Warsaw University of Technology

Faculty of Power and Aeronautical Engineering

CATALOGUE OF COURSES

Undergraduate studies (B.Sc. degree)
TOK 2006

Warsaw 2011
The undergraduate studies last 7 semesters and conclude with the Bachelor of Science degree. They are offered in two specializations. Please see the table below:

<table>
<thead>
<tr>
<th>Field of Studies</th>
<th>Specialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engineering</td>
<td>Aerospace Engineering</td>
</tr>
<tr>
<td>Power Engineering</td>
<td>Power Engineering</td>
</tr>
</tbody>
</table>

The program of B.Sc. studies is the same for all specializations during the first two semesters. The studies within a particular specialization can be launched when a sufficient number of students have been admitted by the Dean of the Faculty.

Heads of specializations:
- Aerospace Engineering – prof. Cezary Galiński
- Power Engineering – prof. Tadeusz Skoczkowski

Regulations of Studies

Students must comply with the „Regulations of Studies of Warsaw University of Technology” accepted by the University Senate. Please see the following sections for more details.

Dean of the Faculty decides in matters not specified by the Regulations.

Course of studies

From the second semester students must design an individual study plan for next semesters, which includes the obligatory courses, especially the specialization courses that must be repeated, and possibly the courses included in the program for higher semesters of studies.

When designing the individual study plan for the next semester, students must decide on:
- Electives - if included in the programme. There is no separate list of electives. An elective can be any course which is not included in the programme of other fields of studies given in English. Dean of the Faculty approves optional electives, e.g. lectured by the Visiting Professors.
- Division and subject of intermediate projects.
- Division and scope of diploma seminar. The seminar provides knowledge and skills required in diploma project preparation.
• Division and subject of diploma project. The division is the same as in case of diploma seminar.
Students can also select from a range of foreign language or physical education courses.

Individual study plan for the next semester must be prepared according to the prerequisites given in the catalogue, i.e. courses which must be completed before the beginning of the current course.

After each semester, the student performance is assessed and the registration procedure for the next semester is performed. At the end of the study program all the requirements for graduation must fulfilled.

**Registration procedures for each semester**

**ECTS Credit System**

During each course a certain number of ECTS points are earned in accordance with the course significance, difficulty and the student workload required. The total number of credit points that can be earned for all courses in each semester is 30.

**Evaluation System**

1. At the end of each semester, students obtain one final grade for each course (regardless of the course division into lectures, tutorials and laboratory work).
2. The grading scale starts with a failing grade 2 and consists of five passing grades: 3, 3 1/2, 4, 4 1/2, 5.
3. In exceptional cases, students may obtain “condition” N final grade, which means that the student performance during the semester is evaluated positively, but the student is not allowed to take the final exam (due to valid reasons). The lecturer defines the procedures in case of “condition” N. This grade obliges the student to complete the course by the end of the following semester the latest, so that he does not need to repeat it and pay extra fee. If the student fails to complete the course during the following semester, the course must be repeated. Consequently, the student is obliged to cover the costs of the course repetition according to University Regulations. There are no credit points for “condition” N.

**Requirements for registration for each semester**

1. In order to register for the next semester, students are required to have a sufficient number of credit points as given in the table below.
<table>
<thead>
<tr>
<th>Registration for semester</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of collected credits</td>
<td>17</td>
<td>38</td>
<td>68</td>
<td>98</td>
<td>130</td>
<td>170</td>
</tr>
</tbody>
</table>

2. Students who fail to collect the required number of points are removed from the study programme, with the exception of the last two semesters of studies, for which the student can re-register.

3. Students must repeat the failed course during the next available semester. Courses can be repeated twice. Students who fail to complete the course three times will be removed from the Faculty. Students are obliged to cover the costs of course repetition according to University Regulations.

4. Dean can approve student sick leave or leave of absence. First year students may obtain sick leave only.

5. In some cases, the Dean can grant a student who is on the leave, the right to take certain courses "in advance".

6. Duration of undergraduate studies must not be longer than nine semesters. In case the student is granted the leave, duration of studies is prolonged accordingly.

**Requirements for graduation**

Requirements for graduating with the B.Sc. degree are as follows:

- Completion of all courses in the study program,
- 4-week internship (in industry)
- Collecting 210 ECTS points including the preparation of B.Sc. thesis
- Writing B.Sc. thesis and passing the final exam.

The final grade for the completed study program is an average of grades received for each course. Failing grades are not included in the average.

\[
\text{Average grade} = \frac{\sum_{i=1}^{Z} g_i \cdot O_i}{\sum_{i=1}^{Z} g_i}
\]

- \(Z\) – number of completed courses,
- \(g_i\) – number of ECTS points allocated to the course,
- \(O_i\) – grade for the course.
Final examinations are held four times a year – in January, March, June and October.

**Brief study schedule**

Brief study schedule includes information on the course title and the number of hours per semester and week. Information about a course division into lectures, tutorials, laboratory work and projects as well as the number of credit points can be found in a table for each semester. Complete information about courses can be found in the last part of the catalogue on courses contents.

**LEGEND for the list of courses (following pages)**

In the following section the list of courses is given, divided into suggested sequence during standard semesters of study.

In each semester the standard set of courses gives 30 ECTS points. In the case the required (named and specified) courses do not fill standard 30 ECTS points – then ELECTIVE courses should be taken in the amount summing the semester load to 30 ECTS. Compare remarks on elective courses in the section "Course of Studies".

In the headers of tables the following abbreviations/acronyms are used:

- **Lc** – Lecture
- **T** – Tutorial
- **Lb** – Laboratory
- **P** – Project
- **S** – Seminar
### Field of Study Energetyka

<table>
<thead>
<tr>
<th>Power Engineering</th>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
<th>Semester 4</th>
<th>Semester 5</th>
<th>Semester 6</th>
<th>Semester 7</th>
</tr>
</thead>
</table>

Date 18.04.2011
### Field of Study Energetyka
#### Field of Specialization Power Engineering
#### Semester 1

**List of common courses:**

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANW101</td>
<td>Algebra and geometry</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>ANW102</td>
<td>Calculus 1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>3.</td>
<td>ANW106</td>
<td>Computer science 1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td>ANW105</td>
<td>Engineering graphics</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>ANW104</td>
<td>Engineering physics</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>ANW109</td>
<td>Environment protection</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>ANW71</td>
<td>Health and Safety Training</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>ANW72</td>
<td>Library Training</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>ANW107</td>
<td>Materials 1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>ANW108</td>
<td>Mechanics 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>ANWF1</td>
<td>Physical Education and Sports 1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12.</td>
<td>ANPL1</td>
<td>Polish Language 1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13.</td>
<td>ANW103</td>
<td>The Wittgenstein's Philosophy - Ethics</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
Field of Study Energetyka  
Field of Specialization Power Engineering  
Semester 2

List of common courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANW90</td>
<td>Calculus 2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>ANW114</td>
<td>Computer science 2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>ANW112</td>
<td>Economics</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>ANW113</td>
<td>Electric Circuits 1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>ANW118</td>
<td>Engineering graphics - CAD 1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>ANJ1</td>
<td>English Language 1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>ANW115</td>
<td>Mechanics 2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>8.</td>
<td>ANW117</td>
<td>Mechanics of structures 1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>ANWF2</td>
<td>Physical Education and Sports 2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10.</td>
<td>ANPL2</td>
<td>Polish Language 2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11.</td>
<td>ANW116</td>
<td>Thermodynamics 1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>
Field of Study Energetyka  
Field of Specialization Power Engineering  
Semester 3

List of common courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANW123</td>
<td>Basics of automation and control 1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>ANW91</td>
<td>Calculus 3</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>ANJ2</td>
<td>English Language 2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>ANW122</td>
<td>Fluid mechanics 1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>ANW124</td>
<td>Machine design 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>ANWF3</td>
<td>Physical Education and Sports 3</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

List of field of study courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANK317</td>
<td>Electric circuits 2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ANK423</td>
<td>Heat transfer 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>ANK405</td>
<td>Theory of heat machines</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>ANK411</td>
<td>Thermodynamics 2 (lab)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>ANK413</td>
<td>Thermodynamics 3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
### Field of Study Energetyka
#### Field of Specialization Power Engineering
#### Semester 4

**List of common courses:**

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANW135</td>
<td>Electronics 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>ANJ3</td>
<td>Foreign Language 3</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>NJAC1</td>
<td>Languages - C1_Egzam (English)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>ANW125</td>
<td>Machine design 2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>ANWF4</td>
<td>Physical Education and Sports 4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**List of field of study courses:**

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANK380</td>
<td>Combustion and Fuels</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ANK333</td>
<td>Electric Machines 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>ANK381</td>
<td>Electric Power Systems</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td>ANK316</td>
<td>Electronics 2 (lab)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>ANK340</td>
<td>Fluid mechanics 2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>ANK341</td>
<td>Fluid mechanics 3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>ANK376</td>
<td>Fundamentals of Management</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>ANK424</td>
<td>Heat transfer 2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>9.</td>
<td>ANK351</td>
<td>Measurements and technique of experiment</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>ANK406</td>
<td>Theory of flow machines</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
Field of Study Energetyka  
Field of Specialization Power Engineering  
Semester 5

List of common courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ANJ4</td>
<td>Foreign Language 4</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>ANWF5</td>
<td>Physical Education and Sports 5</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

List of field of study courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ANK442</td>
<td>Electric Machines II (lab)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>ANK329</td>
<td>Electric Power Systems 2 (lab)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>ANK390</td>
<td>Energy systems</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>ANK364</td>
<td>Fundamentals of Operation and Maintenance</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>ANK332</td>
<td>Marketing (ang)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

List of specialization courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ANS510</td>
<td>Chemistry of Water</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>ANS603</td>
<td>Energy sources and conversion</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>ANS549</td>
<td>Internal Combustion Engines</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>ANS539</td>
<td>Rotodynamic Pumps and Pumping Systems</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>ANS521</td>
<td>Steam Boilers</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>ANS577</td>
<td>Turbines</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
List of common courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANJ5</td>
<td>Foreign Language 5</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>ANW127</td>
<td>Intermediate Engineering Project</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>ANWF6</td>
<td>Physical Education and Sports 6</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>ANW126</td>
<td>Physics 1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

List of field of study courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANK443</td>
<td>Energy Management</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

List of specialization courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANS534</td>
<td>Advanced Renewable Energy Sources</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ANS555</td>
<td>Control of Heat Processes</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>ANS540</td>
<td>Heat Pumps</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>ANS524</td>
<td>Power Engineering Machines and Systems 1 (lab)</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>ANS516</td>
<td>RES - Solar Engineering 1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>ANS566</td>
<td>Technologies of Environmental Protection</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>ANS550</td>
<td>Thermal Power Stations</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
Field of Study Energetyka
Field of Specialization Power Engineering
Semester 7

List of common courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANW128</td>
<td>Engineering Diploma Seminar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>ANW136</td>
<td>Engineering Diploma Thesis</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

List of specialization courses:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course number</th>
<th>Course name</th>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
<th>ECTS points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANS625</td>
<td>Energy Market</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ANS527</td>
<td>Energy storage</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>ANS576</td>
<td>Gas turbines and gas-steam systems</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>ANS525</td>
<td>Power Engineering Machines and systems II (lab)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>ANS517</td>
<td>RES - Solar Engineering 2 (Lab)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
SYLLABUS

Course name: Advanced Renewable Energy Sources
Course name in other language: ARES
Short name: ANS534
Course number: English
Responsible for the course: prof. dr hab. inż. Roman Domański
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 1, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 30, 15, 0, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 6
Prerequisits:
Heat transfer 1 (ANK423) , Heliotechnika 1 (NS516) , Termodynamika (ZNW116)

Contents - short:
Teaching evaluation of renewable energy. Evaluation of implementation possibilities for renewable energy, evaluation of environmental threats related to energy storage and conversion processes, feasibility of individual technologies of renewable energy storage. Presenting new and future renewable energy technologies.

Bibliography:
Materials for students placed on website

Course results:
After passing the subject student will be able to analyze renewable energy resources and needs for storage systems. Understand relation between the renewable and fossil and nuclear energy conversion systems, understand the limits for renewables.

Grading criteria:
60% multiple-choice test carried out at the end of the lectures, 40% homework grade.
Own work:
Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

Detailed contents:
Basic terms related to energy conversion processes. World’s energy resources (fossil fuel and nuclear) versus renewable energy sources. The basic parameters for energy storage. Energy conversion

Additional remarks (by course staff):
Lecture based on Power Point presentations
Course name: Algebra and geometry
Course name in other language: Algebra i geometria.
Short name: ALG
Course number: ANW101
Course language: English
Responsible for the course: dr Ewa Lewińska
ECTS: 4
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 0, 3, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 0, 45, 0, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 1
Lotnictwo i Kosmonautyka - undergraduate, full time
Mechanical Engineering - undergraduate, full time
Mechanika i Budowa - undergraduate, full time
Maszyn
Contents - short:
- to get students familiar with basic concepts of linear algebra and with some elements of 3-d analytic geometry;
- to introduce fundamental abstract definitions of linear spaces, algebraic bases, linear mappings and to reinterpret earlier material from this abstract point of view.

Bibliography:
- Anton H., Rorres Ch.-Elementary Linear Algebra, John Wiley and Sons 2010,
- Lay D.C.- Linear Algebra and its Applications, Addison-Wesley 2003,

Course results:
- After completing the course students will know basic concepts of linear algebra and 3-d analytic geometry.
- They will also see them in the deeper abstract setting of linear spaces and linear mappings.
- Thus they will be prepared for other mathematical courses where some algebraic background is required.

Grading criteria:
- 50% at a mid-semester class test, 50% at an exam,
- if the class test is failed, then 100% at an exam.

Detailed contents:
- 1. Complex Numbers.
2. Polynomials.
Factorization of Real Polynomials.
3. Matrices and Determinants.
an Evaluation of Determinants of Order 2 and 3. Laplace Expansion Theorem. Other Properties of
4. Inverse of a Matrix.
5. Systems of Linear Equations.
Matrix Representation. Elementary Operations on Equations in a System and Corresponding Elementary
Row Operations on Rows in the Augmented Matrix of the System. Gauss Elimination Method for Systems
with a Nonsingular Matrix.
Definition of a Rank of a Matrix and Operations which do not Change a Rank. The Kronecker-Capelli
Theorem (the Consistency Theorem).
Definition. Characteristic Polynomial. Definition of an Algebraic and a Geometric Multiplicity of an
Eigenvalue. Theorem about Eigenvalues and Eigenvectors of a Real Matrix.
Vectors in the 3-d Cartesian Coordinate System. Scalar, Vector and Box Products. Area of a
Parallelogram and Volume of a Parallelepiped. Angle between Vectors. Various Equations of Planes and
Lines and Orthogonal Projections onto them.
8. Linear Spaces. Linear Operators.
Definition of a Linear Space and Examples. Linear Subspaces and Examples. Linear Combinations,
Linear Independence and Linear Dependence of Vectors. Algebraic Basis and Dimension of a Linear
Space. Examples.
Definition of a Linear Mapping, its Kernel and Image. General Linear Equations: a Relation between
Solutions of Nonhomogeneous and Homogeneous Equations and Illustration of this Relation for Linear
Algebraic Systems and Linear Differential Equations.
Diagonalization of Matrices. Diagonalization of Real Symmetric Matrices.
SYLLABUS

Course name: Basics of automation and control 1
Course name in other language: Podstawy Automatyki i Sterowania 1
Short name: BAC1
Course number: ANW123
Course language: English
Responsible for the course: dr inż. Tomasz Dziewoński
ECTS: 4
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 1, 0, 0, 0 ]
Form of grading: Continuous assessment
by semester: [ 30, 15, 0, 0, 0 ]

Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka - undergraduate, full time 3
Lotnictwo i Kosmonautyka - undergraduate, full time 3
Mechanical Engineering - undergraduate, full time 3
Mechanika i Budowa - undergraduate, full time 3
Maszyn

Prerequisites:
Calculus 1 (ANW102) , Calculus 2 (ANW90)

Contents - short:

Bibliography:
[1] Ogata Katsuhiko: Modern Control Engineering, Prentice Hall;
[2] lecture notes/ materials provided by lecturer

Course results:
The objective of the course is to gain the following abilities:
- ability to transform the functions using Laplace transform,
- ability to describe the control system in Laplace domain,
- ability to create and simplify the block diagrams of controled objects,
- ability to evaluate the typical system responses for standard inputs,
- ability to apply basic stability criteria,
- ability to describe and analyse the control system in time and frequency domains.

**Grading criteria:**
100% continuous assessment.
2 classworks during semester + individual activity and short tests assessment.

**Detailed contents:**
1) Basic introduction to the concept of Control Systems.
2) Definition and interpretation of terms: CONTROL SYSTEM, FEEDBACK CONTROL, STABILITY of the system.
3) Introduction and application of Laplace Transform as analysis and design tool for linear dynamical systems.
4) Transfer function definition.
5) Block diagram representation of physical systems.
7) Introduction of poles and zeros concept, dominant poles. Characteristic equation, steady state error, system types.
8) Basic principles of feedback control: PID controller.
9) Stability analyses, Routh-Hurwitz method.
10) Principles of frequency domain analysis; concept of frequency response, Bode plots, Nyquist plots and Nyquist stability.
SYLLABUS

Course name: Calculus 1
Course name in other language: CALC1
Short name: ANW102
Course number: English
Course language: prof. dr hab. inż. Andrzej Fryszkowski
Responsible for the course:
ECTS: 7
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 3, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 30, 45, 0, 0, 0 ]

Field of Study: Energetyka - undergraduate, full time
Field of Specialization:
Study level: Recommended semester:

- undergraduate, full time

- undergraduate, full time

- undergraduate, full time

- undergraduate, full time

Contents - short:
1. to convey and reinforce the knowledge on real number sequences, functions of one variable, the constant e, one-variable differential and integral calculus, definite and improper integrals, and their application,
2. to acquire thorough understanding of basic concepts and computational processes, and to master skills of using them,
3. to acquire the skill of correct mathematical reasoning and inference.

