit analysis</th>
<th>Learning time: 63h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 7h</td>
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<td>Laboratory classes: 13h</td>
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<td>Self study: 43h</td>
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**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.

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<tr>
<th>(ENG) 2. Terahertz (THz) Photonics</th>
<th>Learning time: 62h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 13h</td>
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<td>Laboratory classes: 6h</td>
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<td>Self study: 43h</td>
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**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.

### Qualification system

Project (design, practical implementation and measure): 45% (group)  
Individual exercises: 25% (group)  
Final examination: 30% (individual)
Bibliography

Basic:


Complementary:


Others resources:

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