# Syllabus

## Course description

<table>
<thead>
<tr>
<th>Course title</th>
<th>Applied Mechanics and Technologies for Energy Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course code</td>
<td>45531</td>
</tr>
<tr>
<td>Scientific sector</td>
<td>ING-IND/16 and ING-IND/13</td>
</tr>
<tr>
<td>Degree</td>
<td>Master Energy Engineering</td>
</tr>
<tr>
<td>Semester</td>
<td>I</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Academic year</td>
<td>2022/23</td>
</tr>
<tr>
<td>Credits</td>
<td>12</td>
</tr>
<tr>
<td>Modular</td>
<td>Yes</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Total lecturing hours</th>
<th>36 + 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total lab hours</td>
<td>0</td>
</tr>
<tr>
<td>Total exercise hours</td>
<td>24 + 24</td>
</tr>
</tbody>
</table>

**Attendance**: Strongly recommended

**Prerequisites**

Module 1: students should be familiar with the basic knowledge of mathematical analysis.

Module 2: Some knowledge of electrical machines is preferred, e.g. the content of the course "Electric Power Conversion Equipment”

**Course page**: [Course Offering / Free University of Bozen-Bolzano (unibz.it)](http://unibz.it)

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### Module 1

**Technologies and Production Processes for Energy Engineering**

**Lecturer**

*Dr. Pasquale Russo Spena*

Faculty of Science and Technology  
mail  [pasquale.russospena@unibz.it](mailto:pasquale.russospena@unibz.it)

**Scientific sector of the lecturer**

Ing-Ind/16 Manufacturing Technology and Systems

**Teaching language**

English

**Office hours**

By appointment

**Teaching assistant (if any)**

18

**List of topics covered**

Basic knowledge about the main features of power generation, storage, and distribution plants. Examination of the production processes (both conventional and advanced) used to yield components and assemblies in the energy engineering field, including:

- a) gas power generation plants;
- b) solar power plants;
- c) eolic plants;
d) tanks and pressure containers for energy storage;
e) tube and piping for energy distribution;
f) electric energy distribution.

Teaching format
The course is based on hours of frontal lectures and hours
dedicated to classroom and/or laboratory activities.
The topics of the course are reported in the lecture notes
provided by the professor, as well as in the textbooks of
the bibliography. After each lecture, the corresponding pdf
presentation will be posted in the Reserve Collection
database.
The professor can also provide additional material (e.g.,
research papers).
The professor can be contacted by students for questions
and clarifications by appointment.

Learning outcomes

Knowledge and understanding:
Students will
1. acquire a knowledge about some important production
   processes used for the fabrication of the main mechanical
   assemblies and components in the energy industry;
2. be able to identify the advantages and limitations of
   these industrial production processes;
3. acquire a basic knowledge of a production process

Applying Knowledge and understanding:
4. Students will be able to select some manufacturing
   processes to be used in the energy industry.
5. Students will have the ability to apply their knowledge
   to identify which are the main systems and issues of a
   production process.
6. The exercises in the classroom, progress tests,
   conversations with the teacher, and the performance of
   specific tasks would allow to assess and evaluate the
   students’ ability to apply his knowledge and understanding
   of the topics covered during the course.

Making judgments:
Students will acquire an autonomy of judgment that will
allow him
7. to select proper manufacturing processes for the
   fabrication of some mechanical assemblies and
   components in the energy engineering field;
8. to examine objectively the results obtained from
   analytical processing, numerical simulations or
   experimental laboratory tests;
9. to make use of technical and scientific literature.

Communication skills:
10. Students will have the ability to structure and prepare
    scientific and technical documentations inherent to the
    selection of some manufacturing processes used in the
11. Students will have the ability to present, communicate, discuss and argue the topics covered in the course.

**Learning skills:**
12. The students will develop learning skills through the individual study of the topics dealt in the lecturing and exercise hours. In addition, the analysis of different problems relative to the fabrication of mechanical components for the energy engineering field will also be addressed by group discussions.
13. The students will have the opportunity to extend the knowledge of the topics of the course by consulting scientific literature, specialized texts, technical standards and international standards that the professor will provide during the course.

### Assessment

**Formative assessment**
In class discussion about the topics covered during the course (ILOS assessed 1,2,3,6,12).

**Summative assessment**
The assessment of the course is:
- Oral exam (ILOS assessed 4,5,7,8,11)
The oral exam consists in 2 or 3 open-end questions to assess the knowledge and understanding of the topics of the course and the ability of the student to present, communicate, discuss and argue the basics of industrial plant systems and of some industrial processes used in energy industry. Moreover, the student will should reflect on the characteristics of a production process and its limitations in terms of product quality, cost and so forth.

### Assessment language
English

### Evaluation criteria and criteria for awarding marks
The evaluation criterion of the oral exam is based on the knowledge of the topics of the course, the clarity of the response and the properties of language of the student (in relation to the language of the course), the pertinence and the relevance of the response, and the autonomy of judgment.

