COURSE DESCRIPTION CARD - SYLLABUS

Course name

Heat Engineering and Heat Measurements

Course

Field of study

Environmental Engineering Second-cycle Studies

Area of study (specialization)

Heating, Air Conditioning and Air Protection

Level of study

Second-cycle studies

Form of study

full-time

Year/Semester

1/1

Profile of study

general academic

Course offered in

polish

Requirements

compulsory

Number of hours

Lecture

30

Laboratory classes

15

Other (e.g. online)

Tutorials

15

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

prof.dr hab.inż. Janusz Wojtkowiak

email: janusz.wojtkowiak@put.poznan.pl

tel.61 6652442

Faculty of Environmental Engineering and Energy

ul. Berdychowo 4, 61-131 Poznań

Responsible for the course/lecturer:

Prerequisites

1.Knowledge: Mathermatics: differential and integral equations and their solutions. Physics: technical thermodynamics, basics of thermal engineering and fluid mechanics.

2.Skills:

Application of differential and integral description of physical phenomena, solution of differential equations. Solving tasks in thermal engineering and fluid mechanics.

3.Social competencies:

Awareness of the need of permanent updating and supplementing knowledge and engineering skills.

Course objective

Extension of knowledge and skill of basic heat engineering and experimental techniques used in build and natural environmental engineering

Course-related learning outcomes

Knowledge

1. Student gains a wider knowledge and skills concerning heat engineering and measurements needed for solving advanced thermodynamic problems in environmental engineering appearing in build and natural environment.

2. Student knows methods and thermal properties needed for theoretical and design solution of thermodynamic problems appearing in environmental engineering.

3. Student knows rules of calculation of energy balances, heat losses and heat efficiency concerning equipment and systems in environmental engineering.

4. Student knows an advanced knowledge concerning development tendencies and new achievements in heat equipment and processes in environmental engineering.

5. Student understands the principle of operation of a nuclear power plant and knows the thermal and flow issues occurring in the core of a nuclear reactor.

6. Student has an extended knowledge of the calculation of the uncertainty of measurement results and the statistical processing of the results of experimental tests.

Skills

1. Student can find and estimate information taken from literature and internet concerning heat engineering equipment appearing in environmental engineering.

2. Student can find adequate relationships describing analysed heat processes and how determine thermodynamic properties needed for calculations

3. Student can recognize and solve advanced design and operation problems occurred in heat equipment and critically estimate a design solution and recognize a danger hazard in erected and operated heat equipment.

4. Student can plan and realize operating tests and prototype investigations equipment appearing in environmental engineering and can determine an accuracy and analyse obtained results of calculation and measurements and can critically analyse obtained results of calculations and measurements and develop conclusions.

5. Student can develop a detailed energy balance, calculate heat efficiency and heat losses of analysed equipment.

6. The student can perform thermal-flow calculations of the core of a nuclear reactor and determine the temperature distribution in the nuclear fuel.

7. The student is able to determine the uncertainty of the results of experimental investigations and approximate the results of measurements.

Social competences

1. Student understand a team cooperation in solved problems.

2. Student is aware of the range and limits of the used calculation methods and relationships as well as importance of possessed theoretical and practical knowledge.

3. Student understands a need of examination and verification of results of used calculation and experimental methods.

4. The student is aware of the need for innovative thinking and action.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:

The final exam consists of two parts:

Part 1: Test of competence dealing with solving of heat engineering problems (2 problems).

Part 2: Test of understanding of fundamentals of heat engineering (4 questions).

In some cases an oral examination is used. Also an 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:

45-minute of written final test at the end of semester.

Continuous assessment of student activity during each tutorial (reward of activity).

Laboratory training (exercises):

15 minute short entrance test before each laboratory training and final assessment of of the written report and eventual oral presentation of the results

Programme content

Introduction, subject contents. Thermodynamic system and control volume. International scale of temperature. Amount of substance. Ideal and real gas equation of state. Mass and energy conservation. Gas mixtures. Energy of the system, internal energy. Energy of fluid flow, enthalpy. Heat specific of ideal and real gas, model of semi ideal gas. First law of thermodynamics. Second law of thermodynamics. Entropy, principle of increase of entropy. Typical thermodynamic processes. Work and heat of the thermodynamic process. Calculations of the entropy increases of ideal, semi ideal and real gases. Energy balance of the fluid flow machinery. Comparison of isentropic compression of ideal and real gases. Water vapour, processes of water vapour. Water vapour enthalpy chart. Properties of liquid and vapour water, tables, charts and computer program. Properties and processes of humid air, psychrometric chart. Combustion: properties of fuels, stoichiometric equations of combustion, excess of air, calculation and measurement of content of combustion fumes, dew point temperatures of flue gases, calculation and measurements of higher and lower heating values. Adiabatic flame temperature. Typical thermodynamic cycles. Power and heat cogeneration systems. Linde cycle, refrigeration and heat pump coefficient of performance (COP). Maximum reversible work, definition and application of exergy. Analysis of the uncertainty of the results of experimental research. Uncertainty of type A and B. Final / total uncertainty in multiple indirect measurement. Polynomial approximation. Regression. Nuclear power plant - principle of operation, structure and efficiency. Heat generation in the reactor core, temperature distribution in nuclear fuel.

Teaching methods

Classical lecture with elements of conversation

Tutorials: problem solving and discussion

Laboratory exercises: teaching by experimentation

Bibliography

Basic

1. SZARGUT J., Termodynamika techniczna. Wyd. Politechniki Śląskiej, Gliwice, 2000

2. KALINOWSKI E., Termodynamika. Skrypt Politechniki Wrocławskiej, Wrocław, 1994

3. SMUDSZ R., WILK J., WOLAŃCZYK F., Termodynamika. Repetytorium. Oficyna Wyd. Politechniki Rzeszowskiej, Wyd. III, stron 115, Rzeszów, 2009

4. WIŚNIEWSKI S., Termodynamika techniczna. WNT, Warszawa 1993

5. OCHĘDUSZKO St., Termodynamika stosowana. WNT, Warszawa, 1964

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8. OLEŚKOWICZ-POPIEL C., WOJTKOWIAK J., Właściwości termofizyczne powietrza i wody ? przeznaczone do obliczeń przepływów i wymiany ciepła. Wyd. Polit. Poznańskiej, Poznań, 2010

9. OLEŚKOWICZ-POPIEL C.,AMANOWICZ Ł., Eksperymenty w technice cieplnej. Wyd. Polit. Poznańskiej, Poznań, 2016

Additional

1. RUBIK M., Pompy ciepła, Wyd. II, Ośrodek Informacji. Technika Instalacyjna w Budownictwie, Warszawa 1999

2. SONNTAG R.E., BORGNAKKE C., VAN WYLEN G.J., Fundamentals of Classical Thermodynamics, SI Version, 6th Edition, John Wiley and Sons, Inc., U S A, 2003

3. SONNTAG R.E., BORGNAKKE C., Introduction to Engineering Thermodynamics, 2nd Edition, John Wiley and Sons, Inc., U S A, 2007

4. SCHMIDT P., BAKER D., EZEKOYE O., HOWELL J., Thermodynamics. An Integrating Learning System. International Edition., John Wiley and Sons, Inc., U S A, 2006

5. CENGEL Y.A., BOLES M.A., Thermodynamics. An Engineering Approach. 6 Edition (SI Units), McGraw-Hill Higher Education, 2007

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam) [1]	40	1,5

[1] delete or add other activities as appropriate