# SYLLABUS

## 1. Data about the program of study

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| 1.1 Institution | Technical University of Cluj-Napoca |
| 1.2 Faculty | Automation and Computer Science |
| 1.3 Department | Computer Science |
| 1.4 Field of study | Computer Science and Information Technology |
| 1.5 Cycle of study | Bachelor of Science |
| 1.6 Program of study / qualification | Computer Science / Engineer |
| 1.7 Form of education | Full time |
| 1.8 Subject code | 24. |

## 2. Data about the subject

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|---|---|---|---|---|---|---|
| 2.1 Subject name | | | | | ***Numerical methods*** | |
| 2.2 Course responsible / lecturer | | | | | Prof. univ. dr. Ivan Dumitru-Mircea - mircea.ivan@math.utcluj.ro | |
| 2.3 Teachers in charge of applications | | | | | Prof. univ. dr. Roșca Daniela - daniela.rosca@math.utcluj.ro | |
| 2.4 Year of Study | II | 2.5 | Semester | 4 | 2.6 Type of assessment (E - exam, C - colloquium, V - verification) | E |
| 2.7 Subject category | *DF – fundamentală, DD – în domeniu, DS – de specialitate, DC – complementară* | | | | | DF/DI |
| | *DI – Impusă, DOp – opțională, DFac – facultativă* | | | | | |

## 3. Estimated total time

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|---|---|---|---|---|---|---|---|
| 3.1 Number of hours per week | 4 | 3.2 | lectures | 2 | 3.3 | applications | 2 |
| 3.4 Total hours in the teaching plan | 128 | 3.5 | lectures | 28 | 3.6 | applications | 28 |
| Individual study | | | | | | | |
| Manual, lecture material and notes, bibliography | | | | | | | 20 |
| Supplementary study in the library, online, and in the field | | | | | | | 4 |
| Preparation for seminars/laboratory works, homework, reports, portfolios, essays | | | | | | | 15 |
| Tutoring | | | | | | | 0 |
| Exams and tests | | | | | | | 5 |
| Other activities | | | | | | | 0 |

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| 3.7 Total hours of individual study | 44 |
| 3.8 Total hours per semester | 100 |
| 3.9 Number of credit points | 4 |

## 4. Pre-requisites (where appropriate)

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| 4.1 Curriculum | Basic knowledge of Differential and Integral Calculus |
| 4.2 Competence | Competences in Elementary Differential and Integral Calculus: derivatives, integrals, series. |

## 5. Requirements (where appropriate)

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| 5.1 For the course | - |
| 5.2 For the applications | - |

**6. Specific competences**

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| 6.1 Professional competences | **C1 –** Operating with basic Mathematical, Engineering, and Computer Science concepts (5 credits)<br>• **C1.1 –** Recognizing and describing concepts that are specific to the fields of calculability, complexity, programming paradigms, and modeling computational and communication systems<br>• **C1.3 –** Building models for various components of computing systems<br>• **C1.5 –** Providing a theoretical background for the characteristics of the designed systems |
| 6.2 Cross competences | N/A |

**7. Discipline objectives (as results from the *key competencies gained*)**

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| 7.1 | General objective | A presentation of the concepts, notions, methods, and fundamental techniques used in Numerical methods. |
| 7.2 | Specific objectives | Use of numerical algorithms in order to solve problems in engineering. |

