COURSE DESCRIPTION CARD

<table>
<tr><td colspan="10">Faculty of Civil Engineering and Environmental Sciences</td></tr>
<tr><td>Field of study</td><td colspan="6">Environmental Engineering</td><td colspan="2">Degree level and programme type</td><td>Bachelor's degree</td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="6">International School of Engineering</td><td colspan="2">Study profile</td><td>academic profile</td></tr>
<tr><td rowspan="2">Course name</td><td colspan="6" rowspan="2">Heat exchange</td><td colspan="2">Course code</td><td>19284202H</td></tr>
<tr><td colspan="2">Course type</td><td>obligatory</td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>V</td></tr>
<tr><td>32</td><td>16</td><td>32</td><td></td><td></td><td></td><td></td><td>No. of ECTS credits</td><td>5</td></tr>
<tr><td>Entry requirements</td><td colspan="9">mathematics, physics</td></tr>
<tr><td>Course objectives</td><td colspan="9">Knowledge about essential issues of heat exchange. Ability of solving heat exchange problems. Skills to measure basic thermal values.</td></tr>
<tr><td>Course content</td><td colspan="9"><u>Lecture:</u> Basics of heat transfer. Heat conduction equation. Steady heat conduction. Transient heat conduction. Heat transfer through a plane wall subjected to convection on both sides. Heat transfer through a cylindrical or spherical layer subjected to convection on both sides. Heat exchangers. Heat transfer from finned surfaces. Fundamentals of convection. External forced convection. Internal forced convection. Natural convection. Fundamentals of thermal radiation. Radiation heat transfer.
<u>Classes:</u> Steady heat conduction in plane walls. Steady heat conduction in cylinders. Heat transfer through a plane wall subjected to convection on both sides. Heat transfer through a cylinder subjected to convection on both sides. Heat transfer from finned surfaces. Forced convection. Natural convection. Radiation heat transfer.
<u>Laboratory classes:</u> Experiment #1. Study of heat transfer by natural convection. Experiment #2. Study of double-pipe heat exchanger: 1. Energy balance for the exchanger and heat loss analysis. Experiment #3. Study of shell-and-tube heat exchanger: 1. Energy balance for the exchanger and heat loss analysis. Experiment #4. Study of double-pipe heat exchanger: 2. Determination of the exchanger effectiveness. The effectiveness – NTU method. Experiment #5. Study of shell-and-tube heat exchanger: 2. Determination of the exchanger effectiveness. The effectiveness – NTU method. Experiment #6. Study of double-pipe heat exchanger: 3. Heat transfer under counter and parallel flow conditions. Experiment #7. Study of shell-and-tube heat exchanger: 3. Heat transfer under counter and parallel flow conditions. Experiment #8. Study of double-pipe heat exchanger: 4. Effect of flow on heat transfer. Calculation of Reynolds number and Nusselt number. Experiment #9. Study of shell-and-tube heat exchanger: 4. Effect of flow on heat transfer. Calculation of Reynolds number. Experiment #10. Determination of heat pump efficiency.</td></tr>
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	Experiment #11. Determination of the overall heat transfer coefficient for building partitions. Experiment #12. Determination of the operative temperature. Experiment #13. Temperature determination with an optical pyrometer.	
Teaching methods	**multimedial presentation (lectures), solving problems (classes), measurements (laboratory classes)**	
Assessment method	**lecture – written exam; classes - test; laboratory classes – evaluation of reports, verification of preparation for classes**	
Symbol of learning outcome	**Learning outcomes**	**Reference to the learning outcomes for the field of study**
LO1	**The student knows and understands at an advanced level the issues of heat transfer, which are the basis of the processes taking place in environmental engineering.**	EN_IS1_W02
LO2	**The student knows and understands at an advanced level selected issues in the field of detailed knowledge, necessary to understand thermal and flow processes occurring in environmental engineering.**	EN_IS1_W04
LO3	**The student is able to use the theoretical basis of heat transfer for engineering calculations.**	EN_IS1_U01
LO4	**The student is able to plan and carry out advanced experiments as well as interpret the obtained results and draw conclusions.**	EN_IS1_U07
LO5	**The student is able to act creatively, cooperate in a group, assuming various roles in it.**	EN_IS1_U16
LO6	**The student is ready to analyze the content obtained from various sources and to critically assess the possibility of their use in professional work.**	EN_IS1_K01
Symbol of learning outcome	**Methods of assessing the learning outcomes**	**Type of tuition during which the outcome is assessed**
LO1	**written exam**	**L**
LO2	**written exam, test**	**L, C**
LO3	**test, evaluation of reports**	**C, LC**
LO4	**evaluation of reports, verification of preparation for classes**	**LC**
LO5	**observation of work during laboratory classes**	**LC**
LO6	**written exam, test**	**L, C**
Student workload (in hours)		**No. of hours**
Calculation	**lecture attendance**	**32**
	participation in classes, laboratory classes	**48**
	preparation for classes, laboratory classes and tests	**30**
	working on reports	**15**
	preparation for and participation in exam	**10**
	participation in student-teacher sessions related to the classes	**5**
	TOTAL:	**135**

Quantitative indicators		HOURS	No. of ECTS credits
Student workload – activities that require direct teacher participation		85	3.4
Student workload – practical activities		98	3.9
Basic references	1. Cengel Y.A. Heat and mass transfer: a practical approach. McGraw-Hill, Boston, 2007. 2. Incropera F.P. [et al.] Introduction to heat transfer. Wiley J., Hoboken, 2007.		
Supplementary references	1. Wong K.-F.V. Intermediate heat transfer. Taylor and Francis, New York, 2003 (online). 2. Nellis G., Klein S. Heat transfer. Cambridge University Press, Cambridge, 2009.		
Organisational unit conducting the course	Department of HVAC Engineering	Date of issuing the programme	
Author of the programme	Cezary Pieńkowski, DSc, Eng.	14.10.2023	

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar