Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-0CDGKLP-0307	Name of the course	Polish	**Termodynamika środowiska**	
			English	**Environmental Thermodynamics**	
Type of the course	Specialty subjects				
Course coordinator	Prof. dr hab. inż. Paweł Gierycz				
Implementing unit	Faculty of Chemical and Process Engineering	Scientific discipline / disciplines*	Chemical Engineering, Chemical Sciences, Materials Engineering, Biomedical Engineering, Physical Sciences, biotechnology		
Level of education	Education of doctoral students	Semester	Winter semester		
Language of the course	English				
Type of assessment:	Credit with a grade	Number of hours in a semester	30	ECTS credits	2
Minimum number of participants	12	Maximum number of participants	32	Available for students (BSc, MSc)	No

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	2	-	-	-	-
	in a semester	30	-	-	-	-

* does not apply to the Researcher's Workshop-

1. Prerequisites

Completed lectures: mathematics, physics, chemistry (physical)

2. Course objectives

The aim of the proposed series of lectures is:

- Learning about the properties of the four basic natural environment compartments, i.e.: Earth's atmosphere, water, soil and living organisms.
- Getting to know mutual relations and interaction between those natural environment compartments (Earth's atmosphere, water, soil, living organisms).
- Understanding (based of the phase equilibria and the laws of thermodynamics) the rules of pollution distribution between different natural environment compartments (different pollution distribution models).

3. Course content (separate for each type of classes)

Lecture

1. **Introduction to environmental thermodynamics:** basic definitions and information concerning natural environment and its four main compartments (Earth's atmosphere, water, soil, living organisms), ecology, global environmental threats as well as the principles of sustainable development.
2. **The laws of thermodynamics in the description of environmental processes:** the first, the second, the third and the zeroth law of thermodynamics, metabolism, exergy, exergy analysis, energy transfer in the natural environment.
3. **Earth's atmosphere**: structure, chemical composition and physico-chemical properties of Earth's atmosphere, pollution of the Earth's atmosphere and related global threats: greenhouse effect, ozone hole and acid rains.
4. **Wind:** wind definitions, causes of wind formation, power of wind (mathematical description), the influence of the wind on the climate in local and global scale.
5. **Water:** structure and physico-chemical properties of water, the water cycle in the natural environment (including clouds formation).
6. **Physics of ground:** soil and its structure and physico-chemical properties, water in the soil (surface tension, water evaporation, etc.).
7. **Energy:** non-renewable, renewable and unconventional energy: coal, petroleum, nuclear energy, water fall energy, wind energy, solar energy, geothermal energy, tidal energy, biomass, biogas.
8. **Pollution distribution in the natural environment:** phase equilibria (vapor-liquid, liquid-liquid, liquid-solid, vapor-liquid-solid), octanol-water partition coefficient, partition coefficients between different

environmental compartments, mass and energy balances, basic model describing distribution of pollutants in the natural environment. **9. Modeling of pollutants distribution in the natural environment:** examples of the use of different models of pollutants distribution to the calculation of real problems related to the natural environment pollution.
Laboratory

4. Learning outcomes			
	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	He has established knowledge useful for preparing thermodynamic (mass and energy) balances concerning propagation of pollutants in the natural environment.	SD_W1 (P8S_WK)	written test
K02	He has established knowledge necessary for the analysis of natural environmental processes, i.e. for preparing appropriate mass and energy balances taking into account all the components of natural environment.	SD_W2 (P8S_WG)	written test
K03	He has knowledge of new trends and the most important achievements in the field of chemical and process engineering concerning the recovered (from renewable and unconventional sources) energy processing technologies.	SD_W3 (P8S_WG)	written test
Skills			
S01	He can get information from the literature, data bases and other sources in order to comply projects concerning distribution of pollutants in the natural environment.	SD_U1 (P8S_UW)	written test
S02	He can make a project concerning distribution of pollutants between different environmental compartments (air, water, soil, biota) in the local and global scale.	SD_U2 (P8S_UW)	written test
S03	He can, based on the acquired knowledge of natural environment and distribution of pollutants, use modern chemical and process engineering for design of pro-ecological industrial processes.	SD_U4 (P8S_UK) SD_U7 (P8S_UO) SD_U8 (P8S_UU)	written test
Social competences			
SC01	Having extensive knowledge of natural environment and emerging new environmental threats he understands the need for a critical evaluation of the achievements of the discipline represented as well as constant training and improving his professional competences.	SD_K1 (P8S_KK) SD_K2 (P8S_KK)	written test
SC02	He can use pro-ecological solutions in the studied issues of modern chemical and process engineering.	SD_K3 (P8S_KO) SD_K4 (P8S_KO)	written test

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Pass a subject: positive result of the written test concerning the content of the lectures. A (multiple-choice) test of 20 questions, lasting 40 min., taking place after the end of the entire series of lectures. Grades: Grade - 5.0: 19 - 20 points, Grade - 4.5: 17 - 18 points, Grade - 4.0: 15 - 16 points, Grade - 3.5: 13 - 14 points, Grade - 3.0: 11 - 12 points, failing to pass (Grade - 2.0) ≤ 10 points

6. Literature
Basic literature: [1] R.P. Schwarzenbach, „Environmental organic chemistry", John Wiley & Sons, New Jersey, 2003. [2] S.E. Manahan, „Environmental Chemistry", CRC Press, New York, 2005. [3] H.F. Hemond, E.J. Fechner-Levy, „Chemical Fate and Transport in the Environment", Academic Press, New York, 2000. Supplementary literature: [1] D. Mackay, „Multimedia Environmental Models. The Fugacity Approach.", Taylor & Francis, New York, 2001. [2] R.S. Boethling, D. Mackay, „Handbook of Property Estimation Methods for Chemicals: Environmental and Health Sciences", Lewis Publishers, Boca Raton, 2000. [3] K.T. Valsaraj, "Elements of Environmental Engineering: Thermodynamics and kinetics", CRC Press, New York, 2000.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	30
2	Hours of consultations with the academic teacher, exams, tests, etc.	10
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	10
4	Amount of time devoted to the preparation for exams, test, assessments	10
	Total number of hours	**60**
	ECTS credits	**2**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)