Module summary
The course is aimed at acquiring knowledge and skills in electrical engineering, familiarization with professional vocabulary and applying the acquired knowledge during practical exercises.

Description of learning outcomes for module

<table>
<thead>
<tr>
<th>MLO code</th>
<th>Student after module completion has the knowledge/ knows how to/is able to</th>
<th>Method of learning outcomes verification (form of completion)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social competence</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_K001</td>
<td>Student is able to work in group and knows the importance of power system for economy and industry</td>
<td>Involvement in teamwork, Activity during classes, Execution of exercises, Completion of laboratory classes</td>
</tr>
<tr>
<td><strong>Skills</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_U001</td>
<td>Students know: how measure and calculate parameters and characteristics of induction motor, how measure and calculate parameters characteristics of synchronous machine, how the PWM converter works with induction motor, how measure and calculate parameters and characteristics of DC motor, how measure and calculate parameters and characteristics of 1-phase induction motors</td>
<td>Activity during classes, Report, Execution of laboratory classes, Completion of laboratory classes</td>
</tr>
</tbody>
</table>
M_U002  | Students know: how to use measurement devices, how to measure and calculate basic parameters of DC and AC circuits, how to measure and calculate basic parameters of 3-phase AC circuit, how measure and calculate parameters of transformer, |
| Execution of laboratory classes, Report, Completion of laboratory classes, Activity during classes |

Knowledge

M_W001  | Student has a basic knowledge about: laws in DC and AC circuits, electronic elements, systems of electricity production |
| Examination, Execution of laboratory classes |

M_W002  | Student has a basic knowledge about: control systems of electrical machines, actuators and measurement devices. |
| Examination, Report, Execution of laboratory classes, Completion of laboratory classes |

M_W003  | Student has a basic knowledge about: induction machines, synchronous machines, DC brushed and brushless motors, universal motors, special construction of electromechanical converters |
| Report, Completion of laboratory classes, Examination, Execution of laboratory classes |

**FLO matrix in relation to forms of classes**

<table>
<thead>
<tr>
<th>MLO code</th>
<th>Student after module completion has the knowledge/ knows how to/is able to</th>
<th>Form of classes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lectures</td>
<td>Auditorium classes</td>
</tr>
</tbody>
</table>

Social competence

M_K001  | Student is able to work in group and knows the importance of power system for economy and industry |
| - | - | + | - | - | - | - | - | - | - | - |

Skills

M_U001  | Students know: how measure and calculate parameters and characteristics of induction motor, how measure and calculate parameters characteristics of synchronous machine, how the PWM converter works with induction motor, how measure and calculate parameters and characteristics of DC motor, how measure and calculate parameters and characteristics of 1-phase induction motors |
| - | - | + | - | - | - | - | - | - | - | - |
Module content

Lectures
1. Instantaneous power in electrical circuits. Active power.
2. First and second Kirchhoff’s laws. Thevenin’s principle.
4. Transient and steady state in R+L circuits.
5. Transient and steady state in R+L+C circuits.
8. Transients in R+L+C circuits.
9. AC (Alternating Current) circuits. Active, reactive and apparent power.
11. Series and parallel resonance.
15. Electromagnetic energy conversion.
17. Induction machine. Steady-state torque versus speed characteristics.
22. Stepping motors. Angular and frequency characteristics.
24. Piezoelectric motors and actuators.

**Laboratory classes**
Calculating of power in three-phase circuits.
Measurements and calculations of the transformer.
Measurements and analysis of induction machine properties, based on Kloss’s formula, work with PWM converter.
Measurements and analysis of synchronous machine properties.
Measurements and analysis of mechanical properties of DC motors.
Measurements and analysis of 1-phase induction motors properties
Measurements and analysis of universal motor properties.

**Method of calculating the final grade**
Mlab – average mark of the laboratory reports
Mtest – mark of the test
Mfinal – final mark
Mfinal = 0.5• Mlab+0.5• Mtest

**Prerequisites and additional requirements**

**Recommended literature and teaching resources**

**Scientific publications of module course instructors related to the topic of the module**
2. Influence of non-sinusoidal voltage supply on harmonic spectrum of stator currents of induction machines; Paweł DYBOWSKI; EPQU’03 : Electrical Power Quality and Utilisation : 7th international conference : September 17-19, 2003, Cracow, Poland
3. Badania laboratoryjne samowzbudzonego generatora indukcyjnego; Paweł DYBOWSKI, Waclaw ORLEWSKI; Przegląd Elektrotechniczny / Stowarzyszenie Elektryków Polskich. — 2012 R. 88 nr 5a, s. 234–237
4. Problems of practical diagnostics of induction machines in industry; Paweł DYBOWSKI, Witold RAMS, Jan RUSEK; Electrical Power Quality and Utilisation Journal. ISSN 1896-4672 . — 2008 vol. 14 no. 1 s. 79–83
5. Obliczenia polowe zjawisk cieplnych w maszynie z magnesami trwałymi; Waldemar MILEJ, Paweł DYBOWSKI; Przegląd Elektrotechniczny / Stowarzyszenie Elektryków Polskich. — 2012 R. 88 nr 6, s. 146–149.
6. Transient state operation of small-power commutator motors - possibilities of using tach generators; Zbigniew TERTIL, Paweł DYBOWSKI; EPQU ‘99 : Electrical Power Quality and Utilisation : 5th international conference : September 15-17,1999, Cracow
7. Diagnostyka silnika indukcyjnego napędu wentylatora spalin; Paweł DYBOWSKI, Henryk KRAWIEC, Waldemar MILEJ; Maszyny Elektryczne : zeszyty problemowe. — 2014 nr 4 (104), s. 253–258
9. Diagnostyka silnika indukcyjnego z wykorzystaniem dostępnych napięć stojącej; Paweł DYBOWSKI, Waldemar MILEJ; Napędy i Sterowanie. — 2013 R. 15 nr 3, s. 108-113
10. Pomiary mocy czynnej, napięć i prąдов przy zasilaniu małych silników komutatorowych – możliwości powstawania błędów pomiarowych; Paweł DYBOWSKI, Zbigniew TERTIL; Maszyny Elektryczne : zeszyty problemowe ; ISSN 0239-3646. — 2000 nr 61 s. 153-158.

Additional information

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**Student workload (ECTS credits balance)**

<table>
<thead>
<tr>
<th>Student activity form</th>
<th>Student workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in lectures</td>
<td>28 h</td>
</tr>
<tr>
<td>Participation in laboratory classes</td>
<td>20 h</td>
</tr>
<tr>
<td>Realization of independently performed tasks</td>
<td>25 h</td>
</tr>
<tr>
<td>Preparation for classes</td>
<td>15 h</td>
</tr>
<tr>
<td>Examination or Final test</td>
<td>2 h</td>
</tr>
<tr>
<td>Preparation of a report, presentation, written work, etc.</td>
<td>5 h</td>
</tr>
<tr>
<td>Contact hours</td>
<td>5 h</td>
</tr>
<tr>
<td>Summary student workload</td>
<td>100 h</td>
</tr>
<tr>
<td>Module ECTS credits</td>
<td>4 ECTS</td>
</tr>
</tbody>
</table>