SYLLABUS OF A MODULE

Polish name of a module	**Termodynamika obiegów cieplnych**
English name of a module	**Thermodynamic Cycles**
ISCED classification - Code	0715
ISCED classification - Field of study	*Mechanics and metal trades*
Languages of instruction	*English*
Level of qualification:	*2 – MSc (EQF 7)*
Number of ECTS credit points	*5*
Examination:	*EW – exam written*

Number of hours per semester:

Lecture	Exercises	Laboratory	Seminar	E-learning	Project
45	45	0	0	0	0

MODULE DESCRIPTION

MODULE OBJECTIVES

O1. Students know theory of thermodynamic cycles fundamentals.

O2. Students acquire skills in thermodynamic cycle calculations.

PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Fundamentals of mathematics and thermodynamics.
2. Fundamentals of thermal machinery principles.
3. Capability of using source literature.
4. Data analysis and presentation of results.

LEARNING OUTCOMES

LO 1 – The student possesses knowledge on thermodynamic cycles

LO 2 – The student possesses knowledge on fundamentals of thermal machinery

LO 3 – The student has ability to calculate various thermodynamic cycles.

MODULE CONTENT

Type of classes – lecture	**Number of hours**
Lec 1 – Introduction to thermodynamic cycles. Review of thermodynamics.	**3**
Lec 2 – Classification of thermodynamic cycles in thermal machinery. Energy balance. Thermodynamic parameters. Carnot cycle.	**3**
Lec 3 – Fundamentals of internal combustion engines. Real and theoretical thermodynamic process.	**3**
Lec 4 – Otto cycle. Diesel cycle. Sabathe-Seilinger cycle.	**3**
Lec 5 – Overexpanded cycle. Design and practical implementations.	**3**
Lec 6 - Fundamentals on modelling engine thermodynamic cycle with combustion process.	**3**
Lec 7 - Thermal machinery with external heat source. Stirling engine. Pros and cons.	**3**
Lec 8 – Gas turbines. Brayton cycle.	**3**
Lec 9 – Introduction to steam engines and steam turbines. Power systems applications.	**3**
Lec 10 - Fundamentals of Clausius-Rankine cycle. H-S and T-S diagrams.	**3**
Lec 11 - Secondary reheating and regenerative heating in the steam power plant.	**3**
Lec 12 – Waste heat recovery systems. Applications in use.	**3**
Lec 13 – Other machinery for heat and power generation. Renewable energy. Geothermal and solar systems. Nuclear power plants.	**3**
Lec 14 – Heat pumps. Refrigerators.	**3**
Lec 15 – Summarizing and conclusion on heat and power generation.	**3**
Sum	**45**
Type of classes – Tutorials.	**Number of hours**
Tut 1-2 – Introduction to several computational tools for thermodynamic calculations.	**6**
Tut 3 – Calculations and Carnot cycle analysis.	**3**
Tut 4 – Calculations and analysis of Otto cycle.	**3**
Tut 5 - Calculations and analysis of Diesel cycle.	**3**
Tut 6 – Calculations and analysis of Sabathe-Seilinger cycle.	**3**
Tut 7 - Calculations and analysis of overexpanded cycle.	**3**
Tut 8-9 – Modeling IC engine thermodynamic cycle based on the 0-D model for heat release.	**6**
Tut 9 - Calculations and analysis of the Stirling engine.	**3**
Tut 10-11 - Modelling Clausius-Rankine cycle and its analysis.	**6**
Tut 12-13 – Applying regenerative heating and secondary reheating to Clausius-Rankine cycle. Calculus and analysis of the cycle.	**6**
Tut 14 – Analysis of waste heat recovery systems applications to thermal machinery.	**3**
Tut 15 – Calculations of the heat pump thermodynamic cycle.	**3**
Sum	**45**

TEACHING TOOLS

1. – Lecture with the use of multimedia presentations
2. – Tutorials of thermodynamic cycles calculation
3. – Instructions to classes
4. – Own codes and commercial software

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

F1. - assessment of the ability to apply the acquired knowledge while doing the exercises
F2. - evaluation of reports on the implementation of exercises covered by the curriculum
F3. - 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 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	45
1.2	Tutorials	45
1.3	Laboratory	0
1.4	Seminar	0
1.5	Project	0
1.6	Consulting teacher during their duty hours	5
1.7	Examination	3
	Total number of contact hours with teacher:	98
2. Student's individual work		
2.1	Preparation for tutorials and tests	10
2.2	Preparation for laboratory exercises, writing reports on laboratories	0
2.3	Preparation of project	0
2.4	Preparation for final lecture assessment	0
2.5	Preparation for examination	10
2.6	Individual study of literature	7
	Total number of hours of student's individual work:	27
	Overall student's workload:	125
Overall number of ECTS credits for the module		5 ECTS
Number of ECTS points that student receives in classes requiring teacher's supervision:		3.92 ECTS
Number of **ECTS** credits acquired during practical classes including laboratory exercises and projects:		1.8 ECTS

BASIC AND SUPPLEMENTARY RESOURCE MATERIALS

1. Cengel Y, Boles M, Thermodynamics: An Engineering Approach, McGraw-Hill Education; 8 edition, 2014
2. Moran JN, Shapiro HN, Principles of Engineering Thermodynamics, John Wiley & Sons Inc, 2015
3. Mayhew Y, Rogers GFC, Mayhew YR, Engineering Thermodynamics : Work and Heat Transfer, Longman, Pearson Education Limited, 1996

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