Electrical Characterisation and Reliability

Code: 43431  
ECTS Credits: 6

<table>
<thead>
<tr>
<th>Degree</th>
<th>Type</th>
<th>Year</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>4314939 Advanced Nanoscience and Nanotechnology</td>
<td>OT</td>
<td>0</td>
<td>A</td>
</tr>
</tbody>
</table>

**Contact**

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Email: Montse.Nafria@uab.cat

**Use of languages**

Principal working language: english (eng)

**Prerequisites**

No prerequisites are required for students accepted to the program. It is advisable to have knowledge in electronic devices and their applications.

**Objectives and Contextualisation**

This module aims to address the electrical characterization in nanoelectronic devices to assess their performance and reliability.

**Skills**

- Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
- Continue the learning process, to a large extent autonomously
- Identify the characterisation and analysis techniques typically adopted in nanotechnology and know the principles behind these, within one's specialisation.
- Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.

**Learning outcomes**

1. Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
2. Continue the learning process, to a large extent autonomously
3. Describe the principles and identify the possibilities of electric characterisation techniques at the nanoscale.
4. Design accelerated reliability tests in nanoelectronics.
5. Know the mechanisms of variability and malfunction in nanodevices.
6. Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.
7. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
8. Use device-level instruments and characterisation methods in nanoelectronic devices.
Content


2.- Failure mechanisms in nanodevices: Dielectric breakdown, Hot Carrier injection (HCI) and BTI. Resistive switching phenomenon in dielectrics and applications. Characterization of Random Telegraph Noise (RTN) in nanodevices.


5.- Advanced electrical characterization at the nanoscale. Operating principles and application to nanoelectronics probes for atomic force conductivity (C-AFM), capacitance (SCM) and contact potential (KPFM). Spreading resistance (SSRM). Other techniques.

Methodology

Students must attend lectures, problem solving classes / cases / exercises and problem-based learning, with an active participation of students in the classroom. Must also make the presentation and defense of works about specific topics and participate in the practical activities at lab.

Activities

<table>
<thead>
<tr>
<th>Title</th>
<th>Hours</th>
<th>ECTS</th>
<th>Learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type: Directed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classes to solve problems / cases / exercises and problem-based learning</td>
<td>10</td>
<td>0.4</td>
<td>1, 3, 4, 5, 6, 7</td>
</tr>
<tr>
<td>Lectures</td>
<td>12</td>
<td>0.48</td>
<td>6</td>
</tr>
<tr>
<td>Oral presentation and discussion of works</td>
<td>6</td>
<td>0.24</td>
<td>1, 6</td>
</tr>
<tr>
<td>Practical activities</td>
<td>8</td>
<td>0.32</td>
<td>3, 4, 5, 6, 7, 8</td>
</tr>
<tr>
<td><strong>Type: Supervised</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tutorials</td>
<td>8</td>
<td>0.32</td>
<td>6</td>
</tr>
<tr>
<td><strong>Type: Autonomous</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal study, reading articles and reports of interest</td>
<td>60</td>
<td>2.4</td>
<td>6</td>
</tr>
<tr>
<td>Preparation of works</td>
<td>44</td>
<td>1.76</td>
<td>1, 2, 6</td>
</tr>
</tbody>
</table>

Evaluation

The evaluation of the degree of acquisition of skills by students is made taking into account the activities indicated in the table, with their weights. To pass the course as a whole, the student must have an average of 5, whenever there is at least a 3 in each of the evaluation activities.

Tests are planned for final recovery, which can be theoretical and / or practical to recover the parts not previously passed, provided in these previous tests students take at least 3.
For academic needs, according to course development, assessment procedures may be adjusted.

Without prejudice to other disciplinary action deemed appropriate and in accordance with current academic regulations, will qualify with a zero irregularities committed by the student that may lead to a change in the qualification of an act of assessment. Therefore, copying or allowing copying a practice, work, or any evaluation activity will involve suspending it with a zero, if necessary to overcome it passed, the entire course will be suspended. Not be recoverable evaluation activities described in this way and by this procedure, so the course will be suspended directly without the opportunity to recover in the same academic year.

The dates of assessment and delivery of works will be published in the campus virtual, and may be subject to change for reasons of better programming. Always the information about these changes will be announced in campus virtual, as it is understood that this is the common platform for information exchange between teachers and students.

Evaluation activities

<table>
<thead>
<tr>
<th>Title</th>
<th>Weighting</th>
<th>Hours</th>
<th>ECTS</th>
<th>Learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance and active classroom participation</td>
<td>30%</td>
<td>0</td>
<td>0</td>
<td>1, 3, 4, 5, 6, 7, 8</td>
</tr>
<tr>
<td>Delivery of reports / works</td>
<td>30%</td>
<td>0</td>
<td>0</td>
<td>1, 2, 3, 4, 5, 6, 8</td>
</tr>
<tr>
<td>Oral defense of works</td>
<td>30%</td>
<td>0</td>
<td>0</td>
<td>1, 6</td>
</tr>
<tr>
<td>Synthesis tests, theoretical or practical</td>
<td>Between 10% and 60%, according to the part to recover</td>
<td>2</td>
<td>0.08</td>
<td>1, 6</td>
</tr>
</tbody>
</table>

Bibliography

- Eugene V. Dirote, "Focus on Nanotechnology Research", Nova Publishers, 2004
• Luo Weichun, Yang Hong, Wang Wenwu, Xu Hao, Ren Shangqing, Tang Bo, Tang Zhaoyun, Xu Jing, Yan Jiang, Zhao Chao, Chen Dapeng, Tianchun Ye, "Channel Hot-Carrier degradation characteristics and trap activities of high-k/metal gate nMOSFETs", 20th IEEE International Symposium on the Physical and Failure Analysis of Integrated Circuits (IPFA), Page(s): 666 - 669, 2013.
• International Electrotechnical Commission, standard IEC 61124, and AENOR UNE-EN 61124, "Reliability testing. Compliance tests for constant failure rate and constant failure intensity", 2014
• International Technology Roadmap for Semiconductors. Semiconductor Industry association(www.itrs.net)
• www.agilent.com
• www.Keithley.com