Syllabus
Course description

<table>
<thead>
<tr>
<th>Course title</th>
<th>Introduction to printing technologies and flexible components</th>
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<tbody>
<tr>
<td>Course code</td>
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<tr>
<td>Scientific sector</td>
<td>ING-INF01</td>
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<tr>
<td>Degree</td>
<td>PhD in Advanced Systems Engineering</td>
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<tr>
<td>Semester</td>
<td>2</td>
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<tr>
<td>Year</td>
<td>1</td>
</tr>
<tr>
<td>Academic year</td>
<td>2020/2021</td>
</tr>
<tr>
<td>Credits</td>
<td>3</td>
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<tr>
<td>Modular</td>
<td>No</td>
</tr>
<tr>
<td>Total lecturing hours</td>
<td>30</td>
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<tr>
<td>Attendance</td>
<td>Preferred</td>
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<tr>
<td>Prerequisites</td>
<td>None</td>
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<tr>
<td>Course page</td>
<td>None</td>
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<tr>
<td>Specific educational objectives</td>
<td>The course is a specialized course in the interdisciplinary</td>
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<tr>
<td></td>
<td>area of physics, material science, chemistry, electronics,</td>
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<td></td>
<td>and biotechnology, addressing the implementation of flexible</td>
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<td></td>
<td>electronics technologies.</td>
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<td>It is designed to acquire knowledge in flexible electronics</td>
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<td></td>
<td>device technology, from materials, processes, devices to</td>
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<td></td>
<td>systems and applications: state of the art and current status</td>
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<td></td>
<td>on commercialization.</td>
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<td>The specific educational objectives are to:</td>
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<td>- Acquire basic understanding and knowledge of printing and</td>
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<td></td>
<td>microfabrication technologies.</td>
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<td></td>
<td>- Acquire basic understanding and knowledge of device</td>
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<tr>
<td></td>
<td>characterization methods.</td>
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<td></td>
<td>- Acquire “practical” experience with different fabrication</td>
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<tr>
<td></td>
<td>and characterization techniques.</td>
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<tr>
<td>Lecturer</td>
<td>Luisa Petti</td>
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<tr>
<td>Scientific sector of the</td>
<td>ING-INF01</td>
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<tr>
<td>lecturer</td>
<td></td>
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<tr>
<td>Teaching language</td>
<td>English</td>
</tr>
<tr>
<td>Office hours</td>
<td>From Monday to Friday, on appointment</td>
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<tr>
<td>List of topics covered</td>
<td>1. Flexible electronics: general introduction</td>
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<td></td>
<td>- Historical background</td>
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<td></td>
<td>- Materials, devices, systems, applications</td>
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<tr>
<td></td>
<td>- Fabrication techniques</td>
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<tr>
<td></td>
<td>- Unique aspects, status in the field and trends</td>
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</table>
2. Thin-film microfabrication techniques  
   - Basics and fundamentals  
   - Deposition and structuring methods  

3. Printing techniques 
   - Basics and fundamentals  
   - Fluid formation and rheology for printing  
   - Inks and printing techniques  
   - Additional coating and structuring methods  

4. Alternative fabrication techniques 
   - Laser processing  
   - Additive manufacturing  

5. Thin-film transistors and circuits 
   - Thin film transistors (TFTs) 
     - Device operation, materials, and structures 
     - Device characterization and performance 
     - UNIBZ's case study: sub-micrometer Indium-Gallium-Zinc-Oxide TFTs and spray-coated carbon nanotube TFTs 
   - Thin film circuits 
     - From transistors to circuits 
     - Other passive and active thin-film components 
     - Digital and analog circuits  

6. Sensors and biosensors 
   - Sensors 
     - Principles and fundamentals 
     - Examples of flexible physical, chemical and optical sensors 
   - Biosensors 
     - Principles and fundamentals 
     - Examples of flexible biosensors  

7. Actuators 
   - Principles and fundamentals 
   - Examples of flexible optical and thermal actuators  

8. Energy harvesting and storage components 
   - Energy harvesters 
     - Principles and fundamentals 
     - Examples of flexible energy harvesters 
   - Storage components 
     - Principles and fundamentals
9. **Further processing components**
   - Interconnections, antennas, memories

10. **Integrated Systems**
    - System integration strategies
    - Examples of fully flexible and hybrid systems

11. **Applications**
    - Examples applications from academia and industry
    - Roadmapping

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**Teaching format**

Digital format (provided on teams) divided in:

- **Theoretical lectures using:**
  - Slides
  - Videos (e.g., conference presentations, laboratory tutorials)

- **Practical exercises:**
  - Use of softwares (e.g. Origin, Corel) for data analysis and plotting.

- **Projects & assignments:**
  - Informal discussions on presentations and scientific papers
  - Preparation of short papers based on literature review

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**Learning outcomes**

**Knowledge and understanding**: theoretical know-how on printing, microfabrication, and characterization technologies for electronic components.

**Applying knowledge and understanding**: practical know-how on printing, microfabrication, and characterization technologies for electronic components.

**Making judgments**: Capability of identifying the most suitable fabrication and characterization methods to realize specific electronic devices for a given targeted application.

**Communication skills**: ability to give a specialized technical presentation supported by power-point slides.

**Learning skills**: performing a literature review on a given topic; extracting the most valuable information and embedding it in a presentation.

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**Assessment**

A project work developed by the student will be assessed:
<table>
<thead>
<tr>
<th><strong>Presentation and discussion of a topic related to the contents of the course agreed between lecturer and students.</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Assessment language</strong></td>
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<tr>
<td><strong>Evaluation criteria and criteria for awarding marks</strong></td>
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<tr>
<td><strong>Required readings</strong></td>
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<tr>
<td><strong>Supplementary readings</strong></td>
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