GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Heat flows, PG_00064051		
Field of study	Technical Physics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2028/2029
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	5.0
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		

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						

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	60.0	125

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_W05] has knowledge of programming methodologies and techniques, as well as the use of selected IT tools in physics and engineering.	The student has knowledge of numerical methods for solving heat conduction equation problems using Matlab or other computational tool.	[SW1] Assessment of factual knowledge
[K6_W02] possesses structured knowledge of the fundamentals of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and molecular physics, solid-state physics, and nuclear and particle physics.	The student knows and is able to explain the definitions of physical quantities and the laws describing heat transfer through conduction, convection, and radiation.	[SW1] Assessment of factual knowledge
[K6_U02] is able to analyse and solve complex and non-standard scientific and technical problems using appropriate analytical, computational, numerical, simulation or experimental methods.	The student is able to select and apply appropriate analytical and numerical methods (e.g., in the Matlab environment) for the solution and analysis of complex heat conduction problems.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools

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
semester project	50.0%	40.0%
exam (60 min.)	50.0%	50.0%
Matlab test (60 min.)	50.0%	10.0%

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 = 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. 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 T0. 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. 2. Consider a sphere of radius R, whose initial temperature is T0 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 activites within the subject	Not applicable