Course guide
230669 - MEMS - Mems. Microelectromechanical Systems

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.
Degree: MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2023  ECTS Credits: 5.0  Languages: English

LECTURER
Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
2. 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.

TEACHING METHODOLOGY
- Lectures
- Application classes
- Individual work (distance)
- Exercises
- Extended answer test (Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

Understanding the general principles and tools of the microelectromechanical systems and devices and its applications.

Learning results of the subject:

- Independent ability to propose, plan and develop MEMS devices and applications
- Ability to understand multidomain problems: thermal, fluidic, mechanical and electrical
- Ability to design a fabrication process of a MEMS device
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>86.0</td>
<td>68.80</td>
</tr>
<tr>
<td>Hours large group</td>
<td>39.0</td>
<td>31.20</td>
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</tbody>
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**Total learning time:** 125 h

CONTENTS

(ENG) 1. Introduction to MEMS

**Description:**
- Introduction to MEMS, examples, applications.
- MEMS design and fabrication process outline.

**Full-or-part-time:** 2h
- Theory classes: 1h
- Self study: 1h

(ENG) 2. Force scaling

**Description:**
- Scaling of forces to the microworld.
- Examples

**Full-or-part-time:** 5h
- Theory classes: 1h
- Self study: 4h

(ENG) 2. Elasticity

**Description:**
- Stress and strain
- Elastic properties of main materials
- Beam equation
- Membranes
- Flexures

**Full-or-part-time:** 16h
- Theory classes: 4h
- Self study: 12h

(ENG) 4. Piezoresistance and piezoelectricity

**Description:**
- Piezoresistance and piezoelectric coefficients
- Pressure sensors based on piezoresistors

**Full-or-part-time:** 18h
- Theory classes: 6h
- Self study: 12h
### (ENG) 5. Electrostatic actuation and sensing

**Description:**
- Electrostatic force
- Pull-in and pull-out
- Comb actuators and differential capacitance

**Full-or-part-time:** 16h  
Theory classes: 4h  
Self study: 12h

### (ENG) 6. Resonators

**Description:**
- Resonator model  
- Equivalent circuit  
- Applications

**Full-or-part-time:** 14h  
Theory classes: 4h  
Self study: 10h

### (ENG) 7. Inertial sensors

**Description:**
- Accelerometers  
- Gyroscopes

**Full-or-part-time:** 15h  
Theory classes: 4h  
Self study: 11h

### (ENG) 8. Microfluidics and electrokinetics

**Description:**
- Pressure driven flow  
- Electrokinetic flow  
- Nanoparticle selfassembly  
- Dielectrophoresis  
- Liquid lenses and displays

**Full-or-part-time:** 11h  
Theory classes: 5h  
Self study: 6h

### (ENG) 9. RF-MEMS

**Description:**
- RF-MEMS

**Full-or-part-time:** 11h  
Theory classes: 5h  
Self study: 6h
(ENG) 10. Fabrication processes

Description:
- Bulk micromachining
- Surface micromachining
- Foundry services

Full-or-part-time: 18h
Theory classes: 6h
Self study: 12h

ACTIVITIES

(ENG) THEME WORK

Description:
Short bibliographic research work on a topic of interest to the student. Made a summary in technical magazine format and brief presentation in the classroom.

Full-or-part-time: 6h
Self study: 6h

EXTENDED ANSWER TEST

Description:
Final examination.

GRADING SYSTEM

Class Attendance 10%
Homework consists on deliverables: 40%
... Problem solving from the problem collection and Tests
... MEMS world awareness
Course project (Research work, paper writing and ppt) 50%

BIBLIOGRAPHY

Basic:
RESOURCES

Audiovisual material:
- Exemples. Resource

Hyperlink:
- Transparencies. Resource