STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Heat Engineering	**1010101231010130905**

Field of study	Profile of study (general academic, practical)	Year /Semester
Environmental Engineering First-cycle Studies	**(brak)**	**2 / 3**

Elective path/specialty	Subject offered in:	Course (compulsory, elective)
-	**Polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
First-cycle studies	**full-time**

No. of hours				No. of credits
Lecture: **30**	Classes: **30**	Laboratory: **15**	Project/seminars: **-**	**6**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
(brak)	**(brak)**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**6 100%**

Responsible for subject / lecturer:

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Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Mathematics: basic algebra, functions, equations and inequalities, trigonometry, analitycal geometry, theory of basic probability, systems of equations, fundamentals of differential and integral calculus of one variable at a level 5KRK.
2	**Skills**	Analysis and solving of equations and systems of equations, mathematical formulation of engineering problems, solving of simple differential equations, aplication of integral calculus in heat engineering..
3	**Social competencies**	Awareness of the need of permanent updating and supplementing knowledge and engineering skills.

Assumptions and objectives of the course:

Gain by students basic knowledge and calculation skills in heat engineering necessary of solving fundamental and simple problems they can meet in the build and natural environmet.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Student knows physical properties characterizing gazes, liquids and solids, and understands their behaviour and knows their units. - [- K_W03]
2. Student has a general knowledge concerning heat engineering and heat flow. - [- K2_W03]
3. Student knows basic methods needed for solving basic problems concerning processes and equipment occuring in environmetal engineering. - [- K2_W03]
4. Student knows basic rules concerning energy balances and knows definitions of energy efficiency, heat effects and heat losses concerning equipment in environmental engineering. - [- K2_W03]
5. Student knows and understands the tendencies and development directions concerning heat equipment in environmental engineering. - [- K2_W03]

Skills:

1. Student can apply determine thermal properties needed for calculations. - [- K2_U01]
2. Student can find the needed relationships describing the discussed thermal problems. - [- K2_U01, K2_U013]
3. Student can recognized and solve simple design and operation problems conc. heat equipment. - [- K2_U01, K2_U013]
4. Student can assess the design solution and find a build and operated thermal equipment. - [- K2_U01]
5. Student can plan and realize a simple operating tests. - [- K2_U01, K2_U013]
6. Student can determine an accuracy of calculation and measurement results. - [- K2_U01, K2_U013]
7. Student can develop a general energy balance and determine thermal efficiency and heat losses of analysed equipment. - [- K2_U01, K2_U013]
8. Student can find and estimate literature data conc. analysed processes and equipment. - [- K2_U01, K2_U08, K2_09]

Social competencies:

1. Student is aware of the ranges and limits of the used relationships and methods in solving heat engineering problems. - [- K2_U01]
2. Student is convinced of the need of examine and verification of the applied methods, calculation and experimental results. - [- K2_U02]
3. Student is aware of the significance of team cooperation during solving theoretical and operating problems. - [- K2_U03]

Assessment methods of study outcomes

Lecture:

The final exam consists of two parts:

Part 1: Test of competence conc. solving heat engineering problems (1 to 3 problems).

Part 2: Test of understanding of fundamentals of heat engineering (3 to 5 questions).

In some cases the oral examination is used. Also the activity of students during lectures and tutorials is taken into account.

Tutorials:

Two written short tests during the semester and one written final test.

Continuous assessment of student activity (rewarding activity).

Laboratory training (exercises):

Assessment of each student before laboratory training and assessment of the written report and eventual oral presentation of the results.

Continuous assessment during laboratory training (rewarding activity).

Course description

Introduction, subject contents. Application of the heat engineering and heat transfer. Thermodynamic system and control volume, thermodynamic parameters. Ideal gas equation of thermal state. Ideal and real gas. Amount of substance. Gas mixtures. Principle of mass and energy conservation. Energy of system. Heat specific. Internal energy and enthalpy. Energy of fluid flow. Gibbs and Meyer formulas. Typical thermodynamic processes. Work and heat of the thermodynamic process. First law of thermodynamics. Irreversible processes. Second law of thermodynamics. Entropy. Efficiency of the compression and expansion processes. Throttling process. Ventilators, blowers and compressors. Working fluids. Properties of liquid and vapour water. Thermodynamic cycles: Carnot, Otto, Diesel and Joule. Clausius-Rankine cycle. Linde cycle. Refrigeration and heat pump coefficient of performance (COP). Humid air, psychrometric chard, dew point temperature. Fuels, combustion process, enthalpy of formation (higher and lower heating value). Efficiency of combustion chamber. Introduction to heat transfer. Heat flux by conduction, convection and radiation. Overall heat transfer. Steady and transient heat conduction. Lumped capacitance method, Biot and Fourier numbers. Heating and cooling of plate and regular bodies. Forced and natural convection, Nusselt number, Reynolds, Prandtl and Grashof numbers. Convection in boiling and condensation. Heat transfer by radiation, solar radiation. Heat exchangers.

