**SYLLABUS**

**1. Information regarding the programme**

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| 1.1 Higher education institution | Babes-Bolyai University, Cluj-Napoca |
| 1.2 Faculty | Mathematics and Computer Science |
| 1.3 Department | Department of Mathematics |
| 1.4 Field of study | Mathematics and Computer Science |
| 1.5 Study cycle | Bachelor |
| 1.6 Study programme / Qualification | Mathematics and Computer Science |

**2. Information regarding the discipline**

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|---|---|---|---|---|---|---|---|
| 2.1 Name of the discipline | Complements of Mathematical Analysis | | | | | | |
| 2.2 Course coordinator | Lect. dr. Berinde Stefan | | | | | | |
| 2.3 Seminar coordinator | Lect. dr. Berinde Stefan | | | | | | |
| 2.4. Year of study | 2 | 2.5 Semester | 4 | 2.6. Type of evaluation | VP | 2.7 Type of discipline | Op. |

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

| | | | | | |
|---|---|---|---|---|---|
| 3.1 Hours per week | 4 | Of which: 3.2 course | 2 | 3.3 seminar/laboratory | 2 |
| 3.4 Total hours in the curriculum | 56 | Of which: 3.5 course | 28 | 3.6 seminar/laboratory | 28 |
| Time allotment: | | | | | hours |
| Learning using manual, course support, bibliography, course notes | | | | | 30 |
| Additional documentation (in libraries, on electronic platforms, field documentation) | | | | | 10 |
| Preparation for seminars/labs, homework, papers, portfolios and essays | | | | | 20 |
| Tutorship | | | | | 14 |
| Evaluations | | | | | 20 |
| Other activities: ..... | | | | | |
| 3.7 Total individual study hours | 94 | | | | |
| 3.8 Total hours per semester | 150 | | | | |
| 3.9 Number of ECTS credits | 6 | | | | |

**4. Prerequisites** (if necessary)

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| 4.1. curriculum | • Mathematical Analysis I |
| 4.2. competencies | • Understanding calculus on the real axis |

**5. Conditions** (if necessary)

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| 5.1. for the course | • Class room with blackboard |
| 5.2. for the seminar /lab activities | • Class room with blackboard |

**6. Specific competencies acquired**

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| **Professional competencies** | • C1.5 Elaborarea unor proiecte si lucrari de prezentare a unor rezultate si metode matematice.<br>• C5.4 Evaluarea comparativa si utilizarea eficienta a diferitelor metode de demonstratie |
| **Transversal competencies** | • CT2. Desfasurarea eficienta si eficace a activitatilor organizate in echipa |

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

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| 7.1 General objective of the discipline | • Complementary results from the field of classical analysis on the real axis |
| 7.2 Specific objective of the discipline | • introduction to theory of continued fractions<br>• solving linear recurrences by methods of characteristic equation and generating function<br>• computational techniques based on operations with power series<br>• study of some remarcable series and products, and their connection with Riemann zeta function<br>• applications to number theory and combinatorics |

**8. Content**

| 8.1 Course | Teaching methods | Remarks |
|---|---|---|
| 1. A short history of mathematical analysis | interactive exposure, explanation, didactical demonstration | |
| 2. Real numbers – irrationality and transcendence | interactive exposure, explanation, didactical demonstration | |
| 3. Real numbers – continued fractions | interactive exposure, explanation, didactical demonstration | |
| 4. Applications of continued fractions to number theory | interactive exposure, explanation, didactical demonstration | |
| 5. Linear recurrent sequences | interactive exposure, explanation, didactical demonstration | |
| 6. Nonlinear recurrent sequences | interactive exposure, explanation, didactical demonstration | |
| 7. Techniques of linearisation | interactive exposure, explanation, didactical demonstration | |
| 8. Extreme limits of a sequence | interactive exposure, explanation, didactical demonstration | |
| 9. Operations with power series (I) | interactive exposure, explanation, didactical demonstration | |
| 10. Operations with power series (II) | interactive exposure, explanation, | |

| | | |
|---|---|---|
| | didactical demonstration | |
| 11. Method of generating function | interactive exposure, explanation, didactical demonstration | |
| 12. Applications of recurrences to combinatorics | interactive exposure, explanation, didactical demonstration | |
| 13. Exam preparation | interactive exposure, explanation, didactical demonstration | |
| 14. Due examination | | |

Bibliography

1. Hardy G.H. et al.: An introduction to the theory of numbers, Oxford University Press, 2008

2. Mickens R.E.: Difference equations. Theory, applications and advanced topics, CRC Press, 2015

3. Wilf H.S.: generatingfunctionology, A.K. Peters Ltd., Massachusetts, 2006

4. Zorich V.A.: Mathematical Analysis I, Springer, 2004

5. ***: Pagina cursului Complemente de analiza matematica (notite de curs ale titularului), *http://math.ubbcluj.ro/~sberinde/comp/*

| 8.2 Seminar / laboratory | Teaching methods | Remarks |
|---|---|---|
| 1. Classic inequalities | project exposure by student team | |
| 2. Remarcable numbers as limits of sequences | project exposure by student team | |
| 3. Irrationality and transcendence of some remarcable numbers | project exposure by student team | |
| 4. Toeplitz theorem and applications | project exposure by student team | |
| 5. Arithmetic-geometric mean. Gauss formula | project exposure by student team | |
| 6. Stirling formula | project exposure by student team | |
| 7. Remarcable recurrences and applications | project exposure by student team | |
| 8. Infinite products | project exposure by student team | |
| 9. Bernoulli polynomials and numbers | project exposure by student team | |
| 10. Riemann Zeta function | project exposure by student team | |
| 11. Euler's Gamma function | project exposure by student team | |
| 12. Euler's Beta function | project exposure by student team | |
| 13. Proofs from the lists | conversation, exercise and didactic proof | |
| 14. Due examination | | |

Bibliography

1. Cobzas S.: Analiza matematica (Calcul diferential), Presa Universitara Clujeana, 1997

2. Duren P.: Invitation to Classical Analysis, AMS, 2012

3. Kaczor W.J., Nowak M.T.: Problems in Mathematical Analysis, vol. I si II, AMS, 2001

4. Mercer P.R.: More calculus of a single variable, Springer, 2014

5. Siretchi, Gh.: Calcul diferential si integral, vol. I si II, Editura Stiintifica si Enciclopedica, 1985

6. ***: Pagina cursului Complemente de analiza matematica (notite de curs ale titularului),

*http://math.ubbcluj.ro/~sberinde/comp/*

**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**

- This lecture is useful for teacher and research candidates in mathematics, enriching their knowledge in classical mathematical analysis. More specifically, we address new methods and results which might be useful later for a master degree preparation in mathematics or a related field.

**10. Evaluation**

| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Share in the grade (%) |
|---|---|---|---|
| 10.4 Course | Knowledge of basic concepts and results, problem solving | Written exam | 50 |
| 10.5 Seminar/lab activities | Individual project evaluation | Continous observation, dialogue | 50 |
| 10.6 Minimum performance standards | | | |
| ➢ Grade 5 | | | |

| Date | Signature of course coordinator | Signature of seminar coordinator |
|---|---|---|
| 27 april 2020 | lect.dr. Stefan Berinde | lect.dr. Stefan Berinde |

| Date of approval | Signature of the head of department |
|---|---|
| ..... | prof.dr. Octavian Agratini |