FACULTY OF MECHANICAL AND POWER ENGINEERING

SUBJECT CARD

Name of subject in Polish:	Termoekonomiczna analiza procesów energetycznych
Name of subject in English:	Thermoeconomic analysis of energy processes
Main field of study (if applicable):	Power engineering
Specialization (if applicable):	Computer aided mechanical and power engineering
Profile:	**academic**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional-specialization**
Subject code:	W09ENG-SM0057
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	crediting with grade*		crediting with grade*		
For group of courses mark final course with (X)					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes	0		2		
including number of ECTS points for direct teacher-student contact (BK) classes	1		1,5		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Competence in the basics of thermodynamics, heat and mass transfer.

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SUBJECT OBJECTIVES

C1 - to familiarize students with the principles of Life Cycle Assessment
C2 - to acquaint students with the basic elements of LCA analysis
C3 - to familiarize students with the tools to optimize energy processes
C4 - to acquaint students with the methods of calculating exergy and entropy

SUBJECT LEARNING OUTCOMES

relating to knowledge:
PEK_W01 - has knowledge of the LCA basic definitions, principles and rules
PEK_W02 - knows how to analyze the object and prepare it components to LCA
PEK_W03 - familiar with the methods of optimizing energy processes and devices
PEK_W04 - knows the principles of the exergy and entropy analysis of energy processes

relating to skills:
PEK_U01 - can set the goal and scope in LCA software as well as conduct the inventory analysis
PEK_U02 - can set the impact assessment in LCA software as well as perform the results interpretation

PEK_U03 - can perform the basic optimization of energy processes
PEK_U04 - can perform the basic optimization of energy devices

PROGRAM CONTENT

Lectures		Number of hours
Lec 1	Overview of LCA	2
Lec 2	Goal and scope definition	2
Lec 3	Inventory Analysis	2
Lec 4	Impact assessment	2
Lec 5	Interpretation	2
Lec 6	Introduction to Carbon Footprint (CFP), benchmarking and energy efficiency	2
Lec 7	Water Footprint	2
Lec 8	The partial test	2
Lec 9	Energy and Exergy - introduction	2
Lec 10	Work Potential - case study	2
Lec 11	Exergy Destruction - case study	2
Lec 12	The Second Law Efficiency - case study	2
Lec 13	Entropy - introduction	2
Lec 14	Entropy generation - case study	2
Lec 15	The partial test	2
	Total hours	30

Laboratory		Number of hours
Lab 1	openLCA Overview and first steps	2
Lab 2	openLCA Basic Modelling	4
Lab 3	SimaPro Introduction	2
Lab 4	Developing a model for an air-conditioning system including thermal energy storage: case study CIESOL building	2
Lab 5	Life cycle assessment exercise: THERBIOR project	4
Lab 6	Exergy analysis of a steam power plant	4
Lab 7	Exergy analysis of a two stage compressor	4
Lab 8	Exergy analysis of an absorption chiller	2
Lab 9	Exergy analysis of an air water heat exchanger	2
Lab 10	Entropy analysis of a storage tank filled with granite	4
	Total hours	30

TEACHING TOOLS USED

N1. Traditional lecture with multimedia presentation
N2. Self-work of students - preparation for final test
N3. Self-work of students - preparation for classes and laboratory
N4. Consultation hours
N5. Reports prepared by students

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT - lecture

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEK_W01, PEK_W02	The partial test from Lec1÷Lec7
F2	PEK_W03, PEK_W04	The partial test from Lec9÷Lec14
C = 1/2·F1 + 1/2·F2		

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT - laboratory

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEK_U01÷PEK_U04	oral answers
F2	PEK_U01÷PEK_U04	written reports of laboratory classes
C = 1/5·F1 + 4/5·F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Consequential-LCA, 2015. Further Theory on the Rebound Effect. www.consequential-lca.org
[2] Berger M, Finkbeiner M (2010) Water footprinting: How to assess water use in life cycle assessment? Sustainability 2:919-944.
[3] EEA, 2016. Waterbase - Water Quality. European Environment Agency. https://www.eea.europa.eu/data-and-maps/data/waterbase-water-quality.
[4] ISO/TS 14067:2013 – Greenhouse Gases – Carbon Footprint of products – requirements & guidelines for quantification and communication.
[5] Ecoinvent, 2018. Ecoinvent - the world's most consistent & transparent life cycle inventory database. https://www.ecoinvent.org/.
[6] Yunus Cengel, Michael Boles, Thermodynamics: An Engineering Approach, 8th Edition, 2020
[7] Yunus Cengel, Heat Transfer: A Practical Approach, 2nd Edition, 2002

SECONDARY LITERATURE:

[1] www.lifecycleinitiative.org
[2] www.openlca.org
[3] Truls Gundersen, Introduction to Exergy and Energy Quality, Energy and Process Engineering, 2009
[4] Jan Szargut, Egzergia: Poradnik obliczania i stosowania, Gliwice, 2007 (in Polish)

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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