# 230692 - TECHDEV - Fabrication and Characterization Technologies for Micro and Nano Devices

**Coordinating unit:** 230 - ETSETB - Barcelona School of Telecommunications Engineering  
**Teaching unit:** 710 - EEL - Department of Electronic Engineering  
**Academic year:** 2019  
**Degree:** MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)  
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)  
**ECTS credits:** 5  
**Teaching languages:** English

## Teaching staff

**Coordinator:** Sandra Bermejo  
**Others:** Joaquim Puigdollers  
Isidro Martin

## Prior skills

Basic knowledge of semiconductor physics and technology

## Requirements

Student must have passed or being simultaneously enrolled to Micro and Nano Technologies (MNT, core subject of the Master)

## Teaching methodology

Face to face classes and laboratory sessions

## Learning objectives of the subject

- Ability to characterize basic semiconductor devices  
- Ability to fabricate and characterize basic organic devices  
- Ability to learn basic nano fabrication and characterization techniques

## Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>26h</th>
<th>20.80%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>13h</td>
<td>10.40%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
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</tbody>
</table>
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### Content

<table>
<thead>
<tr>
<th><strong>Basic semiconductor device characterization: the crystalline silicon diode</strong></th>
<th><strong>Learning time:</strong> 44h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td>Theory: (8 h)</td>
<td>Laboratory classes: 4h</td>
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<tr>
<td>Review of current flow through energy barriers</td>
<td>Self study: 32h</td>
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<tr>
<td>Calculation of recombination current at the space charge region.</td>
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<tr>
<td>Dependence of current on the temperature.</td>
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<tr>
<td>Impact of series and shunt resistance</td>
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<tr>
<td>Analysis of impedance response of c-Si diodes up to 1 MHz. Simplified model with lumped elements and complete model from EDO's solution.</td>
<td></td>
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</tbody>
</table>

**Related activities:**

- **Lab:** (4h)
  - 1 session: c-Si diode characterization: I-V-T. Fitting with two diode and two resistor model. Calculation of activation energy of diffusion current.
  - 1 session: impedance measurement of the diode up to 1 MHz. Fitting the results and determination of characteristic diode parameters: $n$, $Rs$, lifetime, etc.

<table>
<thead>
<tr>
<th><strong>Organic semiconductor devices and technologies</strong></th>
<th><strong>Learning time:</strong> 44h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td>Theory: (8h)</td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td>Introduction to organic semiconductors</td>
<td>Self study: 32h</td>
</tr>
<tr>
<td>Organic devices. Flexible electronics</td>
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<tr>
<td>Organic Thin-Film Transistors (OTFTs)</td>
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<tr>
<td>Organic Solar cells (OSCs)</td>
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</table>

**Related activities:**

- **Lab:** (4h)
  - 1 session: Fabrication of Organic Thin-Film Transistor (OTFT) based on pentacene semiconductor.
  - 1 session: Measurement of the electrical characteristics of a OTFT: output, transfer and saturation characteristics.
# Fabrication and Characterization Technologies for Micro and Nano Devices

## Fabrication and Characterization of Nanostructured Devices

**Learning time:** 43h  
- Theory classes: 8h  
- Laboratory classes: 4h  
- Self study: 31h

### Description:

**Theory:** (8 h)
- Fabricating technology: review basic clean room fabrication techniques
- Nanolithography: Optical lithography, Electron-beam lithography, Nanoimprint lithography, Multiphoton lithography, Scanning probe lithography
- Characterization: Superficial (SEM, FIB, TEM, AFM), structural (XDR, topography), energy (electrowetting, contact angle), chemical (XPS), mechanical (internal stress/residual stress, microindentation-nanoindentation, adhesion tests), optical (ellipsometry)
- Case study: Colloidal crystal fabrication and characterization

**Related activities:**
- **Lab:** (4 h)
  - 1 session: electrospray deposition
  - 1 session: SEM characterization and optical characterization

## Qualification System

- Short answer exams: 40%
- Laboratory assessments: 40%
- Small Project: 20%

## Bibliography

**Basic:**