Course guide
205122 - 205122 - Microfluids and Mems for Smarts Sensors and Actuators

Last modified: 11/04/2025

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 712 - EM - Department of Mechanical Engineering.

Degree: MASTER'S DEGREE IN AUTOMATIC SYSTEMS AND INDUSTRIAL ELECTRONICS (Syllabus 2012). (Optional subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).
MASTER'S DEGREE IN RESEARCH IN MECHANICAL ENGINEERING (Syllabus 2021). (Optional subject).
MASTER'S DEGREE IN MECHANICAL ENGINEERING RESEARCH (Syllabus 2024). (Optional subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2025). (Optional subject).

Academic year: 2025 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: JASMINA CASALS TERRE

Primer quadrimestre:
JASMINA CASALS TERRE - Grup: 1

Others:

TEACHING METHODOLOGY

The course is developed through lectures including theoretical sessions imparted with the aid of powerpoint presentations and more applicative and more visual sessions with videos, stellar catalogues and simulations

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 design and characterize different type of microfluidic and micromechanics sensors and actuators for applications in energy, bioengineering and others…

STUDY LOAD

Type	Hours	Percentage
Hours large group	15,0	20.00
Self study	48,0	64.00
Hours small group	12,0	16.00

Total learning time: 75 h

CONTENTS

Module 1: Introduction

Description:
Present the context of the master's degree and the labor market. Establish the professional profile of the expert in bioengineering and indicate in which way the subject contributes to it.

Related activities:
Lab visit

Full-or-part-time: 3h
Theory classes: 1h
Self study : 2h

Module 2: Scaling Laws

Description:
Describe the physical laws that govern the phenomena that appear when the objects are miniaturized. Effects on electrostatics, electromagnetic, mechanical, fluidic and electrical phenomena.

Related activities:
Problemas

Full-or-part-time: 8h
Theory classes: 2h
Self study : 6h

Module 3: Microfabrication Processes

Description:
Description of the processes of photolithography, implantation, diffusion, oxidation, chemical and physical deposition and etching methods.

Related activities:
Problems. A micromachined part will be provided to the students who will have to detail the manufacturing steps.
Lab session. The student will get familiar with the equipment used in a manufacturing process such as: soft-lithography: spinner, chemical processes, plasma ... One Device will be built using several processes.

Full-or-part-time: 15h
Theory classes: 2h
Laboratory classes: 3h
Self study : 10h

Module 4: Mechanical Behavior at micro scale

Description:
Identify and model the mechanical efforts applied in microdevices. Principles of electrostatic performance. Mathematical formulation of electromechanical coupling. Solving problems with electromechanics micro-devices. Stability of the electromechanical microdevices.

Related activities:
Problems. Modelling a micromechanical sistemas obtain the effort-deformation relationship.
Lab session of Mechanical Modelling. Introduction to ANSYS micromechanical modelling.

Full-or-part-time: 24h
Theory classes: 6h
Laboratory classes: 3h
Self study : 15h

Module 5: Microfluidic principles

Description:
Introduction to the use of microfluidics in research and in the market. Characteristics of microchannel flux and methods to control microchannel flux. Characteristics of microfluidic microvalves, micromixers, micropumps.

Related activities:
Problem. Modelling the microfluidic behavior of a microfluidic circuit. Establish the flow-rate pressure loss relationship.
Lab session Sensor and MicroParticle Image Velocimetry.

Full-or-part-time: 25h
Theory classes: 7h
Laboratory classes: 3h
Self study : 15h

GRADING SYSTEM

In Class Problems (30%)
Lab sessions (70%)

BIBLIOGRAPHY

Basic:
- Senturia, Stephen D. Microsystem design [on line]. Boston [etc.]: Kluwer Academic, cop. 2001 [Consultation: 14/11/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b117574. ISBN 0792372468.
- Bruus, Henrik. Theoretical microfluidics [on line]. Oxford: Oxford University Press, 2008 [Consultation: 23/04/2025]. Available on: https://research-ebsco-com.recursos.biblioteca.upc.edu/plink/fc8081b2-fadd-3f90-a8b2-e3cb99499393. ISBN 9780199235094.