POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Process thermodynamics [S1IChiP1>TP]

Course

Field of study	Year/Semester
Chemical and Process Engineering	2/3
Area of study (specialization)	**Profile of study**
–	general academic
Level of study	**Course offered in**
first-cycle	Polish
Form of study	**Requirements**
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	0	0
Tutorials	**Projects/seminars**	
30	0	

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

The student should have knowledge of mathematics in the field of differential and integral calculus (K_W01). The student should have knowledge of physics, in particular mechanics, to the extent enabling understanding of process thermodynamics (K_W02). The student should be able to use specialist literature and draw conclusions on its basis (K_U01). The student should be able to implement self-education (K_U05). The student should understand the need for further training and raising their professional competences (K_K01).

Course objective

Mastering knowledge of the thermodynamic foundations of chemical and process engineering operations and processes: balancing principles and thermodynamics in closed and open systems in stationary and non-stationary conditions, in reversible and irreversible processes; properties of gases, liquids and solids, as well as phase transitions between them. Using this knowledge to analyze thermodynamic transformations and cycles in technology.

Course-related learning outcomes

Knowledge:

1. the student has knowledge of the basic concepts and definitions in the field of thermodynamics. [k_w02, k_w10]
2. student has knowledge of balancing principles and thermodynamics principles - [k_w10]
3. student has knowledge of the description of matter properties and phase transitions - [k_w10]
4. student has knowledge about thermodynamic cycles and their application in technology - [k_w02, k_w10]

Skills:
1. has the ability to obtain and critically evaluate information from literature - [k_u01]
2. has the ability to use balance sheet principles for basic engineering calculations. - [k_u07]
3. has the ability to analyze the use of thermodynamic transformations and cycles in technology, in particular in issues related to chemical and process engineering. - [k_u07]
4. has the ability to self-study. - [k_u05]

Social competences:
1. the student understands the need for self-education and raising their professional competences. - [k_k01]
2. the student is aware of compliance with ethics in a broad sense. - [k_k03]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Completion of the tutorials is based on the average grade of at least two written tests (stationary credit) / tests with essay-type questions on the Ekursy platform (remote credit). Each test consists of at least four tasks and is graded according to the score: 51% -60% (3.0), 61% -70% (3.5); 71% -80% (4.0), 81% - 90% (4.5), 91% -100% (5.0). A necessary condition to pass the subject - calculation of the average grade, is to obtain a positive grade (at least 3.0) from all the tests carried out as part of the subject.
Oral exam on mastery and understanding of the whole material.

Programme content

The course covers the thermodynamic foundations of chemical and process engineering operations and processes as well as their use in technology.
In particular, the following are discussed:
basic concepts of thermodynamics (matter, substance, mass, thermodynamic system, phase, state parameters, stationary and non-stationary conditions, thermodynamic equilibrium);
the concept of a continuous medium, continuous kinematics, stress tensor, mass and component balancing in closed and open systems in stationary and non-stationary conditions;
zero thermodynamic principle, thermal equilibrium, temperature;
quasistatic, reversible and irreversible processes, the first law of thermodynamics, energy forms (internal energy, enthalpy, free energy and free enthalpy), Hess"s laws, system heat capacity and specific heat;
the second law of thermodynamics, entropy, Carno cycle, cycle efficiency, Carno principle, reduced heat, entropy properties, achieving thermal equilibrium in an irreversible process, entropy in statistical terms;
thermodynamics of low temperatures, the third law of thermodynamics;
Maxwell thermodynamic equations and their application;
microscopic and macroscopic properties of gases, liquids and solids;
perfect gas (experimental laws, Clapeyron equation, Dalton"s law, thermodynamic transformations)
semi-perfect gas and real gas (virial equation, internal energy, condensation and critical point, state equations, compressibility factor);
kinetic theory of the structure of matter (Clapeyron equation, principle of energy partitioning, specific heat of perfect gas, real gas and solids);
Phase transitions of the first and second kind, Gibbs rule, phase diagrams, equations describing the phase transformations of the first and second kind, evaporation curve;
thermodynamic cycles: Carnot (ideal engine, ideal cooler), Rankine (steam turbine), Joule (gas turbine, jet engine), Otto, Diesel, Sabathi (internal combustion engines), Linde, refrigerators, heat pumps, liquefaction ;
moist gases (isobaric humidification, wet gas parameters, Clapeyron equation, enthalpy and internal energy of wet gas, i-X graph, wet gas isobaric transformations).

Course topics

none

Teaching methods

lectures and tutorials

Bibliography

Basic
1. Elwell D., Pointon A.J., Termodynamika klasyczna, WNT, Warszawa 1976
2. Michałowski St., Wańkowicz K., Termodynamika procesowa, wyd. 2, WNT, Warszawa 1999
3. Kalinowski E., Termodynamika, Wyd. Politechniki Wrocławskiej, 1994
4. Biń A.K., Machniewski P., Przykłady i zadania z termodynamiki procesowej, Oficyna Wydawnicza Politechniki Warszawskiej, 2002
5. Rowiński R.S., Szutkowski P., Termodynamika. Zbiór zadań, Wyd. U. Warmińsko-Mazurskiego, Olsztyn 2003
Additional
1. Szargut J., Termodynamika, PWN, Warszawa, 1985
2. Bochowski H., Elementy termodynamiki statystycznej, WNT, Warszawa, 1998
3. Stokłosa A., Podstawy termodynamiki fenomenologicznej i statystycznej dla chemików, Wyd. Politechniki Krakowskiej, 1999
4. Wróblewski A.K., Historia fizyki od czasów najdawniejszych do współczesności, PWN, Warszawa, 2006

Breakdown of average student's workload

	Hours	ECTS
Total workload	105	4,00
Classes requiring direct contact with the teacher	75	2,90
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,10