University of Gdańsk

Subject card

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|---|---|---|---|
| Subject name and code | Programming and Data Analysis Methods - laboratory, PG_00206210 | | |
| Field of study | Oceanography | | |
| Date of commencement of studies | October 2027 | Academic year of realisation of subject | 2027/2028 |
| Education level | Master's studies | Subject group | Obligatory subject group in the field of study<br>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 inż. Anna Nenca | |
| | 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-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<br>[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<br>[SW5] implementation of a problem task |
| [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<br>[SU5] implementation of a problem task |

<table>
<tr><td>Subject contents</td><td>1. Fundamental principles and concepts of programming in Python. Advanced aspects of the Jupyter Notebook environment and script-based programming.<br>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).<br>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.<br>4. Visualization of time series and two- and three-dimensional fields. Use of advanced features of the Matplotlib library.<br>5. One-dimensional and two-dimensional interpolation methods (linear interpolation, polynomial interpolation, splines).<br>6. Selected techniques of time series analysis, data filtering and smoothing. Introduction to spectral analysis (FFT).<br>7. Data clustering methods (k-means and DBSCAN algorithms), dimensionality reduction (PCA) as an application of linear algebra in environmental data analysis.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>in-class problem solving</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td>final written examination</td><td>51.0%</td><td>60.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>• Kong Q., Siauw T., Bayen A., 2020. Python Programming and Numerical Methods: A Guide for Engineers and Scientists, Academic Press,<br>• McKinney W. 2023 - Python for Data Analysis, Helion (in Polish)<br>• Cohen, M., X., 2024. Practical Linear Algebra for Data Science: From Core Concepts to applications using Python. Helion (in Polish)<br>• Emery W., Thomson R., 2024. Data Analysis Methods in Physical Oceanography, Elsevier Science (or previous editions)</td></tr>
<tr><td>Supplementary literature</td><td>• Saha, A. 2015. Doing math in Python:Use Programming to Explore Algebra, Calculus and More! Helion (in Polish)<br>• VanderPlas J., 2023 - Python Data Science Handbook: Essential Tools for Working with Data, Helion (in Polish)<br>• Talley D. et al, 2011 - Descriptive Physical Oceanography, Edition 6</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
</table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>Find an inverse of a matrix</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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