STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Heat Engineering**			Code **1010134241010130905**
Field of study **Environmental Engineering Extramural First-**	Profile of study (general academic, practical) **(brak)**		Year /Semester **2 / 4**
Elective path/specialty **-**	Subject offered in: **Polish**		Course (compulsory, elective) **obligatory**
Cycle of study: **First-cycle studies**	Form of study (full-time,part-time) **part-time**		
No. of hours Lecture: **20** Classes: **20** Laboratory: **10** Project/seminars: **-**			No. of credits **5**
Status of the course in the study program (Basic, major, other) **(brak)**	(university-wide, from another field) **(brak)**		
Education areas and fields of science and art **technical sciences** **Technical sciences**			ECTS distribution (number and %) **5 100%** **5 100%**

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 (achieved during lectures, tutorials and laboratory exercises) - [- K_W03]

2. Student has a general knowledge concerning heat engineering and heat flow (achieved during lectures and tutorials) - [- K2_W03]

3. Student knows basic methods needed for solving basic problems concerning processes and equipment occuring in environmetal engineering (achieved during lectures and tutorials) - [- 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 (achieved during lectures and tutorials) - [- K2_W03]

5. Student knows and understands the tendencies and development directions concerning heat equipment in environmental engineering (achieved during lectures, tutorials and laboratory exercises) - [- K2_W03]

Skills:

1. Student can apply determine thermal properties needed for calculations (achieved during lectures, tutorials and laboratory exercises) - [- K2_U01]

2. Student can find the needed relationships describing the discussed thermal problems (achieved during lectures, tutorials and laboratory exercises) - [- K2_U01, K2_U013]

3. Student can recognized and solve simple design and operation problems conc. heat equipment (achieved during lectures, tutorials and laboratory exercises) - [- K2_U01, K2_U013]

4. Student can assess the design solution and find a build and operated thermal equipment (achieved during lectures, tutorials and laboratory exercises) - [- K2_U01]

5. Student can plan and realize a simple operating tests (achieved during laboratory exercises) - [- K2_U01, K2_U13]

6. Student can determine an accuracy of calculation and measurement results (achieved during tutorials and laboratory exercises) - [- K2_U01, K2_U13]

7. Student can develop a general energy balance and determine thermal efficiency and heat losses of analysed equipment (achieved during lectures, tutorials and laboratory exercises) - [- K2_U01, K2_U13]

8. Student can find and estimate literature data conc. analysed processes and equipment (achieved during lectures and tutorials) - [- 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 (achieved during lectures, tutorials and laboratory exercises) - [- K2_U01]

2. Student is convinced of the need of examine and verification of the applied methods, calculation and experimental results (achieved during lectures, tutorials and laboratory exercises) - [- K2_U02]

3. Student is aware of the significance of team cooperation during solving theoretical and operating problems (achieved during lectures, tutorials and laboratory exercises) - [- K2_U03]

Assessment methods of study outcomes

Lecture (results W03, U01, U08, U09, U13)

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.

To pass each of the two parts of the exam (as well as to pass the tutorials) there is necessary to obtain at least 50% of the maximum points (max=20 points). The exam is passed if both part 1 and part 2 are passed. Corrected (Improved) is only this part which was failed.

Grading system:

0-9 points = 2,0 (failed)

10-12 points = 3,0 (sufficient)

13-14 points = 3,5 (sufficient plus)

15-16 points = 4,0 (good)

17-18 points = 4,5 (good plus)

19-20 points = 5,0 (very good)

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.

Teaching methods

Classical lecture with elements of conversation

Tutorials ? solving problems method

Laboratory exercises ? teaching by experimentation

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., WOJTKOWIAK J., Eksperymenty w wymianie ciepła. Wyd. II, Wyd. Polit. Poznańskiej, Poznań, 2007
10. OLEŚKOWICZ-POPIEL C., WOJTKOWIAK J., Właściwości termofizyczne powietrza i wody ? przeznaczone do obliczeń przepływów i wymiany ciepła. Wyd. Polit. Poznańskiej, Poznań, 2010
11. OLEŚKOWICZ-POPIEL C., AMANOWICZ Ł., Eksperymenty w technice cieplnej, Wyd. Polit. Poznańskiej, Poznań, 2016 (49 zł.)

Additional bibliography:

1. SCHMIDT P., BAKER D., EZEKOYE O., HOWELL J., Thermodynamics. An Integrating Learning System. International Edition., John Wiley & Sons, Inc., U S A, 2006 (205,-zł)

2. SONNTAG R.E., BORGNAKKE C., Introduction to Engineering Thermodynamics, 2nd Edition, John Wiley & 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 (contact hours)	20
2. Tutorials (contact hours, practical training)	20
3. Laboratory training (contact hours, practical training)	10
4. Preparation to tutorials (autonomus learning)	15
5. Preperation to laboratory training (autonomus learning)	15
6. Consultations (contact hours)	3
7. Preparation to final tutorial test (autonomus learning)	17
8. Preparation to examination test and presence at the test (autonomus learning)	25

Student’s workload

Source of workload	hours	ECTS
Total workload	125	5
Contact hours	55	2
Practical activities	30	1