Bibliography:
1. Thomas “Calculus”
2. Robert A. Adams, Calculus. A complete course
3. Thomas G. Finney: Calculus, ed. Addison-Wesley

Course results:
After completing his course the students will be able to:
1. establish the convergence of sequences and evaluate limits of basic types of sequences;
2. establish the limits of functions and known basic types of functions;
3. evaluate derivatives of elementary functions, know basic rules of differentiation and apply derivatives in evaluations approximate values of expressions, tangent lines, finding the limits of undetermined expressions, finding local extrema of a function and drawing it’s graph;
4. calculate the indefinite integrals of elementary functions;
5. know basic properties of definite integrals (proper and improper), methods of evaluations and implement definite integrals in to evaluation computing areas of planar figures, arc length of the curves, surface areas, volumes of revolved solids;
6. know basic properties of functions of two and three variables;
7. evaluate partial derivatives of arbitrary order and write down the Taylor expansion;
8. find local extrema of functions of two and three variables;
9. examine local extrema of implicit functions.

Grading criteria:
50% continuous assessment based on laboratory work and tests, 50% written final exam

Detailed contents:
4. Function increment. Definition of the derivative of a function at a given point and its geometric interpretation. Derivatives of some common functions. The derivative of a sum, a product and a quotient of functions. The derivative of a composition. Tangent and normal lines at a point to a curve f(x).
7. Derivatives of higher order with the use to identify extrema. Inflection points. Concave and convex functions. Necessary and sufficient conditions for inflection points. Examining the function and plotting its graph.
8. Indefinite integral - definition; antiderivative; integral of some common functions; properties. Techniques of integration.
10. Definite integrals: definition and geometrical interpretation. Improper integrals of the first and the second kind. Applications of integrals; computing areas of planar figures, arc length of the curves, surface areas, volumes of revolved solids.
12. Gradient of a function at a point. Higher order partial derivatives. Taylor formula with the second and higher order.
SYLLABUS

Course name: Calculus 2
Course name in other language: CALC2
Short name: ANW90
Course language: English
Responsible for the course: prof. dr hab. inż. Andrzej Fryszkowski
ECTS: 5

Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 2, 2, 0, 0, 0 ]
by semester: [ 30, 30, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 2

Contents - short:
to convey and reinforce the knowledge on definite integrals (proper and improper) and their applications, series (numeric and functional), functions of many variables (sets, limits and continuity, multivariable calculus), ordinary differential equations, Frenet trihedron, line and surface integrals, Green, Stokes and Gauss Theorems.
2. to acquire thorough understanding of basic concepts and computational processes and to master skills of using them (labs) and to master the skill of correct mathematical reasoning and inference.

Bibliography:
1. Thomas “Calculus”
2. Robert A. Adams, Calculus. A complete course
3. Thomas G. Finney: Calculus, ed. Addison-Wesley

Course results:
After completing his course the students will be able to:
1. solve basic differential equations of 1st and higher order.
2. Implement differential equations to some practical problems in mechanics, biology etc.;
3. Evaluate double and triple integrals on bounded and unbounded regions.
4. Apply double and triple integrals in calculations of volume, area of surfaces, area of planar regions, moments of inerties and centers of the mass.
5. Know line integrals and basic applications of them.
Grading criteria:
50% continuous assessment based on laboratory work and tests, 50% written final exam

Detailed contents:
2. Solving nonhomogenous linear differential equations by the method of integrating factor and the method of variation of a parameter. Linear equations of the higher order. General and particular solutions. Initial value problems. Linear equation of the second order transformable to equation of the first order.
3. Method of trial functions for nonhomogenous equation of the m-th order with constant coefficients.
SYLLABUS

Course name: Calculus 3
Course name in other language: CALC3
Short name: CALC3
Course number: ANW91
Course language: English
Responsible for the course: prof. dr hab. inż. Andrzej Fryszkowski
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 1, 2, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 15, 30, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Recommended semester: 3

Field of Study: Lotnictwo i Kosmonautyka
Field of Specialization: undergraduate, full time
Recommended semester: 3

Field of Study: Mechanical Engineering
Field of Specialization: undergraduate, full time
Recommended semester: 3

Field of Study: Mechanika i Budowa
Field of Specialization: undergraduate, full time
Recommended semester: 3

Field of Study: Maszyn
Field of Specialization: undergraduate, full time
Recommended semester: 3

Contents - short:
1. to convey and reinforce the knowledge on real number sequences, functions of one variable, the constant e, one-variable differential and integral calculus, definite and improper integrals, and their application,
2. to acquire thorough understanding of basic concepts and computational processes, and to master skills of using them,
3. to acquire the skill of correct mathematical reasoning and inference.

Bibliography:
1. Thomas “Calculus”
2. Robert A. Adams, Calculus. A complete course
3. Thomas G. Finney: Calculus, ed. Addison-Wesley

Course results:
After completing his course the students will be able to:
1. Evaluate surface integrals.
2. Implement and Gauss Theorems to vector field calculus.
3. Establish the convergence of number series.
4. Find radius and area of convergence of power series, expand the basic elementary functions into power series.
5. Apply power series in evaluation of number series.
6. Know trigonometric series and basic applications of them.

**Grading criteria:**
50% continuous assessment based on laboratory work and tests, 50% written final exam

**Detailed contents:**
1. Non oriented surface integrals and their applications
2. Oriented surface integrals.
SYLLABUS

Course name: Chemistry of Water
Course name in other language: COW
Short name: ANS510
Course number: English
Course language: prof. dr hab. inż. Andrzej Miller
Responsible for the course:

ECTS: 2
Course level: basic
Form of grading: Continuous assessment

Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 2, 0, 0, 0, 0 ]
by semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 5

Contents - short:
basic knowledge about water and steam in power engineering technologies

Course results:
basic knowledge about water and steam in power engineering technologies

Grading criteria:
Final test

Detailed contents:

Additional remarks (by course staff):
All course info available on http://energetyka.itc.pw.edu.pl
SYLLABUS

Course name: Combustion and Fuels
Course name in other language:
Short name: COMF
Course number: ANK380
Course language: English
Responsible for the course: prof. dr hab. inż. Rudolf Klemens
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: intermediate weekly: [ 1, 1, 0, 0, 0 ]
Form of grading: Continous assesment by semester: [ 15, 15, 0, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 4

Prerequisits:
Fluid mechanics 1 (ANW122) , Thermodynamics 1 (ANW116)

Contents - short:
Lectures on: fuel properties; basic mechanisms of combustion and flame propagation in mixtures of different fuels with air; dynamics of explosion development and suppression; problems of environmental pollution

Bibliography:
2) J. H.S. Lee: " The detonation phenomenon" Cambridge University Press, 2008;

Course results:
Completion of the course results in the knowledge in the domain of: fuel properties; mechanism of ignition and flame propagation; explosion development and suppression, environmental pollution

Grading criteria:
The subject is completed on the basis of the final written test

Detailed contents:
Basic properties of fuels and combustible mixtures; exploitation and processing of fossil fuels, bio-fuels, toxic properties of fuels and their combustion products, thermal and chain theory of self ignition; forced ignition; diffusion combustion-laminar and turbulent; kinetic combustion-laminar and turbulent; flame stabilization; mechanism of combustion of solid fuel particles and fuel droplets; combustion in technical
facilities - burners and combustion chambers, transition from deflagration to detonation, detonation combustion; explosion parameters of combustible mixtures; passive and active methods of explosion suppression.

Additional remarks (by course staff):
As the subject is of an interdisciplinary character and is not based on a particular text book, students participation in lectures is highly recommended. The students absent from the lectures usually find it later difficult to comprehend courses in physical- chemical phenomena presented during the lectures and definitely attain poorer results at subject completion.
SYLLABUS

Course name: Computer science 1
Course name in other language: CS1
Short name: CS1
Course number: ANW106
Course language: English
Responsible for the course: prof. dr hab. inż. Jacek Rokicki

ECTS: 5
Course level: basic
Form of grading: Continuous assessment

Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 2, 0, 2, 0, 0 ]
by semester: [ 30, 0, 30, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Study level: 1
Recommended semester: 1

Field of Study: Lotnictwo i Kosmonautyka
Field of Specialization: undergraduate, full time
Study level: 1
Recommended semester: 1

Field of Study: Mechanical Engineering
Field of Specialization: undergraduate, full time
Study level: 1
Recommended semester: 1

Field of Study: Mechanika i Budowa
Field of Specialization: undergraduate, full time
Study level: 1
Recommended semester: 1

Contents - short:
Basic ability to write, compile and run programs in the C language

Bibliography:

Grading criteria:
2 tests on theoretical part, work and progress of each student are evaluated in the framework of the point system, individual semester project.

Detailed contents:
Basic information related to operating systems and computer networks. Word-processing and spreadsheets used in typical engineering applications. Programming language C - variables and their types, arithmetical and logical operations, control statements, functions, tables and pointers, structures. Input and Output. Code examples. Basic algorithms (sorting), simple numerical methods. Practical programming skills.

Additional remarks (by course staff):
The laboratory groups can consist of at most 12 students
Course name: Computer science 2
Course name in other language: Informatyka 2
Short name: CS2
Course number: ANW114
Course language: English
Responsible for the course: prof. nzw. dr hab. inż. Jacek Szumbarski
ECTS: 2
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 1, 0, 1, 0, 0 ]
Form of grading: Continous assesment
by semester: [ 15, 0, 15, 0, 0 ]

Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka - undergraduate, full time 2
Lotnictwo i Kosmonautyka - undergraduate, full time 2
Mechanical Engineering - undergraduate, full time 2
Mechanika i Budowa - undergraduate, full time 2
Maszyn -

Prerequisites:
Calculus 1 (ANW102)

Contents - short:
Basic knowledge and practical skills in the area of numerical techniques applied to the problems like: post-processing of measurement data and numerical analysis of simple dynamical systems.

Bibliography:
1) Lecture notes provided by the course instructor.

Course results:
Basic theoretical knowledge in the elementary numerical methods such as polynomial and spline interpolation, polynomial approximation, root finding, numerical integration, solution of ordinary differential equations (Euler, Runge-Kutta methods) and linear algebraic systems (Gauss elimination and related methods)
Development of the programming skills in C language
Grading criteria:

2 tests on theoretical part, work and progress of each student are evaluated in the framework of the point system, individual semester project.

Detailed contents:

2. Least-squares approximation: formulation and geometrical interpretation, the method of normal equations, the method of orthogonal polynomials.
4. Numerical solution of initial-value problems for ordinary differential equations: transformation to the standard form, the Euler method and convergence analysis, single-step higher-order methods, the standard RK4 method, problem of the time step adaptation.
5. Cubic spline interpolation: formulation, end-point conditions, 3-diagonal systems and the Thomas algorithm.

Additional remarks (by course staff):

The laboratory groups can consist of at most 12 students.
# SYLLABUS

<table>
<thead>
<tr>
<th>Course name:</th>
<th>Control of Heat Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course name in other language:</td>
<td>CONTRHEAT</td>
</tr>
<tr>
<td>Short name:</td>
<td>ANS555</td>
</tr>
<tr>
<td>Course number:</td>
<td>English</td>
</tr>
<tr>
<td>Responsible for the course:</td>
<td>prof. dr hab. inż. Janusz Lewandowski</td>
</tr>
<tr>
<td>ECTS:</td>
<td>2</td>
</tr>
<tr>
<td>Course level:</td>
<td>Exam</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Number of hours: [ Lc, T, Lb, P, S ]</td>
</tr>
<tr>
<td></td>
<td>weekly: [ 2, 0, 0, 0, 0 ]</td>
</tr>
<tr>
<td></td>
<td>by semester: [ 30, 0, 0, 0, 0 ]</td>
</tr>
<tr>
<td>Field of Study:</td>
<td>Energetyka</td>
</tr>
<tr>
<td>Field of Specialization:</td>
<td>Power Engineering</td>
</tr>
<tr>
<td>Study level:</td>
<td>undergraduate, full time</td>
</tr>
<tr>
<td>Recommended semester:</td>
<td>6</td>
</tr>
</tbody>
</table>
### SYLLABUS

**Course name:** Economics  
**Course name in other language:** Ekonomia  
**Short name:** ECON  
**Course number:** ANW112  
**Course language:** English  
**Responsible for the course:** prof. dr hab. Janusz Gudowski  

**ECTS:** 2  
**Number of hours:**  
- weekly: [2, 0, 0, 0, 0]  
- by semester: [30, 0, 0, 0, 0]  

**Field of Study:**  
- Energetyka  
- Lotnictwo i Kosmonautyka  
- Mechanical Engineering  
- Mechanika i Budowa  
- Maszyn  

**Field of Specialization:**  
- undergraduate, full time  
- undergraduate, full time  
- undergraduate, full time  
- undergraduate, full time  

**Study level:** Recommended semester:  
- 2  
- 2  
- 2  
- 2

**Contents - short:**  
To learn fundamental economics  

**Bibliography:**  
1. P.A. Samuelson, W.D. Nordhaus, Introduction to economics (latest issue)  

**Course results:**  
After completing the course the students will be able to specify the rules of economic phenomena.  

**Grading criteria:**  
Test  

**Detailed contents:**  
Economics as the science. The sense of processes of production. The ideas of wealth and its sources.  
The sense of value. The essence of economic growth.  
Quantitative and qualitative aspects of economic growth. The level of life. The idea of development  
Notions: market-supply-demand; elasticities measures; types of goods, the theory of consumer  
Types of market; theory of competition; the state contribution to market economy  
Genesis of contemporary macroeconomics. The conflict between demand and neoliberal approach  
The essence of the main today’s schools of economics
SYLLABUS

Course name: Electric Circuits 1
Course name in other language: Elektrotechnika 1
Short name: ELCIR1
Course number: ANW113
Course language: English
Responsible for the course: prof. dr hab. inż. Tadeusz Skoczkowski
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 1, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 30, 15, 0, 0, 0 ]

Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka - undergraduate, full time 2
Lotnictwo i Kosmonautyka - undergraduate, full time 2
Mechanical Engineering - undergraduate, full time 2
Mechanika i Budowa - undergraduate, full time 2
Maszyn

Prerequisites:
Calculus 1 (ANW102), Calculus 2 (ANW90), Computer science 1 (ANW106)

Contents - short:
To be able to use fundamental laws of linear electric circuits to solve electric DC and AC circuits.
Know how to analyse electric circuits containing independent and dependent sources using loop and nodal techniques.
Know how to analyse electric circuits using additional techniques e.g. superposition, source transformation, Thevenin's and Norton's equivalent circuits.
To get familiar with calculation of electric power and energy in DC and AC electric circuits.
To be able to analyse first- and second order transient circuits.
To understand variable-frequency performance of basic elements, resonant circuits and passive filters.

Bibliography:
Further Readings:

Course results:
- Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing electric circuits.
- Ability to identify and formulate a problem related to electric circuits.
- Ability to apply the fundamental laws of electric circuit to compute basic electric quantities (current, voltage, powers).
- Ability to select a simple electrical component or system to meet desired engineering needs.

Grading criteria:
Two assessments + final exam

Detailed contents:

Course name: Electric Machines 1
Course name in other language: Maszyny Elektryczne 1
Short name: EMACH
Course number: ANK333
Course language: English
Responsible for the course: prof. dr hab. inż. Tadeusz Skoczkowski
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: intermediate
weekly: [ 1, 1, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 15, 15, 0, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 4
Prerequisites:
Electrical engineering (ANW113A) , Electronics 1 (ANW135)

Contents - short:
Knowledge and understanding of construction and principles of operation of transformers and rotating electric machines employed in industry.
Knowledge on speed control techniques of rotating electrical machines.
Understanding the principles of electric energy generators used in power stations.
Mastering the application of power electronics in supply of electric machines.

Bibliography:
Further Readings:
Course results:
General knowledge on transformers and electric machines used in industry. Ability to select transformer or electric machine to specific industrial purpose. Understanding basic electric drives with power electronic supply.

Grading criteria:
Two assessments + final exam

Detailed contents:
DC-to-AC converter with pulse-width modulation. DC-to-AC sine wave converter. DC-to-AC 3-phase converter.

SYLLABUS

Course name: Electric Machines II (lab)
Course name in other language: Maszyne elektryczne 2 (lab)
Short name: EMACH2
Course number: ANK442
Course language: English
Responsible for the course: prof. dr hab. inż. Tadeusz Skoczkowski

ECTS: 1
Course level: basic
Form of grading: Continuous assessment
Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 0, 0, 1, 0, 0 ]
by semester: [ 0, 0, 15, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 5

Prerequisites:
Electrical engineering (ANW113A), Electric Machines 1 (ANK333), Electronics 1 (ANW135)

Contents - short:
To get familiar with practical aspects of construction and principles of operation of transformers and rotating electric machines employed in industry.
To understand practical aspects of measurement of parameters and characteristics of electric machines.
To understand methods of speed control techniques of rotating electrical machines.

