230670 - EDM - Electronic Devices Modelling

Degree competences to which the subject contributes

Learning objectives of the subject:
The aim of the Electronic Devices Modeling course is to understand the performance of modern electronic devices using TCAD and Compact Modeling tools. Principles of the DC, AC, RF, Noise, Large-Signal, Temperature, and Optoelectronic modeling of semiconductor devices are explained and their application to modern devices (CMOS, FinFET, CNFET, GFET, HBT, HEMT, LEDs, Solar Cells,¿) is analysed.

Learning results of the subject:
- Ability to understand TCAD and Compact Modeling tools of electronic devices.
- Ability to understand the principles of the DC, AC, RF, Noise, Large-Signal, Temperature, and Optoelectronic performance of semiconductor devices.
- Ability to analyze and develop models of field effect devices: CMOS, FinFET, CNFET, and GFET.
- Ability to analyze and develop models of bipolar devices: BJT, and HBT.
- Ability to analyze and develop models of optoelectronic devices: Solar Cells and LEDs.
- Ability to understand electrical function of modern electronic devices: Field Effect Devices, Bipolar Devices and Optoelectronic Devices.
- Ability to understand DC, AC, RF, Large-Signal, Noise and Temperature performance of electronic devices.
- Ability to model electronic semiconductor devices using TCAD tools.

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2016
Degree: DEGREE IN ELECTRONIC ENGINEERING (Syllabus 1992). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ERASMUS MUNDUS MASTER'S DEGREE IN PHOTONICS ENGINEERING, NANOPHOTONICS AND BIOPHOTONICS (Syllabus 2010). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator: JUAN MIGUEL LÓPEZ GONZÁLEZ

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
- Individual work (distance)
- Exercises
- Oral presentations

Learning objectives of the subject

Learning objectives of the subject:
230670 - EDM - Electronic Devices Modelling

- Ability to develop analytical and compact models for low and high frequency integrated electronic devices.

<table>
<thead>
<tr>
<th>Study load</th>
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<tbody>
<tr>
<td><strong>Total learning time</strong>: 125h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours large group:</td>
<td>39h</td>
<td>31.20%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
<td>0h</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
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</table>
## Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time: 9h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Introduction</strong></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study : 6h</td>
</tr>
</tbody>
</table>

**Description:**
Introduction to TCAD and compact modeling

**Specific objectives:**
- Subject contents and presentation
- Compact modeling
- TCAD modeling

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time: 9h</th>
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</thead>
<tbody>
<tr>
<td><strong>2. Technology Computer Aided Design (TCAD)</strong></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>Modeling: using ATLAS</td>
<td>Self study : 6h</td>
</tr>
</tbody>
</table>

**Description:**
Technology Computer Aided Design (TCAD) Modeling: using ATLAS

**Specific objectives:**
- Structure
- Materials
- Mathematics

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time: 9h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Compact Modeling: using IC-CAP and MATLAB</strong></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study : 6h</td>
</tr>
</tbody>
</table>

**Description:**
Compact Modeling: using IC-CAP and MATLAB

**Specific objectives:**
- IC-CAP Basic
- MATLAB Basic
### 4. Semiconductors

**Description:**
Theory and modeling of Semiconductors

**Specific objectives:**
- Semiconductor equations
- Energy band parameters
- Material parameters

**Learning time:** 9h
- Theory classes: 3h
- Self study: 6h

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### 5. Junctions

**Description:**
Theory and modeling of Junctions

**Specific objectives:**
- PN homojunctions
- Heterojunctions

**Learning time:** 9h
- Theory classes: 3h
- Self study: 6h

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### 6. Metal-semiconductor junctions

**Description:**
Theory and modeling of Metal-semiconductor junctions

**Specific objectives:**
- Metal-semiconductor theory
- Metal-semiconductor TCAD

**Learning time:** 6h 18m
- Theory classes: 0h 18m
- Self study: 6h
### 7. Graphene

<table>
<thead>
<tr>
<th>Description:</th>
<th>Theory and modeling of Graphene</th>
</tr>
</thead>
</table>
| Specific objectives: | - Graphene physics  
- Graphene electrical properties  
- Applications of Graphene |

**Learning time:** 6h 18m  
- Theory classes: 0h 18m  
- Self study: 6h

### 8. Optoelectronics modeling

<table>
<thead>
<tr>
<th>Description:</th>
<th>Theory and modeling of optoelectronics devices</th>
</tr>
</thead>
</table>

**Learning time:** 6h 18m  
- Theory classes: 0h 18m  
- Self study: 6h

### 9. Direct current (DC) modeling

<table>
<thead>
<tr>
<th>Description:</th>
<th>Direct current (DC) modeling of electronic devices</th>
</tr>
</thead>
</table>
| Specific objectives: | - DC datasheets  
- DC measurements  
- DC modeling |

**Learning time:** 6h 18m  
- Theory classes: 0h 18m  
- Self study: 6h
### 10. Alternating current (AC) modeling

**Description:**
Alternating current (AC) modeling of electronic devices

**Specific objectives:**
- AC datasheets
- AC measurements
- AC modeling

**Learning time:** 6h 18m
- Theory classes: 0h 18m
- Self study: 6h

### 11. Radio frequency (RF) and Microwave modeling

**Description:**
Radio frequency (RF) and Microwave modeling of electronic devices

**Specific objectives:**
- RF and Microwave datasheets
- RF and Microwave measurements
- RF and Microwave modeling

**Learning time:** 9h
- Theory classes: 3h
- Self study: 6h

### 12. Noise modeling

**Description:**
Noise modeling of electronic devices

**Learning time:** 9h
- Theory classes: 3h
- Self study: 6h
Planning of activities

<table>
<thead>
<tr>
<th>EXERCISES</th>
<th>Description: Exercises to strengthen the theoretical knowledge.</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDIVIDUAL HOMEWORK</td>
<td>Description: Modeling of an electronic device.</td>
</tr>
<tr>
<td>ORAL PRESENTATION</td>
<td>Description: Presentation of a work about modeling of an electronic device.</td>
</tr>
</tbody>
</table>

Qualification system

Exercises: from 50 % to 70 %  
Individual assessments: from 20 % to 40 %  
Oral presentations: from 10 % to 20 %

Bibliography

Basic:

Others resources:
- User manuals of ATLAS-SILVACO TCAD (www.silvaco.com) and ICCAP-Agilent Compact Modeling (www.agilent.com) softwares.