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: 2021
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