Bibliography:

Course results:
To be able to prepare theoretically and practically laboratory experiments.
To be able to carry out basic laboratory experiments on electrical machines.
To be able present experiment results in a written report.
To be able to analyze possible causes of discrepancy between theory and practice.
Grading criteria:
Tests after each laboratory unit

Detailed contents:

Experiment 1. Transformer Test

Experiment 2. DC Shunt Machine Test

Experiment 3. AC 3-phase AC Induction Ring Test

Experiment 4. Synchronous Machine Test

Experiment 5. Variable Speed Induction Motor Drive Test

Experiment 6. Variable Speed Industrial Drives Test
### SYLLABUS

**Course name:** Electric Power Systems  
**Course name in other language:** Przesyłanie energii elektrycznej i techniki zabezpieczeń 1  
**Short name:** EPS  
**Course number:** ANK381  
**Course language:** English  
**Responsible for the course:** prof. dr hab. inż. Tadeusz Skoczkowski  
**ECTS:** 5  
**Number of hours:**  
- Lc: 2  
- T: 1  
- Lb: 0  
- P: 0  
- S: 0  
**Course level:** intermediate  
**Form of grading:** Continuous assessment  
- weekly:  
  - Lc: 2  
  - T: 1  
  - Lb: 0  
  - P: 0  
  - S: 0  
- by semester:  
  - Lc: 30  
  - T: 15  
  - Lb: 0  
  - P: 0  
  - S: 0  

**Field of Study:** Energetyka  
**Field of Specialization:** Power Engineering  
**Study level:** undergraduate, full time  
**Recommended semester:** 4  

**Prerequisites:**  
Electrical engineering (ANW113A), Electronics 1 (ANW135)  

**Contents - short:**  
- To understand the conversion from primary energy sources to electric energy.  
- To understand the work of power generators in the power system.  
- To get familiar with the transmission and distribution networks and their basic components.  
- To understand the monitoring, co-ordination and control of electric power networks.  
- To understand the utilization of electric energy (industrial, commercial and residential loads).  
- To understand the principles of power system control (power, voltage, frequency).  
- To highlight future power system.  

**Bibliography:**  

**Course results:**  
- Ability to apply knowledge of basic electric circuit, power electronic and engineering to understand electric power networks.  
- Ability to understand the technologies of electric energy generation.  
- Ability to understand how electric energy is transmitted and distributed.  
- Ability to understand technical measures used to secure the reliable operation of electric power systems.
Ability to understand electricity market operation with limitations due to technical constraints.

Grading criteria:
Two tests + final assessment

Detailed contents:
Course name: Electric Power Systems 2 (lab)  
Course name in other language: Przesyłanie energii elektrycznej i technika zabezpieczeń 2 (lab)  
Short name: EPSYS2  
Course number: ANK329  
Course language: English  
Responsible for the course: prof. dr hab. inż. Tadeusz Skoczkowski  
ECTS: 3  
Number of hours: [ Lc, T, Lb, P, S ]  
Weekly: [ 0, 0, 2, 0, 0 ]  
Form of grading: Continuous assessment  
By semester: [ 0, 0, 30, 0, 0 ]  
Field of Study: Energetyka  
Field of Specialization: Power Engineering  
Study level: undergraduate, full time  
Recommended semester: 5  
Prerequisits:  
Electrical engineering (ANW113A) , Electric Power Systems (ANK381) , Electronics 1 (ANW135)  
Contents - short:  
To gain knowledge on construction, operation and maintenance of transmission and distribution networks.  
To get familiar with power network components and equipment.  
To understand practical methods of power and energy measurement in power systems.  
To understand reasons of faults and protection of electric power systems.  
To get familiar with programmable logic controllers used in industry.  
To obtain basic knowledge on utilization of electric energy and end-user requirements.  
To gain knowledge on numerical modelling of electric drives and load matching in electric drives.  
To gain practical knowledge on power factor correction.  
To get familiar with electric installations and equipment of wind power station.  
To get familiar with numerical modeling of power system (e.g. wind power station, small hydro power station).  
Bibliography:  
Further Readings:  
Course results:
- Ability to understand practical issues concerning construction, operation and maintenance of transmission and distribution networks.
- Ability to understand faults and methods of protection of electric power systems.
- Possession of knowledge on practical methods of power factor correction.
- Ability to understand methodology of load matching in electric drives.
- Familiarity of methods of numerical modeling of electric loads and power systems (electric drives, wind power station, small hydro power station).

Grading criteria:
- Tests after each laboratory unit.

Detailed contents:
- Numerical modeling of small hydro power station. Modeling of a Small Hydro Power Station.
SYLLABUS

Course name: Electric circuits 2
Course name in other language: Elektrotechnika 2
Short name: EC2
Course number: ANK317
Course language: English
Responsible for the course: prof. dr hab. inż. Tadeusz Skoczkowski
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic weekly: [ 0, 0, 2, 0, 0 ]
Form of grading: Continuous assessment by semester: [ 0, 0, 30, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 3
Prerequisites:
Electrical engineering (ANW113A), Electronics 1 (ANW135)

Contents - short:
Getting familiar with basic measurement methods – measurements of electrical values.
Investigation of fundamental 3-phase circuits and electric shock protection networks.
Study the relationship of fundamental electric circuits laws.
Learning the various methods of calculating electric power and energy.
Study the accuracy of electrical measuring instruments.
Getting familiar with typical measurements methods in electrical machines.
Learning the fundamentals of practical aspects of electrical machines.

Bibliography:

Grading criteria:
Successfully completion of all the laboratory experiments

Detailed contents:
   Methods of impedance measurement. Measurements with analog meters and digital multimeter.
Analogue oscilloscope. Digital oscilloscope. Data loggers. Measurements of resistance and reactance. Practical illustrations of voltage divider and current divider. Verification of voltage and current relations in star and delta connected systems. Observation of the wave shape of an alternating (sinusoidal) supply on CRO and to measure its phase, frequency, time period and amplitude. Work and applications of instrument transformers. Basic troubleshooting in electrical circuits.


Additional remarks (by course staff):
Person limit for one experiment is 3-4 students
Course name: Electronics 1  
Course name in other language: Elektronika 1  
Short name: ENICS1  
Course number: ANW135  
Course language: English  
Responsible for the course: prof. dr hab. inż. Tadeusz Skoczkowski  
ECTS: 2  
Number of hours: [Lc, T, Lb, P, S]  
Course level: intermediate  
Number of hours: [0, 0, 0]  
Form of grading: Continuous assessment  
Number of hours: [15, 15, 0, 0]  
Field of Study: Energetyka - undergraduate, full time  
Field of Specialization: undergraduate, full time  
Recommended semester: 4  
Prerequisites: Electrical engineering (ANW113A) , Engineering physics (ANW104)  
Contents - short:  
To obtain basic knowledge on analogue and digital electronic circuit.  
To understand the principle of operation, construction and characteristics of basic semiconductor devices.  
To learn the terminology of electronics.  
To understand the functions performed by typical analogue and digital components and circuits.  
To be able to analyse simple electronic circuit.  
To get familiar with troubleshooting in electronic circuits.  
To get familiar with manufacture’s specification sheets and application guidelines.  
Bibliography:  
Further Readings:  
3. EWB MultiSim Student Edition Lite v.10.  

Course results:
Ability to understand fundamentals, abilities and limits of modern electronics.
Ability to recognise and understand basic electronic circuits.
Ability to apply knowledge of electric circuit to analyse basic electronics circuits.
Ability to use manufacture’s documentation to select proper elements and circuits.
Ability to find faults in basic electronic circuits.

Grading criteria:
lesson quizzes +two tests + final assessment

Detailed contents:
ALOGUE

DIGITAL
2. Logic Gates. Inverter. AND Gate. OR Gate. NAND Gate. NOR Gate. Exclusive-OR and Exclusive-NOR.


SYLLABUS

Course name: Electronics 2 (lab)
Course name in other language: Elektronika II (lab)
Short name: ENICS2
Course number: ANK316
Course language: English
Responsible for the course: dr inż. Jan Szymczyk

ECTS: 1
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 0, 0, 1, 0, 0 ]
Form of grading: Continous assesment
by semester: [ 0, 0, 15, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full
time
Recommended semester: 4

Lotnictwo i Kosmonautyka

Field of Specialization: Aerospace Engineering
Study level: undergraduate, full
time
Recommended semester: 4

Prerequisits:
Electric Circuits 1 (ANW113) , Electric circuits 2 (ANK317) , Electronics 1 (ANW135)

Contents - short:
The aim of this course is to develop and practice the skills learned in Electronics I, demonstrate measurement methods and electronic devices in practice.

Bibliography:
5. Laboratory tutorial.

Course results:
After completing this course students will be able to specify basic electronic parameters, its interpretation and meanings and implement methods of measurement of electronics circuits

Grading criteria:
short tests before and after each exercise

Detailed contents:
transistor amplifiers, operational amplifier, sine wave oscillators, voltage stabilizers (direct current), impulse circuits, digital circuits, analogue-digital converters and digital-analogue converters.
## SYLLABUS

<table>
<thead>
<tr>
<th>Course name:</th>
<th>Energy Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course name in other language:</td>
<td>ENERMAN</td>
</tr>
<tr>
<td>Short name:</td>
<td>ANK443</td>
</tr>
<tr>
<td>Course number:</td>
<td>English</td>
</tr>
<tr>
<td>Course language:</td>
<td>dr inż. Paweł Skowroński</td>
</tr>
<tr>
<td>Responsible for the course:</td>
<td></td>
</tr>
<tr>
<td>ECTS:</td>
<td>2</td>
</tr>
<tr>
<td>Course level:</td>
<td>basic</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Exam</td>
</tr>
<tr>
<td>Number of hours:</td>
<td>[ Lc, T, Lb, P, S ]</td>
</tr>
<tr>
<td>weekly:</td>
<td>[ 1, 1, 0, 0, 0 ]</td>
</tr>
<tr>
<td>by semester:</td>
<td>[ 15, 15, 0, 0, 0 ]</td>
</tr>
<tr>
<td>Field of Study:</td>
<td>Energetyka</td>
</tr>
<tr>
<td>Field of Specialization:</td>
<td>Power Engineering</td>
</tr>
<tr>
<td>Study level:</td>
<td>undergraduate, full time</td>
</tr>
<tr>
<td>Recommended semester:</td>
<td>6</td>
</tr>
</tbody>
</table>

### Contents - short:
- Basic rules and conditions of energy management – including technical, economical and legal factors; (related to Polish conditions)

### Bibliography:
- Materials provided by lecturer

### Course results:
- Student understands a role of energy in economy, basic aspects of energy supply and final use, and principles of energy markets and possible regulations on energy activities.

### Grading criteria:
- final test

### Detailed contents:
- Primary energy sources – abundance and availability. Review of processes of: energy generation, conversion, transmission, distribution, storage, and final use – economic and environmental aspects.
- Energy carriers. Conventional processes of energy use – space heating, transport, driver, lightening, energy use in households, energy use in chosen industrial processes - total energy consumption, power demand, daily and seasonal variability, load factors. Basic and peak energy sources. SSM and DSM.
- Energy costs. Cost structure In generation, distribution, and energy turn-over. Cost division in cogeneration.
- Forecasting of domestic fuel and energy carriers demand and prices.
- Economic conditions of construction and operation of energy generation systems. Investment profitability indices. Least cost planning method.
Direct and cumulative energy consumption.
SYLLABUS

Course name: Energy Market
Course name in other language: Rynek Energii
Short name: ENERMAR
Course number: ANS625
Course language: English
Responsible for the course: dr hab. inż. Konrad Świrski

ECTS: 3

Number of hours: [ Lc, T, Lb, P, S ]
Weekly: [ 2, 0, 0, 0, 0 ]
By semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 7

Contents - short:
Knowledge about modern energy market and IT systems supporting electricity trading. Electricity market in Poland and Europe - energy pool, bilateral contracts, balancing markets. Emission allowances and trading. TPA (Third Party Access) in Poland and Europe. Prices and tariffs on the market. Calculation of profits due to electricity supplier exchange.

Bibliography:
Full materials (updated annually) available on http://energetyka.itc.pw.edu.pl/pe

Course results:
Knowledge of modern regulation of electricity market. Information about market structure, types of contracts, volumes and prices on the market. Possibility of evaluation of profits due to TPA supplier contract for individual and industrial consumers.

Grading criteria:
Point scoring methodology (individual work during lectures and final internet test) according to regulation available on http://energetyka.itc.pw.edu.pl/re

Detailed contents:
Course introduce to the problem of electricity market (trading) in Poland and with some aspects in other European countries. Wide description of electricity market regulation and current status of trade action is presented. Additionally, the course presents IT systems supporting electricity trading and simulation of the process from the point of view of wholesale trading companies and generating units – units, power plants, power corporations. Simulation of energy trading (pool, balancing market) processes. Base course curriculum as below:
1. Power system in Poland and Europe - information about power system in Poland and Europe, installed capacity, demand, forecast of changes toward 2030, investment process (new power plants), regulations (current and introduced in 2015-2020) affecting power sector
2. Electricity market fundamentals - the idea of liberalized electricity market, history of the markets, base regulations, wholesale and retailed market
3. Segments in electricity markets (volumes and prices)- detailed information about electricity market in Poland, how to trade electricity, historical data, how the market changed 2000-2010
4. Bilateral contracts (and simulation) - detailed description of bilateral contracts segment - regulation, volumes and prices, computer simulation (and negotiation) of bilateral contract
5. Energy Pool (and simulation)- detailed description of electricity pool - regulation, volumes and prices, computer simulation of energy pool
6. Balancing market (with simulation) - detailed description of balancing market segment - regulation, volumes and prices, computer simulation
7. Electricity price for consumers - system of retaile market, price tariffs, demand of electricity
8. TPA in Poland and Europe - Third Party Access regulation (possibility of changing energy supplier) - regulation in Poland and Europe, procedures to change supplier, simulation of profits
9. Forecasting - electricity forecasting - techniques and computer software, practical simulation of electricity demand forecasting (using linear models and time series methods)
10. Emission allowances and emission trading - european regulation regarding emission, impact of emission allowances on energy generation cost, new investment in energy sector fulfilling emission regulations
11. IT systems for electricity trading - computer system supporting electricity trading, overview of the systems at System Operator and other participants of electricity market - presentation and simulation
12. Poland and Europe - comparison of electricity markets, electricity pools - Nordpool, IPX

Additional remarks (by course staff):
All course info available on http://energetyka.itc.pw.edu.pl/re
**SYLLABUS**

Course name: Energy sources and conversion  
Course name in other language: ESAC  
Short name: ANS603  
Course language: English  
Responsible for the course: prof. dr hab. inż. Roman Domański  
ECTS: 2  
Number of hours:  
<table>
<thead>
<tr>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>course level: basic</th>
<th>weekly:</th>
<th>by semester:</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

Field of Study: Energetyka  
Field of Specialization: Power Engineering  
Study level: undergraduate, full time  
Recommended semester: 5  
Prerequisites:  
Fizyka 1 (ZNW135), Termodynamika (ZNW116)  

Contents - short:  
Teaching evaluation of energy storage and resources. Evaluation of implementation possibilities for new energy storage technologies, evaluation of environmental threats related to energy storage and conversion processes, feasibility of individual technologies of energy storage. Presenting new and future energy storage technologies for different energy sources.  

Bibliography:  

Course results:  
After passing the subject student will be able to analyze energy resources and storage systems, identify threats attributable to energy storage systems, carry out an energy balance for energy sources with energy storage, evaluate energy security of a system with storage, understand relation between the energy storage systems and renewable energy sources, understand needs for energy storage for all energy conversion processes, realize shortcomings of prospective energy storage technologies and limitations in their industrial implementation today.  

Grading criteria:  
60% multiple-choice test carried out at the end of the lectures, 40% homework grade.  
Own work:
Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

**Detailed contents:**


**Additional remarks (by course staff):**

Lecture based on Power Point presentations
SYLLABUS

Course name: Energy storage
Course name in other language: ESTO
Short name: ANS527
Course number: English
Course language:
Responsible for the course: prof. dr hab. inż. Roman Domański
ECTS: 2
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 0, 0, 0, 0 ]
Form of grading: Continous assesment
by semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 7

Prerequisites:
Heat transfer 1 (ANK423), Termodynamika (ZNW116)

Contents - short:
Teaching evaluation of energy storage and resources. Evaluation of implementation possibilities for new energy storage technologies, evaluation of environmental threats related to energy storage and conversion processes, feasibility of individual technologies of energy storage. Presenting new and future energy storage technologies for different energy sources.

Bibliography:
Materials for students placed on website

Course results:
After passing the subject student will be able to analyze energy resources and storage systems, identify threats attributable to energy storage systems, carry out an energy balance for energy sources with energy storage, evaluate energy security of a system with storage, understand relation between the energy storage systems and renewable energy sources, understand needs for energy storage for all energy conversion processes, realize shortcomings of prospective energy storage technologies and limitations in their industrial implementation today.

Grading criteria:
60% multiple-choice test carried out at the end of the lectures, 40% homework grade.
Own work:
Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

Detailed contents:  
Basic terms related to energy conversion processes. World’s energy resources (organic fossil fuels, nuclear fuels, renewable sources). The basic parameters for energy storage. Energy conversion efficiency for selected processes and devices. Issues of energy accumulation in various forms. Possibility of energy storage. Thermal energy storage, (long and short term – heat storage tanks, ground storage, PCM storage), mechanical energy storage (flywheels). CAES energy storage systems for power plants, industry and air weapons. Hydrogen as an energy carrier, hydrogen production and storage. Fuel cells as energy storage and conversion system. Hydro storage power plant. Electrical energy storage (batteries, capacitors, super capacitors, electromagnetic systems, superconducting magnetic energy storage (SMES)). Examples of energy storage systems. Efficiency of energy storage in different forms. Increase of energy conversion efficiencies by introducing the energy storage.

Additional remarks (by course staff):  
Lecture based on Power Point presentations
SYLLABUS

Course name: Energy systems
Course name in other language: ENERSYS
Short name: ANK390
Course number: ANK390
Course language: English
Responsible for the course: dr inż. Paweł Skowroński
ECTS: 3
Course level: basic
Number of hours: [ Lc, T, Lb, P, S ]
Form of grading: Continous assesment
by semester: [ 15, 15, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 5

Contents - short:
System-like feature of power industry. Creation and operation of power systems. Chosen energy system characteristic. Methods and goals of mathematical modeling of energy systems.

Bibliography:
Materials provided by lecturer
Additional e.g:

Course results:
Student is able to make an analysis and synthesis of simpler energy systems, and develop simplified mathematical models of the systems (steady state).
Student knows structure and rules of operation of domestic energy systems.

