COURSE DESCRIPTION CARD - SYLLABUS

Course name
Heat Engineering and Heat Measurements [S2IŚrod2-ZwCKiOP>TC]

Course

Field of study
Environmental Engineering

Year/Semester
1/1

Area of study (specialization)
Heating, Air Conditioning and Air Protection

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

4,00

Coordinators

prof. dr hab. inż. Janusz Wojtkowiak
janusz.wojtkowiak@put.poznan.pl

Lecturers

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

The module program covers the following topics:
1. thermodynamics of gas compression and expansion processes,
2. theoretical foundations for calculating the power of turbomachinery,
3. fuels and combustion,
4. real thermodynamic cycles of machines and systems,
5. mathematical description of water vapor,
6. mathematical description of humid air,
7. exergy and its application,
8. conversion of nuclear energy into heat,
9. measurement uncertainties.

Course topics

The lecture program covers the following topics:
1. adiabatic compression and expansion of gas, compressor and gas turbine power, isentropic efficiency,
2. total energy of the flowing fluid,
3. power of turbomachinery in terms of the first and second laws of thermodynamics,
4. combustion, basic concepts, stoichiometry, oxygen demand, air demand, exhaust gas composition and temperature,
5. theoretical and real thermodynamic cycles,
6. the structure and principles of operation of selected machines and systems and their efficiency,
7. water vapor as a working fluid - approximation equations dedicated for computer calculations,
8. humid air, mathematical description - derivation of basic equations,
9. humid air - mathematical description of the processes of cooling, mixing and humidification,
10. exergy, exergy losses, exergy efficiency,
11. nuclear power plant - principle of operation, structure, efficiency, heat obtained as a result of fission of nuclear fuel,
12. nuclear steam generation systems,
13. mathematical foundations of uncertainty analysis of measurement results.

The tutorials cover the following topics:
1. calculations of the power and efficiency of fans, blowers, compressors, pumps and turbines,
2. calculation of the oxygen and air demand necessary for the combustion of selected fossil fuels, calculation of the composition and temperature of exhaust gases,
3. calculations of power and efficiency of selected thermodynamic cycles,
4. calculations of the thermodynamic cycle of a steam power plant,
5. calculations of the processes of cooling, mixing, humidification and drying of humid air,
6. calculation of the total uncertainty of the final result in multiple indirect measurements.

The laboratories cover the following topics:
1. testing the energy efficiency of compressor heat pumps,
2. research on the energy efficiency of a hydrogen fuel cell,
3. testing the energy efficiency of a thermoelectric heating and cooling device.

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
6. Pomiary cieplne, T. 1 i T. 2, Praca zb. (Red. T.R. Fodemski), WNT, Warszawa, 2001
7. SZARGUT J., GUZIK A., GÓRNIAK H.: Zadania z termodynamiki technicznej, Wyd. Pol. Śląskiej, Gliwice 2008
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	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50