Annex 9
to the Rector's Ordinance No. 35/19
of 12 June 2019

COURSE SPECIFICATION

Course code	**M#1-S1-ME-408**
Course title in Polish	**Mechanika Płynów**
Course title in English	**Fluid Mechanics**
Valid from (academic year)	**2019/2020**

GENERAL INFORMATION

Programme of study	**MECHANICAL ENGINEERING**
Level of qualification	**first-cycle**
Type of education	**academic**
Mode of study	**full-time**
Specialism	**all**
Department responsible	**Department of Mechanics**
Course leader	**dr hab. inż. Robert Pastuszko**
Approved by	

COURSE OVERVIEW

Course type	**basic**
Course status	**compulsory**
Language of instruction	English
Semester of delivery	**semester 4**
Pre-requisites	**Mathematics**
Examination required (YES/NO)	NO
ECTS value	**3**

Mode of instruction	**lecture**	**class**	**laboratory**	**project**	**seminar**
No. of hours per semester	**15**	**15**	**15**		

LEARNING OUTCOMES

Category of outcome	Outcome code	Course learning outcomes	Corresponding programme outcome code
Knowledge	W01	On completion of the course, students will have knowledge on basic properties of fluids; a student will be able to know the differences between ideal and real fluids.	MiBM1_W04 MiBM1_W21
	W02	A student will have skills on fluid statics including basic equations of statics; a student will know the instruments for measuring pressure and their applications; a student will be familiar with the differences between absolute pressure, negative pressure and overpressure, Pascal's law; a student will have and elementary knowledge on determining hydrostatic forces on submerged surfaces; a student will have the skills to understand fluids in rigid-body motion.	MiBM1_W04 MiBM1_W21
	W03	A student will be able to use basic notions of fluid kinematics; a student will have a fundamental knowledge of about equations of continuity.	MiBM1_W04 MiBM1_W21
	W04	A student will be familiar with mass and volume flow rate; a student will have knowledge on: Euler and Bernoulli equations, Reynolds number and other similarity numbers used in fluid mechanics; a student will have basic knowledge on energy losses and the methods of their determining; a student will have an elementary knowledge flows around solid bodies by viscous fluids, and drag and lift forces.	MiBM1_W04 MiBM1_W21
Skills	U01	A student will have the skills to determine main properties of fluids with temperature and pressure changes.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
	U02	A student will be able to utilize Pascal's law to calculate force increase in a hydraulic system; a student will have the skills of calculating hydrostatic pressure in closed containers; a student will be able to solve basic problems concerning fluids in rigid-body motion.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
	U03	A student will be able to to determine mass and capacity flow rates; a student will have the skills to apply the continuity equation; a student will be able to determine the Reynolds number.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
	U04	A student will have the skills to utilize Bernoulli equation for internal flow of an ideal fluid.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
	U05	A student will have the skills to utilize the Bernoulli equation for internal flow of a real fluid.	MiBM1_U01 MiBM1_U03 MiBM1_U04 MiBM1_U20 MiBM1_U21
Competence	K01	A student will be aware of the impact of fluid storage and transport method on the natural environment.	MiBM1_K01 MiBM1_K02 MiBM1_K03

	K02	A student will be able to work in a team during measurements and to analyze the results; a student will be aware of the importance of knowledge concerning the principles of teamwork.	MiBM1_K01 MiBM1_K02 MiBM1_K03 MiBM1_K04