Grading criteria:
final test

Detailed contents:
Chosen topics of general system theory. Basic energy and technological processes. Features and structures of big energy systems.
Rules of energy systems creation/development.
Goals and methods (chosen) of mathematical modeling of energy systems. Examples of solution of simulation and optimization of energy systems.
Polish power system, Polish gas system, local municipal heating systems, chosen power stations – as electricity generation systems, and heat generation plant – structure, elements, internal relations, internal system constraints, load variability, development planning.
Course name: Engineering Diploma Seminar
Course name in other language: Seminarium dyplomowe inżynierskie
Short name: EDS
Course number: ANW128
Course language: English
Responsible for the course: prof. dr hab. inż. Paweł Pyrzanowski

ECTS: 2
Course level: advanced
Form of grading: Exam
Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 0, 0, 0, 2, 0 ]
by semester: [ 0, 0, 0, 30, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 7

Field of Study: Lotnictwo i Kosmonautyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 7

Field of Study: Mechanical Engineering
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 7

Field of Study: Mechanika i Budowa
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 7

Field of Study: Maszyn
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 7

Contents - short:
Gaining skills of information gathering and its critical analysis; learning presentation skills.

Bibliography:
Books, textbooks, scientific journals, the Internet

Course results:
Gaining the ability of information gathering, and performing its critical assessment (especially concerning information obtained from the Internet). Learning how to prepare short and concise presentations and how to present in limited time. Learning how to defend a thesis in front of an audience.

Grading criteria:
The elements that are subject to evaluation include: the quality of collected information, quality of elaborated analysis, especially the critical discussion of collected data, and quality of the given presentation. It is recommended that the presentation is conducted during a student group meeting, and the students should contribute to its evaluation.

Detailed contents:
It is recommended that the subject is completed in two steps:
1. Collecting materials on the given subject with the aid of all available information sources: including books, textbooks, journals and the Internet. The collected material must be analysed and summarised in the form of a short report containing references to the literature sources used. This part should be
conducted under the supervision of the advisor and its progress must be controlled during individual meetings. An important part of this stage is a critical analysis of the collected material and its relation to the knowledge gained during studies. It is required to use both domestic and international source materials.

2. Work presentation. Results presentation must be performed in front of a bigger audience during a student group seminar. Each of the students will be given 10-15 minutes of presentation time, followed with questions stated by the seminar participants. This stage is considered preparation to the upcoming thesis defense.

Additional remarks (by course staff):
The seminar should be prepared under the supervision of a scientific supervisor. It must follow the engineering diploma thesis themes. The seminar should match the area of studies programme and specialisation.
SYLLABUS

Course name: Engineering Diploma Thesis
Course name in other language: Przygotowanie pracy dyplomowej inżynierskiej
Short name: EDT
Course number: ANW136
Course language: English
Responsible for the course: prof. dr hab. inż. Paweł Pyrzanowski

ECTS: 15
Number of hours: [ Lc, T, Lb, P, S ]
Course level: advanced
weekly: [ 0, 0, 0, 12, 0 ]
Form of grading: Exam
by semester: [ 0, 0, 0, 180, 0 ]

Field of Study: Field of Specialization:
Energetyka - undergraduate, full time
Lotnictwo i Kosmonautyka - undergraduate, full time
Mechanical Engineering - undergraduate, full time
Mechanika i Budowa - undergraduate, full time
Maszyn -

Study level: Recommended semester:
undergraduate, full time 7

Contents - short:
Synthesis of engineering knowledge acquired during first degree studies. Gaining the ability of solving the given problem and preparing the report.

Bibliography:
Books, textbooks, scientific journals, the Internet

Course results:
Gaining the ability: - to solve the engineering problem, - perform selection of relevant literature, - choosing research methods, - presentation of obtained results and its critical analysis.

Grading criteria:
The promoter and reviewer verify the realisation of task given to the student, they fill out the thesis assessment forms. With positive evaluation the student is permitted to diploma defence, the final grade is decided by the commission.

Detailed contents:
Detailed contents depend on the topic and the nature of work (design-prototyping, computational, experimental).
Additional remarks (by course staff):
The scope of work is terms to consultation between the student and his individual supervisor. The topic must be consistent with study programme and specialisation.
The elaborated thesis report is evaluated. The student is permitted to attend the diploma exam (and the diploma defence) if he/she completed the required study programme and the other requirements specified in study regulations are fulfilled.
## SYLLABUS

**Course name:** Engineering graphics  
**Course name in other language:** Grafika inżynierska  
**Short name:** ENGRA  
**Course number:** ANW105  
**Course language:** English  
**Responsible for the course:** dr inż. Witold Mirski  
**ECTS:** 2  
**Number of hours:**  
<table>
<thead>
<tr>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Course level:** basic  
**Form of grading:** Continous assessment  
**Number of hours by semester:**  
| 15 | 0 | 15 | 0 | 0 |  

**Field of Study:**  
**Field of Specialization:**  
**Study level:** Recommended semester:  
- Energetyka - undergraduate, full time 1  
- Lotnictwo i Kosmonautyka - undergraduate, full time 1  
- Mechanical Engineering - undergraduate, full time 1  
- Mechanika i Budowa - undergraduate, full time 1  
- Maszyn -  

**Contents - short:**  
Creating the orthogonal projection of spatial geometrical forms onto adequate plane of projection. Learning of the spatial imagination.

**Bibliography:**  

**Course results:**  
Getting the skill of rational use of space.

**Grading criteria:**  
Positive results of tests as well as home and class work.

**Detailed contents:**  
Basic information about the axonometric projection. Introduction to the descriptive geometry using the Monge’s method. Projection of such simple geometric elements as points, straight lines and planes. Their common elements. Spatial relationships between those elements. Auxiliary-view method. Projection of revolution. Projection of surfaces of basic geometric shapes: rectangular prisms, cylinders, cones and spheres (cross-sections and points of intersections, intersection lines. Creating of components of complex objects on the base of two-dimensional sketch using a Computer Aided Design three-dimensional system (3D-CAD).
Additional remarks (by course staff):

Two teachers for group of 26÷32 students (tutorial). Term of registration according to the dean’s information.
Course name: Engineering graphics - CAD 1
Course name in other language: Zapis Konstrukcji - CAD 1
Short name: EGCAD1
Course number: ANW118
Course language: English
Responsible for the course: dr inż. Witold Mirski
ECTS: 2
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 0, 0, 2, 0, 0 ]
Form of grading: Continous assessment
by semester: [ 0, 0, 30, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Recommended semester: 2
Course results:
Getting the skill of making the technical drawing of machine’s element according to the rules of International (ISO) and Polish Standards - drawing by hand and using the 2D-CAD system.

Bibliography:
3. International (ISO) and Polish Standards.

Prerequisits:
Engineering graphics (ANW105)

Contents - short:
Making views of machine’s element basing on the real object according to the rules of International Standards (ISO) and the technical drawing.

Detailed contents:
Introduction to the technical drawing. Part view and axonometric projection of machine’s element basing on the real object. Modification of the technical drawing. Technical drawing of assemblies and parts with

Additional remarks (by course staff):
Group of 12 students for one teacher. Term of registration according to the information of dean of faculty.
Course name: Engineering physics
Course name in other language: Fizyka inżynierska
Short name: EPHYS
Course number: ANW104
Course language: English
Responsible for the course: dr inż. Nikołaj Uzunow

ECTS: 3
Course level: basic
Form of grading: Continuous assessment
Number of hours: [ Lc, T, Lb, P, S ]
Weekly: [ 1, 2, 0, 0, 0 ]
By semester: [ 15, 30, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 1

Field of Study: Lotnictwo i Kosmonautyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 1

Field of Study: Mechanical Engineering
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 1

Field of Study: Mechanika i Budowa
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 1

Field of Study: Maszyn
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 1

Contents - short:
Recollection of the basic principles and laws of the fields of physics being most important regarding the programme of this Faculty: mechanics - mass, momentum, moment of momentum, and energy conservation laws in translatory and rotary motion; field theory - gravity field, electrostatic field, magnetic field; thermodynamics - intensive quantities, perfect gas, gas processes, extensive quantities, first law of thermodynamics, thermodynamic cycles, second law of thermodynamics; hydrodynamics - continuity law, Bernoulli equation.

Bibliography:

Course results:
Better preparation for the much more profound and complex courses on mechanics, electrotechnics, thermodynamics, and fluid dynamics in the next semesters.

Grading criteria:
Two tests: I – conservation laws, field theory; II - thermodynamics, hydrodynamics.
Both tests have to be passed. The final grade is an average of the grades obtained on the tests.

Detailed contents:
Lectures and exercises:
1. Basic physical quantities and SI measuring units; scalar and vector quantities; basic vector calculus.
2. Physical systems; fundamental interactions; modelling principles; Newton laws; curvilinear motion.
3. Momentum change law; momentum conservation law; moment of inertia; Steiner law; moment of momentum change law; moment of momentum conservation law. Engineering applications.
4. Kinetic energy in translatory and rotary motion; potential energy; conservative and dissipative forces; mechanical energy change law; mechanical energy conservation law. Engineering applications.
5. Gravity field: source quantity (mass), force, intensity (acceleration), flux, potential, energy. Engineering applications.
8. Intensive thermodynamic quantities; macroscopic (classical) and microscopic (statistical) approach; mass and molar approach; perfect gas model; Clapeyron equation; Dalton law. Engineering applications.
11. Hydrodynamics: compressibility; continuity law; Bernoulli equation. Engineering applications.
### SYLLABUS

**Course name:** English Language 1  
**Course name in other language:** LANG1  
**Short name:** ANJ1  
**Course number:**  
**Course language:** English  
**Responsible for the course:** mgr Tomasz Rączka  
**ECTS:** 2  
**Number of hours:**  
- **Course level:** basic  
- **Form of grading:** Continuous assessment  
- **weekly:** [0, 2, 0, 0, 0]  
- **by semester:** [0, 30, 0, 0, 0]  
**Field of Study:**  
- Energetyka  
- Lotnictwo i Kosmonautyka  
- Mechanical Engineering  
- Mechanika i Budowa Maszyn  
**Study level:** undergraduate, full time  
**Recommended semester:** 2

---

**Program Rozwojowy Politechniki Warszawskiej**

---

**UNIA EUROPEJSKA**

**FUNDUSZ SPOŁECZNY**

---

**KAPITAŁ LUDZKI**

**NARODOWA STRATEGIA SPÓJNOŚCI**

---

**FACULTY OF POWER AND AERONAUTICAL ENGINEERING**

**WARSAW UNIVERSITY OF TECHNOLOGY**

Nowowiejska 24, 00-665 Warsaw, POLAND, Room 125  
Phone: (+48) 22 621 5310, (+48) 22 234 7354  
Fax/Phone: (+48) 22 625 7351  
e-mail: dziekan@meil.pw.edu.pl

---

**Date:** 18.04.2011

---

**Wygenerowano z użyciem Verbis Dean's Office, www.verbis.pl**
## SYLLABUS

**Course name:** English Language 2  
**Course name in other language:** LANG2  
**Short name:** ANJ2  
**Course number:** ANJ2  
**Course language:** English  
**Responsible for the course:** mgr Tomasz Rączka  

ECTS: 2  
Course level: basic  
Form of grading: Continuous assessment  
Number of hours: 
- weekly: [ 0, 2, 0, 0, 0 ]  
- by semester: [ 0, 30, 0, 0, 0 ]  

Field of Study:  
<table>
<thead>
<tr>
<th>Field of Study</th>
<th>Field of Specialization</th>
<th>Study level:</th>
<th>Recommended semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energetyka</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>3</td>
</tr>
<tr>
<td>Lotnictwo i Kosmonautyka</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>3</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>3</td>
</tr>
<tr>
<td>Mechanika i Budowa Maszyn</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>3</td>
</tr>
</tbody>
</table>
### SYLLABUS

**Course name:** Environment protection  
**Course name in other language:**  
**Short name:** EPROT  
**Course number:** ANW109  
**Course language:** English  
**Responsible for the course:** dr inż. Piotr Krawczyk  

<table>
<thead>
<tr>
<th>ECTS:</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course level:</td>
<td>basic</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td>Number of hours:</td>
<td>[ Lc, T, Lb, P, S ]</td>
</tr>
<tr>
<td>weekly:</td>
<td>[ 2, 0, 0, 0, 0 ]</td>
</tr>
<tr>
<td>by semester:</td>
<td>[ 30, 0, 0, 0, 0 ]</td>
</tr>
</tbody>
</table>

**Field of Study:**  
- Energetyka  
- Lotnictwo i Kosmonautyka  
- Mechanical Engineering  
- Mechanika i Budowa  
- Maszyn

**Field of Specialization:**  
- undergraduate, full time

**Study level:**  
- Recommended semester: 1

**Contents - short:**  
Basic knowledge of the environment protection problems

**Bibliography:**  
No relevant issues

**Grading criteria:**  
The assessment is based on two tests, held in the middle and at the end of the semester. The tests consist of several questions to be answered. Students have to obtain positive grades on both tests. The final grade is calculated as an average from the two tests.

**Detailed contents:**  
SYLLABUS

Course name: Fluid mechanics 1
Course name in other language: Mechanika Płynów I
Short name: FLUMECH1
Course number: ANW122
Course language: English
Responsible for the course: prof. nzw. dr hab. inż. Jacek Szumbarski

ECTS: 4
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [2, 1, 0, 0, 0]
Form of grading: Exam
by semester: [30, 15, 0, 0, 0]

Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka - undergraduate, full time 3
Lotnictwo i Kosmonautyka - undergraduate, full time 3
Mechanical Engineering - undergraduate, full time 3
Mechanika i Budowa - undergraduate, full time 3
Maszyn

Prerequisites:
Calc. 1 (ANW102), Calculus 2 (ANW90), Mechanics 1 (ANW108)

Contents - short:
Basic concepts and theoretical constructs of the mechanics of continuum, summary of necessary mathematical tools.
Fluid statics: basic theory and engineering applications.
Fluid kinematics: description of fluid motion and deformation.
Fluid dynamics: stress in fluids, equations of motion, energy equation, Bernoulli equation, calculation of dynamic reactions, etc.
Selected models of fluid flow: flow in pipes, boundary layer.
Elementary introduction to turbulent flows.

Bibliography:
4. Lecture notes provided by the instructor (PDF slides)
Course results:
   Good knowledge of the fundamental concepts and principles of the Fluid Mechanics, skills in solving basic problems in fluid statics and dynamics of an ideal and viscous liquid.

Grading criteria:
   2 tests in the tutorial part + the final exam.

Detailed contents:
   1. Fluid as a continuous medium
   2. Elements of fluid statics: equilibrium equations and condition, manometers, fluid reaction on the solid walls, the Archimedes law.
   3. Fluid kinematics: Lagrangian and Eulerian descriptions, vector field of the fluid velocity, trajectories of fluid elements and streamlines, the streamfunction, vorticity and related theorems, tensor description of the fluid deformation.
   4. Principle of mass conservations and the continuity equation.
   5. Dynamics of continuum: tensor description of stress in fluid, the linear momentum principle and general equation of motion, the principle of angular momentum and the symmetry of the stress tensor.
   6. Viscous fluids: rheological model of the Newtonian fluid, Navier-Stokes Equation, problem of the boundary conditions, examples of analytical solutions.
   8. Integral form of the momentum principle and its application to determination of the reaction force exerted on immersed bodies. Aerodynamic coefficients.
   11. Introduction to the boundary layer theory: Prandtl’s equation, the layer thickness, The Blasius solution, integral von Karman equation, boundary layer separation.
   12. Elementary introduction to the theory of turbulent flows: physical characteristics of a turbulent flow, the laminar-turbulent transition, averaging procedure and the Reynolds Equations, the closure problem.
SYLLABUS

Course name: Fluid mechanics 2
Course name in other language: FLUMECH2
Short name: ANK340
Course number: English
Course language: mgr inż. Konrad Gumowski
Responsible for the course:
ECTS: 1
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 0, 0, 1, 0, 0 ]
Form of grading: Continous assesment
by semester: [ 0, 0, 15, 0, 0 ]
Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka Power Engineering undergraduate, full time 4
Mechanika i Budowa Maszyn Computer Aided Engineering undergraduate, full time 4
Prerequisits:
Fluid mechanics 1 (ANW122)

Contents - short:
Familiarizing students with basic knowledge of the physics of fluids, and basic measurements techniques.

Bibliography:

Course results:
After completing his course the students will be able to measure and specify: flow conditions, pressure gradients and aerodynamic forces.

Grading criteria:
Assessment method: e.g. 60% continuous assessment based on laboratory work, 40% exam
Practical work: e.g. Project/laboratory classes, where students will design and implement a simple measurements of flow conditions and parameters.

Detailed contents:
Measurement techniques for the flow-rate, velocity and pressure.
1) Thermo- and laser-anemometry.
2) Measurements of viscosity coefficient and hydraulic losses.
3) Flow visualisation techniques.
4) Pressure distribution and drag coefficient the on bluff bodies.
5) Aerodynamics coefficients on lifting surfaces.
## SYLLABUS

**Course name:** Fluid mechanics 3  
**Course name in other language:** Mechanika Płynów III  
**Short name:** FLUMECH3  
**Course number:** ANK341  
**Course language:** English  
**Responsible for the course:** prof. nzw. dr hab. inż. Jacek Szumbarski

### ECTS:
2

### Number of hours:
- [ Lc, T, Lb, P, S ]
- weekly: [ 1, 1, 0, 0, 0 ]
- by semester: [ 15, 15, 0, 0, 0 ]

### Form of grading:
Exam

### Field of Study:
Energetyka  
Mechanika i Budowa Maszyn

### Field of Specialization:
Power Engineering  
Computer Aided Engineering

### Study level:
undergraduate, full time  
undergraduate, full time

### Recommended semester:
4  
4

### Prerequisites:
Fluid mechanics 1 (ANW122)

### Contents - short:
To learn about essential concepts and theoretical methods of the compressible flow dynamics. To acquire practical skills in solving simple engineering problem in the one-and two-dimensional ideal gas dynamics.

