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: 2020
Degree: MASTER’S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
MASTER’S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: Pradell Cara, Lluis
Others: Ignasi Corbella
         Joan O’Callaghan
         Lluís Pradell
         María Concepción Santos Blanco

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/admitances 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
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,
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

<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>
<td></td>
<td>Hours small group: 13h</td>
<td>10.40%</td>
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<tr>
<td></td>
<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: 42h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 9h</td>
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<td>Laboratory classes: 12h</td>
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<td>Self study : 21h</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.

<table>
<thead>
<tr>
<th>1.1 Advanced design of microwave filters</th>
<th>Learning time: 20h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
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<td>Laboratory classes: 6h</td>
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<td>Self study : 10h</td>
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**Description:**
Analysis and synthesis of microwave filters with arbitrary transfer function using coupling matrix techniques

<table>
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<tr>
<th>1.2 Non linear analysis of microwave circuits</th>
<th>Learning time: 22h</th>
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<tr>
<td></td>
<td>Theory classes: 5h</td>
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<td>Practical classes: 6h</td>
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<td></td>
<td>Self study : 11h</td>
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**Description:**
Theoretical analysis of non linear systems and simulation techniques
Analysis and design of Mixers and Oscillators and simulation techniques

<table>
<thead>
<tr>
<th>2. Terahertz (THz) Photonics</th>
<th>Learning time: 44h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 9h</td>
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<tr>
<td></td>
<td>Laboratory classes: 13h</td>
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<tr>
<td></td>
<td>Self study : 22h</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.
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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. 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/ )