**SYLLABUS**

**1. Information regarding the programme**

| | |
|---|---|
| 1.1 Higher education institution | **Babeş Bolyai University** |
| 1.2 Faculty | **Faculty of Mathematics and Computer Science** |
| 1.3 Department | **Department of Mathematics** |
| 1.4 Field of study | **Mathematics** |
| 1.5 Study cycle | **Master** |
| 1.6 Study programme / Qualification | **Advanced Mathematics** |

**2. Information regarding the discipline**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.1 Name of the discipline (en)<br>(ro) | | | **Special Chapters of Numerical Analysis**<br>**Capitole Speciale de Analiza Numerica** | | | | |
| 2.2 Course coordinator | | | **Assoc. Prof. Teodora Catinas** | | | | |
| 2.3 Seminar coordinator | | | **Assoc. Prof. Teodora Catinas** | | | | |
| 2.4. Year of study | **2** | 2.5 Semester | **4** | 2.6. Type of evaluation | **E** | 2.7 Type of discipline | **Optional** |
| 2.8 Code of the discipline | | MME3405 | | | | | |

**3. Total estimated time** (hours/semester of didactic activities)

| | | | | | |
|---|---|---|---|---|---|
| 3.1 Hours per week | 3 | Of which: 3.2 course | 2 | 3.3 seminar/laboratory | 1 |
| 3.4 Total hours in the curriculum | 36 | Of which: 3.5 course | 24 | 3.6 seminar/laboratory | 12 |
| Time allotment: | | | | | hours |
| Learning using manual, course support, bibliography, course notes | | | | | 30 |
| Additional documentation (in libraries, on electronic platforms, field documentation) | | | | | 20 |
| Preparation for seminars/labs, homework, papers, portfolios and essays | | | | | 33 |
| Tutorship | | | | | 20 |
| Evaluations | | | | | 30 |
| Other activities: ..... | | | | | - |

| | |
|---|---|
| 3.7 Total individual study hours | 133 |
| 3.8 Total hours per semester | 169 |
| 3.9 Number of ECTS credits | 8 |

**4. Prerequisites** (if necessary)

| | |
|---|---|
| 4.1. curriculum | • |
| 4.2. competencies | • Knowledge of some classical and modern procedures of Numerical Analysis and the ability to work with them. Improvment of programming skills in MATLAB for implementing numerical algorithms. |

**5. Conditions** (if necessary)

| | |
|---|---|
| 5.1. for the course | • |
| 5.2. for the seminar /lab activities | • Room with blackboard and computers. |

**6. Specific competencies acquired**

| | |
|---|---|
| **Professional competencies** | • Ability to understand and manipulate advanced concepts, results and theories in the fields of mathematics. |
| **Transversal competencies** | • Ability to use mathematical software and advanced methods of numerical analysis and programming for numerical solving of problems.<br>• Ability to model and analyze from a mathematical point of view real processes from other sciences, economics and engineering. |

**7. Objectives of the discipline** (outcome of the acquired competencies)

| | |
|---|---|
| 7.1 General objective of the discipline | • Knowledge, understanding and use of some classical and modern concepts of Numerical Analysis and the improvment of the capacity of using them in problems.<br>• Be able to implement numerical algorithms in order to solve practical problems. |
| 7.2 Specific objective of the discipline | • Consolidation of theoretical and practical knowledge about the basic numerical algorithms<br>• Acquire some theoretical and practical knowledge regarding classical and modern procedures of approximation and interpolation for different types of domains, numerical integration methods, numerical solving of linear/nonlinear systems of equations and differential equations.<br>• Ability to apply numerical algorithms to solve practical and real life problems. |

**8. Content**

| 8.1 Course | Teaching methods | Remarks |
|---|---|---|
| 1. Introductive notions: linear spaces, spaces of functions, Peano type theorems. Classical interpolation methods. Study of the interpolation error. | Exposure: description, explanation, examples. | |
| 2. Some linear and positive approximation operators. | Exposure: description, explanation, examples. | |
| 3. Polynomial spline interpolation operators. Spline interpolation operators of Lagrange type. | Exposure: description, explanation, examples, proofs. | |

| | | |
|---|---|---|
| 4. Spline interpolation operators of Hermite and Birkhoff type. Study of the interpolation error. | Exposure: description, explanation, examples, proofs. | |
| 5. Interpolation operators on rectangular domains. Exemples of interpolation operators for square. | Exposure: description, explanation, examples, proofs, dialogue. | |
| 6. Interpolation operators on simplex domains. Exemples of interpolation operators for triangle. | Exposure: description, explanation, examples, proofs, dialogue. | |
| 7. Interpolation operators on arbitrary domains. Univariate Shepard interpolation. Bivariate Shepard interpolation. | Exposure: description, explanation, examples. | |
| 8. Numerical differentiation and integration. Newton-Cotes quadrature formulas. Romberg's algorithm. Adaptive quadratures formulas. General quadrature formulas. | Exposure: description, explanation, examples. | |
| 9. Gauss type quadrature formulas. Chebyshev type quadrature formulas. | Exposure: description, explanation, examples. | |
| 10. Numerical methods for solving nonlinear equations in R: one-step methods and multi-step methods. Inverse interpolation of Lagrange, Hermite and Birkhoff type. | Exposure: description, explanation, examples, proofs, dialogue. | |
| 11. Numerical methods for solving nonlinear systems: succesive approximation method and Newton's method. | Exposure: description, explanation, examples. | |
| 12. Numerical methods for solving diferential equations: Taylor interpolation method, Euler and Runge-Kutta methods. | Exposure: description, explanation, examples, proofs. | |