### Bibliography:

### Course results:
After completing his course the students:
- should know the basic physical concepts and mathematical models of gas dynamics  
- can calculate various gas parameters in isentropic flows  
- can solve one-dimensional stationary flows with shock waves  
- can determine various forms of the gas flow inside the Laval nozzle  
- can solve simple one-dimensional gasdynamic problems with frictions or heat transfer  
- can solve simple one-dimensional unsteady problems using the method of characteristics and Riemann invariants  
- should know essentials about stationary two-dimensional gas flows

### Grading criteria:
2 tests during the course, final exam.
Detailed contents:

2. First integral of the energy equation, Crocco equation.
3. Dynamics of small disturbances, acoustic approximation, speed of sound and the Mach number.
4. Isentropic and adiabatic gas flow: basic relations, stagnation and critical parameters, examples of application.
5. The normal shock wave
6. Stationary motion of an ideal gas in the duct with variable section. The Laval nozzle.
7. Stationary motion of the gas in the presence of heat transfer.
8. Stationary motion of the gas through the duct with friction.
9. One dimensional unsteady motion of a compressible fluid, method of characteristics and Riemann invariants, simple waves and emergence of shocks, examples of application.
10. Two-dimensional potential flow.
11. Two-dimensional and stationary motion of the gas, an oblique shock wave.
**SYLLABUS**

Course name: Foreign Language 3  
Course name in other language: LANG3  
Short name: ANJ3  
Course language: English  
Responsible for the course: mgr Tomasz Rączka  
ECTS: 2  
Number of hours: [ Lc, T, Lb, P, S ]  
Course level: basic  
weekly: [ 0, 2, 0, 0, 0 ]  
Form of grading: Continous assesment  
by semester: [ 0, 30, 0, 0, 0 ]

Field of Study:  
Field of Specialization:  
Study level: Recommended semester:  
Energetyka - undergraduate, full time  
Lotnictwo i Kosmonautyka - undergraduate, full time  
Mechanical Engineering - undergraduate, full time  
Mechanika i Budowa - undergraduate, full time  
Mechanical Engineering - undergraduate, full time  

Date 18.04.2011
SYLLABUS

Course name: Foreign Language 4
Course name in other language: LANG4
Short name: ANJ4
Course language: English
Responsible for the course: mgr Tomasz Rączka

ECTS: 2
Course level: basic
Form of grading: Continuous assessment

Number of hours:
weekly: [0, 4, 0, 0, 0]
by semester: [0, 60, 0, 0, 0]

Field of Study: Energetyka -
Field of Specialization:
Study level: undergraduate, full time
Recommended semester: 5

Lotnictwo i Kosmonautyka -
undergraduate, full time
5

Mechanical Engineering -
undergraduate, full time
5

Mechanika i Budowa Maszyn -
dergraduate, full time
5
Course name: Foreign Language 5
Course name in other language: LANG5
Short name: ANJ5
Course number: English
Course language: mgr Tomasz Rączka
Responsible for the course: ECTS: 2
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 0, 4, 0, 0, 0 ]
Form of grading: Continous assesment
by semester: [ 0, 60, 0, 0, 0 ]
Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka - undergraduate, full time 6
Lotnictwo i Kosmonautyka - undergraduate, full time 6
Mechanical Engineering - undergraduate, full time 6
Mechanika i Budowa - undergraduate, full time 6
Maszyn -
Course name: Fundamentals of Management
Course name in other language: Podstawy zarządzania
Short name: FOM
Course number: ANK376
Course language: English
Responsible for the course: dr Sylwia Michalska

ECTS: 2
Course level: basic
Form of grading: Continuous assessment

Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 2, 0, 0, 0, 0 ]
by semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 4

Contents - short:
This course is a short presentation of the most important management theories and methods (like Taylorism, Fayolism etc). Students will also learn about groups - dynamic of groups, roles in groups, mechanisms of people’s communication, team building. They learn about different communication methods, specially in he situation of conflict (mediation, negotiation etc). We will discuss about the factors of motivation, effectiveness.

Bibliography:
Recommended texts (reading):
M. McKay, M. Davis, P. Fanning "Sztuka skutecznego porozumiewania się" GPW 2004
P. Hartley „Komunikacja w grupie” Zysk i s-ka 2000
T. Tyszka „Psychologiczne pułapki oceniania i podejmowania decyzji” GPW 1999
W. Stephan, C. Stephan, „Wywieranie wpływu przez grupy. Psychologia relacji” GPW 1999
P. Thompson "Sposoby komunikacji interpersonalnej" Zysk i s-ka 1998

Course results:
After completing his course the students will be able to recognize relation in groups, will be conscious, how to (better) communicate and cooperate with other people, will be able to (better) organize his (and others) work, making rational decisions.

Grading criteria:
test - open and closed questions about most basic aspect of theories and problems presented during the course.

Detailed contents:
Contents (lecture’s programme):
• What is management? - who can organize work of other people, what abilities we need, to work in groups.
• Why people cooperate? - dynamics of group, group roles, team building.
• Most important management theories - how the idea of management changed, why this change was necessary?
• Manager’s functions - what are the duties and competences of manager?
• Manager’s roles.
• Management of quality.
•Communication - how people communicate, problems with cultural differences.
•Manipulation - how can we avoid manipulation.
•Negotiations - positional, problematic, mediation - when, why and how?
•Effectiveness - what make people working good?
### SYLLABUS

**Course name:** Fundamentals of Operation and Maintenance  
**Course name in other language:** FOAM  
**Short name:** FOAM  
**Course number:** ANK364  
**Course language:** English  
**Responsible for the course:** dr hab. inż. Konrad Świrski  
**ECTS:** 5  
**Number of hours:** [ Lc, T, Lb, P, S ]  
**Course level:** basic  
**Form of grading:** Continuous assessment  
**by semester:** [ 30, 15, 0, 0, 0 ]

**Field of Study:** Energetyka  
**Field of Specialization:** Power Engineering  
**Study level:** undergraduate, full time  
**Recommended semester:** 5

**Contents - short:**  
Knowledge about Fundamentals of machinery operations and operations standards. Diagnostic and performance monitoring systems. Fundamentals of operation in power

**Bibliography:**  
Full materials available on http://energetyka.itc.pw.edu.pl/pe

**Course results:**  
Group work

**Grading criteria:**  
Point scoring methodology (individual work during lectures and final web test) according to regulation available on http://energetyka.itc.pw.edu.pl/pe

**Detailed contents:**  
Knowledge about Fundamentals of machinery operations and operations standards. Diagnostic and performance monitoring systems. IT systems supporting operation. Fundamentals of operation in power (with performance monitoring systems). Lectures supplemented with simulation and exercises utilizing industrial data

**Additional remarks (by course staff):**  
All course info available on http://energetyka.itc.pw.edu.pl/pe
Course name: Gas turbines and gas-steam systems
Course name in other language: GASTUR
Short name: ANS576
Course number: English
Course language: prof. dr hab. inż. Andrzej Miller
Responsible for the course:
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: advanced
weekly: [ 2, 0, 0, 0, 0 ]
Form of grading: Continuous assessment
by semester: [ 30, 0, 0, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 7

Contents - short:
Advance knowledge of gas turbine and gas-steam system selection for power system analyzed

Course results:
Advance knowledge of gas turbine and gas-steam system selection for power system analyzed.

Grading criteria:
Final test

Detailed contents:
Gas turbine and gas-steam system in power engineering – state of the art and future perspectives. Also design principles, parameters and performance including off-design ones

Additional remarks (by course staff):
All course info available on http://energetyka.itc.pw.edu.pl
## SYLLABUS

**Course name:** Health and Safety Training  
**Course name in other language:** HST  
**Short name:** ANW71  
**Course number:** ANW71  
**Course language:** English  
**Responsible for the course:** prof. dr hab. inż. Paweł Pyrzanowski  
**ECTS:** 0  
**Number of hours:**  
**Course level:** basic  
**Form of grading:** Continuous assessment  
**Number of hours:**  
**Field of Study:** Energetyka  
**Field of Specialization:** undergraduate, full time  
**Recommended semester:** 1  
**Field of Study:** Lotnictwo i Kosmonautyka  
**Field of Specialization:** undergraduate, full time  
**Recommended semester:** 1  
**Field of Study:** Mechanical Engineering  
**Field of Specialization:** undergraduate, full time  
**Recommended semester:** 1  
**Field of Study:** Mechanika i Budowa Maszyn  
**Field of Specialization:** undergraduate, full time  
**Recommended semester:** 1
SYLLABUS

Course name: Heat Pumps
Course name in other language: HEATPUMP
Short name: HEATPUMP
Course number: ANS540
Course language: English
Responsible for the course: prof. dr hab. inż. Roman Domański

ECTS: 2
Course level: basic
Form of grading: Continous assesment

Number of hours: [ Lc, T, Lb, P, S ]
Weekly: [ 1, 1, 0, 0, 0 ]
By semester: [ 15, 15, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 6

Prerequisites:
Termodynamika (ZNW116)

Contents - short:
Teaching evaluation of energy resources. General information about heat pumping technology. Evaluation of implementation possibilities for new heat pump technologies, evaluation of environmental threats related to heat pumps and energy conversion processes, feasibility of individual technologies of heat pumps. Presenting new and future heat pump technologies for different energy sources.

Bibliography:
Materials for students placed on website

Course results:
After passing the subject student will be able to analyze energy systems with heat pumps, understand needs for heat pump application, energy storage for all energy conversion processes, realize shortcomings of prospective heat pump technologies and limitations in their implementation today.

Grading criteria:
60% multiple-choice test carried out at the end of the lectures, 40% homework grade.
Own work:
Homework done in teams of 2-3. Subject and form of work (paper, calculations) determined at the beginning of a semester.

Detailed contents:
ground, solid state. Earth as an energy source. Ground heat exchangers. Thermal energy storage (long and short term – ground storage, PCM storage). Heat pump application systems. Reduction of CO2 emissions through the use of heat pump systems. Increase of energy conversion efficiencies by introducing heat pumps and energy storage.

Additional remarks (by course staff):
Lecture based on Power Point presentations
SYLLABUS

Course name: Heat transfer 1
Course name in other language: Wymiana Ciepła 1
Short name: HETRA1
Course number: ANK423
Course language: English
Responsible for the course: prof. dr hab. inż. Piotr Furmański

ECTS: 3
Course level: basic
Form of grading: Exam
Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 1, 1, 0, 0, 0 ]
by semester: [ 15, 15, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 3

Mechanika i Budowa Maszyn
Field of Study: Mechanika i Budowa Maszyn
Field of Specialization: Computer Aided Engineering
Study level: undergraduate, full time
Recommended semester: 5

Prerequisites:
Thermodynamics 1 (ANW116)

Contents - short:

Bibliography:
2) Materials for students placed on website

Course results:
Ability to solve simple problems in heat conduction, heat convection and thermal radiation.

Grading criteria:
2 tests, practical and theoretical exams, point system of evaluation

Detailed contents:
Lectures:
1. Basic and complex modes of heat transfer.
3. Transient heat conduction. Characteristic features of heat conduction for limiting values of Biot and Fourier similarity numbers.
5. Forced convection in internal and external flows.
6. Natural convection in channels, open and closed spaces.

Tutorials:
1. Temperature and heat transfer calculations for simple geometries of solids for heat conduction in steady state.
2. Temperature and heat transfer calculations for simple geometries of solids for heat conduction in transient state.
3. Determination of the convective heat transfer coefficient, heat flux and temperature distribution for nonisothermal internal flow of fluids.
4. Determination of the convective heat transfer coefficient and heat flux for nonisothermal external flow of fluids.
5. Determination of the convective heat transfer coefficient, heat flux for natural convection in open and closed spaces.
6. Determination of the convective heat transfer coefficient, heat flux and an amount of the new phase formed for condensation and boiling.
7. Calculation of radiative heat transfer between grey and diffuse surfaces.
SYLLABUS

Course name: Heat transfer 2
Course name in other language: Wymiana ciepła II
Short name: HETRA2
Course number: ANK424
Course language: English
Responsible for the course: prof. dr hab. inż. Tomasz Wiśniewski

ECTS: 1
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 0, 0, 1, 0, 0 ]
Form of grading: Continous assesment
by semester: [ 0, 0, 15, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 4

Prerequisits:
Heat transfer 1 (ANK423)

Contents - short:

Bibliography:

Course results:
Student is able to measure properly basic thermal properties of solids with use of Poensgen apparatus, DSC calorimeter and regular regime methods. Student is able to measure convective heat transfer coefficients and thermal contact resistance between solids.

Grading criteria:
final test

Detailed contents:
SYLLABUS

Course name: Intermediate Engineering Project
Course name in other language: Praca przejściowa inżynierska
Short name: IEPRO
Course number: ANW127
Course language: English
Responsible for the course: prof. dr hab. inż. Paweł Pyrzanowski
ECTS: 6
Number of hours: [ Lc, T, Lb, P, S ]
Course level: advanced
weekly: [ 0, 0, 0, 4, 0 ]
Form of grading: Exam
by semester: [ 0, 0, 0, 60, 0 ]

Field of Study: Energetyka - undergraduate, full time
Field of Specialization: undergraduate, full time
Study level: 6
Recommended semester: 6

Lotnictwo i Kosmonautyka - undergraduate, full time
Mechanical Engineering - undergraduate, full time
Mechanika i Budowa - undergraduate, full time
Maszyn

Contents - short:
Solution of a given problem and the elaboration of a short report on the subject of performed work.

Bibliography:
Books and textbooks, scientific journals, the Internet.

Course results:
Gaining the ability: to solve problems, perform selection of relevant literature, choosing research methods, presentation of obtained results and its critical analysis.

Grading criteria:
Evaluation criteria: problem statement, literature overview, problem solution and its written presentation.

Detailed contents:
Detailed contents depend on the topic and the nature of work (design-prototyping, computational, experimental).

Additional remarks (by course staff):
The scope of work is terms to consultation between the student and his individual supervisor. The topic must be consistent with study programme and specialisation.
SYLLABUS

Course name: Internal Combustion Engines
Course name in other language: INTCOMENG
Short name: ANS549
Course language: English
Responsible for the course: prof. dr hab. inż. Andrzej Teodorczyk
ECTS: 2
Number of hours: Lc, T, Lb, P, S
weekly: 2, 0, 0, 0, 0
by semester: 30, 0, 0, 0, 0
Course level: basic
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 5
Prerequisites:
Thermodynamics 1 (ANW116)
Contents - short:
Fundamentals, operation and construction of Internal Combustion Engines. Calculations of basic engine parameters.
Bibliography:
Course results:
Students will be able to calculate basic parameters of ICE
Grading criteria:
Test at the end of the course (50%); 2 homework assignments (50%).
Final mark on the basis of sum of points from the test and assignments.
Detailed contents:
History of ICE; Types of engines; Prospects for ICE; Thermodynamic principles; Combustion and fuels; Spark ignition engines; Compression ignition engines; Induction and exhaust processes; Two stroke engines; In-cylinder motion and turbulent combustion; Turbocharging; Mechanical design considerations; Calculation of engine cycles; Emissions
## SYLLABUS

### Course name:
Languages - C1_Egzam (English)

### Course name in other language:

### Short name:
EC1ANG

### Course number:
NJAC1

### Course language:
English

### Responsible for the course:
mgr Tomasz Rączka

### ECTS:
0

### Number of hours:
[ Lc, T, Lb, P, S ]

### Course level:
basic

### weekly:
[ 0, 0, 0, 0, 0 ]

### Form of grading:
Exam

### by semester:
[ 0, 0, 0, 0, 0 ]

### Field of Study:

<table>
<thead>
<tr>
<th>Field of Study</th>
<th>Field of Specialization</th>
<th>Study level</th>
<th>Recommended semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energetyka</td>
<td></td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
<tr>
<td>Lotnictwo i Kosmonautyka</td>
<td></td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td></td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
<tr>
<td>Mechanika i Budowa Maszyn</td>
<td></td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
</tbody>
</table>
## SYLLABUS

**Course name:**
Library Training

**Course name in other language:**

**Short name:**
LIBTRA

**Course number:**
ANW72

**Course language:**
English

**Responsible for the course:**
prof. dr hab. inż. Paweł Pyrzanowski

**ECTS:**
0

**Number of hours:**
[Lc, T, Lb, P, S]

**Course level:**
basic

**weekly:**
[0, 1, 0, 0, 0]

**Form of grading:**
Continuous assessment

**by semester:**
[0, 15, 0, 0, 0]

**Field of Study:**

<table>
<thead>
<tr>
<th>Field of Study</th>
<th>Field of Specialization</th>
<th>Study level</th>
<th>Recommended semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energetyka</td>
<td></td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>Lotnictwo i Kosmonautyka</td>
<td></td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td></td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>Mechanika i Budowa Maszyn</td>
<td></td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
</tbody>
</table>

**Date:** 18.04.2011

**Source:** Wygenerowano z użyciem Verbis Dean's Office, www.verbis.pl
SYLLABUS

Course name: Machine design 1
Course name in other language: Podstawy Konstrukcji Maszyn I
Short name: MDES1
Course number: ANW124
Course language: English
Responsible for the course: prof. dr hab. inż. Stanisław Bogdański
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 1, 1, 0, 0, 0 ]
Form of grading: Continuous assessment
by semester: [ 15, 15, 0, 0, 0 ]

Field of Study: Energetyka - undergraduate, full time
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 3
Recommended semester: 3

Prerequisites:
Algebra and geometry (ANW101), Calculus 1 (ANW102), Calculus 2 (ANW90), Computer science 1 (ANW106), Computer science 2 (ANW114), Engineering graphics (ANW105), Materials 1 (ANW107), Mechanics 1 (ANW108), Mechanics 2 (ANW115), Mechanics of structures 1 (ANW117), Thermodynamics 1 (ANW116)

Contents - short:
To gain an understanding of design philosophies and to learn how to incorporate into the process of design the earlier-studied principles of strength of materials, materials science, mechanics, etc. To learn the fundamentals of designing for static and fatigue loading with the use of simple machine elements (joints, fasteners, beams and shafts) as the examples

Bibliography:

Course results:
Understanding of design philosophies and ability to incorporate into the process of design the earlier-studied principles of strength of materials, materials science, mechanics, etc. Knowledge and ability to apply in practice the fundamentals of designing for static and fatigue loading with the use of simple
machine elements (joints, screws and fasteners, preloaded bolts under static and dynamic loadings, beams and shafts) as the examples.

