GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Heat flows, PG_00051075		
Field of study	Technical Physics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2024/2025
Education level	first-cycle studies	Subject group	Optional subject group 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	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Sebastian Bielski	
	Teachers	dr inż. Sebastian Bielski	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	15.0	15.0	0.0	60

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
Number of study hours	60	5.0	35.0	100

Subject objectives

Presentation of knowledge concerning the heat transfer mechanisms. Application of analytical and numerical methods to solve the heat conduction problems.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_U02	Students uses analytical and numerical (Matlab) methods to solve heat conduction problems.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools
K6_W02	Students explain the definitions of quantities and laws used in the analysis of heat conduction, convection and thermal radiation.	[SW1] Assessment of factual knowledge

Subject contents	Lecture: 1. Preliminaries. 1.1. Definitions. 1.2. Heat transfer mechanisms: conduction, convection, thermal radiation. 1.3. Quantities and laws describing the heat transfer: conduction, Newton"s law of cooling, radiation. 2. Equations describing the heat transfer. 2.1. Thermal conductivity. 2.2. The temperature field. 2.3. The heat equation. 2.4. Boundary conditions. 3. Stationary heat conduction with no heat sources. 3.1. 1-dimensional case. 3.2. Multilayered walls. 3.3. 2-dimensional case. 4. Stationary heat conduction with heat sources. 4.1. The heat equation in case of the presence of the heat sources. 4.2. 1-dimensional cases of the heat conduction. 5. Non-stationary heat conduction. 5.1. Infinite wall. 5.2. A rod with insulated lateral surface. 5.3. Sphere. 5.4. Cylinder. 5.5. 2-dimensional case. 5.6. Non-stationary heat conduction in presence of the heat sources. 5.7. 1-dimensional cases, time-dependent boundary conditions. 5.8. The Pennes equation. 6. Convection 6.1. Continuity equation 6.2. Navier-Stokes equation 6.3. Energy equation 7. Thermal radiation. 7.1. Definitions. 7.2. Emissivity. 7.3. Heat transfer via radiation between two parallel surfaces. Laboratory: Basic commands of Matlab Project: Solving stationary and non-stationary heat conduction problems.
Prerequisites and co-requisites	

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Matlab test	50.0%	10.0%
semester project	50.0%	40.0%
exam	50.0%	50.0%

Recommended reading

Basic literature	R. Karwa, Heat and mass transfer, Springer, Singapore, 2017 J. H. Lienhard, J. H. Lienhard, A heat transfer textbook, Phlogiston Press, Cambridge, 2004 https://www.mathworks.com/help/
Supplementary literature	M. Kaviany, Principles of heat transfer
eResources addresses	Adresy na platformie eNauczanie: Przepływy ciepła_24/25 - Moodle ID: 42922 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=42922

Example issues/ example questions/ tasks being completed	LECTURE 1. Describe the quantities that affect the heat transfer via radiation between two parallel surfaces. 2. Derive the heat diffusion equation. 3. How much energy is radiated each second by one square meter of the black body if the spectral radiance peaks at = 484 nm? a) E = 1.47 J; b) E = 1.47 kJ; c) E = 0.735 J; d) none of the values above. 4. Describe the 1-dimensional case of the heat conduction in case of constant heat generation rate. LABORATORY 1. The temperature distribution in a cylinder of radius R = 0.5 is described by the equation: T''(r) + (1/r)*T'(r) + A = 0. Use the function ode45 and find the solution to this equation with the boundary condition T(R) = 400. Assume A = 2400. PROJECT 1. Consider a thin uniform rod of length L whose lateral surface is insulated from heat. The initial temperature of the rod is T0. From the time t = 0 both ends of the rod are maintained at 0. Determine the temperature of the rod for t > 0. The solution is to be found by two methods: analytical and numerical.
Work placement	Not applicable

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