Bibliography


**1.** O. Agratini, I. Chiorean, Gh. Coman, R.T. Trîmbitaş, *Analiză Numerică şi Teoria Aproximării,* vol. III, Ed. Presa Univ. Clujeană, 2002;

**2.** R. L. Burden, J. D. Faires, *Numerical Analysis,* PWS Publishing Company, 2010.

**3.** I. Chiorean, T. Cătinaş, R. Trîmbitaş, *Analiză numerică,* Ed. Presa Univ. Clujeană, 2010.

**4.** Gh. Coman, T. Cătinaş, şi alţii, *Interpolation operators*, Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2004.

***5.*** Gh. Coman, I. Chiorean, T. Cătinaş, *Numerical Analysis. An Advanced Course,* Ed. Presa Univ. Clujeană, 2007.

***6.*** S. D. Conte, Carl de Boor, *ELEMENTARY NUMERICAL ANALYSIS. An Algorithmic Approach,* SIAM, 2017.

***7.*** W. Gander, M.J. Gander, F. Kwok, *Scientific Computing,* Springer Internat. Publishing, 2014.

***8.*** W. Gautschi, *Numerical Analysis. An introduction,* Birkhauser, Basel, 1997

***9.*** R. Plato, *Concise Numerical Mathematics,* Amer. Math. Soc., 2003.

***10.*** D.D. Stancu, Gh. Coman, O. Agratini, R. Trimbitas, *Analiză Numerică şi Teoria Aproximării,* vol. I, Ed. Presa Univ. Clujeană, 2001;

***11.*** D.D. Stancu, Gh. Coman, P. Blaga, *Analiză Numerică şi Teoria Aproximării,* vol. II, Ed. Presa Univ. Clujeană, 2002;

***12.*** R. Trîmbitaş, *Numerical Analysis*, Ed. Presa Univ. Clujeană, 2007.


| 8.2 Seminar/Laboratory | Teaching methods | Remarks |
|---|---|---|
| 1. Introductory examples and problems. | Explanation, dialogue, practical examples. | |
| 2. Applied problems to polynomial interpolation and to linear/positive operators. | Explanation, dialogue, examples. | |
| 3. Computation of some tensorial product and boolean sum operators for square and triangle. Graphical representations. | Explanation, dialogue, examples. | |

| | | |
|---|---|---|
| 4. Exemples of univariate and bivariate Shepard interpolation operators. | Explanation, dialogue, examples. | |
| 5. Exemples and applied problems for Newton-Cotes quadratures formulas, Romberg's algorithm and adaptive quadratures formulas. Applied problems to Gauss type quadrature formulas. | Explanation, dialogue, examples. | |
| 6. Exemples of numerical methods for solving nonlinear equations and systems. Solving some differential equations using Euler and Runge-Kutta methods. Ending of evaluation for seminar/lab work. | Explanation, dialogue, examples. | |

**Bibliography**


1. R. L. Burden, J. D. Faires, *Numerical Analysis*, PWS Publishing Company, 2010.
2. W. Gander, M.J. Gander, F. Kwok, *Scientific Computing*, Springer Internat. Publishing, 2014.
3. A. Kharab, R. B. Guenther, *An introduction to numerical methods. A Matlab approach*, Taylor&Francis Group, 2006.
4. R. Trîmbitaş, *Numerical Analysis*, Ed. Presa Univ. Clujeană, 2007.


**9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program**

- The content of the course is important for seeing the application of mathematical knowledge in solving practical and real life problems.

**10. Evaluation**

| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Share in the grade (%) |
|---|---|---|---|
| 10.4 Course | - know the basic principles of Numerical Analysis;<br>- apply the course concepts<br>- problem solving | Written exam. | 70% |
| 10.5 Seminar/lab activities | - be able to implement course concepts and the numerical algorithms<br>- apply techniques for different practical problems | Evaluation and continuous observations during the semester. | 30% |
| 10.6 Minimum performance standards | | | |
| ➢ At least grade 5 (from a scale of 1 to 10) at written exam and laboratory work. | | | |

Date | Signature of course coordinator | Signature of seminar coordinator

18.04.2018

Date of approval | Signature of the head of department