Grading criteria:
The basic points of regulations associated with grading are as follows:
1. Only the student who is registered for this course can complete it.
2. The presence at the lectures and tutorials of the course is obligatory and checked.
3. Basically, in order to complete the course one has to get positive grades from all three regular tests held during the course. However, the student who has got at least one positive grade from these tests has also a chance to complete the course by taking an additional test called "the improvement test".
4. "The improvement test" is organized once at the end of the semester. This test covers the whole material of the course.
5. In extraordinary cases the Head of the Fundamentals of Machine Design Department makes the decision concerning completing the course.
The final grade for the course is determined on the basis of the continuous assessment i.e. the results from the regular and/or the improvement tests.

see: http://itlims.meil.pw.edu.pl/zpk/dla_studentow/regulaminy/machine_design_1.pdf

Detailed contents:
Introduction to design: design process, problem formulation and calculation, experimental tests, the engineering model, factors of safety and design codes, patents and standards, safety regulations, limiting conditions, optimization and evaluation criteria.
Static failure theories - short reminder.
Fatigue failure theories:
Mechanisms of fatigue failure (crack initiation and propagation stages, fracture), fatigue failure models (fatigue regimes, the stress-life and the strain-live approaches, the LEFM approach), fatigue loads (rotating machinery loading, service equipment loading), measuring fatigue failure criteria (fully reversed stresses, S-N curve, endurance limit, fatigue strength, combined mean and alternating stresses, Gerber line, Goodman line, fracture mechanics criteria, testing actual assemblies).
Estimating fatigue failure criteria [theoretical and corrected fatigue strength and endurance limit, correction factors (loading, size, surface, temperature, reliability, environment), estimated S-N curve].
Notches and stress concentrations (geometric and fatigue stress concentration factor, notch sensitivity).
Designing for high-cycle fatigue [designing for fully reversed and fluctuating stresses, creating the modified Goodman diagram, an augmented Goodman diagram, applying stress concentration effects with fluctuating stresses, determining the safety factor with fluctuating stresses (case 1 for independent variation of mean and alternating stresses, cases 2, 3 and 4 for constant: alternating stress, mean stress, ratio of alternating over mean stress)].
Modelling and calculations in selected areas of machine design:
Welded connections [fusion welding, fabrication by welding, types and forms of welds (butt, fillet, plug, transverse, longitudinal, skewed), stresses in welds (eccentrically loaded welds, weld centre of gravity and moment of inertia, direct and bending shear stresses)].
Riveted connections [typical applications, materials and types of rivets and methods of riveting, types of riveted joints (lap, single strap, butt), types of welded joints failure, stresses in rivets and riveted joints (shearing and bearing condition for rivets, plates and straps, tension in a plate and a strap, shearing of
edge of plate/strap, condition for equal loading capacity of plate and straps, gravity centre of joint, direct
and moment forces in joints with eccentric load)]. Cemented joints.
Screws and fasteners [standard thread forms and dimensions, power screws (square, acme, and buttress
threads, typical applications, force and torque analysis, friction coefficient, self locking and back driving,
efficiency, ball screws), stresses in threads (axial stress, shear stress, minimum nut length, torsional
stress), types of screw fasteners (classification by intended use, by thread type, by head style), nuts and
washers (lock nuts, lock washers, sems), manufacturing fasteners (thread cutting, thread rolling, head
forming).
Preloaded fasteners (preloaded bolts under static loading, bolt and clamped material stiffness, material
and bolts characteristic, joint constant, safety factor against separation and against yielding).
Preloaded fasteners under dynamic loading (mean and alternating stresses in a bolt, benefits of preload,
determining fatigue safety factor for the bolt with the use of the Goodman diagram), determining the joint
stiffness factor (confined and unconfined gaskets), controlling preload (torsional stress due to torquing of
bolts), fasteners in shear (bolted and doweled eccentrically loaded joints)].

Additional remarks (by course staff):
Standard registration procedure is required. Handouts are distributed during the course. Additional
materials (problems, supplements, etc) are displayed on the course website.
### Course Information

**Course name:** Machine design 2  
**Course name in other language:** Podstawy Konstrukcji Maszyn II  
**Short name:** MDES2  
**Course number:** ANW125  
**Course language:** English  
**Responsible for the course:** prof. dr hab. inż. Stanisław Bogdański  
**ECTS:** 3  
**Field of Study:** Energetyka - undergraduate, full time  
**Field of Specialization:** undergraduate, full time  

<table>
<thead>
<tr>
<th>Field of Study</th>
<th>Field of Specialization</th>
<th>Recommended semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energetyka</td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
<tr>
<td>Lotnictwo i Kosmonautyka</td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
<tr>
<td>Mechanika i Budowa</td>
<td>undergraduate, full time</td>
<td>4</td>
</tr>
</tbody>
</table>

**Prerequisites:**
- Computer methods in engineering analysis (ANK370), Engineering graphics - CAD 2 (ANK431),  
  Machine design 1 (ANW124), Manufacturing technology 1 (ANK399), Mechanics of structures 2 (ANK427)  

**Contents - short:**
To present methods of analysis and design of various important machine elements and sub-assemblies as well as to explain their role and way of functioning in machines and systems. To make an introduction to surface failure phenomena and to the tooth gears, belt and chain drives.

**Bibliography:**

**Course results:**
Completing this course should result in the following effects:
In the topic of springs and flexible elements students are expected to gain knowledge about the theory and types of springs as well as flexible elements, their typical features and applications, ways of operation, materials used for them, methods of modelling and analysis. Spring modelling and analysis for constant and variable loads and consequently determining dimensions are illustrated on tutorials with the use of typical examples. Hence, students should gain skill to calculate springs and design them for static
and dynamic loading conditions on their own. Designing flexible elements is illustrated on the example of cylindrical and block rubber cushioners.

Regarding surface failure, students are familiarised with the knowledge on main parameters of surface roughness geometry, theory of friction and wear, types of surface wear, theories of various types of concentrated contact, types and features of surface fatigue. Apart from theory, students are trained in determining the rate of abrasive wear and in calculating contact patch dimensions and contact stresses in contact couple members.

Grading criteria:
The basic points of regulations associated with grading are as follows:
1. Only the student who is registered for this course can complete it.
2. The presence at the lectures and tutorials of the course is obligatory and checked.
3. There are the two ways of completing the course:
a). The first way is by passing the exam, which is held during the examination session. The exam consists of two parts, theoretical (5 questions) and practical (3 problems). To pass the exam it is necessary to get positive grades from both parts.
b). The second way is by getting positive grades from all 3 tests held during the course. Moreover, the student who has got at least two positive grades from the tests has also a chance to complete the course by taking an additional test called "the improvement test".
4. "The improvement test" is organized once at the end of the semester. This test covers the whole material of the course.
5. In extraordinary cases the Head of the Fundamentals of Machine Design Department makes the decision about completing the course.
The final grade for the course is determined on the basis of the results of exam or the continuous assessment
i.e. the results from the regular and/or the improvement tests.
see: http://itlims.meil.pw.edu.pl/zpk/dla_studentow/regulaminy/machine_design_2.pdf

Detailed contents:
Springs and flexible elements: types and applications, materials used, modelling and analysis, spring index and rate, linear and non-linear spring characteristics, deflections and stresses, strength of wires used for springs, stress concentration factors, active number of coils, accumulated energy, spring ends, spring fixing and assembling, spring buckling, safety factors for springs, rubber and elastomeric cushioners, hysteresis of loading, dumping.
Surface failure: surface geometry, friction and wear, surface fatigue, spherical and cylindrical contact.
Machine sub-assemblies: sliding bearings-introduction to hydrodynamic lubrication theory, infinitely short and long bearing, load carrying capacity diagrams, design and materials used.
Rolling element bearings: types and classifications, selection- fatigue life, dynamic and static load rating, radial and combined loads, calculation procedures, bearing manufacturers catalogues, bearing mounting and sealing details, pairs of bearings, “O” and “X” bearing systems.
Shaft keys and couplings:-types of keys, stresses in key slots and stress concentration factors, calculation of keys, couplings classifications, types of rigid and compliant couplings, flexible couplings, torsional resonance of shaft and the role of torsionally flexible couplings, methods of avoiding the resonance
Clutches and brakes: selection and specification, materials;
friction clutches and brakes-disk, cone clutches and brakes, multidisc clutches, uniform pressure and uniform wear approach, drum brakes and clutches, band clutches and brakes, dynamics of friction clutch engagement, model and real diagram of engagements, role of spring in clutch adjusting, heat generation and balance;
overrunning and safety clutches.
Tooth gears, belt and chain drives; basic schemes, features, calculations and selection.

Additional remarks (by course staff):
Standard registration procedure is required. Handouts are distributed during the course. Additional materials (problems, supplements, etc) are displayed on the course website
**SYLLABUS**

Course name: Marketing (ang)
Course name in other language: Marketing
Short name: MKTANG
Course number: ANK332
Course language: English
Responsible for the course: mgr Justyna Ścibiorek

<table>
<thead>
<tr>
<th>ECTS:</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course level:</td>
<td>basic</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Continuous assessment</td>
</tr>
</tbody>
</table>

Number of hours: [ Lc, T, Lb, P, S ]
Weekly: [ 2, 0, 0, 0, 0 ]
By semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 5

Field of Study: Mechanika i Budowa Maszyn
Field of Specialization: Computer Aided Engineering
Study level: undergraduate, full time
Recommended semester: 7

Contents - short:

Celem przedmiotu jest przedstawienie podstaw i założeń marketingu oraz nabycie praktycznych umiejętności w zakresie stosowania mechanizmów, technik i narzędzi marketingowych. Studenci będą mieli możliwość zapoznania się z praktycznym zastosowaniem narzędzi marketingowych dzięki analizie przykładów ich zastosowania w firmach międzynarodowych.

Bibliography:
1. Ph. Kotler; "Marketing"; 2003
3. D. Aaker; "Building strong brands"; 2009
4. Źródła internetowe

Course results:

Umiejętność różnicowania narzędzi marketingowych. Zapoznanie z praktycznym zastosowaniem narzędzi marketingowych.

Grading criteria:

Obecność na zajęciach.
Uzyskanie pozytywnej oceny ze wszystkich ćwiczeń.
Projekt końcowy

Detailed contents:

Wykłady:
1. Basic marketing rules and instruments - Zapoznanie z podstawowymi instrumentami marketingowymi oraz zasadami. Wprowadzenie do teorii marketingu.
2. Strategic planning - Planowanie strategiczne przedstawione jako element komplementarny z narzędziami marketingowymi. Zastosowanie planowania strategicznego w planowaniu działań marketingowych.

3. Analyses of customer's market and his decisions - Analiza rynku konsumenta oraz faktorów wpływających na decyzje podejmowane przez konsumentów.


5. Competition strategies - Analiza konkurencji oraz strategie zdobywania rynku.

6. Brand and product strategy forming - Przedstawienie strategii kreowania wizerunku firmy, marki oraz nowego produktu na rynku.

7. Marketing Mix - Dokładne omówienie narzędzi marketingu mix z podziałem na narzędzia stosowane w firmach produkcyjnych oraz usługowych.

Ćwiczenia:

1. Analiza SWOT przedsiębiorstwa

2. Zastosowanie narzędzi marketingu mix w firmie Sanyo

3. Narzędzia marketingu mix - przykład restauracji

4. Wprowadzanie nowego produktu na rynek analiza przykładu z firmy Amway

5. Segmentacja rynku na przykładzie firmy Amway - studium przypadku

6. Analiza decyzji konsumentów na przykładzie firmy finansowej Zurich

7. Kreowanie wizerunku marki na rynku na przykładzie firmy Barclays - studium przypadku

8. Prezentacja projektów końcowych:
   - Factors influencing the decision to purchase products by consumers in the selected shopping mall
   - Creating corporate image - on the chosen example
   - Promotion Tools (fairs, exhibitions) in the industrial market
   - The role and functions of food packaging
   - An image of a women In advertising
   - Distribution of the product as a marketing tool for business
SYLLABUS

Course name: Materials 1
Course name in other language: MATS1
Short name: MATS1
Course number: ANW107
Course language: English
Responsible for the course: prof. dr hab. inż. Piotr Czarnocki
ECTS: 2
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 0, 0, 0, 0 ]
Form of grading: Continuous assessment
by semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester: 1

Lotnictwo i Kosmonautyka
undergraduate, full time
Study level: Recommended semester: 1

Mechanical Engineering
undergraduate, full time
Study level: Recommended semester: 1

Mechanika i Budowa
undergraduate, full time
Study level: Recommended semester: 1

Maszyn

Contents - short:
To gain fundamental engineering knowledge about various structures of engineering materials to be able to understand their mechanical properties

Bibliography:
1) Book 1: J.F. Shackelford, „Introduction to Material Science for Engineers”
2) Book 2: W. D. Callister Jr., “Materials Science and Engineering –An Introduction”
3) Documentation on http:// non
Further Readings:
- will be provided by lecturer

Course results:
After completing this course the students will have general knowledge about relations between the structure and mechanical properties of various engineering materials

Grading criteria:
100% assessment based on 4 tests
Practical work: non

Detailed contents:
Important mechanical properties of metals and polymers – definitions, measures and related most important tests. Background of material structure: crystal structures, defects and imperfections, polymer
SYLLABUS

Course name: Measurements and technique of experiment
Course name in other language: Miernictwo i techniki eksperymentu
Short name: MTE
Course number: ANK351
Course language: English
Responsible for the course: prof. dr hab. inż. Janusz Narkiewicz
ECTS: 2
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 1, 1, 0, 0, 0 ]
Form of grading: Continuous assessment
by semester: [ 15, 15, 0, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 4
Mechanika i Budowa Maszyn
Computer Aided Engineering
undergraduate, full time
4

Contents - short:
Basic terms of statistics illustrated by technical examples, foundamenetals of measurements data processing and analysis for static and time varying signals.

Bibliography:

Course results:
Understanding basic concepts of statistics. Ability to apply proper stochastic model for data processing and hypothesis testing.

Grading criteria:
Regular and control tests.

Detailed contents:
### SYLLABUS

**Course name:** Mechanics 1  
**Course name in other language:** MECHS1  
**Short name:** MECHS1  
**Course number:** ANW108  
**Course language:** English  
**Responsible for the course:** prof. dr hab. inż. Ryszard Maroński  
**ECTS:** 3  
**Number of hours:** [ Lc, T, Lb, P, S ]  
**Course level:** basic  
**Form of grading:** Continuous assessment  
**by semester:** [ 15, 15, 0, 0, 0 ]  
**Field of Study:** Energetyka - undergraduate, full time  
**Field of Specialization:** Lotnictwo i Kosmonautyka - undergraduate, full time  
**Study level:** Mechanical Engineering - undergraduate, full time  
**Recommended semester:** Mechanika i Budowa - undergraduate, full time  

**Contents - short:**  
To learn theory and numerical problems in Statics  

**Bibliography:**  
3. Any academic textbook (engineering course) on General Mechanics, part: Statics.  
For solving of problems, in addition to the above textbooks:  
2. Collection of problems in mechanics, in russian, and in polish as: J. Mieszczerski: “Zbiór zadań z mechaniki, PWN, many editions; solutions to this collection … in German (author Neuber H., VEB Verlag, Berlin 1962, 1963), and in Polish as: Romuald Romicki: “Rozwiązania zadań z mechaniki zbioru J. W. Mieszczerskiego”, PWN, many editions.  

**Course results:**  
After completing his course the students will be able to determine the loads of the statically determinate 3-D rigid constructions.
Grading criteria:
3 written tests during semester

Detailed contents:
Fundamental concepts and principles of statics. Equilibrium of a particle: forces in a plane and in a space. Equilibrium of a rigid body in two and three dimensions: external and internal forces, reactions and constrains, equivalent system of forces, moment of a force about a point and about an axis, reduction of a system of loads to one force and one couple (wrench). Statically determinate and indeterminate systems. Dry friction. Geometry of masses: centre of mass (gravity), areal and mass moments of inertia.
SYLLABUS

Course name: Mechanics 2  
Course name in other language: MECHS2  
Short name: MECHS2  
Course number: ANW115  
Course language: English  
Responsible for the course: prof. dr hab. inż. Ryszard Maroński

ECTS: 5  
Course level: basic  
Form of grading: Exam  
Number of hours: [ Lc, T, Lb, P, S ]  
weekly: [ 2, 2, 0, 0, 0 ]  
by semester: [ 30, 30, 0, 0, 0 ]

Field of Study: Energetyka  
Field of Specialization: undergraduate, full time  
Study level: Recommended semester: 2

Lotnictwo i Kosmonautyka  
Mechanical Engineering  
Mechanika i Budowa  
Maszyn

Prerequisites:  
Algebra z geometrią (NW101) , Analiza 1 (NW102)

Contents - short:  
To learn theory and numerical problems of Kinematics and Dynamics

Bibliography:  
3. Any academic textbook (engineering course) on General Mechanics, parts: Kinematics and Dynamics. For solving of problems, in addition to the above textbooks:  
1. Collection of problems in mechanics, in russian, and in polish as: J. Mieszczerski: "Zbiór zadań z mechaniki", PWN, many editions;solutions to this Collection … in German (author Neuber H., VEB Verlag, Berlin 1962, 1963), and in Polish as: Romuald Romicki: “Rozwiązania zadań z mechaniki zbioru J. W. Mieszczerskiego”, PWN, many editions.

