GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Numerical methods in civil engineering, PG_00045891		
Field of study	Civil Engineering		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2023/2024
Education level	second-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	1	Language of instruction	Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Hydraulic Engineering -> Faculty of Civil and Environmental Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Dariusz Gąsiorowski	
	Teachers	dr hab. inż. Dariusz Gąsiorowski	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	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	45	2.0	3.0	50

Subject objectives	Achivement of basic knowledge dealing with the selected numerical techniques applied in hydraulic engineering.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W01] has knowledge of higher mathematics, physics and chemistry, which is a base of subjects, such as construction theory and advanced material technology	The student formulates the solution problem for the equations describing selected flow problems in hydraulic engineering as free surface flow in open channel, flow in the system of reservoirs and pipes, pollutant transport, groundwater flow. He describes solution of engineering problem using algorithm and he applies the numerical methods for solving the afore-mentioned problems.	[SW3] Assessment of knowledge contained in written work and projects
[K7_U14] is able to plan and to interpret the geotechnical investigatons, to analyse the foundation stability; can design direct and deep foundations in complex soil conditions for complcated statical and dynamical loads	The student is able to perform a detailed plan of experiment and to interpret its results. Student is able to perform a detailed design of fundation for various complex ground conditions	[SU4] Assessment of ability to use methods and tools
[K7_K02] Rocognizes the significance of knowledge in solving cognitive and practical problems; reliably evaluates results of his own and team research	The student understands the need for the dissemination of knowledge concerning environmental engineering (including hydrology, flood protection, water management, hydraulic engineering and drainage) to the public and can do it in an interesting, understandable and objective way. Student is able to use the acquired knowledge concerning his specialization (including hydrology, flood protection, water management, hydraulic engineering and drainage) in a creative way; understands the need to continuously deepen and verify in practice his professional skills; understands the problem of responsibility for his own work (the results of calculations, the quality of the reports etc.) and the responsibility for the work of the team.	[SK1] Assessment of group work skills
[K7_K01] is aware of necessity of professional competences improvement; obeys the professional ethics code	The student understands the need for the dissemination of knowledge concerning civil engineering to the public and he can do it in an interesting, understandable and objective way.	[SK4] Assessment of communication skills, including language correctness

Subject contents

LECTURE Methods for solution of the systems of linear algebraic equations: direct methods, iterative methods. Solution of the nonlinear algebraic equations and their systems. Interpolation and approximation: interpolation using the spline functions, approximation using the least squares method. Solution of the ordinary differential equations: initial value problem and boundary-value problem. Numerical methods of solution: one-step methods, explicit and implicit multi-step methods. Methods of solution for the systems of ordinary differential equations. Solution of equation for the steady gradually varied flow in open channel. Solution of the system of equations describing unsteady flow in reservoir, conduit and chamber. Numerical solution of the partial differential equations. Classification of equations. Well posed problem of solution. Finite difference method, approximation of the derivatives of I and II order. Finite element method. Solution of the diffusion equation (unsteady flow across a dike) and the advection-diffusion equations (pollutants transport in open channel). Solution of the Laplace equation (confined steady groundwater flow). Solution of the unsteady open channel flow equations.

LABORATORY EXERCISES Numerical solution of the ordinary differential equations describing selected flow problems existing in the hydraulic and environmental engineering (Runge-Kutta method, implicit trapezoidal rule). Numerical solution of the diffusion equation using explicit difference scheme.

Prerequisites and co-requisites

Knowledge of basics computer and operating system service Windows. Knowledge of the subject Mathematics, Bases of Computer Science and Hydraulics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Participation in lectures - 40 %, participation in laboratories, including working out a computer codes, making calculations, preparing a report and its presentation - 60 %	65.0%	100.0%

Recommended reading	Basic literature	1. Fortuna Z., Macukow B., Wąsowski J,: Numerical methods (Metody numeryczne). WNT Warszawa 1982. 2. Szymkiewicz R.: Mathematical modeling of flow in rivers and channels (Matematyczne modelowanie przepływów w rzekach i kanałach), Wyd. Naukowe PWN Warszawa 2000. 3. Szymkiewicz R.: Numerical methods in hydraulic engineering (Metody numeryczne w inżynierii wodnej). Wyd. Politechniki Gdańskiej, 2007. 4. Szymkiewicz R.: Numerical modeling in open channel hydraulics. Springer, 2010. 5. Szymkiewicz R., Huang S., Szymkiewicz A.: Introduction to computational engineering hydraulics. Gdansk University of Technology, 2016
	Supplementary literature	1. Fletcher C.A.J.: Computational techniques for fluid mechanics. Springer,1991
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	1.Solution of nonlinear algebraic equation (critical depth, normal depth). 2. Approximation of the rating curve using the method of least squares. 3 . Computation of the flow profile behind a dam - numerical solution of the ordinary differential equation. 4. Numerical solution of the diffusion equation.	
Work placement	Not applicable	