POZNAN UNIVERSITY OF TECHNOLOGY
EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)
pl. M. Skłodowskiej-Curie 5, 60-965 Poznań

COURSE DESCRIPTION CARD - SYLLABUS

Course name
ENERGY VERSUS EXERGY APPROACH IN ENERGY MANAGEMENT

Course

Proposed by Discipline
Environmental engineering, mining and energy

Year/Semester
III/6

Type of studies
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

Number of hours

Lecture	Tutorials	Projects/seminars
4		

Number of credit points

1

Lecturers

Responsible for the course/lecturer:
prof. dr hab. inż. Tomasz Mróz
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Faculty of Environmental Engineering and Energy
Poznan University of Technology
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Responsible for the course/lecturer:

Prerequisites

Knowledge: he/she knows fundamental principles concerning thermodynamics.

Skills: he/she can use thermodynamic laws in practical applications.

Social competencies: he/she knows the needs of energy conservation.

Course objective

The main objectives of the course is to obtain knowledge concerning the use of energy and exergy balances in evaluation of energy systems. Those two balances are efficient tools in optimization of energy systems both in commercial and industrial applications. The use of energy and exergy approach allows for the improve of energy efficiency of existing systems and design of new low energy or nearly zero energy systems.

Course-related learning outcomes

Knowledge

A PhD student who graduated from doctoral school knows and understands:

1) the principles of energy and exergy modelling of energy systems, [P8S_WG/SzD_W01]

2) the need of primary energy consumption reduction and knows the tools of energy use optimization, [P8S_WK/SzD_W05]

3) the need of sustainable development of energy systems. [P8S_WK/SzD_W07]

Skills

A PhD student who graduated from doctoral school can:

1) create the energy and exergy balances of complex energy systems and critically analyzed achieved results, [P8S_UW/SzD_U02]

2) transfer energy and exergy analysis results to the economic and social sphere. [P8S_UW/SzD_U03]

Social competences

A PhD student who graduated from doctoral school is ready to:

1) initiate actions joined with sustainable development of energy systems to the public interest. [P8S_KO/SzD_K05]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

PQF code	Methods for verification of learning outcomes	Assessment criteria
W01, W05, W07	Creation of the energy and exergy model of chosen thermodynamically open system - report part #1	Evaluation of the report delivered
U02, U03	Case study calculations for given input data - report part #2	Evaluation of the report delivered
K05	Discussion on achieved calculation results with respect to the rules of sustainable development	Evaluation of student's activity

Programme content

1. Fundamentals concerning energy balance equation (Basic energy forms, Integral and differential form of energy balance equation, Definition of energy efficiency).
2. Application of energy balance in evaluation of complex energy systems (Energy balance equation for inlet-exhaust air handling unit, Energy balance equation for double flash geothermal power plan).
3. Fundamentals concerning exergy balance equation (Irreversibility of energy processes – Guoy’a-Stodoli Law, The entropy sources, Definition of exergy and internal exergy losses, Definition of exergy efficiency).
4. Application of exergy balance in evaluation of complex energy systems (Exergy balance equation for gas fired CHP plant, Energy balance equation for compressor heat pump).

Teaching methods

Lecture: multimedia presentation including illustrations and examples.

Bibliography

Basic

1. Mróz T. M.: Energy Management in Built Environment. Tools and Evaluation Procedures. Publishing House of Poznań Universuty of Technology, 2013, pp. 168.

2. Ballarini I., Corrado V.: Application of energy rating methods to the existing building stock. Analysis of some residential buildings in Turin. Energy and Buildings 41 (2009), pp. 790-800.

3. Feist W., Schnieders J., Dorer V., Haas A.: Re-inventing air heating: Convenient and comfortable within the frame of the Passive House concept. Energy and buildings. 37 (2005), pp. 1186-1203.

4. Hoinka K., Ziębik A.: Mathematical Model for the choice of an energy management structure of complex buildings, Energy 35 (2010), pp. 1146-1156.

5. Mahdavi A., Doppelbauer E.: A performance comparison of passive and low-energy buildings. Energy and Buildings, 42 (2012), pp. 1314-1319.

