## Syllabus
### Course description

<table>
<thead>
<tr>
<th>Course title</th>
<th>Electric Power Conversion Equipment</th>
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<tbody>
<tr>
<td>Course code</td>
<td>45511/47558 (for LM-33)</td>
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<tr>
<td>Scientific sector</td>
<td>ING-IND/32 &quot;Power Electronic Converters, Electrical Machines and Drives&quot;</td>
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<tr>
<td>Degree</td>
<td>Master Energy Engineering</td>
</tr>
<tr>
<td>Semester</td>
<td>2</td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
</tr>
<tr>
<td>Academic year</td>
<td>2023/2024</td>
</tr>
<tr>
<td>Credits</td>
<td>6</td>
</tr>
<tr>
<td>Modular</td>
<td>no</td>
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<tr>
<td>Total lecturing hours</td>
<td>36</td>
</tr>
<tr>
<td>Total lab and exercise hours</td>
<td>24</td>
</tr>
<tr>
<td>Attendance</td>
<td>Not mandatory</td>
</tr>
<tr>
<td>Recommended preliminary knowledge</td>
<td>Electrotechnics</td>
</tr>
<tr>
<td>Connections with other courses</td>
<td></td>
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<tr>
<td>Course page</td>
<td>Course Offering / Free University of Bozen-Bolzano (unibz.it)</td>
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### Specific educational objectives
The course discusses the theoretical basis and the practical applications of electrical energy conversion (electrical-to-electrical and electro-mechanical), with a special focus on electrical machines and their control. The main conversion topologies are introduced and studied. Practical aspects and applications will be considered, highlighting the advantages achievable with state-of-the-art technologies.

### Lecturers
- Prof. Stefano Nuzzo
- Dr. Giampaolo Devito

### Scientific sector of the lecturer
ING-IND/32

### Teaching language
English

### Office hours
On appointment

### Office assistant (if any)
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### List of topics covered
- Recalling electrical engineering, including electric and magnetic circuits, principles and main laws.
- Introduction to motion control, motor-load dynamic, motion trajectories, overview of components of an
electric drive.
- Electro-mechanical conversion, actuators, rotating electrical machines, main terminology and industrial standards
- DC motor: operating principles, main features and construction, mechanical characteristics, exercises.
- DC motor control: recalling control theory, including Laplace transforms, block schemes, nested loops, current and speed loops, choice of PI parameters, exercises
- Static conversion using power electronics: generalities, H bridge, 2- and 3- levels modulation, current ripple.
- Matlab-Simulink: implementation of DC motor control block scheme
- Brushless synchronous motors: operating principles, main features, DC vs. AC brushless motors
- AC brushless motor control: $\alpha-\beta$ and $d-q$ transforms (Park and Clark transforms), operating limits, maximum-torque-per-ampere (MTPA) and maximum-torque-per-voltage (MTPV) strategies.

**Professional applications of the covered topics**

Frontal lectures, exercises in lab

**Teaching format**

**Learning outcomes**

(1) **Knowledge and understanding:**
Master the most important concepts about electro-mechanical energy conversion, static conversion, and electrical machines and drives for different applications.

(2) **Applying knowledge and understanding:**
Verification of the requirements of an electric drive and understanding of real-world operations of electric drives in different application fields.

(3) **Making judgments:**
Ability to select the more adequate electric drive (and its components) for a certain application.

(4) **Communication skills:**
Acquisition of the field-related technical terminology. Ability to describe the state-of-the-art of the technology adopted in energy conversion systems. Ability to present the acquired knowledge and competences with a proper language.

(5) **Learning skills:**
Improvement in the ability to autonomously extend the knowledge acquired during the study course, by reading and understanding scientific and technical documentation.

**Assessment**

**Formative assessment**
In class with written exercises and using Simulink (assessment of ILOs 1, 2, 5).
### Summative assessment

The assessment of the course consists of two parts:
- Written examination on basic electric circuits, La Place transforms, DC motor, AC brushless motors.
- Eventual oral examination: assessed through questions relative to theoretical aspects.
All ILOs except the number 5 are assessed in the summative assessment.

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<tr>
<th>Assessment language</th>
<th>English</th>
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### Evaluation criteria and criteria for awarding marks

The final grade will take into account both the marks obtained in the two parts of the overall assessment.

The following aspects will be considering in the evaluation:
- Written examination: clarity and correctness of answers, ability to summarize and evaluate results, presentation quality
- Oral examination: clarity and correctness of answers with proper language, ability to summarize and evaluate results, presentation quality, problem solving ability, skills in critical thinking.

### Required readings

Lecture notes and documents for exercise will be available on Teams and the reserve collections.

There is no single textbook covering the entire course content. The material is collected from various sources.

### Supplementary readings