



Subject card

Subject name and code	Heat flows, PG_00051075						
Field of study	Technical Physics						
Date of commencement of studies	October 2023		Academic year of realisation of subject		2025/2026		
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 -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Sebastian Bielski				
	Teachers		dr inż. Sebastian Bielski				
Lesson types	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						
	eNauczanie source addresses: Moodle ID: 2905 Przepływy ciepła (od 2025/26) https://enauczanie.pg.edu.pl/2025/course/view.php?id=2905						
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_W02] Has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, solid-state physics, nuclear and elementary particle physics.		The student explains the definitions of physical quantities and the laws governing heat transfer by conduction, convection and thermal radiation.		[SW1] Assessment of factual knowledge		
	[K6_U02] Can analyze and solve simple scientific and technical problems, based on possessed knowledge, using analytical, numerical, simulation and experimental methods.		The student uses analytical and numerical methods (Matlab) to solve heat conduction problems.		[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment		
	[K6_W05] Has knowledge of programming methodology and techniques, and the use of selected IT tools in physics and technology.		The student is familiar with basic Matlab commands that enable, for example, solving initial-value and boundary-value problems and creating plots.		[SW1] Assessment of factual knowledge		

Subject contents	Course content – lecture 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. Course content – laboratory • Basic Matlab commands. • Numerical solution of steady-state and transient heat-conduction problems. • Use of the PDE Modeler tool for modeling two-dimensional heat conduction. Course content – project Solving non-stationary heat conduction problems: • analytical solution • numerical solution • preparation of the report		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Matlab test	50.0%	10.0%
	exam	50.0%	50.0%
	semester project	50.0%	40.0%
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		

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 $\lambda = 484 \text{ nm}$? a) $E = 1.47 \text{ J}$; b) $E = 1.47 \text{ kJ}$; c) $E = 0.735 \text{ J}$; 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: $T''(r) + (1/r) \cdot T'(r) + A = 0.$ Use the function ode45 and find the solution to this equation with the boundary condition $T(R) = 400$. Assume $A = 2400$. 2. Find the steady-state temperature distribution in a rectangle where two adjacent sides have zero temperature and the remaining two sides are maintained at temperature T_0. PROJECT 1. Consider a thin uniform rod of length L whose lateral surface is insulated from heat. The initial temperature of the rod is T_0. 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. 2. Consider a sphere of radius R, whose initial temperature is T_0 and whose surface is maintained at zero temperature from time $t = 0$. Determine how the temperature will change within the sphere for $t > 0$. The solution is to be found using two methods: analytical and numerical.
Practical activities within the subject	Not applicable

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