

# Course guide 2301210 - FPE - Flexible and Printed Electronics

 

 Last modified: 29/05/2025

 Unit in charge: Teaching unit:
 Barcelona School of Telecommunications Engineering 1042 - URV - Universitat Rovira i Virgili.

 Degree:
 MASTER'S DEGREE IN SEMICONDUCTOR ENGINEERING AND MICROELECTRONIC DESIGN (Syllabus 2024). (Optional subject).

 Academic year: 2025
 ECTS Credits: 4.0
 Languages: English

LECTURER		
Coordinating lecturer:	BENJAMÍ IÑIGUEZ NICOLAU	
Others:	Segon quadrimestre: ALBERT CIRERA HERNÁNDEZ - 11 GEMMA GABRIEL BUGUÑA - 11 BENJAMÍ IÑIGUEZ NICOLAU - 11 LLUIS FRANCESC MARSAL GARVI - 11 ELOI RAMON GARCIA - 11	

## **PRIOR SKILLS**

1) Understanding of the physics and operation basic semiconductor devices (in particula diodes and MOSFETs) and their fabrication processes.

2) Understanding of basic integrated circuit design.

3) Understanding of basic delectron evice characterization techniques.

## **LEARNING RESULTS**

## Knowledges:

KT01. Identify semiconductor devices, technological processes, the most appropriate microelectronic design tools, and relationships between these elements in order to integrate a given product or system into microelectronic technologies.

KT03. Describe the physical principles underlying current semiconductor devices in relation to their application, as well as their emerging trends, modelling and characterisation techniques.

KT04. Identify and describe the different manufacturing and characterisation processes in microelectronics and their applicability according to the functional and cost requirements of the final integrated product.

KT07. Identify gender stereotypes and roles and how they may impact professional practice.

### Skills:

ST06. Plan the different activities involved in successfully carrying out an assigned task within a team, managing time and resources appropriately.

#### **Competences:**

CT03. Apply the processes of semiconductor engineering and microelectronic design to fields in diverse areas of science or engineering where integrated systems are required.

## **TEACHING METHODOLOGY**

Theoretical lectures and problems: 18 h. Laboratory exercises: 12 h



# LEARNING OBJECTIVES OF THE SUBJECT

1. Be able to understand and devise potential solutions for the challenges faced by the microelectronic industry in the context of flexible and printed electronics.

2. Understand the main fabrication processes of devices for flexible and printed electronics.

3. Get to know the physical properties of materials used in these applications.

4. Understand the physics and operation of devices used in flexible and printed electronics, as well as solutions to increase their performance.

5. Get to know and understand the main applications in flexible and printed electronics, as well as the architectures needed for them.

## **STUDY LOAD**

Туре	Hours	Percentage
Hours small group	12,0	12.00
Self study	70,0	70.00
Hours large group	18,0	18.00

Total learning time: 100 h

## **CONTENTS**

## Materials

### **Description:**

Brief review of the fundamentals of flexible materials. Physics of amorphous semiconductor and organic materials. Substrates. Conductive inks. Dielectrics. Interfaces and contacts for flexible and printed electronics. Mechanics of thin film-on-flexible substrate structure.Characterization

## **Specific objectives:**

Get to know the physical properties of materials used in flexible and printed electronics.

#### **Related activities:**

1) Problems and solutions.

2) Laboratori exercise: Modification of inks and interaction with substrates.

## **Full-or-part-time:** 7h 15m Theory classes: 4h Laboratory classes: 3h Self study : 0h 15m



## **Fabrication processes**

## **Description:**

Solution processes. CVD, PECVD and VPD deposition techniques. Micro/nano fabrication on flexible substrates. Printing methods: inkjet printing, screen printing, gravure, electrospray, R2R,...3D printing. Sintering. Coating and encapsulation

## Specific objectives:

Understand the main fabrication processes of devices for flexible and printed electronics.

#### **Related activities:**

1) Problems and solutions

2) Laboratory exercise: Fabrication of components by printing methods

Full-or-part-time: 8h 20m Theory classes: 5h Laboratory classes: 3h Self study : 0h 20m

#### Devices

# Description:

Structure of the devica and doping profile, manutacturing and materils of TFT MOS devices. Characteristics and models.

#### **Specific objectives:**

Thin Film Transistors (TFTs): types. Thin Film Transistors: physics, operation and modeling. Other devices for flexible and printed electronics: diodes, LEDs, OPV, sensors. Reliability.

#### **Related activities:**

1) Problems and solutions.

2) Laboratory exercise: Simulation of Thin Film Transistors with TCAD (process and performance)

Full-or-part-time: 8h 20m Theory classes: 5h Laboratory classes: 3h Self study : 0h 20m

#### Applications

#### **Description:**

Flexible Hybrid Electronics. Large area electronics, displays and sensor arrays. Design of Flexible Electronics circuits. Wearable health monitoring. Bioelectronics. Wireless applications and IoT sensors.

## Specific objectives:

Get to know and understand the main applications in flexible and printed electronics, as well as the architectures needed for them.

**Related activities:** Problems and solutions.

Full-or-part-time: 4h 15m Theory classes: 4h Self study : 0h 15m



## **GRADING SYSTEM**

Exam (two partial exams, 2nd call exam): 60% Laboratory exercises: 40%

## **EXAMINATION RULES.**

Written exams: questions and problems.

Reports of the laboratory exercises.

## **BIBLIOGRAPHY**

#### **Basic:**

- Suganuma, K. Introduction to printed electronics [on line]. New York, NY: Springer Nature, 2014 [Consultation: 02/05/2024]. Available on: <u>https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-1-4614-9625-0</u>. ISBN 9781461496250.

- Hussain, A.M. Introduction to flexible electronics [on line]. Boca Raton, FL: CRC Press, 2022 [Consultation: 06/05/2024]. Available on:

https://www-taylorfrancis-com.recursos.biblioteca.upc.edu/books/mono/10.1201/9781003010715/introduction-flexible-electronics-aft ab-hussain. ISBN 9781003010715.

- Brotherton, S.D. Introduction to thin film transistors: physics and technology of TFTs [on line]. Cham: Springer International Publishing, 2013 [Consultation: 02/05/2024]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-00002-2. ISBN 9783319000022.