STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Fluid Mechanics**		Code **1010101221010130197**

Field of study **Environmental Engineering First-cycle Studies**	Profile of study (general academic, practical) **(brak)**	Year /Semester **1 / 2**

Elective path/specialty **-**	Subject offered in: **-**	Course (compulsory, elective) **obligatory**

Cycle of study: **First-cycle studies**	Form of study (full-time,part-time) **full-time**

No. of hours Lecture: **30** Classes: **30** Laboratory: **15** Project/seminars: **-**	No. of credits **5**

Status of the course in the study program (Basic, major, other) **(brak)**	(university-wide, from another field) **(brak)**

Education areas and fields of science and art **technical sciences** **Technical sciences**	ECTS distribution (number and %**)** **5 100%** **5 100%**

Responsible for subject / lecturer: prof. dr hab. inż. Janusz Wojtkowiak, prof. nadzw. email: janusz.wojtkowiak@put.poznan.pl tel. 6652442, 6652413 Faculty of Civil and Environmental Engineering ul. Piotrowo 5 60-965 Poznań	Responsible for subject / lecturer: Dr inż. Ilona Rzeźnik (tutorials) email: ilona.rzeznik@put.poznan.pl tel. (61) 6652524 Faculty of Civil and Environmental Engineering ul. Piotrowo 5 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Mathematics: algebra - functions, equations and inequalities, plane and space geometry, trigonometry, analytic geometry, basic probability theory, equations and systems of equations, elements of differential and integral calculus of functions of one variable at a level 5/6 KRK
		Physics: fundamental lows of physics, rules of mass momentum and energy conservation in classical mechanics, statics, kinematics, dynamics, and hydraulics at level 5 KRK
2	**Skills**	Solving algebraic equations and systems of algebraic equations, formulating physical problems in the language of mathematics, solving simple differential equations, the use of integral calculus to calculate the geometrical quantities (eg, surface areas) and physical quantities (eg, average values of velocity, momentum of inertia), solving typical problems in classical mechanics - statics, kinematics, dynamics and hydraulics.
3	**Social competencies**	Awareness of the need to constantly update and supplement knowledge and skills

Assumptions and objectives of the course:

Purchase by the students basic knowledge and skills in fluid mechanics necessary to solve common tasks of fluid flows occurring in the build and natural environment.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. The students knows physical quantities characterizing fluids, understands their physical meaning and knows their units - [K_W03]

2. The student has knowledge of hydrostatic force on plane and curved surfaces - [K_W03, K_W07]

3. Student knows and understands equations describing force and torque by the flow on the walls - [K_W03, K_W07]

4. The student has an elementary knowledge of the laws governing the operation of turbomachinery (pumps, funs, blowers and compressors) - [K_W03, K_W04, K_W05]

5. The student has ordered knowledge of the phenomena responsible for the loss of pressure in the pipes and fittings and knows the equations used to describe them - [K_W02, K_W03, K_W05, K_W07]

6. The student has a basic knowledge necessary for modeling the flow of water in the soil - [K_W03, K_W07]

7. The student understands the causes of water hammer and cavitation phenomena in hydraulic systems, and knows the laws used to describe them - [K_W03, K_W07]

8. The student knows and understands the phenomena occurring during the flow in open channels (free surface flow) and knows equations describing these phenomena - [K_W03, K_W07]

9. The student knows and understand the laws describing liquid flows from the tanks - [K_W03, K_W04]

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Skills:
1. The student can apply and convert units of physical quantities used in fluid mechanics - [K_U01]
2. The students can calculate: hydrostatic forces on plane and curved surfaces of the tanks, the forces of dynamic interactions between flowing fluid and pipe walls and immersed bodies, the power and efficiency of turbomachines - [K_U01, K_U013,]
3. The student can calculate: pressure losses in straight pipes and fittings, the pressure differences that cause a chimney effect and natural ventilation, the pressure increase and velocity of pressure wave in water hammer phenomenon - [K_U01, K_U013,]
4. The student can calculate: danger of cavitation in hydraulic systems, flow rates in free surface flows, optimal shapes of channels in free surface flows, discharge time of tanks and vessels - [K_U01, K_U013,]
5. The student can measure: pressure of fluid (static, dynamic and total), average velocity of fluid in internal and free surface flows, pressure losses in pipes and fittings, power and efficiency of pumps, fans and blowers - [K_U01, K_U08, K_U09]