COURSE CONTENT

Type of instruction*	Topics covered
lecture	1. Introduction to fluid mechanics. Real and ideal fluids. The properties of fluids. Forces acting on fluids.
	2. Fluid statics. Basic equation of fluid statics. The equation of fluid equilibrium in a three-dimensional system. Pressure and pressure measurement. Pascal's law.
	3. Pressure measurement devices. Hydrostatic forces on submerged plane and curved surfaces. Stevin's paradox. Fluids in rigid-body motion.
	4. Buoyancy, floating and stability. Archimedes' principle. Elements of compressible fluids statics.
	5. Basic concepts of fluid kinematics. Continuity equation. The description of fluid motions. The dynamics of fluids – Euler's equation of motion. Bernoulli's equation. The applications of Bernoulli's equation.
	6. Dynamic equations of viscous fluid (Navier-Stokes). Internal flow. The Hagen-Poiseuille law. Laminar and turbulent flows. Major and minor losses.
	7. Bernoulli equation including energy losses. Types of fluid flow problems. Energy and hydraulic grade lines.
	8. The concept of a boundary layer. Flow over cylinders and spheres. Drag and lift forces.
class	1. Physical properties of fluids: mass, density.
	2. Physical properties of fluids: compressibility, expansion, viscosity.
	3. Hydrostatic pressure. Pressure–depth relationship, Pascal's law.
	4. Hydrostatic balance. Connected vessels.
	5. Mass and volumetric mass flow rate. Continuity equation.
	6. Bernoulli's equation for a perfect fluid.
	7. Bernoulli's equation for real fluid. Major and minor losses. Reynolds number.
laboratory	1. Passing requirements. Familiarizing students with health and safety and fire protection regulations in the Laboratory of Fluid Mechanics. Principles of developing experimental data.
	2. Measurement of shear stresses and viscosity.
	3. Relative equilibrium of liquids.
	4. Flow visualization - critical Reynolds number.
	5. Losses by pipe friction: determination of Darcy friction factor during the flow of water in the close loop.
	6. Head losses: determination of the head loss factor for the sudden change of area.
	7. Determining of the characteristics of a selected flow machine (a pump).

*) Please delete rows in the table above that are not applicable.

ASSESSMENT METHODS

Outcome code	**Methods of assessment** *(Mark with an X where applicable)*					
	Oral examination	Written examination	Test	Project	Report	Other
W01			X			
W02			X			
W03			X			
W04			X			
U01			X		X	
U02			X		X	
U03			X		X	

U04			X		X	
U05			X		X	
K01						X
K02			X			

ASSESSMENT TYPE AND CRITERIA

Mode of instruction*	Assessment type	Assessment criteria
lecture	**non-examination assessment**	The pass mark is a minimum of 50% for the final in-class test.
class	non-examination assessment	The pass mark is a minimum of 50% for all the in-class tests
laboratory	non-examination assessment	The pass mark is a minimum of 50% for each pre-lab test and each post-lab report.
project	non-examination assessment	
seminar	non-examination assessment	

*) Please delete rows in the table above that are not applicable.

OVERALL STUDENT WORKLOAD

ECTS weighting							
	Activity type	**Student workload**					**Unit**
1.	Scheduled contact hours	L	C	Lab	P	S	h
		15	15	15			
2.	Other contact hours (office hours, examination)	2	2	2			h
3.	**Total number of contact hours**	**51**					h
4.	**Number of ECTS credits for contact hours**	**2,0**					ECTS
5.	**Number of independent study hours**	**24**					h
6.	**Number of ECTS credits for independent study hours**	**1,0**					ECTS
7.	**Number of practical hours**	**50**					h
8.	**Number of ECTS credits for practical hours**	**2,0**					ECTS
9.	**Total study time**	**75**					h
10.	**ECTS credits for the course** *1 ECTS credit = 25-30 hours of study time*	**3**					ECTS

READING LIST

1. Y. Nakayama, R.F. Boucher: Introduction to Fluid Mechanics, Butterworth-Heinemann 2002
2. Y. A. Cengel, J. M. Cimbala: Fluid Mechanics. Fundamentals and Applications, McGraw-Hill Inc. 2014.
3. B. R., Munson, D. F. Young, T. H. Okiischi, W. W. Huebsch: Fundamental of Fluid Mechanics, John Wiley & Sons Inc., 2009.
4. J. B. Evett. C. Liu: 2 500 Solved Problems in Fluid Mechanics & Hydraulics, McGraw-Hill Inc., 1988.