Contents of tutorials:

1. Energy balance. Internal energy. Energy of fluid flow, enthalpy. I Low of Thermodynamics. Thermal properties.
2. Equation of thermal state. Absolute and shaft work.
3. Typical thermodynamic processes of ideal gases. Compressors.
4. II Low of Thermodynamics, entropy, thermodynamic cycles, available energy (exergy)
5. Water steam.
6. Clausius-Rankin cycle.
7. Tutorial test 1.
8. Ideal gas solutions.
9. Wet gases.
10. Combustion.
11. Heat conduction.
12. Convective heat transfer.
13. Heat radiation.
14. Overal heat transfer. Heat exchangers.
15. Tutorial test 2. Kolokwium 2

Contents of laboratory training:

1. Introduction to experimenyal training. Accuracy estimation of measurements and investigations.
2. Temperature and pressure instruments and measurements.
3. Measurements of fuel combustion values.
4. Investigation of heat exchangers.

Basic bibliography:

1. KALINOWSKI E., Termodynamika. Skrypt Politechniki Wrocławskiej, Wrocław 1994
2. GÓRNIAK H., SZYMCZYK J., Podstawy termodynamiki. Wyd. Politechniki Śląskiej, Wyd. III, Gliwice, Cz. 1?1997, Cz. 2?1999
3. SMUDSZ R., WILK J., WOLAŃCZYK F., Termodynamika. Repetytorium. Oficyna Wyd. Politechniki Rzeszowskiej, Wyd. III, stron 115, Rzeszów, 2009 (cena 10 zł)
4. SZARGUT J., Termodynamika techniczna. Wyd. Politechniki Śląskiej, Gliwice 2000
5. OCHĘDUSZKO St., Termodynamika stosowana. WNT, Warszawa, 1964
6. SZARGUT J., GUZIK A., GÓRNIAK H., Zadania z termodynamiki technicznej. Wyd. Politechniki Śląskiej, Gliwice 2008
7. Pomiary cieplne, T. 1 i T. 2, Praca zb. (Red. T.R. Fodemski), WNT, Warszawa 2001
8. WIŚNIEWSKI St., WIŚNIEWSKI T.S., Wymiana ciepła. WNT, Warszawa, 1997
9. OLEŚKOWICZ-POPIEL C., AMANOWICZ Ł., Eksperymenty w technice cieplnej. Wyd. Polit. Poznańskiej, Poznań, 2016
10. OLEŚKOWICZ-POPIEL C., WOJTKOWIAK J., Eksperymenty w wymianie ciepła. Wyd. II, Wyd. Polit. Poznańskiej, Poznań, 2007
11. OLEŚKOWICZ-POPIEL C., WOJTKOWIAK J., Właściwości termofizyczne powietrza i wody-przeznaczone do obliczeń przepływów i wymiany ciepła. Wyd. Polit. Poznańskiej, Poznań, 2010

Additional bibliography:

1. SCHMIDT P., BAKER D., EZEKOYE O., HOWELL J., Thermodynamics. An Integrating Learning System. International Edition., John Wiley and Sons, Inc., U S A, 2006 (205,-zł)
2. SONNTAG R.E., BORGNAKKE C., Introduction to Engineering Thermodynamics, 2nd Edition, John Wiley and Sons, Inc., U S A, 2007
3. CENGEL Y.A., BOLES M.A., Thermodynamics. An Engineering Approach. 6 Edition (SI Units), McGraw-Hill Higher Education, 2007

Result of average student's workload

Activity	**Time (working hours)**
1. Lectures	30
2. Tutorials	30
3. Laboratory training	15
4. Preparation to tutorials	15
5. Preperation to laboratory training	15
6. Consultations	3
7. Preparation to final tutorial test	10
8. Preparation to examination tests	25

Student's workload

Source of workload	**hours**	**ECTS**
Total workload	143	6
Contact hours	78	3
Practical activities	65	3