Course results:  
After completing his course the students will be able to analyse the kinematics and dynamics of the translation, rotation about a fixed axis and planar motion of a rigid body.
Grading criteria:

3 written tests during semester, final written examination

Detailed contents:

Kinematics (Geometry of motion): equations of motion of a particle in various reference frames. Motions of a rigid body: translation; rotation about a fixed axis; plane motion, including motion of a particle relative to a moving frame.

Dynamics (Kinetics): dynamic equations of motion of a particle in various reference frames. Theorems about the rate of change of linear momentum, angular momentum, and energy of a particle, system of particles and a rigid body. Dynamic equations of translation, rotation about a fixed axis, and plane motion of a rigid body. Dynamic reactions in rotation about a fixed axis.
Course name: Mechanics of structures 1

Course number: ANW117

Course language: English

Responsible for the course: dr inż. Jakub Pawlicki

ECTS: 4

Number of hours: [ Lc, T, Lb, P, S ]

Course level: basic

Field of Study: Energy

Field of Specialization: undergraduate, full time

Recommended semester: 2

Field of Study: Aviation and Space Engineering

Field of Specialization: undergraduate, full time

Recommended semester: 2

Field of Study: Mechanical Engineering

Field of Specialization: undergraduate, full time

Recommended semester: 2

Field of Study: Mechanics and Building Machinery

Field of Specialization: undergraduate, full time

Recommended semester: 2

Prerequisites:
Mechanics 1 (ANW108)

Contents - short:
To learn fundamentals of deformable bodies mechanics: stress, strain, material behavior as an introduction to structural analysis and design for static loads. Presenting concepts of statical structural analysis: equilibrium conditions, stress-strain relation (Hooke’s law) and structure deformation. Develop knowledge for strength analysis of one-dimensional structures in basic load cases: tension-compression, torsion and bending.

Bibliography:
1) Roy Craig Jr. “Mechanics of Materials”
2) John Hearn “Mechanics of Structures”
3) Documentation on http://
Further Readings: - will be provided by lecturer

Course results:
After completing his course the students will be able to specify and implement statical equilibrium based methods to solve simple stress – deformation analysis problems for one dimensional structures.
Grading criteria:
tests, home works, examination

Detailed contents:
<table>
<thead>
<tr>
<th>Course name:</th>
<th>Physical Education and Sports 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course name in other language:</td>
<td>PES1</td>
</tr>
<tr>
<td>Short name:</td>
<td>ANWF1</td>
</tr>
<tr>
<td>Course number:</td>
<td>English</td>
</tr>
<tr>
<td>Responsible for the course:</td>
<td>mgr Bożena Gronek</td>
</tr>
<tr>
<td>ECTS:</td>
<td>0</td>
</tr>
<tr>
<td>Course level:</td>
<td>basic</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td>Number of hours:</td>
<td>[ Lc, T, Lb, P, S ]</td>
</tr>
<tr>
<td>weekly:</td>
<td>[ 0, 2, 0, 0, 0 ]</td>
</tr>
<tr>
<td>by semester:</td>
<td>[ 0, 30, 0, 0, 0 ]</td>
</tr>
<tr>
<td>Field of Study:</td>
<td>Field of Specialization:</td>
</tr>
<tr>
<td>Energetyka</td>
<td>-</td>
</tr>
<tr>
<td>Lotnictwo i Kosmonautyka</td>
<td>-</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>-</td>
</tr>
<tr>
<td>Mechanika i Budowa Maszyn</td>
<td>-</td>
</tr>
<tr>
<td>Study level:</td>
<td>Recommended semester:</td>
</tr>
<tr>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
</tbody>
</table>
SYLLABUS

Course name: Physical Education and Sports 2
Course name in other language: PES2
Short name: ANWF2
Course language: English
Responsible for the course: mgr Bożena Gronek
ECTS: 0
Number of hours: [ Lc, T, Lb, P, S ]
Weekly: [ 0, 2, 0, 0, 0 ]
Form of grading: Continous assesment
By semester: [ 0, 30, 0, 0, 0 ]
Course level: basic
Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Study level: Recommended semester:
Recommended semester:
Field of Specialization:
Mechanical Engineering - undergraduate, full time
Mechanika i Budowa Maszyn - undergraduate, full time
Lotnictwo i Kosmonautyka - undergraduate, full time
Lotnictwo i Kosmonautyka - undergraduate, full time
### SYLLABUS

**Course name:** Physical Education and Sports 3  
**Course name in other language:**  
**Short name:** PES3  
**Course number:** ANWF3  
**Course language:** English  
**Responsible for the course:** mgr Bożena Gronek  

<table>
<thead>
<tr>
<th>ECTS:</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course level:</td>
<td>basic</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td>Number of hours:</td>
<td>[ Lc, T, Lb, P, S ]</td>
</tr>
<tr>
<td>weekly:</td>
<td>[ 0, 2, 0, 0, 0 ]</td>
</tr>
<tr>
<td>by semester:</td>
<td>[ 0, 30, 0, 0, 0 ]</td>
</tr>
</tbody>
</table>

**Field of Study:**  
- **Energetyka**  
- **Lotnictwo i Kosmonautyka**  
- **Mechanical Engineering**  
- **Mechanika i Budowa Maszyn**  

**Field of Specialization:**  
- undergraduate, full time  
- undergraduate, full time  
- undergraduate, full time  
- undergraduate, full time  

**Study level:**  
- undergraduate, full time  
- undergraduate, full time  
- undergraduate, full time  
- undergraduate, full time  

**Recommended semester:**  
- 3  
- 3  
- 3  
- 3  

---

**Date:** 18.04.2011
# SYLLABUS

**Course name:** Physical Education and Sports 4  
**Short name:** PES4  
**Course number:** ANWF4  
**Course language:** English  
**Responsible for the course:** mgr Bożena Gronek  
**ECTS:** 0  
**Number of hours:** weekday: [Lc, T, Lb, P, S]  
**Course level:** basic  
**Weekly:** [0, 2, 0, 0, 0]  
**Form of grading:** Continuous assessment  
**By semester:** [0, 30, 0, 0, 0]  

**Field of Study:**  
**Field of Specialization:**  
**Study level:** Recommended semester:  
**Energetyka**  
-  
undergraduate, full time  
undergraduate, full time  
undergraduate, full time  
undergraduate, full time  
undergraduate, full time  
4  

**Lotnictwo i Kosmonautyka**  
-  
undergraduate, full time  
4  

**Mechanical Engineering**  
-  
undergraduate, full time  
4  

**Mechanika i Budowa Maszyn**  
-  
undergraduate, full time  
4
SYLLABUS

Course name: Physical Education and Sports 5
Course name in other language: PES5
Short name: ANWF5
Course language: English
Responsible for the course: mgr Bożena Gronek
ECTS: 0
Course level: basic
Form of grading: Continuous assessment
Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 0, 2, 0, 0, 0 ]
by semester: [ 0, 30, 0, 0, 0 ]

Field of Study: Field of Specialization: Study level: Recommended semester:

Energetyka - undergraduate, full time 5
Lotnictwo i Kosmonautyka - undergraduate, full time 5
Mechanical Engineering - undergraduate, full time 5
Mechanika i Budowa - undergraduate, full time 5
### Course Information

**Course name:** Physical Education and Sports 6  
**Course code:** ANWF6  
**Short name:** PES6  
**Course language:** English  
**Responsible for the course:** mgr Bożena Gronek  
**ECTS:** 0  
**Course level:** basic  
**Form of grading:** Continuous assessment  

<table>
<thead>
<tr>
<th>Study level</th>
<th>Recommended semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>undergraduate, full time</td>
<td>6</td>
</tr>
</tbody>
</table>

**Number of hours:**  
- weekly: [0, 2, 0, 0, 0]  
- by semester: [0, 30, 0, 0, 0]  

**Field of Study:**  
- Energetyka  
- Lotnictwo i Kosmonautyka  
- Mechanical Engineering  
- Mechanika i Budowa Maszyn
SYLLABUS

Course name: Physics 1
Course name in other language: PHYS1
Short name: ANW126
Course language: English
Responsible for the course: dr inż. Cezariusz Jastrzębski
ECTS: 3
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 0, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 30, 0, 0, 0, 0 ]
Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka - undergraduate, full time 6
Lotnictwo i Kosmonautyka - undergraduate, full time 6
Mechanical Engineering - undergraduate, full time 6
Mechanika i Budowa - undergraduate, full time 6
Maszyn

Contents - short:
The objective of the subject is to acquaint students with elements of modern physics especially quantum mechanics and to present its recent history, importance in general word perception and particularly its importance in physics, chemistry, modern electronics and materials science. Another objective is to teach students the skills of defining correctly area of physics and nanoscience where classical approach fails and quantum mechanical approach is needed to understand the physical phenomena.
The scope covered by the subject is basis of quantum mechanics and its applications in atomics physics, chemistry and materials science. Basic level skills of quantum mechanical problems solving complete the task.

Course results:
exam

Grading criteria:
To be decided later on the basis of availability of books, internet sources etc

Detailed contents:
Lecture 1
Fundamental assumptions of classical and quantum mechanics, where classical physics fails, blackbody radiation, Planck’s formula, de Broglie waves, optical spectra of light atoms, photoelectric effect.
Lecture 2

Lecture 3

Lecture 4

Lecture 5


Lecture 6

Lecture 7

Lecture 8
Quantum numbers in spherical coordinates, principal quantum number, magnetic (azimuthal) quantum number, spin quantum number. Magnetic effects on atomic spectra – the Zeeman effect. Energy levels on electrons in atom. Optical spectra and selection rules. The role of spin.

Lecture 9

Lecture 10

Lecture 11

Lecture 12

Lecture 13

Lecture 14
Analogy between optics and solid state physics. Optical constants-recall, wave equation and Schrödinger equation. Light in periodic structures. Photonic crystals. Energy gap in a crystal and in a photonic crystal. Lecture 15
### SYLLABUS

**Course name:** Polish Language 1  
**Course name in other language:** PLANG1  
**Short name:** ANPL1  
**Course language:** English  
**Responsible for the course:** mgr Marta Szpak  
**ECTS:** 0  
**Number of hours:**  
- **weekly:** [Lc, T, Lb, P, S]  
- **by semester:** [0, 30, 0, 0, 0]  
**Course level:** basic  
**Form of grading:** Continuous assessment  
**Field of Study:**  
<table>
<thead>
<tr>
<th>Field of Study</th>
<th>Field of Specialization</th>
<th>Study level:</th>
<th>Recommended semester:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energetyka</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>Lotnictwo i Kosmonautyka</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
<tr>
<td>Mechanika i Budowa Maszyn</td>
<td>-</td>
<td>undergraduate, full time</td>
<td>1</td>
</tr>
</tbody>
</table>
## SYLLABUS

**Course name:** Polish Language 2  
**Course name in other language:** PLANG2  
**Short name:** ANPL2  
**Course number:**  
**Course language:** English  
**Responsible for the course:** mgr Marta Szpak  
**ECTS:** 0  
**Number of hours:**  
- **Course level:** basic  
- **Form of grading:** Continuous assessment  
- **weekly:** [0, 2, 0, 0, 0]  
- **by semester:** [0, 30, 0, 0, 0]  

**Field of Study:**  
- **Energetyka**  
- **Lotnictwo i Kosmonautyka**  
- **Mechanical Engineering**  
- **Mechanika i Budowa Maszyn**  
**Field of Specialization:**  
-  
**Study level:** undergraduate, full time  
**Recommended semester:** 2
SYLLABUS

Course name: Power Engineering Machines and Systems 1 (lab)
Course name in other language: Laboratorium maszyn i urządzeń energetycznych 1
Short name: PEMS1LAB
Course number: ANS524
Course language: English
Responsible for the course: dr inż. Jerzy Kuta

ECTS: 2
Course level: basic
Form of grading: Continous assessment

Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 0, 2, 0, 0, 0 ]
by semester: [ 0, 30, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 6

Prerequisites:
Heat transfer 1 (ANK423) , Sensors and measurements systems (ANS511)

Contents - short:
Improving the energy efficiency, different ways of power equipment regulating, Knowledge about locations of various types energy losses.
Learning how to research and development characteristics of the equipment used in power generation

Bibliography:
catalogues of power equipment

Course results:
After completion of course knowledge about the influence of the parameters of pumps, fans, compressors and how they control for energy efficiency. Knowledge about formation place of various kinds of energy losses.

Grading criteria:
participation in exercises, written reports

Detailed contents:
flow meters, parameters measurement, ways of regulating pumps, compressors, fans, turbines, heaters, turbines, combustion engines, heat exchangers.
1 The operation of heat exchangers substation
2 Measurement of thermal conductivity of insulation.
3 Disposition of heat
4 EC Zeran - preparation of water
5 Examination of the ejector
6 Examination of working conditions of pump
7 Measurement of flow
8 Data Acquisition
9 Analysis of gases
SYLLABUS

Course name: Power Engineering Machines and systems II (lab)
Course name in other language: PEMS2LAB
Short name: ANS525
Course number: English
Course language: dr inż. Jerzy Kuta
Responsible for the course:

ECTS: 2
Course level: basic
Form of grading: Continuous assessment
Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 0, 0, 2, 0, 0 ]
by semester: [ 0, 0, 30, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 7

Contents - short:

Grading criteria:
participation in exercises, written reports

Detailed contents:
boilers and steam generators, turbines, heat exchangers, regulation and control, thermal measurements water technology, nuclear technology, HVAC systems (Heating, Ventilation, Air Conditioning)
## SYLLABUS

**Course name:** RES - Solar Engineering 1

**Course name in other language:**

**Short name:** SOLENG1

**Course number:** ANS516

**Course language:** English

**Responsible for the course:** prof. dr hab. inż. Dorota Chwieduk

**ECTS:** 2

**Number of hours:** [ Lc, T, Lb, P, S ]

**Course level:** basic

**Weekly:** [ 2, 0, 0, 0, 0 ]

**Form of grading:** Continuous assessment

**By semester:** [ 30, 0, 0, 0, 0 ]

**Field of Study:** Energetyka

**Field of Specialization:** Power Engineering

**Study level:** undergraduate, full time

**Recommended semester:** 6

**Prerequisits:**

Fizyka (DW001), Termodynamika (ZNK414), Wymiana ciepła 1 (NK423), Wymiana ciepła 2 (NK424)

**Contents - short:**

To learn fundamentals of solar energy: sky and solar radiation models, measurements, methods of conversion: thermal and photovoltaic and active and passive use of solar energy. To learn about designing of the solar energy self sufficient buildings, solar heating active and passive systems and photovoltaics systems. To learn how to evaluate availability of solar radiation, irradiation on surfaces with different orientation and inclination, type and size of solar systems. To get known how to determine the characteristics of solar active systems including its storage ability and dimensioning of solar systems and their elements. To plan the building concept from the energy point of view. To learn how to estimate energy efficiency and economic efficiency of solar systems. Recognizing of basic and auxiliary elements of solar systems. Review of domestic and commercial application to learn on selection of solar system type according to type and scale of the application, and energy and economic efficiency.

**Bibliography:**

7. Gordon J.: Solar energy the state of the art., ISES position papers, UK 2001

Course results:
Students get fundamental knowledge on solar energy (radiation) and practical information on applied devices and systems, what includes theory on systems operation, performance and characteristics, and technical data on the system elements, modes of operation and integration into domestic and commercial heating/cooling and power (electric) systems. After completing his course the students will be able to specify all elements of different types of solar systems, to select the type of the solar conversion method and the installation according to the user needs. They will be prepared to design and evaluate solar systems depending on the expected working conditions. Students could propose and plan solar heating/cooling system and its dimensioning and evaluate its performance. Students would be able to evaluate energy and economic efficiency of solar collectors and whole systems and their environmental impact. They would be able to implement modern idea of solar passive systems into building architectural and energy concept. They could develop practical solution for low energy buildings.

Grading criteria:
100% continuous assessment based on tests and final closing test

Practical work:
Visit to low energy building equipped with solar systems

Detailed contents:
SYLLABUS

Course name: RES - Solar Engineering 2 (Lab)
Course name in other language: 
Short name: SOLENG2LAB
Course number: ANS517
Course language: English
Responsible for the course: prof. dr hab. inż. Dorota Chwieduk
ECTS: 1
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 0, 0, 1, 0, 0 ]
Form of grading: Continuous assessment
by semester: [ 0, 0, 15, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 7

Prerequisites:
Wymiana ciepła 1 (NK423) , Wymiana ciepła 2 (NK424) , Wymiana ciepła 3 (NS590)

Contents - short:
To learn solar radiation measurement methods and test methods for solar collectors. To get experience in determination of energy performance of solar collectors - indoor conditions, under solar simulator. Review of optics and heat transfer phenomena and performance of different types of solar collectors. To measure flow and thermal parameters of solar systems during their operation. To learn how to determine energy performance of solar systems under operation and to predict characteristics of solar systems and compare them to select the best solar collector types ad modes of system operation for given conditions. To get experience in solar thermal application, including different modes of operation. To investigate thermal energy storage options (through specific heat and PCM – Phase Change Materials). To learn how to model energy balance of a solar system and calculate solar energy gains, useful solar energy input, energy stored and heating/cooling energy needs. To learn about planning renewable energy heating/cooling systems coupled with solar systems, integration of different energy sources in one energy system. To learn about simulation in solar process design, including design of active systems and passive and hybrid systems. To estimate costs of investment and running cost to determine economics of systems.

Bibliography:
Course results:
Students get practical knowledge on solar energy (radiation) measurements and testing of solar collectors and systems. They can evaluate effectiveness of operation of solar systems, energy performance and characteristics. They can select devices and equipment for solar active systems and integrate solar system into domestic and commercial heating/cooling systems. After completing this course the students will be able to select the solar system to be the most suitable to planned application, to energy heating/cooling needs and their distribution in time and climatic conditions. They will be able to calculate the solar energy fraction and auxiliary energy use for short time and throughout the year. They could specify all elements of solar systems, their type and size to assure their effective use. They could calculate the reduction in primary energy, greenhouses gas emission, and running costs. They can plan, design, and construct, test and control different types of solar systems. They can advise on improvement of energy efficiency and environment, and economic gains of heating/cooling systems. Students would be able to evaluate thermal energy use in buildings and to propose the upgrading of energy systems by applying solar energy. They would be able to develop solar passive solutions in buildings and implement modern energy effective methods into building concept during the design process and building/energy use.

