Course guides

230852 - SEM - Surface Engineering and Microdevices

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.
Degree: MASTER'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2018). (Compulsory subject).
Academic year: 2020  ECTS Credits: 5.0  Languages: English

LECTURER

Coordinating lecturer: Pradell Cara, Lluis
Others: Casals Terre, Jasmina
Pradell Cara, Lluis

PRIOR SKILLS

- Electromagnetic wave propagation. Guided waves. Transmission lines (input impedance, reflection coefficient, voltage standing-wave ratio, transmitted power, Smith chart). Impedance matching

REQUIREMENTS

- Electromagnetic waves course

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Basic:
CB6. (ENG) Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación
CB7. (ENG) Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB10. (ENG) Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

TEACHING METHODOLOGY

MD1 – Master classes
MD5 - Individual assignments (written document)
MD7 – Practical exercises both theoretical resolution and using software tools (circuit/electromagnetic and electromechanical)
MD10 - Laboratory practice performed by teams

LEARNING OBJECTIVES OF THE SUBJECT

- To understand the behavior of fluids at a micro scale
- To know how to design microfluidic circuits
- To know the methods of integration of microfluidic systems with MEMS sensors
- To know the operation and the main configurations of RF-MEMS micro-switches
- To learn how to analyze RF-MEMS micro-switches mechanically and electromagnetically
- To know the applications of RF-MEMS micro-switches to communication circuits
- To understand and to know how to use experimental configurations to characterize MEMS micro-switches
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>48,0</td>
<td>37.21</td>
</tr>
<tr>
<td>Self study</td>
<td>81,0</td>
<td>62.79</td>
</tr>
</tbody>
</table>

Total learning time: 129 h

CONTENTS

1. Mechanics and Fluid mechanics at micron scale

Description:

Full-or-part-time: 46h
Theory classes: 13h
Laboratory classes: 10h
Self study: 23h

1.1 Introduction to micromechanic and microfluidic behavior

Description:
Introduction Nanotechnology and MEMS, MEMS design, and fabrication technology – Lithography, Etching, MEMS material, Bulk micromachining, Surface micromachining, Microactuator, electrostatic actuation.

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 2h
Self study: 5h

1.2 Biosensor structure

Description:

Full-or-part-time: 8h
Theory classes: 2h
Laboratory classes: 2h
Self study: 4h
1.3 Design and simulation of the biosensor fluidic behavior

Description:
Finite element modelling of a microfluidic mixer.

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 2h
Self study: 5h

1.4 Design and simulation of the biosensor mechanic behavior

Description:
Finite element modeling of a mechanical microswitch.

Full-or-part-time: 8h
Theory classes: 2h
Laboratory classes: 2h
Self study: 4h

1.5 Case studies in bioengineering and communications

Description:
Sample preparation microchips: From macro to micro. MEMS-based bio-chip/sensors for Molecules detection

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 2h
Self study: 5h

2. RF-MEMS micro-devices applied to communication circuits

Description:
Micro-devices applied to reconfigurable RF/microwave communication circuits

Full-or-part-time: 46h
Theory classes: 13h
Laboratory classes: 10h
Self study: 23h

2.1 Introduction to RF-MEMS micro-devices and planar circuits

Description:

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 2h
Self study: 5h
2.2 Design and simulation of planar RF-MEMS micro-switches

Description:
Micro-switch structures: ohmic contact and capacitive contact. Mechanical parameters. Equivalent electrical circuit at RF/microwave frequencies. Steady-state analysis. Simulation tools (circuit analysis)

**Full-or-part-time:** 10h
Theory classes: 3h
Laboratory classes: 2h
Self study: 5h

2.3 RF-MEMS micro-switch electromagnetic simulation

Description:

**Full-or-part-time:** 8h
Theory classes: 2h
Laboratory classes: 2h
Self study: 4h

2.4 Application of RF-MEMS micro-switches to reconfigurable communication circuits. Circuit simulation

Description:

**Full-or-part-time:** 8h
Theory classes: 2h
Laboratory classes: 2h
Self study: 4h

2.5 Experimental characterization of RF-MEMS micro-switches

Description:
Experimental set-up. Laboratory measurement of RF-MEMS micro-switches: pull-in and pull-out voltages. Microwave OFF and ON characteristics

**Full-or-part-time:** 10h
Theory classes: 3h
Laboratory classes: 2h
Self study: 5h

**GRADING SYSTEM**

E1: Written exams: 30-40%
E3: Assignments: 60-70%
BIBLIOGRAPHY

Basic:

RESOURCES

Other resources:
- Course notes and presentations (through the UPC Atenea digital campus)
- Student license for simulation software tools