# SYLLABUS

*TOPICS IN MATHERMATICAL ANALYSIS III*

University year 2025-2026

**1. Information regarding the programme**

| | |
|---|---|
| 1.1. Higher education institution | Babeș-Bolyai University |
| 1.2. Faculty | Mathematics and Computer Science |
| 1.3. Department | Mathematics |
| 1.4. Field of study | Mathematics |
| 1.5. Study cycle | Master |
| 1.6. Study programme/Qualification | Modern Methods in Mathematics Teaching |
| 1.7. Form of education | |

**2. Information regarding the discipline**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.1. Name of the discipline | **Topics in Mathematical Analysis III** | | | | | Discipline code | **MME3010** |
| 2.2. Course coordinator | | | | Prof. Octavian Agratini, PhD | | | |
| 2.3. Seminar coordinator | | | | Prof. Octavian Agratini, PhD | | | |
| 2.4. Year of study | 2 | 2.5. Semester | 4 | 2.6. Type of evaluation | E | 2.7. Discipline regime | Optional |

**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/laborator | **12** |
| **Time allotment for individual study (ID) and self-study activities (SA)** | | | | | **hours** |
| Learning using manual, course support, bibliography, course notes (SA) | | | | | 56 |
| Additional documentation (in libraries, on electronic platforms, field documentation) | | | | | 48 |
| Preparation for seminars/labs, homework, papers, portfolios and essays | | | | | 40 |
| Tutorship | | | | | 10 |
| Evaluations | | | | | 35 |
| Other activities: | | | | | - |
| **3.7. Total individual study hours** | **189** | | | | |
| **3.8. Total hours per semester** | **225** | | | | |
| **3.9. Number of ECTS credits** | **9** | | | | |

**4. Prerequisites** (if necessary)

| | |
|---|---|
| 4.1. curriculum | • Mathematical Analysis 1 (on **R**) |
| 4.2. competencies | Ability to use abstract notions, theoretical results and practical methods of Mathematical Analysis |

**5. Conditions** (if necessary)

| | |
|---|---|
| 5.1. for the course | • Lecture hall equipped with smartboard and video projector. |
| 5.2. for the seminar /lab activities | • Classroom equipped with smart board. |

**6.1. Specific competencies acquired** [1]

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

| | |
|---|---|
| **Professional/essential competencies** | • To use appropriate theoretical results and methods for solving different classes of mathematical analysis problems. |
| **Transversal competencies** | • To apply rigorous and efficient work rules, by adopting a responsible attitude towards the scientific and didactic activities. To develop the own creative potential in specific areas, following the professional ethical norms and principles. |

**6.2. Learning outcomes**

| | |
|---|---|
| **Knowledge** | The student knows: to identify the appropriate method in solving analysis problems. |
| **Skills** | The student is able to apply the mathematical apparatus by making connections between different types of problem approaches. |
| **Responsibility and autonomy:** | The student has the ability to work independently to obtain problem solving and create new statements by composing similar requirements. |

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

| | |
|---|---|
| **7.1 General objective of the discipline** | • Enhanced understanding of some special topics in Mathematical Analysis useful to high-school teachers. |
| **7.2 Specific objective of the discipline** | • Students should acquire solving skills for challenging problems, by an indepth study of key notions and fundamental theoretical results. |

**8. Content**

| **8.1 Course** | **Teaching methods** | **Remarks** |
|---|---|---|
| 1. Sequences defined by linear recurrences with constant coefficients. | Direct instruction, mathematical proof, exemplification | |

| | | |
|---|---|---|
| 2. Special classes of sequences defined by nonlinear recurrences | Direct instruction, mathematical proof, exemplification | |
| 3.Techniques to solve equations | Direct instruction, mathematical proof, exemplification | |
| 4. Series of real numbers: Cauchy and Riemann theorems concerning the permutations of absolutely convergent and of conditionally convergent series, respectively | Direct instruction, mathematical proof, exemplification | |
| 5. Abel, Cauchy and Mertens theorems concerning the product of two series | Direct instruction, mathematical proof, exemplification | |
| 6. The Darboux property. Applications | Direct instruction, mathematical proof, exemplification | |
| 7. Uniformly continuous functions and their sequential characterization; Lipschitz and Hölder continuous functions | Direct instruction, mathematical proof, exemplification | |
| 8. Computing methods for the primitives | Direct instruction, mathematical proof, exemplification | |
| 9. Riemann integrable functions | Direct instruction, mathematical proof, exemplification | |
| 10. Convex functions (one variable); characterizations and regularity properties (continuity, one sided derivability) | Direct instruction, mathematical proof, exemplification | |
| 11. Characterizations of convexity by means of tangent lines, first and second order derivatives | Direct instruction, mathematical proof, exemplification | |
| 12. Approximation of functions | Direct instruction, mathematical proof, exemplification | |

