University of Gdańsk

Subject card

Subject name and code	Programming and Data Analysis Methods - laboratory, PG_00206210		
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
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	4.0
Learning profile	academic	Assessment form	credit
Conducting unit	Division of Mathematical Methods of Physics -> Institute of Theoretical Physics and Astrophysics -> Faculty of Mathematics, Physics and Informatics -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Adrian Kołodziejski	
	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	5.0	50.0	100

Subject objectives

Mastering advanced programming techniques in selected language; proficiency in time series and spatial data visualisation, analysis and interpolation; ability to work with large datasets, competence in the application of selected linear algebra techniques.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[OCEANMU2-U11] is able to work individually and cooperate in laboratory and field groups, performs various functions in them, including managerial ones, performs various assigned tasks	is able to work individually and cooperate in computer laboratory groups, performs various functions in them, including managerial ones, performs various assigned tasks	[SU4] test/exam - oral or written [SU5] implementation of a problem task
[OCEANMU2-W03] has an in-depth understanding of research methods used in oceanography and related sciences, and interprets their mechanisms and interrelationships across different spatial and temporal scales	knows and understands programming techniques used to visualize, analyze and interpolate oceanographical data; is able to use relevant numerical algebra techniques.	[SW4] test/exam - oral or written [SW5] implementation of a problem task
[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 advanced programming techniques and mathematical methods in data analysis and description of processes and phenomena occurring in the marine environment and coastal zone	[SU4] test/exam - oral or written [SU5] implementation of a problem task

Subject contents	1. Fundamental principles and concepts of programming in Python. Advanced aspects of the Jupyter Notebook environment and script-based programming. 2. Operations on multidimensional arrays using numerical libraries NumPy and SciPy. Vectorization of computations and broadcasting mechanisms. Matrix algebra: matrix multiplication, solving systems of linear equations, eigenvalues and eigenvectors, matrix decompositions (introduction to SVD). 3. Working with large datasets. Reading, processing, and writing data in formats commonly used in oceanography (including CSV and HDF5). Use of pandas and xarray libraries for handling tabular and multidimensional data. Time series processing, handling missing data, data aggregation, and filtering. 4. Visualization of time series and two- and three-dimensional fields. Use of advanced features of the Matplotlib library. 5. One-dimensional and two-dimensional interpolation methods (linear interpolation, polynomial interpolation, splines). 6. Selected techniques of time series analysis, data filtering and smoothing. Introduction to spectral analysis (FFT). 7. Data clustering methods (k-means and DBSCAN algorithms), dimensionality reduction (PCA) as an application of linear algebra in environmental data analysis.
Prerequisites and co-requisites	

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
final written examination	51.0%	60.0%
in-class problem solving	51.0%	40.0%

Recommended reading	Basic literature	• Kong Q., Siauw T., Bayen A., 2020. Python Programming and Numerical Methods: A Guide for Engineers and Scientists, Academic Press, • McKinney W. 2023 - Python for Data Analysis, Helion (in Polish) • Cohen, M., X., 2024. Practical Linear Algebra for Data Science: From Core Concepts to applications using Python. Helion (in Polish) • Emery W., Thomson R., 2024. Data Analysis Methods in Physical Oceanography, Elsevier Science (or previous editions)
	Supplementary literature	• Saha, A. 2015. Doing math in Python:Use Programming to Explore Algebra, Calculus and More! Helion (in Polish) • VanderPlas J., 2023 - Python Data Science Handbook: Essential Tools for Working with Data, Helion (in Polish) • Talley D. et al, 2011 - Descriptive Physical Oceanography, Edition 6
	eResources addresses	Basic https://pygis.io/docs/e_interpolation.html - PyGIS library for spatial interpolation https://pythonnumericalmethods.studentorg.berkeley.edu/notebooks/Index.html - Kong Q., Siauw T., Bayen A., Python Programming and numerical methods, Berkeley, 2020,
Example issues/ example questions/ tasks being completed	Find an inverse of a matrix	
Work placement	Not applicable	

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