**Final Mark of the Course “Applied Mechanics and Technologies for energy Efficiency”**
Mathematical average of the marks obtained in the Module 1 and 2.

### Required readings
There is no single textbook that covers the entire course. A collection of suggested readings from various sources will be announced during the course.
### Supplementary readings
Additional textbooks, lecture notes, research papers and readings may be provided by the professor.

<table>
<thead>
<tr>
<th>Module 2</th>
<th>Functional Mechanical Design for Energy Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module code</td>
<td>45531B</td>
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<tr>
<td>Scientific sector</td>
<td>ING-IND/13</td>
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<tr>
<td>Degree</td>
<td>Master Energy Engineering</td>
</tr>
<tr>
<td>Semester</td>
<td>I (winter semester)</td>
</tr>
<tr>
<td>Year</td>
<td>II (second year of master)</td>
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<tr>
<td>Academic year</td>
<td>2022/23</td>
</tr>
<tr>
<td>Credits</td>
<td>6</td>
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</tbody>
</table>

| Total lecturing hours | 32 |
| Total lab hours | 0 |
| Total exercise hours | 24 |
| Attendance | Strongly recommended |
| Prerequisites | None, though some knowledge of electrical machines will be of assistance. E.g. the content of the course “Electric Power Conversion Equipment” (LM-30) |
| Course page | Course Offering / Free University of Bozen-Bolzano (unibz.it) |

### Specific objectives
The course aims at giving the guidelines for the functional design of automatic machines, in particular taking into account mechanical efficiency. Criteria and methods to analyze and choose mechanical devices, design motion laws and to evaluate the best system to minimize the energy dissipation in electromechanical systems will be addressed.

### Lecturer
Dr. Roberto Belotti

### Scientific sector of the lecturer
ING-IND/13

### Teaching language
English

### Office hours
See timetable online: [www.unibz.it/en/timetable/](http://www.unibz.it/en/timetable/) and by appointment

### Teaching assistant (if any)
N.A.

### Office hours of teaching assistant
N.A.

### List of topics covered
- Introduction: Introduction to functional design, classification of the mechanisms and motion systems.
- Basic concepts and definitions. Mechanical efficiency, performance, energy efficiency and energy savings in automatic machines.
| Direct/reverse energy flow and motor–load systems.  
| • Mechanical components for transferring and transforming energy. Classification based on function, working principle as well as performance and efficiency.  
| • Optimization aimed at improving the quality of motion and efficiency.  
| • Energy storage systems and energy recovery. Classification (working principle and scope of use).  
| • Classification of motion laws implemented in automatic machines. Analysis of the main requirements in the design of a motion law and its optimization.  |

### Teaching format
Frontal lectures, hand-calculation exercises, computer-assisted exercises

### Learning outcomes

#### 1. Knowledge and Understanding
- Identify the main components of transmission systems and sources of inefficiency
- Understand the basic principles of energy storage, recovery and redistribution systems;

#### 2. Applying knowledge and understanding
- Evaluate and select the proper transmission system considering mechanical and energy efficiency;

#### 3. Making judgments
- Select and design an effective motion law under different working conditions and targets;
- Choose suitable combination of mechanical and electric components for energy transformation and transfer

#### 4. Communication skills
- Ability to structure and prepare scientific and technical documentation

#### 5. Learning skills
- Ability to independently build upon the knowledge acquired during the study course by reading and understanding scientific and technical documentation.

### Assessment

<table>
<thead>
<tr>
<th>Form</th>
<th>Details</th>
<th>Learning outcomes assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-class exercises</td>
<td>Continuously in exercise courses</td>
<td>1, 2, 3, 4, 5</td>
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### Summative assessment

<table>
<thead>
<tr>
<th>Form</th>
<th>Duration</th>
<th>Learning outcomes assessed</th>
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<tbody>
<tr>
<td>Written exam</td>
<td>3 h</td>
<td>1, 2, 3, 4, 5</td>
</tr>
</tbody>
</table>

### Assessment language

English

### Evaluation criteria and criteria for awarding marks

The written examination will include both theoretical questions and numerical exercises to show ability to solve problems handled in this course.

<table>
<thead>
<tr>
<th>Form</th>
<th>Evaluation criteria and weight</th>
</tr>
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<tbody>
<tr>
<td>Written examination</td>
<td>Theoretical knowledge (35%)</td>
</tr>
<tr>
<td></td>
<td>Correctness of methods (30%)</td>
</tr>
<tr>
<td></td>
<td>Correctness in solution (30%)</td>
</tr>
<tr>
<td></td>
<td>Appropriate use of units (5%)</td>
</tr>
</tbody>
</table>

### Required readings

Slides provided to the students after each lecture and notes taken by students during lecture

### Supplementary readings

A collection of suggested readings from various sources will be announced during the course. Such sources will be papers, manuals, technical notes, and excerpts from textbooks, including