Social competencies:
1. The student understands the need for teamwork in solving theoretical and practical problems - [K_K03, K_K04]
2. The student is aware of the need to repeat the measuring actions and to evaluate the uncertainty of measurement and calculation results - [K_K05]
3. The student sees the need for systematic increasing his skills and competences - [K_K01]

Assessment methods of study outcomes
Lectures
?Final exam consists of two parts. Part 1: knowledge test (4 questions to answer), Part. 2: test of skills (2 problems to solve),
?Continuous assessment during lectures (rewarding activity of the students).
Tutorials
?Two short written tests during the semester and one written final test
?Continuous assessment of the students (rewarding students activity).
Laboratory exercises:
?Assessment of individual prepared reports and their oral presentation
?Continuous assessment of the students during laboratory exercises.

Course description
Classification of fluids. Newtonian and non-newtonian fluids. Shear stress in the fluid, the perfect fluid and viscous fluid. Basic physical properties of fluids. Effect of temperature and pressure on parameters of fluids.
The basic equation of fluid statics. The hydrostatic pressure. Absolute pressure, over-and underpressure. Archimedes low. The pressure distribution in the Earth atmosphere. The surface tension. Hydrostatic force on plane and curved surfaces. The equation of continuity. Local velocity and average velocity of the fluid. The velocity distribution. Friction pressure losses. Laminar and turbulent flows. Critical Reynolds number. Bernoulli equation for inviscit and viscous fluids. Friction factor. Darcy-Weisbach formula. Hagen and Blasius formulas. Roughness of the pipe, Moody chart. Colebroock-White, Walden and Haaland formulas. Minor pressure loss. Calculation of pressure losses in complex hydraulic systems. Momentum of the fluid. Force and torque by the flow on the walls. Water hammer phenomenon. Orifice flow, tank discharge. Weirs. Open channel flows. Chezy formula. Manning roughness coefficient. Subcritical and supercritical free surface flows. Froude number. Optimal shape of open channel cross-section. Measurements of liquid flow in open channels. Underground water motion. Water inflow to traditional and artesian wells. Calculation of gas tank discharge and gas flow in pipes. Bernoulli equation for adiabatic gas flow.

Basic bibliography:
1. Mitosek M., Mechanika płynów w inżynierii i ochronie środowiska. Warszawa, PWN 2001
2. Orzechowski Z., Prywer J., Zarzycki R., Mechanika płynów w inżynierii środowiska. Wyd. 2 zmienione. Warszawa, WNT 2001
3. Jeżowiecka-Kabsch K., Szewczyk H., Mechanika płynów. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2001
4. Mitosek M., Matlak M., Kodura A., Zbiór zadań z hydrauliki dla inżynierii i ochrony środowiska. Oficyna wydawnicza Politechniki Warszawskiej, Warszawa 2004
5. Orzechowski Z., Prywer J., Zarzycki R., Zadania z mechanika płynów w inżynierii środowiska. Warszawa, WNT 2001
6. Bogusławski L. (Red.), Ćwiczenia laboratoryjne z mechaniki płynów. Wydawnictwo Politechniki Poznańskiej, Poznań 1999
7. Niełacny M., Ćwiczenia laboratoryjne z mechaniki płynów. Wydawnictwo Politechniki Poznańskiej, Poznań 1996

Additional bibliography:
1. Munson B.R., Young D.F., Okiishi T.H., Fundamentals of Fluid Mechanics (4rd. Ed.). John Wiley and Sons Inc., New York 2002
2. White F.M., Fluid Mechanics. McGrawHill Book Company. 5th Int. Ed. Boston 2003

Result of average student's workload

http://www.put.poznan.pl/

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Activity	Time (working hours)
1. Participation in lectures	45
2. Participation in tutorials	30
3. Participation in laboratory exercises	15
4. Preparation for the laboratory exercises	9
5. Preparing (at home) reports of the laboratory exercises	8
6. Participation in consultations related to the lectures, tutorials and laboratory exercises	3
7. Preparation for the final test of tutorials	10
8. Preparation for the exam and the present at the exam	15
Student's workload	

Source of workload	hours	ECTS
Total workload	135	5
Contact hours	93	4
Practical activities	15	1