University of Gdańsk

Subject card

Subject name and code	Introduction to Geophysical Fluid Mechanics - laboratory, PG_00206214						
Field of study	Oceanography						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2026/2027		
Education level	Master's studies		Subject group		Obligatory subject group in the field of study 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		3.0		
Learning profile	academic		Assessment form		credit		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr Jordan Badur				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	45.0	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		28.0	75
Subject objectives	Students are introduced into Fluid Mechanics, in geophysical setting, including large and medium-scale ocean circulation using mathematical modelling techniques and relevant software.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[OCEANMU2-K03] is ready to effectively organize his/her own work, is active and persistent and punctuality in completing tasks, is ready to carrying out evaluation of their own activities	is ready to effectively organize his/her own work while solving problems in fluid mechanics, is active and persistent and punctual in completing tasks, is ready to evaluate his/her own activities	[SK4] test/exam - oral or written [SK5] implementation of a problem task
[OCEANMU2-W02] knows and understands complex processes and phenomena occurring in the marine environment, with particular emphasis on the coastal zone, as well as complex relationships between living and non-living elements of the aquatic environment	knows and understands, in-depth, complex aspects of fluid mechanics and medium-to-large scale flows and their interaction with marine life.	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion
[OCEANMU2-U01] is able to formulate and solve complex and unusual problems regarding the functioning of individual components of the marine environment using knowledge from various fields and scientific disciplines and propose solutions	is able to solve complex problems regarding geophysical flows using relevant mathematical, computational and data-based modelling techniques.	[SU4] test/exam - oral or written [SU5] implementation of a problem task
[OCEANMU2-U02] is able to fluently and accurately use scientific terminology when presenting and discussing oceanographic issues, and to propose and justify innovative solutions	can use fluid mechanics terminology fluently and appropriately while discussing oceanographical applications of fluid mechanics	[SU1] oral statement/conversation/ discussion [SU4] test/exam - oral or written
[OCEANMU2-U06] is able to use specialized computer software as well as advanced mathematical and statistical methods to analyze data and describe processes and phenomena occurring in the marine and coastal environment; evaluates their reliability and usefulness and performs critical analysis	can use mathematical methods of fluid mechanics and relevant software to analyse data and solve problems, describe large and mesoscale fluid flows.	[SU4] test/exam - oral or written [SU5] implementation of a problem task

Subject contents

The class will concentrate on discussing and solving problems (using mathematical, analytical techniques and software) on:

1. Fluid kinematics, Lagrangian, Eulerian and mixed formulations; Constitutive equations, mass, momentum, energy and vorticity balance; Turbulence and turbulence closures.
2. The shallow water equation: in a homogeneous, multi-layered and stratified medium; geostrophic balance, thermal wind. Conservation of vorticity and energy in the shallow water approximation. Poincaré waves and Kelvin waves, geostrophic adjustment: energy balance and available potential energy.
3. Advanced analysis of the geostrophic approximation; the planetary and quasi-geostrophic approximations.
4. Frictional boundary layers: the Ekman layer model.
5. Rossby waves and the energy transport equation. Internal waves.
6. Hydrodynamic instability of baroclinic and barotropic flows on the rotating Earth.
7. Ocean circulation: Stommel Munk and Fofonoff models; the two-layer quasi-geostrophic model.

Prerequisites and co-requisites

Passing grade in "Mathematical methods in Oceanography" and "Programming and data analysis" OR working knowledge of single and multi-variate calculus; ability to solve selected types of differential equations and to calculate Fourier transform of a given function.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
assigments and classroom activities	51.0%	20.0%
written examination	51.0%	80.0%

Recommended reading

Basic literature

- Kundu, Cohen, Dowling, 2016. Fluid Mechanics, Academic Press, London (selected chapters),
- Cuishman-Roisin B. & Beckers J.M, 2011. Introduction to Geophysical Fluid Mechanics, Academic Press, Amsterdam (selected chapters)
- Vallis G.K, 2019. Atmosphere and Ocean Dynamics, Cambridge Univ. Press, Singapore,(selected chapters)

	Supplementary literature	• White F., 2017. Fluid Mechanics in Si units, McGraw Hill India (selected chapters, good for developing intuition) • Mellor G.L., 1996. Introduction to physical oceanography, Wyd. AIP Press (selected chapters) • Druet, Cz. 2010. Dynamika morza, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk. • Massel S.R. 2010. Procesy hydrodynamiczne w ekosystemach morskich. Wyd. Uniwersytetu Gdańskiego, Gdańsk. • Pedlosky, J. 2013(1987). Geophysical Fluid Dynamics. Springer, New York.
	eResources addresses	
Example issues/ example questions/ tasks being completed	Formulate, discuss and possibly derive the general vorticity conservation equation for viscous fluids Starting from Euler equation, derive governing equations for the vortex-sheet instability	
Work placement	Not applicable	

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