SYLLABUS OF A MODULE

Polish name of a module	**Silniki cieplne**
English name of a module	**Thermal machines**
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	*6*
Examination:	*EW – exam written*
Available in semester:	*S – Spring only*

Number of hours per semester:

Lecture	Tutorial	Laboratory	Seminar	E-learning	Project
30E	0	30	0	0	0

MODULE DESCRIPTION

MODULE OBJECTIVES

O1. To introduce students with theoretical and practical knowledge in the field of rotating turbomachinery and piston machines, modelling and design basics.

O2. To acquire the practical skills in field of measurement and calculations related to the flow of the medium in heat machinery.

PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of the fundamentals of physics and mechanics.
2. Knowledge of thermodynamics and fluid mechanics.
3. Ability to select measurement methods and measurements.
4. Ability to use various sources of information, including manuals and technical documentation.
5. Ability to work independently and in a group.
6. Ability to correctly interpret and present their own activities.

LEARNING OUTCOMES

LO 1 – Knowledge of design of flow and piston machines.

LO 2 – Knowledge of flow phenomena in flow and piston machines.

LO 3 – Ability to perform measurements of physical quantities.

MODULE CONTENT

Type of classes – lecture	**Number of hours**
Lec 1 - Introduction. Definition of a volumetric and flow machine. Classification of flow and piston machines	**2**
Lec 2 - Dimensional Analysis. Similitude. The equation of fluid motion	**2**
Lec 3 - Velocity triangles in turbomachinery. Flow coefficients. Outline design of axial stages	**2**
Lec 4 - The overall performance and scaling of turbomachines	**2**
Lec 5 - Mean line analyses.	**2**
Lec 6 - Definition of efficiency. Mollier diagrams for turbine/compressor stage.	**2**
Lec 7 - Axial flow turbines and compressors.	**2**
Lec 8 - General aspects of radial turbomachines. Performance of radial turbomachines.	**2**
Lec 9 - Engine types, design and operation parameters.	**2**
Lec 10 - Ideal models of engine cycles: Otto, Diesel, Sabathe and Atkinson.	**2**
Lec 11- Combustion in spark ignitron engines.	**2**
Lec 12 - Combustion in compression ignitron engines.	**2**
Lec 13 - Pollutant formation and control.	**2**
Lec 14 - Engine operating characteristics.	**2**
Lec 15 - Engines powered by alternative fuels	**2**
Sum	**30**
Type of classes– laboratory	**Number of hours**
Lab 1 - Study of flow characteristics in the airfoil wake	**2**
Lab 2 - Determination of the profile flow loss in a simple blade cascade.	**2**
Lab 3 - Determination of the total flow loss in a simple blade cascade.	**2**
Lab 4 - Determination of aerodynamic characteristics of centrifugal fan	**2**
Lab 5 - Determination of aerodynamic characteristics of axial fan.	**2**
Lab 6 - Determination of characteristics of centrifugal water pump.	**2**
Lab 7 - Determination of replacement characteristics of two water pumps.	**3**
Lab 8 - Ideal models of internal combustion engine cycles.	**4**
Lab 9 - Indication of internal combustion engine	**4**
Lab 10 - Zero-dimensional model of engine cycle. Model validation.	**4**
Lab 11 - Investigation of engine with variable compression ratio.	**3**
Sum	**30**

TEACHING TOOLS

1. - lecture using multimedia presentations
2. - laboratory exercises, reports for laboratory exercises
3. - instructions for laboratory exercises
4. - measuring instruments
5. - test stands

WAYS OF ASSESSMENT (F – FORMATIVE, S – SUMMATIVE

F1. - assessment of preparation for laboratory exercises

F2. - assessment of the ability to apply of knowledge to perform exercises
F3. - assessment of exercise reports
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	0
1.3	Laboratory	30
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	20
2.2	Preparation for laboratory exercises, writing reports on laboratories	20
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	20
	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:		2.0 ECTS

BASIC AND SUPPLEMENTARY RESOURCE MATERIALS

1.	Dixon S.L., C.A. Hall, Fluid Mechanics and thermodynamics of turbomachinery, Elsevier, 2010…
2.	Wright T., Gerhart P.M., Fluid Machinery, Application, Selection and Design, CRC Press, Taylor & Francis Group, 2010
3.	Schobeiri, Meinhard T.: Turbomachinery Flow Physics and Dynamic Performance, Springer, 2012
4.	Heywood J.B., Internal combustion engines fundamentals. McGraw-Hill, Inc., 2018.
5.	Laboratory Manual of Gunt Hamburg demonstrators (pumps, axial and centrifugal fans)

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

Prof. dr hab. inż. Witold Elsner, elsner@imc.pcz.pl
Dr hab. inż. Wojciech Tutak, prof. PCz., tutak@imc.pcz.pl,