# COURSE DESCRIPTION

## 1. Program Information

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|---|---|
| **1.1** University | **“Alexandru Ioan Cuza” University of Iaşi** |
| **1.2** Faculty | **Computer Science** |
| **1.3** Department | **Computer Science** |
| **1.4** Study Domain | **Computer Science** |
| **1.5** Study Cycle | **Bachelor** |
| **1.6** Study Program / Qualification | **Computer Science** |

## 2. Course Information

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|---|---|---|---|---|---|---|---|
| **2.1** Course Name | | | **Numerical Calculus** | | | | |
| **2.2** Course Teacher | | | **Anca Ignat** | | | | |
| **2.3** Seminary Teacher | | | **Andreea-Valentina Arusoaie** | | | | |
| **2.4** Study Year | **III** | **2.5** Semester | **6** | **2.6** Evaluation | **E** | **2.7** Course Status* | **OB** |

** OB – Compulsory / OP – Optional*

## 3. Total estimated hours (hours per semester and didactic activities)

| | | | | | |
|---|---|---|---|---|---|
| **3.1** Hours per week | **4** | in which: **3.2** course | **2** | **3.3** seminary/laboratory | **2** |
| **3.4** Hours in curriculum | **56** | in which: **3.5** course | **28** | **3.6** seminary/laboratory | **28** |

| Time Distribution | hours |
|---|---|
| Manual study, Course support, Bibliography, and others | **14** |
| Supplementary Documentation in library, in electronic forums, and on the field | **14** |
| Seminaries/laboratories preparation, homeworks, reports, portfolios and essays | **28** |
| Tutoring | **-** |
| Evaluation | **4** |
| Other activities (consultations per student) | **-** |

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|---|---|
| **3.7** Total hours individual study | **56** |
| **3.8** Total hours per semester | **116** |
| **3.9** Credits | **4** |

## 4. Preconditions (if necessary)

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| **4.1** Of Curriculum | **-** |
| **4.2** Of Skills | **Knowledge of a programming language** |

## 5. Conditions (if necessary)

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|---|---|
| **5.1** For Course Operation | **Course room with videoprojector** |
| **5.2** For Seminary/Laboratory Operation | **Laboratory room with at least 15 computers** |

**6. Specific Skills Acquired**

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|---|---|
| **Professional Skills** | **C1. The description of concepts, theories, and models used in the target domain.**<br>**C2. The use of mathematical and computer science models and tools for solving some specific numerical analysis problems.**<br>**C3. The identification of proper methodologies for solving real life problems.** |
| **Transversal Skills** | **CT1. The application of the rules for a well-organized and efficient work, developing a responsible attitude towards the teaching and scientific fields, in order to achieve the creative capitalization of the student's own potential, by respecting the principles and rules of professional ethics.**<br>**CT2. The use of efficient methods and techniques for learning, acquiring information, research and development of the capabilities to capitalize the knowledge, to adapt to the requirements of a dynamic society and to communicate in Romanian and in an international language.** |

**7. Course Objectives** (from the grid of specific skills acquired)

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|---|---|
| **7.1 General Objectives** | To get acquainted with numerical methods for approximating continuous mathematical problems. |
| **7.2 Specific Objectives** | Upon the completion of this discipline, the students will be able to:<br>▪ Describe the main concepts related to snumerical solving of continuous problems.<br>▪ Use Numerical Calculus libraries for the methods described in course/laboratory classes.<br>▪ Compute approximative solutions for some mathematical problems<br>▪ To be able to analyse and correct programs that contain numerical calculus sub-problems |

**8. General Description**

| **8.1** | **Course** | **Teaching Methods** | **Observations** (hours and bibliographic references) |
|---|---|---|---|
| 1 | Examples, floating point computing, types of errors, propagation of errors, vector and matrix computations, special type matrices | exposition, debate, case studies, exercise | 2, [1,4] |
| 2 | Norms (vectorial, matricial). History of linear systems of equations solving | exposition, debate, case studies, exercises | 2, [1,2] |
| 3 | Errors in numerical computations. Conditioning, stability | exposition, debate, case studies, exercises | 2, [1,2,4] |
| 4 | Substitution methods for triangular systems of equations. Gauss elimination algorithm | exposition, debate, case studies, exercises | 2, [1,2] |

