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.

Learning objectives of the subject

- To know the structure of the surfaces and the main characterization techniques.
- To understand the physical and chemical phenomena that take place on the surfaces of solid materials and their applications.
- To develop the ability to modify a solid surface with desired properties.
- To know how to apply the knowledge acquired to develop microreactors.
- To understand the behavior of fluids at a micro scale.
230852 - SEM - Surface Engineering and Microdevices

- 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>Total learning time: 125h</th>
<th>Hours large group: 44h</th>
<th>35.20%</th>
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<tbody>
<tr>
<td></td>
<td>Self study: 81h</td>
<td>64.80%</td>
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</tbody>
</table>
### 1. Physical Chemistry of surfaces

**Learning time:** 15h
Theory classes: 15h

**Description:**
Design, preparation, characterization and applications of solid surfaces.

#### 1.1 Introduction to surfaces

**Learning time:** 2h
Theory classes: 2h

**Description:**
The surface boundaries. Surfaces at the nanoscale, microscale and macroscale. The importance of defects.

#### 1.2 Structure of surfaces

**Learning time:** 3h
Theory classes: 3h

**Description:**
Ordered vs. amorphous surfaces. Epitaxial relationships. Surface vacancies.

#### 1.3 Solid-liquid and solid-gas interphases

**Learning time:** 2h
Theory classes: 2h

**Description:**
Surface reconstruction and relaxation. Adsorption and desorption phenomena.

#### 1.4 Characterization techniques

**Learning time:** 3h
Theory classes: 3h

**Description:**
Surface characterization techniques. Electron microscopy techniques (HRTEM, STEM), scanning probe microscopies (AFM, STM), and spectroscopies (IR, Raman, XPS).
## 1.5 Applications in sensors and catalysis

**Description:**

**Learning time:** 3h
- Theory classes: 3h

## 1.6 Functionalization of nano- and microreactors

**Description:**

**Learning time:** 2h
- Theory classes: 2h

## 2. Mechanics and Fluid mechanics at micron scale

**Description:**

**Learning time:** 15h
- Theory classes: 15h

## 2.1 Introduction to micromechanics and microfluidic behavior

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

**Learning time:** 3h
- Theory classes: 3h

## 2.2 Biosensor structure

**Description:**

**Learning time:** 2h
- Theory classes: 2h
# 2.3 Design and simulation of the biosensor fluidic behavior

**Description:**
Finite element modelling of a microfluidic mixer.

**Learning time:** 3h
- Theory classes: 3h

# 2.4 Design and simulation of the biosensor mechanic behavior

**Description:**
Finite element modeling of a mechanical microswitch.

**Learning time:** 3h
- Theory classes: 3h

# 2.5 Case studies in bioengineering and communications

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

**Learning time:** 2h
- Theory classes: 2h

# 3. RF-MEMS micro-devices applied to communication circuits

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

**Learning time:** 15h
- Theory classes: 15h

# 3.1 Introduction to RF-MEMS micro-devices and planar circuits

**Description:**

**Learning time:** 3h
- Theory classes: 3h
### 3.2 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)

**Learning time:** 3h
Theory classes: 3h

### 3.3 RF-MEMS micro-switch electromagnetic simulation

**Description:**

**Learning time:** 3h
Theory classes: 3h

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

**Description:**

**Learning time:** 3h
Theory classes: 3h

### 3.5 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

**Learning time:** 3h
Theory classes: 3h

### Qualification system

E1: Written exams: 50-60%
E3: Assignments: 40-50%
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Bibliography

Basic:


Others resources:

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