GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Fluid Mechanics, PG_00051278		
Field of study	Transport and Logistics, Transport and Logistics		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2021/2022
Education level	first-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Theory and Ship Design -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Michał Krężelewski	
	Teachers	mgr inż. Olga Kazimierska dr inż. Michał Krężelewski dr hab. inż. Paweł Flaszyński	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	15.0	0.0	0.0	0.0	30

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	30	4.0	16.0	50

Subject objectives

o familiarize students with the basic concepts and laws of fluid mechanics, such as:
- density, viscosity, compressibility, surface tension,
- Static equilibrium equations of fluid, hydrostatic pressure, fluid forces on straight surfaces, etc.
- Continuity equation,
- The principle of momentum conservation,
- Calculation of hydrodynamic forces,
- The principle of conservation of energy for non-viscous fluid, incompressible flow (Bernoulli eq.)
- Basic issues of viscous liquid flow, determination of losses in the flow.
- The concept of the stress tensor in a real (viscous) fluid.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U02] can work individually and in a team, communicate through various techniques in professional environment and also record, analyse, and present the results of work, can estimate the time needed to complete a given task	The student is able to solve simple tasks in the field of fluid mechanics (fluid statics, 1D ideal and real fluid flows). He can estimate the time and resources to solve the assigned task.	[SU3] Assessment of ability to use knowledge gained from the subject
[K6_W02] has a basic knowledge in physics, including technical mechanics, fluid mechanics, solid-state physics, optics and acoustics necessary to understand basic physical phenomena occurring in transport	The student formulates basic flow problems and solves them based on the laws and methods of fluid mechanics. Applies the laws and methods of fluid mechanics in design and for understanding the physical phenomena occurring in ocean engineering.	[SW3] Assessment of knowledge contained in written work and projects

Subject contents	Scope of the course: The main properties of fluids: - The density, viscosity, compressibility, surface tension, Basic concepts: - Particle fluid - The pressure, shear stress, - Pascal's law. Fluid statics: - The hydrostatic equilibrium equations of fluid - The hydrostatic pressure formula, - Pressure force to the flat surface - - The concept of the center of pressure force, - - Calculation of the moment of pressure force. - - Buoyancy, center of buoyancy. - Stability of floating bodies (ships) - - Metacentric radius, - - Metacentric height, - - Equilibrium conditions. The main issues of fluid kinematics: - A description of the motion of fluids: - - Eulerian method, - - Lagrangian method - Determination of position, velocity and acceleration of the fluid, - The concept of the path of the fluid particles (pathline), streamline, streamsurface, streamtube The principle of conservation of mass (continuity equation): - The concept of the mass flow rate the volumetric flow rate, - The concept of control surface, control volume - Calculation of the flow velocity at varying cross channel The principle of conservation of energy for perfect fluid, incompressible flow (Bernoulli's equation): - Solving one-dimensional flow problems in channels: determination of the flow rate and pressure. The principle of conservation of momentum, - The concept of a volume of liquid, - Guiding principles of conservation of momentum in the form of integral, - Calculation of hydrodynamic forces, The concept of the stress tensor in a real(viscous) fluid. Basic issues of the real fluid flow, determination of loss in the flow: - Generalized Bernoulli equation, - Determining the amount of local loss and linear : - - Types of flow of real fluids: - - - Laminar flow - - - Transitional flow, - - - Turbulent flow.
Prerequisites and co-requisites	Knowledge of the basic concepts of physics / mechanics: - Force (force vector) - Torque, - The arm of force, - What is the pressure (?) - Momentum, potential energy, kinetic energy, - Knowledge of units related to above concepts, Knowledge of the basic concepts of calculus / calculus - Definite integral, - Derivative of the function, - Basic ability to apply integrals in problems of physics - Ordinary differential equations with separated variables - The surface integral, volume integral Knowledge of algebra: - The transformation of algebraic expressions, - The ability to "take before the parenthesis" (!!!) Algebra of vectors: - The scalar product, - Vector product, - Vector component, - The projection of the vector on the direction of the specified unit vector Knowledge of trigonometric functions - Sine, cosine, tangent, cotangent Basic knowledge of stereometry (3D geometry) - Eg .: calculating the volume of a cylinder, cuboid, and the like. - Eg .: calculating the area of the cylinder Knowledge of floating point notation, eg .: * 10 ^ 6 - Ability to use scientific calculator
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture - Colloquium	50.0%	60.0%
Exercises - Colloquium	50.0%	40.0%

Recommended reading	Basic literature	[1] Bar-Meir, Genick, Basics of Fluid Mechanics, Last modified: Version 0.3.4.0 March 17, 2013, www.potto.org/downloads.php [2] Yunus A. Çengel, John M. Cimbala: Fluid Mechanics. Fundamentals and Applications. McGraw Hill Higher Education, Boston, 2006
	Supplementary literature	[3] Bruce R. Munson, Alric P. Rothmayer, Theodore H. Okiishi, Wade W. Huebsch: "Fundamentals of Fluid Mechanics, Student Solutions Manual and Student Study Guide". Wiley, 2012
	eResources addresses	
Example issues/ example questions/ tasks being completed	NOTE: In order to complete the course all colloquia MUST be passed 1. Define the basic terms of determining the properties of the fluid: a) density, b) specific gravity, c) viscosity. 2. Enter the formula for the shear stress for Newtonian fluid. Name the individual members of the equation, draw a sketch illustrating the issue for a simple case. 3. Provide the definition of pressure. Write a basic formula for the pressure, describe occurring in the formula values. 4. Describe the concept rate of volume/mass flow. Provide definitions (formulas): a) the mass flow rate b) the volumetric flow rate 5. Provide and explain the continuity equation in the integral form 6. Derive, on the basis of the second law of Newton's, law of conservation of momentum for the volume of the fluid. Describe members included in the equation. 7. Provide the general form of the stress tensor of the fluid. Describe the elements of the tensor. Show how to obtain the stress on the surface of the direction specified wersorem n. What form takes the stress tensor for an perfect (inviscid) fluid . 8. Formulate energy conservation equation for the perfect (inviscid) fluid and incompressible steady flow along a streamline. Name the individual members of the equation. 9. Liquid is flowing pipeline. In the section "1" a cross-section area is A1, the height above the base z1, the liquid velocity is V1, and the pressure is p1. Provide speed v2, and the pressure p2 in the section "2" pipe, if we know its cross-section area A2 and the height above the baseline z2. The head loss between "1" and "2" is hs. 10. Derive the formula for the hydromechanical reaction acting on the flowed body. 11. What characterizes (in terms of the most important feature): a) perfect fluids, b) real fluids. 12. Give the equation that defines: a) The streamline, b) The path of the fluid paricle (pathline, trajectory). In which case the streamline and the pathline will be the same lines. 13. Calculate the volume and mass flow rate of air through the area A which is an inlet to the building air conditioning system for the following data: - normal unit vector to the A surface: n = [1.414; 0; 1.414], the surface area A = 1m2; - average velocity vector on the surface A: v = [1; 0; 0] [m / s] - air density ro = 1.2 kg / m3 EXERCISES: You should master the tasks solved in the classroom	
Work placement	Not applicable	