| | | | |
|---|---|---|---|
| 5 | LU Decompositions | exposition, debate, case studies, exercises | 2, [1,2] |
| 6 | QR Decompositions | exposition, debate, case studies, exercises | 2, [1,2] |
| 7 | Storing sparse matrices. Iterative methods for solving sparse systems of equations: Jacobi and Gauss-Seidel methods | exposition, debate, case studies, exercises | 2, [1,2,3] |
| 8 | Solving linear system of equations: recapitulation, examples | exposition, debate, case studies, exercises | 2, [1,2] |
| 9 | Iterative methods for symmetric and positive definite matrices: SOR, steapest descent, conjugate gradients | exposition, debate, case studies, exercises | 2, [1,2,3] |
| 10 | Methods for solving the eigenproblem: QR type methods<br>Singular Value Decomposition | exposition, debate, case studies, exercises | 2, [1,2] |
| 11 | Methods for approximating the eigenvalues/egenvectors: power and inverse iteration methods, Hessenberg form | exposition, debate, case studies, exercises | 2, [1,2] |
| 12 | Nonlinear equations roots: bisection, Newton-Raphson, regula falsi, secant methods, mrthods specific for polynomial roots finding | exposition, debate, case studies, exercises | 2, [2,3,4] |
| 13 | Numerical Interpolation: Lagrange, Newton, spline functions, least squares approximation | exposition, debate, case studies, exercises | 2, [2,3,4] |
| 14 | Numerical Optimization | exposition, debate, case studies, exercises | 2, [2,3,4] |

**Bibliography**


- G.H. Golub, C.F. Van Loan, *Matrix Computations*, JHU Press, 1996
- C. Ignat, C. Ilioi, T. Jucan, *Elemente de informatică şi calcul numeric –vol. 2*, Editura Univ. „Al.I. Cuza” Iaşi, 1989,
- R.L. Burden, J.D. Faires, *Numerical Analysis*– Brooks/Cole, Thomson Learning (10-th edition, 2015)
- V. Iorga, B. Jora, *Metode numerice*, Ed. Albastra, Cluj, 2004


| **8.2** | **Seminary / Laboratory** | **Teaching methods** | **Observations** (hours and bibliographic references) |
|---|---|---|---|
| 1 | Computing with errors, elementary functions approximation, efficient algorithms for matrix multiplication | exposition, debate, exercises | 2, [1,2] |
| 2 | LU Decompositions | exposition, debate, exercises | 2, [1,2] |
| 3 | LU Decompositions | exposition, debate, exercises | 2, [1,2] |
| 4 | QR Decompositions | exposition, debate, exercises | 2, [1,2] |

| | | | |
|---|---|---|---|
| 5 | Efficiently storing methods for sparse matrices | exposition, debate, exercises | 2, [1,2] |
| 6 | Iterative methods for solving linear systems of equations: Jacobi | exposition, debate, exercises | 2, [1,2] |
| 7 | Iterative methods for solving linear systems of equations: Gauss-Seidel | exposition, debate, exercises | 2, [1,2] |
| 8 | Iterative methods for solving linear systems of equations: methods for symmetric and positive definite matrices | exposition, debate, exercises | 2, [1,2] |
| 9 | Nonlinear equations roots | exposition, debate, exercises | 2, [1,2] |
| 10 | Approximating roots for polynomials | exposition, debate, exercises | 2, [1,2] |
| 11 | Numerical Interpolation: Lagrange, Newton | exposition, debate, exercises | 2, [1,2] |
| 12 | Numerical Interpolation: spline functions | exposition, debate, exercises | 2, [1,2] |
| 13 | Numerical Optimization | exposition, debate, exercises | 2, [1,2] |
| 14 | Numerical Optimization and solving sparse linear systems of equations | exposition, debate, exercises | 2, [1,2] |

**Bibliography**


- S. Salleh, A.Y. Zomaya, S.A. Bakar, *Computing for Numerical Methods using Visual C++*, Wiley-Interscience, 2008
- Numerical Recipes, http://www.nr.com


**9. Course content synchronization with the expectations of the community representatives, professional associations and employers from the program domain**

**10. Evaluation**

| Activity Type | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 The weight of each evaluation form (%) |
|---|---|---|---|
| **10.4** Course | Written test for evaluating the ability to apply the theoretical knowledge to solving practical problems (1-10, minimum 3) | written test | 50% |
| **10.5** Seminary/ Laboratory | the ability to develop average/high complexity projects solving Numerical Calculus type problems | projects | 50% |
| **10.6** Minimal performance standards | | | |
| - minum 3pt of 10 in written test<br>- total score: minimul 45% of maximum score posible | | | |

Date
23.03.2018

Course Teacher
Anca Ignat

Seminary/Laboratory Teacher
Andreea-Valentina Arusoaie

Department Date of Approval

Director of the Department
Prof. dr. Dorel Lucanu