Bibliography

1. BRECKNER, B.E., POPOVICI, N.: Convexity and Optimization. An Introduction. Editura EFES, Cluj-Napoca, 2006.
2. BRECKNER, W.W., TRIF, T.: Convex Functions and Related Functional Equations. Selected Topics. Presa Universitară Clujeană, 2008.
3. COBZAŞ, Şt.: Analiză matematică (Calcul diferenţial). Presa Universitară Clujeană, Cluj-Napoca, 1997.
4. ROBERTS, A.W., VARBERG, D.E.: Convex Functions. Academic Press, 1973.
5. RUDIN, W.: Principles of Mathematical Analysis. 2nd Edition, McGraw-Hill, New York, 1964.
6. SIREŢCHI, Gh.: Calcul diferenţial şi integral. Vol. 1. Editura Ştiinţifică şi Enciclopedică, Bucureşti, 1985.

8.2

| **8.2 Seminar / laboratory** | **Teaching methods** | **Remarks** |
|---|---|---|
| 1. Sequences defined by linear recurrences. Examples | Problem-based instruction, debate, mathematical proofs | |
| 2. Sequences defined by nonlinear recurrences. Examples | Problem-based instruction, debate, mathematical proofs | |
| 3.The chord and tangent method for solving equations | Problem-based instruction, debate, mathematical proofs | |
| 4. The fixed point method for solving equations | Problem-based instruction, debate, mathematical proofs | |
| 5. Remarkable series of real numbers | Problem-based instruction, debate, mathematical proofs | |
| 6. Mean values theorems. Applications | Problem-based instruction, debate, mathematical proofs | |
| 7. Wallis and Stirling formulas | Problem-based instruction, debate, mathematical proofs | |
| 8. Taylor series | Problem-based instruction, debate, mathematical proofs | |
| 9. Uniform continuity; Lipschitz continuous functions | Problem-based instruction, debate, mathematical proofs | |
| 10. The Darboux property and antiderivability | Problem-based instruction, debate, mathematical proofs | |
| 11. Applications of convexity. Inequalities | Problem-based instruction, debate, mathematical proofs | |
| 12. Classes of linear approximation operators | Problem-based instruction, debate, mathematical proofs | |

Bibliography

1. APOSTOL, T. M.: Modular functions and Dirichlet series in number theory. Springer-Verlag, New York, 1990.
2. BORWEIN, J.M., LEWIS, A.S.: Convex Analysis and Nonlinear Optimization. Theory and Examples.
CMS Books in Mathematics, Springer, 2000.
3. BRECKNER, B.E., POPOVICI, N.: Probleme de analiză convexă în $R^n$. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2003.
4. SIREŢCHI, Gh.: Calcul diferenţial şi integral. Vol. 2: Exerciţii, Editura Ştiinţifică şi Enciclopedică, Bucureşti, 1985.

**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 course ensures a solid theoretical background, according to national and international standards.

**10. Evaluation**

| Activity type | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Percentage of final grade |
|---|---|---|---|
| 10.4 Course | Knowledge of theoretical concepts and theoretical results | Written exam | 70% |
| | Ability to solve practical exercises and theoretical problems | | |
| 10.5 Seminar/laboratory | Active participation to tutorials (problem solving). | Continuous evaluation | 15% |
| | The manner of presentation the report with a theme imposed by the coordinator | Evaluation | 15% |
| 10.6 Minimum standard of performance | | | |
| • The final grade should be greater than or equal to 5. | | | |

**11. Labels ODD (Sustainable Development Goals)[2]**

*Not applicable*

Date: 11.04.2025

Signature of course coordinator

Signature of seminar coordinator

Date of approval:
25.04.2025

Signature of the head of department

Prof. dr. Andrei Mărcuş

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable.*"