6. Szargut J., Ziębik A.: Principles of thermal engineering. PWN Warszawa, 2000 (in Polish).

7. Wene C.O., Ryden B.: A comprehensive energy model in the municipal energy planning process; EJOR 2 (1988), pp. 212-222.

8. Ziębik A., Hoinka K., Kolokotroni M.: System approach to the energy analysis of complex buildings, Energy and Buildings 37 (2005) pp. 930-938.

9. Stanek W.: Examples of application of exergy analysis for the evaluation of ecological effects in thermal processes. International Journal of Thermodynamics, ISSN 1301-9724. Vol 15, pp. 11-16, 2012.

10. Szargut J., Petela R.: Exergy. PWN Warszawa, 1965 (in Polish).

11. Szargut J.: Exergy analysis of thermal processes, Biuletyn Instytutu Techniki Cieplnej Politechniki Warszawskiej 84, (1996) pp.43-52.

12. Szargut J.: Sequence method of determination of partial exergy losses in thermal systems, Exergy, an International Journal, 1 (2) 2001, pp. 85-90.

13. Szargut J.: Exergy. Calculation and application handbook. Wydawnictwo Politechniki Śląskiej, Gliwice 2007 (in Polish).

14. Wall G., Gong W.: On exergy and sustainable development – Part 1: Conditions and concepts. Exergy an International Journal 1 (2001), pp. 128-145.

15. Wang S. P. et all, A phenomenological equation of exergy transfer and its application, Energy, (30) 2005, pp. 8.

16. Vats K. Tiwari G. N.: Energy and exergy analysis of a building integrated semitransparent photovoltaic thermal (BISPVT) system. Applied Energy. 2012.

17. Yucer C. T., Hepbasli A.: Thermodynamic analysis of building using exergy analysis method. Energy and Buildings, 43 (2011) pp. 536-542.

Additional

1. Mróz T.: Thermodynamic and economic performance of the LiBr-H2O single stage absorption water chiller, Applied Thermal Engineering 26 (2006) pp. 2103-2109.

2. Mróz T. M.: Planning of community heating system modernization and development, Applied Thermal Engineering 28 (2008) p. 1844-1852.

3. Sartori I., Hestnes A. G.: Energy use in the life cycle of conventional and low-energy buildings: A review article. Energy and Buildings 39 (2007), pp. 249-257.

4. Solkan software: www.solkan.com.

5. X-Steam 2.6, IF97 properties for water and steam: www.x-eng.com.

6. Bes T.: Exergy in heating, air conditioning and drying processes, Industrial Energy, (11) 1962, pp. 388-392 (in Polish).

7. Gunerhan H., Hepbasli A.: Exergetic modeling and performance evaluation of solar water heating systems for building applications. Energy and buildings 39 (2007) pp. 509-516.

8. Hakan C., Dincer I., Hepbasli A.: Energy and exergy analyses of combined thermochemical and sensible thermal energy storage systems for building heating applications. Energy and buildings 48 (2012) pp. 103-111.

9. Hepbasli A.: Low exergy (LowEx) heating and cooling systems for sustainable buildings and societies. Renewable and Sustainable Energy Reviews 16 (2012) pp. 73-104.

10. Mróz T., Bogusławska Ż.: Exergy analysis of an air heating system, Foundations of Civil and Environmental Engineering, Nr 15 (2012), pp. 105-116.

11. Sakulpipatsin P., Itard L. C. M., Kooi H. J., Boelman E. C., Luscuere P. G.: An exergy application for the analysis of buildings and HVAC systems, Energy and Exergy buildings 42 (2011), pp. 90-99.

12. Wojdyga K.: An investigation into the heat consumption in a low-energy buildings. Renewable Energy 34 (2009) pp. 2935-2939.

Breakdown of average student's workload

	Hours	ECTS
Total workload	15	1.0
Classes requiring direct contact with the teacher	9	0.5
Student's own work (literature studies, preparation for tutorials, project preparation) [1]	6	0.5

[1] delete or add other activities as appropriate