Grading criteria:
100% continuous assessment based on theoretical, experimental and calculation tests (tasks). Practical work: Measurements and tests of solar radiation, solar collectors and solar systems under solar simulator and outdoor conditions. Monitoring and control of solar system operation in real conditions, measurements of thermal and flow parameters. Simulation exercises of solar systems operations. Visit to other solar laboratories, solar active and passive systems in operation.

Detailed contents:
# SYLLABUS

<table>
<thead>
<tr>
<th>Course name:</th>
<th>Rotodynamic Pumps and Pumping Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course name in other language:</td>
<td>Rotodynamic pumps and pumping systems</td>
</tr>
<tr>
<td>Short name:</td>
<td>RPPS</td>
</tr>
<tr>
<td>Course number:</td>
<td>ANS539</td>
</tr>
<tr>
<td>Course language:</td>
<td>English</td>
</tr>
<tr>
<td>Responsible for the course:</td>
<td>dr inż. Krzysztof Karaśkiewicz</td>
</tr>
<tr>
<td>ECTS:</td>
<td>2</td>
</tr>
<tr>
<td>Number of hours:</td>
<td>[ Lc, T, Lb, P, S ]</td>
</tr>
<tr>
<td>Course level:</td>
<td>basic</td>
</tr>
<tr>
<td>weekly:</td>
<td>[ 0, 2, 0, 0, 0 ]</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td>by semester:</td>
<td>[ 0, 30, 0, 0, 0 ]</td>
</tr>
<tr>
<td>Field of Study:</td>
<td>Energetyka</td>
</tr>
<tr>
<td>Field of Specialization:</td>
<td>Power Engineering</td>
</tr>
<tr>
<td>Study level:</td>
<td>undergraduate, full time</td>
</tr>
<tr>
<td>Recommended semester:</td>
<td>5</td>
</tr>
</tbody>
</table>

## Prerequisites:
Fluid mechanics 1 (ANW122), Fluid mechanics 2 (ANK340), Fluid mechanics 3 (ANK341)

## Contents - short:

## Bibliography:
2.) Impeller Pumps - S. Lazarkiewicz, A.T. Troskolanski - Elsevier

## Course results:
- Get acquainted with different types of pumps and principle of their operation
- Learn parameters of pumps and pumping systems
- Learn one dimensional flow theory of pumps. Euler equation, impact of impeller geometry on pump operation parameters
- Learn affinity laws for rotodynamic pumps
- Acquire basic design knowledge of pump impeller and other flow-through pump parts
- Learn about hydraulic forces acting on impeller and how to balance them
- Learn about cavitation in pumps and cavitation characteristics of pump and pumping system
- Get familiar with methods for regulating parameters of rotodynamic pumps
- Learn pump selection and operation
- Review pumps standards and certificates
Grading criteria:
homework and examination

Detailed contents:
Classification of pumps and applications, pump types, special pump types
Basic principles of pump and hydraulic elevator operation.
Characteristic parameters of pump and pumping systems, specific work and head of pump and pumping system, general characteristics of pumping systems
One dimensional flow theory of pumps, velocity triangles, Euler Equation for infinite blade number, specific work and head, flow deflection caused by the blades, slip factor.
Dimensionless coefficients, similarity laws and specific speed
Power balance and efficiencies, disk friction losses, leakage losses through annular seals, power loss caused by the inter-stage seal, leakage loss of radial or diagonal seals, leakage losses in open impellers, mechanical losses
Impact of impeller geometry on the pump performance.
Impeller and volute design.
Hydraulic thrust. Flow phenomena in the impeller sidewall gaps.
Axial thrust, General procedure for calculating axial thrust, Unsteady axial thrust, Axial thrust balancing.
Radial thrust, Radial thrust balancing, Radial thrust prediction
Cavitation. Growth and implosion of vapor bubbles in a flowing liquid. Cavitation in impeller or diffuser. Required NPSH, extent of cavitation, cavitation criteria. Scaling laws for cavitating flows. The suction specific speed. Experimental determination of the required NPSHR
Pump drivers and regulation.
Installation, Operation, and Maintenance
Life Cycle Costs for pumps and pumping systems.
Pumps standards and certificates.
Pump Testing
SYLLABUS

Course name: Steam Boilers
Course name in other language: STB
Short name: ANS521
Course number: English
Course language: dr inż. Wojciech Szwarc
Responsible for the course:

ECTS: 2
Course level: basic
Form of grading: Continous assesment

Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 1, 1, 0, 0, 0 ]
by semester: [ 15, 15, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 5
Course name: Technologies of Environmental Protection

Course name in other language: 

Short name: TEPROT

Course number: ANS566

Course language: English

Responsible for the course: prof. dr hab. inż. Krzysztof Badyda

ECTS: 2

Number of hours: [ Lc, T, Lb, P, S ]

Course level: basic

weekly: [ 2, 0, 0, 0, 0 ]

Form of grading: Continous asseessment

by semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Energetyka

Field of Specialization: Power Engineering

Study level: undergraduate, full time

Recommended semester: 6

Contents - short:
Knowledge about evaluation of main factors depending harmfully emissions from power generating installations, especially in the area of air protection. Knowledge of main technologies of environmental protection used in power generating industry.

Bibliography:
Materials for students placed on website

Course results:
After completing his course the students will be able to evaluate main factors depending harmfully emissions from power generating installations and will have knowledge about main technologies used to reduce dust, SOx, NOx, CO2 emissions

Grading criteria:
standard assessment methods: test and interview at the end of the semester, point system

Detailed contents:
Environment protection legal system and technical possibility of the requirements realization in power generating industry. Best Available Technologies (BAT). Overview of used today and future technologies to reduce emissions of dust, SOx, NOx and CO2. Primary (pre-combustion) and secondary (post-combustion) environmental technologies in power engineering. Typical solutions of waste utilisation used in power engineering.
Exercises: calculation of the harmfully emissions for different plants, reduction technologies. Evaluation of the results.
SYLLABUS

Course name: The Wittgenstein's Philosophy - Ethics
Course name in other language: Filozofia Ludwiga Wittgensteina
Short name: WITT
Course number: ANW103
Course language: English
Responsible for the course: prof. dr hab. Marek Maciejczak

ECTS: 2
Course level: basic
Form of grading: Continous assesment

Number of hours: [ Lc, T, Lb, P, S ]
weekly: [ 2, 0, 0, 0, 0 ]
by semester: [ 30, 0, 0, 0, 0 ]

Field of Study: Field of Specialization: Study level: Recommended semester:
Energetyka - undergraduate, full time 1
Lotnictwo i Kosmonautyka - undergraduate, full time 1
Mechanical Engineering - undergraduate, full time 1
Mechanika i Budowa - undergraduate, full time 1
Maszyn -

Contents - short:
The course on philosophy it is an introduction to analytical philosophy. Its scope is critique of language. To understand how language works means to know better the nature of thoughts, i.e. mind. Wittgenstein’s theory of linguistic meaning seems to be the eminent example of that current of thought. Besides of language, Wittgenstein’s ideas on Mathematics, Ethics, Religion and Society are taken into account.

Bibliography:

Course results:
After completing this course students should be able to work on their personal development by means of philosophical ideas.

Grading criteria:
There are 3 criteria: essay on chosen philosophical issues - presented and discussed in the class, presence on lectures nad taking part into discussion.

Detailed contents:
1. Introduction to philosophy
2. Wittgenstein - person and life
3. Tractatus logico-philosophicus on language
4. Ethics in Tractatus
5. Wittgenstein's experiences during the First World War
6. The lecture on Ethics
7. Examples of ethical problems
8. Anthropological method in philosophy
9. Language games, meaning as use
10. Religious beliefs
11. Culture and value
12-15 Students essays and discussions
# SYLLABUS

**Course name:** Theory of flow machines  
**Course name in other language:** Teoria Maszyn Przepływowych  
**Short name:** TFM  
**Course number:** ANK406  
**Course language:** English  
**Responsible for the course:** dr inż. Jarosław Milewski  
**ECTS:** 3  
**Number of hours:**  
**Course level:** basic  
**Form of grading:** Exam  
**Field of Study:** Energetyka  
**Field of Specialization:** Power Engineering  
**Study level:** undergraduate, full time  
**Recommended semester:** 4  

**Prerequisites:**  
Fluid mechanics 1 (ANW122), Fluid mechanics 3 (ANK341), Theory of heat machines (ANK405),  
Thermodynamics 1 (ANW116), Thermodynamics 3 (ANK413)  

**Contents - short:**  
Theory – to use both thermodynamic and fluid flow mechanic laws. The theory of the turbomachinery stage. Group of stages. The performance characteristics of the stage and group of stages. Dimensional analysis utilization. Experimental investigations – rules of results application in project workflow.  

**Bibliography:**  
Miller A. Teoria Maszyn Przepływowych. Wydawnictwa Politechniki Warszawskiej. 1982  

**Course results:**  
The knowledge about the turbomachinery characteristic, utilization and developing. Background about turbine stage project workflow.  

**Grading criteria:**  
Project realization and test.  

**Detailed contents:**  
1. Introduction  
2. Thermodynamic background  
3. Fluid Flow Machines background  
4. 1D theory of turbine stage  
5. Typical turbine stages  
6. 1D theory of compressor stage  
7. Discussion of the 1D theory  
8. Experimental investigation and theirs utilization in turbomachinery calculations
9. 3D flow in axial turbomachinery stage
10. Turbomachinery losses
# SYLLABUS

**Course name:** Theory of heat machines  
**Course name in other language:** TEHMACH  
**Short name:** ANK405  
**Course number:** ANK405  
**Course language:** English  
**Responsible for the course:** dr inż. Paweł Skowroński  
**ECTS:** 3  
**Number of hours:**  
<table>
<thead>
<tr>
<th>Lc</th>
<th>T</th>
<th>Lb</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
</table>
**Course level:** basic  
**Form of grading:** Exam  
**Weekly:**  
| 2 | 1 | 0 | 0 | 0 |  
**By semester:**  
| 30 | 15 | 0 | 0 | 0 |  

**Field of Study:**  
Energetyka  
Mechanika i Budowa Maszyn  
**Field of Specialization:**  
Power Engineering  
Computer Aided Engineering  
**Study level:** undergraduate, full time  
**Recommended semester:**  
3  
5
Course name: Thermal Power Stations
Course name in other language: TPS
Short name: ANS550
Course language: English
Responsible for the course: dr inż. Adam Smyk
ECTS: 2
Course level: basic
Form of grading: Continous assessment
Number of hours: [ Lc, T, Lb, P, S ] weekly: [ 2, 0, 0, 0, 0 ] by semester: [ 30, 0, 0, 0, 0 ]
Field of Study: Energetyka
Field of Specialization: Power Engineering
Study level: undergraduate, full time
Recommended semester: 6
Contents - short:
Familiarizing students with thermal, thermal-electric, gas and nuclear power stations. Introduction to real fuel cycle and water management. Presentation of electric energy costs and heat production calculations.
Bibliography:
Course results:
After completing this course students will be prepared to calculate the costs of energy production. They will be able to distinguish different types of power stations properly and evaluate their basic parameters: parameters of water, electric power, efficiency and specific fuel consumption. They will also know the methods of increasing the efficiency of such structures.
Grading criteria:
homework and final colloquium
Detailed contents:
Domestic and global energy and fuel resources. Local and worldwide requisition of electric energy and heat. Structure of primary energy sources. Power engineering and environment, TPS thermal cycle – structure and parameters. Conventional condensing power-stations (steam) and gas-steam power station, combined heat and power station (CHPS), nuclear power-stations. Fuel and water management at TPS. Costs of electric energy production at condensing power-stations. Investment and variable costs. Costs of heat production at combined heat and power station.
Course name: Thermodynamics 1
Course name in other language: Termodynamika 1
Short name: THERM1
Course number: ANW116
Course language: English
Responsible for the course: prof. dr hab. inż. Piotr Furmański
ECTS: 5
Number of hours: [ Lc, T, Lb, P, S ]
Course level: basic
weekly: [ 2, 2, 0, 0, 0 ]
Form of grading: Exam
by semester: [ 30, 30, 0, 0, 0 ]

Field of Study: Energetyka
Field of Specialization: undergraduate, full time
Recommended semester: 2

Prerequisites:
Analiza 1 (NW102)

Contents - short:
Knowledge of basic laws governing energy conversion. Ability to apply energy and entropy balances to analysis of different processes, in which simple substances take part. Ability to determine quality of different energy conversion processes. Knowledge of the fundamentals of thermodynamics applied to combustion processes.

Bibliography:
2) Materials for students placed on website

Course results:
To solve problems in energy conversion in different applications using laws of thermodynamics

Grading criteria:
4 tests, practical and theoretical exams, point system

Detailed contents:
Lecture:
1. Thermodynamic system and its properties, thermodynamic functions, irreversible and reversible transformations, microscopic and macroscopic energy, internal energy.
2. Energy interactions (work, heat, energy exchange accompanying mass flow). Enthalpy.
3. 1st Law of Thermodynamics for open system. Special cases (closed system, steady state, cycles). Thermal efficiency of engines and Coefficient of performance (COP) for refrigerators and heat pumps.

Tutorials:
1. Examples of thermodynamic analysis of processes based on the 1st Law of Thermodynamics.
2. Determination of a system state after transformations as well as amount and form of energy exchanged between the system and the surroundings.
3. Calculation of efficiency of different engine cycles and COP of refrigerators and heat pumps.
4. Examples of thermodynamic analysis based on the entropy balance.
5. Thermodynamic transformations in systems containing incompressible substances, vapours and perfect gases.
6. Determination of an amount of air needed for combustion, composition of combustion products and the maximum temperature of combustion.
Course name:
Thermodynamics 2 (lab)

Course name in other language:

Short name:
T2LAB

Course number:
ANK411

Course language:
English

Responsible for the course:
prof. dr hab. inż. Tomasz Wiśniewski

ECTS:
3

Number of hours:
[ Lc, T, Lb, P, S ]

Weekly:
[ 0, 0, 2, 0, 0 ]

Form of grading:
Continous assesment

by semester:
[ 0, 0, 30, 0, 0 ]

Field of Study:
Energetyka

Field of Specialization:
Power Engineering

Study level:
undergraduate, full time

Recommended semester:
3

Contents - short:
Practical demonstration of measurement devices and methods for basic thermodynamic parameters and properties. Measurement and calculation of energy balance components for typical technical devices (piston compressor, IC engine, air conditioner).

Bibliography:

Course results:
Student is able to measure properly temperature and pressure with use of different devices. Student is able to perform basic combustion gasses analysis and measure heating values of gaseous and solid fuels. Student can measure humid air properties. Student is able to make energy balance for piston compressor. IC engine and air conditioner.

Grading criteria:
Short tests after each exercise and final test

Detailed contents:
## SYLLABUS

**Course name:** Thermodynamics 3  
**Course name in other language:** Termodynamika 3  
**Short name:** THERM3  
**Course number:** ANK413  
**Course language:** English  
**Responsible for the course:** prof. dr hab. inż. Piotr Furmański

<table>
<thead>
<tr>
<th>ECTS:</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course level:</td>
<td>advanced</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Exam</td>
</tr>
<tr>
<td>Number of hours:</td>
<td>[ Lc, T, Lb, P, S ]</td>
</tr>
<tr>
<td>weekly:</td>
<td>[ 1, 1, 0, 0, 0 ]</td>
</tr>
<tr>
<td>by semester:</td>
<td>[ 15, 15, 0, 0, 0 ]</td>
</tr>
</tbody>
</table>

- Field of Study: Energetyka  
- Field of Specialization: Power Engineering  
- Study level: undergraduate, full time  
- Recommended semester: 3

### Prerequisites:

Thermodynamics 1 (ANW116)

### Contents - short:

Knowledge of the maximum (minimum) available work, basis of exergy analysis, determination of thermodynamic functions for multi-component systems including ideal mixtures. Thermodynamic transformation of moist gases. Thermodynamic equilibrium in multi-component systems, fundamentals of chemical thermodynamics and electrochemical reactions. Chemical equilibrium

### Bibliography:

3. Materials for students placed on website

### Course results:

After completing his course the students will be able to apply energy and exergy analysis to different processes in multi-component systems, to chemical and electrochemical reactions.

### Grading criteria:

2 tests, practical and theoretical exams, point system of evaluation

### Detailed contents:

Lecture:

2. Thermodynamic functions for multi-component systems.  
5. Thermodynamic equilibrium in multicomponent, multi-phase systems.
7. Chemically reacting systems.
8. The 3rd Law of Thermodynamics.
10. Chemical equilibrium and fundamentals of chemical kinetics.

Tutorials:
1. Examples of exergy analysis of processes in simple and multi-component systems.
2. Transformation of the moist air.
3. Thermodynamic basis of separation of components in multi-component mixtures.
4. Examples of application of chemical thermodynamics to batteries and fuel cells.
5. Analysis of influence of temperature and pressure on equilibrium of chemically reacting systems.
**SYLLABUS**

Course name: Turbines  
Course name in other language: TURBI  
Short name: ANS577  
Course language: English  
Responsibility for the course: dr inż. Jarosław Milewski

<table>
<thead>
<tr>
<th>ECTS:</th>
<th>2</th>
<th>Number of hours:</th>
<th>[ Lc, T, Lb, P, S ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course level:</td>
<td>basic</td>
<td>weekly:</td>
<td>[ 2, 0, 0, 0, 0 ]</td>
</tr>
<tr>
<td>Form of grading:</td>
<td>Continuous assessment</td>
<td>by semester:</td>
<td>[ 30, 0, 0, 0, 0 ]</td>
</tr>
</tbody>
</table>

Field of Study: Energetyka  
Field of Specialization: Power Engineering  
Study level: undergraduate, full time  
Recommended semester: 5