

## Subject card

|                                             |                                                                                                                                                                                                                      |                                                          |                                         |                                     |                                                                                                                                                |            |     |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----|
| Subject name and code                       | Numerical Modelling - laboratory, PG_00206219                                                                                                                                                                        |                                                          |                                         |                                     |                                                                                                                                                |            |     |
| Field of study                              | Oceanography                                                                                                                                                                                                         |                                                          |                                         |                                     |                                                                                                                                                |            |     |
| Date of commencement of studies             | October 2026                                                                                                                                                                                                         |                                                          | 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<br>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                               | 2                                                                                                                                                                                                                    |                                                          | Language of instruction                 |                                     | Polish                                                                                                                                         |            |     |
| Semester of study                           | 3                                                                                                                                                                                                                    |                                                          | ECTS credits                            |                                     | 4.0                                                                                                                                            |            |     |
| Learning profile                            | academic                                                                                                                                                                                                             |                                                          | Assessment form                         |                                     | credit                                                                                                                                         |            |     |
| Conducting unit                             |                                                                                                                                                                                                                      |                                                          |                                         |                                     |                                                                                                                                                |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                   |                                                          | dr Marek Kowalewski                     |                                     |                                                                                                                                                |            |     |
|                                             | Teachers                                                                                                                                                                                                             |                                                          |                                         |                                     |                                                                                                                                                |            |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                          | Lecture                                                  | Tutorial                                | Laboratory                          | Project                                                                                                                                        | Seminar    | SUM |
|                                             | Number of study hours                                                                                                                                                                                                | 0.0                                                      | 0.0                                     | 60.0                                | 0.0                                                                                                                                            | 0.0        | 60  |
|                                             | 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                                                                                                                                                                                                | 60                                                       |                                         | 2.0                                 |                                                                                                                                                | 38.0       | 100 |
| Subject objectives                          | Introduction to applications of numerical methods to physical oceanography including discretisation of simple differential equations and general information on the use of numerical models in physical oceanography |                                                          |                                         |                                     |                                                                                                                                                |            |     |

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| Learning outcomes                                      | Course outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Subject outcome                                                                                                                                                                                       | Method of verification                  |
|                                                        | [OCEANMU2-W01] knows and understands in-depth specialized terminology used in oceanography and related sciences (in Polish and a selected foreign language)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | knows and understands in-depth specialized terminology used in numerical modelling, especially as used in oceanography. (in Polish and English)                                                       | [SW2] presentation/project/paper/report |
|                                                        | [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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | The student is ready to effectively organize his/her own work with numerical modelling techniques, is active, persistent and punctual in completion tasks.                                            | [SK2] presentation/project/paper/report |
|                                                        | [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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | The student knows and understands in-depth selected techniques and aspects of the use of numerical modelling in oceanography                                                                          | [SW2] presentation/project/paper/report |
|                                                        | [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 numerical modelling techniques in data analysis and description of processes occurring in the marine environment and coastal zone                                                             | [SU2] presentation/project/paper/report |
|                                                        | [OCEANMU2-K01] is ready to plan, implement and supervise, individually or collectively, next stages of the entrusted task, is ready to take responsibility for its results;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | is prepared to plan, supervise and punctually deliver individual and group tasks associated with the use of numerical modelling, feels responsible for the results and effects of the work undertaken | [SK2] presentation/project/paper/report |
| Subject contents                                       | 1. Numerical integration of functions, open and closed Newton-Cotes formulas, the trapezoidal rule, and Simpson's rule.<br>2. Solving ordinary differential equations. Discrete representation of a continuous variable. Differential derivatives approximation of derivatives on a discrete grid. Properties of the differential scheme: consistency, accuracy, stability, and efficiency.<br>3. Classification of partial differential equations. Examples of typical equations found in oceanography: hyperbolic equations (wave equation, advection equation), elliptic equations (Laplace, Poisson), and parabolic equations (diffusion equation).<br>4. Construction of simple models: one-dimensional (e.g., heat diffusion in a water column) and two-dimensional (e.g., the advection-diffusion model).<br>5. The Monte Carlo method.<br>6. Neural networks "black-box" models. |                                                                                                                                                                                                       |                                         |
| Prerequisites and co-requisites                        | Passing grade in "Programming and data analysis" OR ability to demonstrate good command of the programming language used in the course.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                       |                                         |
| Assessment methods and criteria                        | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Passing threshold                                                                                                                                                                                     | Percentage of the final grade           |
|                                                        | Reports from practical exercises                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 51.0%                                                                                                                                                                                                 | 100.0%                                  |
| Recommended reading                                    | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | R.H. Stewart, <i>Introduction to Physical Oceanography</i> , Texas T&M University, 2008                                                                                                               |                                         |
|                                                        | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Potter, D. E. (1973). <i>Computational Physics</i> . Wiley, London.                                                                                                                                   |                                         |
|                                                        | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Basic<br><a href="https://open.umn.edu/opentextbooks/textbooks/20">https://open.umn.edu/opentextbooks/textbooks/20</a> - Stewart, Introduction to Physical Oceanography,                              |                                         |
| Example issues/example questions/tasks being completed | Development of a one-dimensional model of heat diffusion in a water column                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                       |                                         |
| Work placement                                         | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                       |                                         |

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