

## Subject card

| Subject name and code                       | Introduction to numerical methods, PG_00037298  |   |   |                                     |        |   |                   |     |  |
|---|---|---|---|-------------------------------------|--------|---|-------------------|-----|--|
| Field of study                              | Technical Physics   |   |   |                                     |        |   |                   |     |  |
| Date of commencement of studies             | October 2021  |   | Academic year of realisation of subject   |                                     |        | 2022/   | 2022/2023         |     |  |
| Education level                             | first-cycle studies   |   | Subject group   |                                     |        | Obligatory subject group in the field of study Subject group related to scientific research in the field of study |                   |     |  |
| Mode of study                               | Full-time studies   |   | Mode of delivery  |                                     |        | at the  | at the university |     |  |
| Year of study                               | 2   |   | Language of instruction   |                                     |        | Polish  |                   |     |  |
| Semester of study                           | 4   |   | ECTS credits  |                                     |        | 4.0   | 4.0               |     |  |
| Learning profile                            | general academic profile  |   | Assessmer   | Assessment form                     |        |   | assessment        |     |  |
| Conducting unit                             | Department of Theoretical Physics and Quantum Information -> Faculty of Applied Physics and Mathematics |   |   |                                     |        |   | d Mathematics     |     |  |
| Name and surname of lecturer (lecturers)    | Subject supervisor  | prof. Andrew Felt                           |   |                                     |        |   |                   |     |  |
|   | Teachers  |   | prof. Andrew Felt   |                                     |        |   |                   |     |  |
|   |   |   | prof. dr hab. Julien Guthmuller   |                                     |        |   |                   |     |  |
| Lesson types and methods of instruction     | Lesson type   | Lecture                                     | Tutorial  | Laboratory                          | Projec | ct Seminar  |                   | SUM |  |
|   | Number of study hours   | 30.0  | 0.0   | 30.0                                | 0.0    |   | 0.0               | 60  |  |
|   | E-learning hours included: 0.0  |   |   |                                     |        |   |                   |     |  |
| Learning activity and number of study hours | Learning activity   | Participation in<br>classes include<br>plan |   | Participation in consultation hours |        | Self-study  |                   | SUM |  |
|   | Number of study hours   | 60  |   | 4.0                                 |        | 36.0  |                   | 100 |  |
| Subject objectives                          | To teach students how to use basic numerical methods.   |   |   |                                     |        |   |                   |     |  |
| Learning outcomes                           | Course outcome  |   | Subject outcome   |                                     |        | Method of verification  |                   |     |  |
|   | K6_W03  |   | Possesses the orderly knowledge of the basic numerical methods which enables to model physical chosen phenomena and some technical processes. |                                     |        | [SW1] Assessment of factual knowledge   |                   |     |  |
|   | K6_U03  |   | Possesses skills of writing applications with needed numerical method using the chosen programming language and adequate bundled software.    |                                     |        | [SU1] Assessment of task fulfilment   |                   |     |  |
|   | K6_W05  |   | Possesses the basic knowledge how to make usage of chosen specific to computer science in physics and technology.                             |                                     |        | [SW1] Assessment of factual knowledge   |                   |     |  |

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| Drawing curves given by formulas. Fractals. Fractional dimension. Examples include the snowflake (the von Koch curve and the Mandelbrot stat.)  2. (2 h.) Methods of finding the roots of functions amoung other subjects: the bisection method. the Newton-Raphson method and hybrid methods.  3. (2 h.) Interpolation methods, amoung other subjects: the Lagrange interpolation and the Hermite interpolation.  4. (2 h.) Interpolation-continued, functions  | Subject contents      | 1. (2 h.) Brief guide to good programming habits. Testing and debugging. Elentary computer graphics.   |                                  |                               |  |  |  |  |  |
|--|-----------------------|--|----------------------------------|-------------------------------|--|--|--|--|--|
| Raphson method and hybrid methods. 3. (2 h.) Interpolation methods, amoung other subjects: the Lagrange interpolation and the Hermite interpolation. 4. (2 h.) Interpolation—continued, functions 5. (2 h.) Methods of solving systems of linear equations includes: the method of Gaussian elimination also in solving tridisponal systems, the Crout method. 6. (2 h.) Approximation of derivatives include: difference formulas of the first and second order of derivatives, the Richardson extrapolation. 7. (2 h.) The least squares method in linear problems. 8. (2 h.) Nonlinear least squares method. 9. (2 h.) Numerical integration including primitive and composite integration formulas. The Romberg integration. 10. (2 h.) Numerical integration including the Gauss-Legendre quadrature, the Gauss-Laguerre quadrature and the Gauss-Hermitie quadrature. 11. (2 h.) Examples of integrals in the technical and physical issues. 12. (2 h.) Numerical integration including improper integrals, multidimensional numerical integration, the Monte-Carlo method. 13. (2 h.) The Discrete Fourier Transform (DFT) and The Fast Fourier Transform (FFT) 14. (2 h.) Solving the ordinary differential equations (part I): the Euler, Runge-Kutta and Runge-Kutta-Ferbiberg methods. 15. A final test.  Prerequisites Taking courses in mathematical analisys, algebra and discrete mathematic.  Assessment methods and criteria  Subject passing criteria Passing threshold Percentage of the final grade Middem colloquium 50.0%  Practical exercise 50.0%  Recommended reading Supplementary literature (1) P.L. DeVries "A first course in computational physics" John Willey 1994 Supplementary literature (1) P.L. DeVries "A first course in computational physics" John Willey 1994 Supplementary blerature (1) P.L. DeVries "A first course in computational physics" John Willey 1994 Supplementary blerature (1) P.D. Devries "A first course in computational physics" John Willey 1994 Supplementary blerature (1) P.D. Devries "A first course in computational physics" John Willey 1994 Suppl     |                       | Drawing curves given by formulas. Fractals. Fractional dimension. Examples include the snowflake (the von Koch curve and the Mandelbrot set. |                                  |                               |  |  |  |  |  |
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| Practical exercise   50.0%   50.0%   50.0%   |                       | Subject passing criteria   | Passing threshold                | Percentage of the final grade |  |  |  |  |  |
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| 3 Formulas on simple and complex method of trapezoids.  4. Romberg integration   | example questions/    |  |                                  |                               |  |  |  |  |  |
| 4. Romberg integration   | tasks being completed | 2 Trójdiagonalny system of four linear equations.  |                                  |                               |  |  |  |  |  |
|  |                       | 3 Formulas on simple and complex method of trapezoids.   |                                  |                               |  |  |  |  |  |
| Work placement Not applicable  |                       | 4. Romberg integration   |                                  |                               |  |  |  |  |  |
|  | Work placement        | Not applicable   |                                  |                               |  |  |  |  |  |

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