**8. Contents**

| **8.1. Lecture (syllabus)** | Teaching methods | Notes |
|---|---|---|
| **Elements of Error Theory.** Floating Point Arithmetic. Absolute and Relative Errors. | Explanation<br>Demonstration<br>Collaboration<br>Interactive activities | 2 hrs |
| Numerical Methods in Linear Algebra. Special Types of Matrices. Norms of Vectors and Matrices. Eigenvalues and Eigenvectors. Error Estimation.<br>Matrix Equations. Pivoting Elimination. Improved Solutions of Matrix Equations. Partitioning Methods for Matrix Inversion. LU Factorization. Doolittle's Factorization. Choleski's Factorization Method. Iterative Techniques for Solving Linear Systems. Jacobi Iterative Method. Gauss-Seidel Iterative Method.<br>Relaxation Methods. Characteristic Polynomial: Leverrier Method. Characteristic Polynomial: Fadeev-Frame Method. | | 4 hrs |
| Solutions of Nonlinear Equations. Method of Successive Approximation. The Bisection Method. The Newton-Raphson Method. The Secant Method. False Position Method. The Chebyshev Method. Numerical Solutions of Nonlinear Systems of Equations. Newton's Method for Systems of Nonlinear Equations. Steepest Descent Method. | | 4 hrs |
| Elements of Interpolation Theory. Lagrange Interpolation. Divided Difference. Mean Value Properties in Lagrange Interpolation. Approximation by Interpolation. Hermite Interpolating Polynomial. Finite Differences. Interpolation of Multivariable Functions. Scattered Data Interpolation. Shepard's Method.<br>Splines. B-splines. | | 6 hrs |
| Elements of Numerical Integration. Richardson's Extrapolation. Numerical Quadrature. Error Bounds in the Quadrature Methods. Trapezoidal Rule. Richardson's Deferred Approach to the Limit.<br>Romberg Integration. Newton-Cotes Formulas. Simpson's Rule. Gaussian Quadrature. | | 4 hrs |
| Elements of Approximation Theory. Discrete Least Squares Approximation. Orthogonal Polynomials and Least Squares Approximation. Rational Function Approximation. Padé Approximation. Trigonometric Polynomial Approximation. Fast Fourier Transform. Bernstein Polynomial. Bézier Curves. *METAFONT.* | | 4 hrs |
| Integration of Ordinary/Partial Differential Equations. The Euler Method. The Taylor Series Method. The Runge-Kutta Method. The Runge-Kutta Method for Systems of Equations. Integration of Partial Differential Equations<br>Parabolic Partial-Differential Equations. Hyperbolic Partial Differential Equations. Elliptic Partial Differential Equations. | | 4 hrs |

Bibliography:


1. Mircea Ivan and Kálmán Pusztai. Numerical Methods with Mathematica. Mediamira, Cluj-Napoca, 2003. ISBN 973-9357-41-5.
2. Mircea Ivan and Kálmán Pusztai. Mathematics by Computer. Comprex Publishing House, Cluj-Napoca, 1992.
3. Ioan Gavrea & Mircea Ivan, ML. Numerical Methods, POSDRU/86/1.2/S/62485, 2013


| **8.2. Applications - Seminars / Laboratory / Projects** | Teaching methods | Notes |
|---|---|---|

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|---|---|---|
| The applications follow the topics of the courses. | Explanation<br>Demonstration<br>Collaboration<br>Interactive activities | 28 hrs |
| Bibliography:<br>1. Mircea Ivan and Kálmán Pusztai. Numerical Methods with Mathematica. Mediamira, Cluj-Napoca, 2003. ISBN 973-9357-41-5. | | |

**9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field**

Collaboration with engineers in order to identify and solve problems raised by the market.

**10. Evaluation**

| Activity type | Assessment criteria | Assessment methods | Weight in the final grade |
|---|---|---|---|
| Course | Ability to understand and use the concepts and proofs creatively | Written examination | 40% |
| Applications | Ability to solve problems and apply algorithms | Written examination | 60% |
| Minimum standard of performance:<br>Ability to present a theoretical subject coherently and to solve problems with practical content. | | | |

| **Date of filling in: 26.02.2025** | **Responsible** | **Title, First name Last name** | **Signature** |
|---|---|---|---|
| | Lectures | Prof.univ. dr. Dumitru-Mircea IVAN | |
| | Applications | Prof.univ.dr. Daniela ROȘCA | |
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| Date of approval by the Department Board | Head of Department of Mathematics,<br>Prof.univ.dr. Dorian Popa |
| Date of approval by the Faculty Council | Dean,<br>Prof.dr.eng. Vlad Mureșan |