GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Modeling of water supply systems, PG_00042513		
Field of study	Environmental Engineering		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2022/2023
Education level	second-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Part-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Sanitary Engineering -> Faculty of Civil and Environmental Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Ryszard Orłowski	
	Teachers	dr inż. Maria Orłowska-Szostak dr inż. Ryszard Orłowski	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	15.0	10.0	0.0	0.0	40
	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	40	5.0	90.0	135

Subject objectives	The aim of the course is to acquaint the students with knowledge and abilities that enable to perform design and analytical works for the systems of water transport and distribution using the computer modeling of flows and storage of water in the system. Students are mastering new methods of the calibration of computer models using genetic algorithms among others. Apart from standard analyses of the system operation In computer performed analyses and design there are taking into account, among others, emergencies and fire situations.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U06] can use the known mathematical methods and models, if needed, to modify them, for: analysis and design of water systems and their components or water flows, migration of pollutants or water and wastewater treatment and sewage sludge handling	Student can use the known computer models for solving analysis tasks or designing optimal water supply systems. He knows the methods of optimal and reliable control of large systems using appropriate computer models.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[K7_W04] knows the basic automation methods, techniques, tools and systems used to solve complex engineering tasks in modeling, optimization and control of processes, objects and systems in environmental engineering	By solving complex engineering tasks in relation to water supply systems, it uses methods, techniques and tools of computer modeling (including professional software) as well as methods and algorithms that take into account optimization and reliability criteria.	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects
[K7_U14] can technically and economically analyze and evaluate the solutions and functioning of facilities and systems in the sanitary engineering or flood protection, water intakes and water infrastructure or water and wastewater treatment plants; can assess the suitability and potential of using new achievements in materials, fixtures, devices and methodologies for designing and modeling the analyzed technical infrastructure and industrial objects, including innovative solutions	Using computer modeling, he comprehensively analyzes the functioning of water transport and distribution systems in it in situations of fire and possible system failures.	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information
[K7_U09] can choose tools (analytical or numerical) to solve engineering problems	Student is able to adapt the tools , including the type of providing the computer software,to solve the task of analysis and optimal design of water supply systems.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools
[K7_W06] has deepened, structured and theoretical knowledge related to hydraulics used in the construction, operation, operation of networks and plumbing, sewage, heating, ventilation or water treatment plants and wastewater treatment facilities	While performing design work, he uses extended and in-depth knowledge in the field of hydraulics, computer modeling and design of water supply network; skillfully uses professional computer programs simulating of flows in the water supply systems to support design.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

Subject contents

LECTURES **1**. Structures of commercial computer programs for the mathematical modelling of flows in water supply systems and types of tasks as well as methods of solving them for the water transport and distribution system (STiDW)**:** a) task of the design type, b) task of redesigning the system (at different scopes of redesigning), c) tasks of the analysis of the existing system. **2**. Data preparation to the model of the existing system and the designed system. **3**. Calibration of the computer model of STiDW: various methods of calibration taking into account various assortment and character of made measurements and various methods of mathematical drawing up results of these measurements; discussions of achieved results of calibrations performed with different methods mentioned above. **4.** Discussing a number of hydraulic relations essential from the point of view of modelling of flows in the water supply system. **5**. The hydraulic drawings of the system of transport and distribution of water, made for the purposes of the computer modelling - examples of different types of pumping stations in water supply systems (at water intakes, zone stations, etc.); describing the water supply system in the form of the graph. **6**. Ways and scopes of practical using the computer modelling of flows in the case of existing system and of the designed system. **7**. Important engineering and design issues: -pressure zoning in water supply systems, -principles of control of flows and storing water using the pumps with the frequency speed drives (FSD) and the pressure reducing valves, - computer assisted dispatcher control of STiDW. **8**. Traditional and of new methods of solving sets of conservation equations describing flows in STiDW.

AUDITORIAL CLASSES Individual example cases of STiDW for distinguish students (maps, plans of water supply systems and the remaining data given as the first approximation) for using on design classes. Data preparation for the modelling carried out on the design classes. Principles/algorithm of the STiDW design with the method of variants analysis. The assortment and the manner of conducted versatile analyses of the defined/seted system.

LABORATORY Starting computer simulations of individual examples of water supply systems, prepared on auditorial classes. Redesigning of examples mentioned above with the method of the analysis of variants for achieving satisfactory results for thoroughly studied systems. Demonstrating (with the help and the participation of students) a number of other examples prepared earlier by the leading person; current discussion and analysis of achieved results of the simulations of individual examples.

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<tr><td>Prerequisites and co-requisites</td><td colspan="2">Mastered basic program with the subject "Water Supply". Knowledge of basis of hydraulics, description of flow in pressure conduits. Basic knowledge of numerical methods; general knowledge of methods of solving of sets of nonlinear equations.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Lab report</td><td>90.0%</td><td>40.0%</td></tr>
<tr><td>Written exam</td><td>50.0%</td><td>60.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>**1**. Kulikowski J. L. (1986). Zarys teorii grafów – zastosowania w technice. PWN, Warsaw, Poland. **2**. Mielcarzewicz E. W. (1998). Obliczanie systemów zaopatrzenia w wodę Arkady, Warsaw, Poland. **3**. Orłowska-Szostak M. Instrukcja opracowywania danych do symulacji programem EPANET opracowana przez prowadzącego zajęcia. Przekazana studentom w formie elektronicznej. **4**. Orłowski R. (2006). „Comprehensive circumscribing of non-linearity cases of a water supply system with smooth flow control”. Archives of Hydro-Engineering and Environmental Mechanics, IBW PAN, Poland, vol. 53 (1), 2006, pp. 7-30. **5**. Findeisen, Wł. (1985). Analiza systemowa. PWN, Warsaw, Poland. **6**. Orłowski, R. (1998). „Projektowanie i analiza systemów wodociągowych z zastosowaniem modelowania matematycznego przepływów ustalonych.” Gaz, Woda i Technika Sanitarna, PZITS, Poland, 7/98, 299 ÷ 307.</td></tr>
<tr><td>Supplementary literature</td><td>**1**. Walski T. M. (1985). Analysis of Water Distribution Systems. Van Nostrand Reinhold Co. Inc., New York. **2**. Grabarczyk Cz. (1997). Przepływy cieczy w przewodach. Metody obliczeniowe. ENVIROTECH, Poznań 1997. **3**. Grabarczyk Cz.(2015). Hydraulika urządzeń wodociągowych Tom 1 i 2. WNT. **4**. Orłowski, R. (1997). Modelowanie matematyczne przepływów ustalonych w systemach wodociągowych. Zeszyty Naukowe Politechniki Gdańskiej, seria: Budownictwo Wodne. Nr 42, Gdańsk, Poland. **5**. Orłowski, R. (1999) „Techniczne i ekonomiczne aspekty płynnego sterowania pracą pomp w systemach i instalacjach wodociągowych, kanalizacyjnych, ciepłej wody i c. o.” Gaz, Woda i Technika Sanitarna, PZITS, Poland, 12/99, 449 ÷ 458.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">The hydraulic drawings of the system of transport and distribution of water, made for the purposes of the computer modelling - examples of different types of pumping stations in water supply systems (at water intakes, zone stations, etc.); describing the water supply system in the form of the graph.

Data preparation to the computer model of the working water supply system and of the water supply system being designed.

Description of various methods and hydraulics of the zoning of the pressure in water supply systems.

Elaboration of computer model of exemplary water supply system and using the model for designing correctly operating water supply system.

Using the computer models in the optimum and reliable, computer assisted dispatcher control of the system of transport and distribution of water.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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