GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Heat exchangers, PG_00055941 | | | | | |
| Field of study | Power Engineering, Power Engineering, Power Engineering | | | | | |
| Date of commencement of studies | October 2021 | | Academic year of realisation of subject | | 2023/2024 | |
| Education level | first-cycle studies | | Subject group | | Optional subject group<br>Subject group related to scientific research in the field of study | |
| Mode of study | Full-time studies | | Mode of delivery | | at the university | |
| Year of study | 3 | | Language of instruction | | Polish | |
| Semester of study | 6 | | ECTS credits | | 2.0 | |
| Learning profile | general academic profile | | Assessment form | | assessment | |
| Conducting unit | Department of Energy and Industrial Apparatus -> Faculty of Mechanical Engineering and Ship Technology | | | | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | | prof. dr hab. inż. Dariusz Mikielewicz | | | |
| | Teachers | | mgr inż. Michał Pysz | | | |

| Lesson types and methods of instruction | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
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| | Number of study hours | 15.0 | 0.0 | 0.0 | 15.0 | 0.0 | 30 |
| | E-learning hours included: 0.0 | | | | | | |

| Learning activity and number of study hours | Learning activity | Participation in didactic classes included in study plan | Participation in consultation hours | Self-study | SUM |
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| | Number of study hours | 30 | 2.0 | 18.0 | 50 |

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| Subject objectives | Presentation of principal mechanisms and laws of heat transfer. Lecture familiarises with methods of solving problems in technical applications, conduction and heat transfer problems as well as rtadiative heat transfer. Presents foundations to sizing of heat exchangers. |

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| Learning outcomes | <table><tr><th>Course outcome</th><th>Subject outcome</th><th>Method of verification</th></tr><tr><td>[K6_U04] is able to design a simple device structure and prepare the accompanying technical documentation, conduct a basic technical and economic analysis of energy systems, including technologies using renewable and pro-ecological energy sources as well as conventional and nuclear energy, design energy installations for them and their basic elements (including electric lighting) ); select, operate and control the most commonly used electrical devices and drive systems.</td><td>Students will be able to design the construction of a simple device and prepare the accompanying technical documentation, carry out basic technical and economic analysis of energy systems, including technologies using renewable and pro-ecological energy sources and conventional and nuclear energy.</td><td>[SU5] Assessment of ability to present the results of task<br>[SU4] Assessment of ability to use methods and tools<br>[SU1] Assessment of task fulfilment</td></tr><tr><td>[K6_W09] knows the dangers of electrical devices and the principles of protection against them, has basic knowledge of heat exchangers, has basic knowledge of power equipment such as pumps, compressors, turbines, combustion engines, boilers, pipelines and their accessories and methods of their selection depending on the needs</td><td>The student has a basic knowledge of heat exchangers, and methods of selecting them according to demand</td><td>[SW3] Assessment of knowledge contained in written work and projects<br>[SW1] Assessment of factual knowledge</td></tr><tr><td>[K6_W06] knows classic and developmental energy technologies, rules for the selection and operation of heat and energy devices and installations, basic principles of energy systems operation, basic issues regarding the reliability of energy devices and diagnostics, environmental effects of energy technologies used, methods of using renewable energy sources</td><td>The student will be familiar with classical and perspective energy technologies, the principles of selection and operation of thermal-energy equipment and installations, basic principles of operation of energy systems, environmental effects of applied energy technologies, ways of using renewable energy sources.</td><td>[SW3] Assessment of knowledge contained in written work and projects<br>[SW1] Assessment of factual knowledge</td></tr></table> |
| Subject contents | Lecture Presentation of major mechanisms and laws governing the flow of heat. Presentation of methods of solving of technical problems incorporating heat conduction, heat convection and radiative heat transfer. Methods of heat transfer intensification. Basics of heat exchanger design.The project consists of designing a heat exchanger for a dedicated application. |
| Prerequisites and co-requisites | maths I, II, III, physics, fluid mechanics, thermodynamics |
| Assessment methods and criteria | <table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Project</td><td>60.0%</td><td>60.0%</td></tr><tr><td>Written exam</td><td>60.0%</td><td>40.0%</td></tr></table> |

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| Recommended reading | Basic literature | 1.Mikielewicz J., Grochal B., Gumkowski S., Polesek-Karczewska S., Mikielewicz D., Wymiana ciepła, Wydawnictwo IMP PAN, 1996 2.F. Incropera, D. deWitt, Fundamentals of heat and mass transfer, 5th edition, CRC Press, 2007. 2.Wiśniewski S., Wiśniewski T., Wymiana ciepła, WNT, 2007. 4.Pudlik W., Wymiana i wymienniki ciepła, Wydawnictwo PG, Gdańsk 1996. |
| | Supplementary literature | No requirements |
| | eResources addresses | Adresy na platformie eNauczanie:<br>Wymienniki ciepła - Moodle ID: 37018<br>https://enauczanie.pg.edu.pl/moodle/course/view.php?id=37018 |

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| Example issues/ example questions/ tasks being completed | 1. Present and discuss known mechanisms of heat transfer on the example of overall heat transfer through a multilayer wall separating two fluids with different temperatures.<br>2. Derive the Peclet equation for overall heat transfer through a single layer wall separating two fluids.<br>3. Derive the expression for temperature distribution and rate of heat in a cylinder and a sphere.<br>4. Define the thermal resistance due to conduction, convection and overall heat transfer.<br>5. Present a definition of heat flux in a two-dimensional temperature field.<br>6. Discuss the examples of geometric similarity; why geometrical similarity is not sufficient for physical modeling of phenomena.<br>7. Derive the form of Biot number; explain in what way it is different from the Nusselt number. What can be assumed if the Biot number tends to zero?<br>8. Derive the form of the Nusselt number; explain in what way is it different from the Biot number.<br>9. Derive the relation enabling calculation of variable in time temperature in a body featuring a small thermal resistance. Conduct the analysis to the form expressing the temperature distribution in terms of non-dimensional numbers.<br>10. Derive the differential equation for a variable in time temperature field for the general case with small thermal resistance with account of radiative heat transfer and a constant heat flux.<br>11. Thermal-electric analogy. Explain the basics.<br>12. Write the expression for the rate of heat through a wall featuring fins on external side. Give the schematic of the problem with relevant explanations.<br>13. Fourier-Kirchoff equation discuss forms of that equation arising as a result of different assumptions, i.e. Fourier, Poisson and Laplace forms of that equation.<br>14. Derive the differential equation for temperature distribution in the pin fin, give the boundary conditions enabling solution of that equation. Subsequently give the assumptions when the rectangular fin can be analysed using that theory.<br>15. Hydrodynamic and thermal boundary layers.<br>16. Momentum-energy analogies for solution of conservation equations.<br>17. Discuss known ways of determination of heat transfer coefficient.<br>18. Give the mechanism of forced and natural convection. Give a set of non-dimensional numbers describing the respective mode of convection.<br>19. Give a major groups of heat exchangers. Present the assumptions for the analysis of recuperators.<br>20. Present a general algorithm for calculation of heat exchanger size.<br>21. Logarithmic mean temperature difference. Give the temperature distribution in cocurrent and counter-current flow. |
| Work placement | Not applicable |