# SYLLABUS OF A MODULE

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| Polish name of a module | **Termodynamika** |
| English name of a module | **Thermodynamics** |
| ISCED classification - Code | 0715 |
| ISCED classification - Field of study | *Mechanics and metal trades* |
| Languages of instruction | *English* |
| Level of qualification: | *1 – BSc (EQF 6)* |
| Number of ECTS credit points | *6* |
| Examination: | *EW – exam written* |
| Available in semester: | *A – autumn only* |

## Number of hours per semester:

| Lecture | Tutorials | Laboratory | Seminar | E-learning | Project |
|---|---|---|---|---|---|
| 30 E | 15 | 15 | 0 | 0 | 0 |

## MODULE DESCRIPTION

### MODULE OBJECTIVES

O1. Understanding the fundamental energy conversion processes.
O2. Understanding and ability to use of the first and second law of thermodynamics.
O3.Understanding the pure substance properties and their mixtures.
O4.Understanding the thermodynamic cycles and cycles efficiency.

### PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge on the mathematical analysis
2. Capability to use various information sources, including technical manuals.
3. Capability of individual work.
4. Data analysis and presentation of results

### LEARNING OUTCOMES

LO 1 – Knowledge on fundamental energy conversion processes and thermodynamics laws

LO 2 – Knowledge on thermodynamic cycles and their efficiencies

LO 3 – Capability of thermodynamic cycles efficiency calculations

**MODULE CONTENT**

| **Type of classes – Lecture** | **Number of hours** |
|---|---|
| **Lec 1-2** - Basic concepts: nature of thermodynamics, system and control volumes, continuum concept, state and equilibrium, processes and cycles, temperature and zero$^{th}$ law of thermodynamics | **2** |
| **Lec 3-6** - Energy, energy transfer, general energy analysis: internal energy, heat transfer, work, first law of thermodynamics, energy conversion efficiency | **4** |
| **Lec 7-8** - Properties of pure substances: concept of a pure substance, phase-change processes, ideal gas, ideal gas equation of state, application of other state equations | **2** |
| **Lec 9-10** - Energy analysis of closed systems | **2** |
| **Lec 11-12** - Mass and energy analysis of control volume | **2** |
| **Lec 13-14** - Second law of Thermodynamics | **2** |
| **Lec 13-16** - Entropy and Exergy analysis | **4** |
| **Lec 17-18** - Maxwell relations, Gibbs and Helmholtz functions | **2** |
| **Lec 19-22** - Gas Power cycles | **4** |
| **Lec 23-26** - Gas mixtures, gas and vapour mixtures, Rankine cycle | **4** |
| **Lec 27-30** - Thermodynamics of chemical reactions: phase and chemical equilibrium | **4** |
| **Sum** | **30** |
| **Type of classes– Tutorials** | **Number of hours** |
| **Tut 1** - Basic concepts | **1** |
| **Tut 2-3** - Energy, energy transfer, general energy analysis: internal energy, heat transfer, work, first law of thermodynamics, energy conversion efficiency | **2** |
| **Tut 4-5** - Properties of pure substances: concept of a pure substance, phase-change processes, ideal gas, ideal gas equation of state, application of other state equations | **2** |
| **Tut 6 -7** - Energy analysis of closed systems and Mass and energy analysis of control volume | **2** |
| **Tut 8-9** - Second law of Thermodynamics, Entropy and exergy analysis | **2** |
| **Tut 10-11** - Gas Power cycles | **2** |
| **Tut 12-13** - Gas mixtures, gas and vapour mixtures | **2** |
| **Tut 14-15** - Thermodynamics of chemical reactions | **2** |
| **Sum** | **15** |
| **Type of classes– Laboratory** | **Number of hours** |
| **Lab 1-2** Measurement precision | **2** |
| **Lab 3-4** –Temperature measurements | **2** |
| **Lab 5-6** – Pressure measurements | **2** |
| **Lab 7-8** – Mass flow rate measurements | **2** |
| **Lab 9-10** – Specific heat capacity | **2** |
| **Lab 11-12** – Humidity measurements | **2** |
| **Lab 13-14** – Experimental determination of overall heat transfer coefficient | **2** |
| **Lab 15** – Density measurements | **1** |
| **Sum** | **15** |

**TEACHING TOOLS**

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|---|
| 1 - Lecture notes |
| 2 – Literature |
| 3 - Thermodynamics laboratory |

## WAYS OF ASSESSMENT ( F – FORMATIVE, S – SUMMATIVE

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| **F1. -** assessment of preparation for laboratory exercises |
| **F2. -** assessment of the ability to apply the acquired knowledge while doing the exercises |
| **F3. -** evaluation of reports on the implementation of exercises covered by the curriculum |
| **F4. -** assessment of activity during classes |
| **S1. -** assessment of the ability to solve the problems posed and the manner of presentation obtained results - pass mark * |
| **S2. -** assessment of mastery of the teaching material being the subject of the lecture - exam |

*) in order to receive a credit for the module, the student is obliged to attain a passing grade in all laboratory classes as well as in achievement tests.

## STUDENT'S WORKLOAD

| L.p. | Forms of activity | Average number of hours required for realization of activity |
|---|---|---|
| **1. Contact hours with teacher** | | |
| 1.1 | Lectures | 30 |
| 1.2 | Tutorials | 15 |
| 1.3 | Laboratory | 15 |
| 1.4 | Seminar | 0 |
| 1.5 | Project | 0 |
| 1.6 | Examination | 3 |
| | Total number of contact hours with teacher: | 68 |
| **2. Student's individual work** | | |
| 2.1 | Preparation for tutorials and tests | 25 |
| 2.2 | Preparation for laboratory exercises, writing reports on laboratories | 25 |
| 2.3 | Preparation of project | 0 |
| 2.4 | Preparation for final lecture assessment | 0 |
| 2.5 | Preparation for examination | 22 |
| 2.6 | Individual study of literature | 10 |
| | Total number of hours of student's individual work: | 82 |
| | Overall student's workload: | 150 |
| **Overall number of ECTS credits for the module** | | 6 ECTS |
| Number of ECTS points that student receives in classes requiring teacher's supervision: | | 2.52 ECTS |
| Number of **ECTS** credits acquired during practical classes including laboratory exercises and projects: | | 2.32 ECTS |

**BASIC AND SUPPLEMENTARY RESOURCE MATERIALS**


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|---|
| 1. Shavit A., Gutfinger C., Thermodynamics: From Concepts to Applications, CRC Press, 2008 |
| 2. Engel T., Reid P., Thermodynamics, Statistical Thermodynamics, & Kinetics, Benjamin Cummings, 2006 |
| 3. Janna W.S., Engineering Heat Transfer, Third Edition, CRC Press, 2009 |
| 4. Cengel, Y.A., Boles M.A., Thermodynamics, an engineering approach, 5th ed., New York, McGraw-Hill, 2006 |
| 5. Moran M.J., Shapiro H.D.: Fundamentals of engineering thermodynamics, John Wiley & Sons, 2000 |
| 6. R.E. Sonntag, C. Borgnakke, G.J. Van Wylen, Fundamentals of Thermodynamics, 6th Edition, John Wiley & Sons, 2003 |
| 7. Shavit A., Gutfinger C., Thermodynamics: From Concepts to Applications, CRC Press, 2008 |
| 8. Engel T., Reid P., Thermodynamics, Statistical Thermodynamics, & Kinetics, Benjamin Cummings, 2006 |


**MODULE COORDINATOR ( NAME, SURNAME, E-MAIL ADDRESS)**


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