SYLLABUS

1. Information regarding the programme

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

2. Information regarding the discipline

2.1 Name of the discipline	Advanced problem solving techniques in mathematics and informatics						
2.2 Course coordinator							
2.3 Seminar coordinator	Trif Tiberiu-Vasile						
2.4 Year of study	1	2.5 Semester	2	2.6. Type of evaluation	Viva voce	2.7 Type of discipline	facultative
2.8 Code of the discipline	MLE2002						

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

3.1 Hours per week	2	Of which: 3.2 course	0	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	28	Of which: 3.5 course	0	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					10
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					27
Tutorship					
Evaluation					
Other activities:					

3.7 Total individual study hours	47
3.8 Total hours per semester	75
3.9 Number of ECTS credits	3

4. Prerequisites (if necessary)

4.1 curriculum	• Calculus 1 (Calculus in R) • Algebra 1 (Linear Algebra)
4.2 competencies	• Logical thinking abilities, problematisation

5. Conditions (if necessary)

5.1 For the course	•
5.2 For the seminar/lab activities	•

6. Specific competencies aquired

Professional competencies	• C1.4 Recognizing the main classes /types of mathematical problems and selecting the appropriate methods and techniques for their solving • C2.1 Identifying the basic notions used to describe some processes and phenomena
Transversal competencies	• CT1 Application of efficient and rigorous working rules, manifest responsible attitudes towards the scientific and didactic fields, respecting the professional and ethical principles. • CT3 Use of efficient methods and techniques for learning, information, research and development of abilities for knowledge acquiring, for adapting to the needs of a dynamic society and for communication in Romanian as well as in a widely used foreign language.

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

7.1 General objective of the discipline	• Preparing students for mathematical competitions by acquiring advanced problem solving methods and techniques
7.2 Specific objectives of the discipline	• Presenting advanced problem solving methods and techniques applicable to mathematical contests for university students • Problem solving sessions: presenting solutions to problems given in mathematical competitions for university students (Traian Lalescu, SEEMOUS, IMC, Putnam)

8. Content

8.1 Course	Teaching methods	Remarks
Bibliography		
8.2 Seminar / laboratory	Teaching methods	Remarks
1. Rank of a matrix, the Frobenius and the Sylvester inequalities, applications to solving contest problems	Lecture, discussion, problematisation	
2. Eigenvalues of certain special clases of matrices (Hermitian/symmetric matrices, skew Hermitian/skew symmetric matrices, unitary/ortogonal matrices), the characteristic polynomial, the Cayley-Hamilton theorem, the minimal polynomial, the Frobenius theorem, applications to solving contest problems	Lecture, discussion, problematisation	
3. Diagonalizable matrices, special clases of diagonalizable matrices (normal matrices, symmetric matrices), the spectral theorem for normal matrices, applications to solving contest problems	Lecture, discussion, problematisation	
4. Canonic forms, the unitary triangularization theorem of Schur, the Jordan canonic form theorem, applications to solving contest problems	Lecture, discussion, problematisation	
5. Dense sets on the real axis, the Dirichlet and the Kronecker theorems, applications to solving contest problems	Lecture, discussion, problematisation	
6. Perfect sets on the real axis, Cantor's set, applications to solving contest problems	Lecture, discussion, problematisation	

7. The Lagrange interpolation polynomial and applications to solving contest problems	Lecture, discussion, problematisation	
8. The generating function method, nonlinear recurences, applications to solving contest problems	Lecture, discussion, problematisation	
9. The Beta and Gamma functions, applications to solving contest problems	Lecture, discussion, problematisation	
10. Passing to the limit under the integral sign (the uniform convergence theorem, Arzelà's bounded convergence theorem, the dominated convergence theorem for improper Riemann integrals), applications to solving contest problems	Lecture, discussion, problematisation	
11+12. Solving some SEEMOUS problems	Lecture, discussion, problematisation	
13+14. Solving problems from the "Traian Lalescu" mathematical contest for university students	Lecture, discussion, problematisation	

Bibliography

1. AIGNER M.: Discrete Mathematics. American Mathematical Society, 2007
2. DE SOUZA P. N., SILVA J.-N.: Berkeley Problems in Mathematics. Third Edition. Springer, 2004
3. GELCA R., ANDREESCU T.: Putnam and Beyond. Springer, 2007
4. KEDLAYA K. S., POONEN B., VAKIL R.: The William Lowell Putnam Mathematical Competition 1985 – 2000. Problems, Solutions, and Commentary. The Mathematical Association of America, 2002
5. RĂDULESCU S., RĂDULESCU M.: Teoreme şi probleme de analiză matematică. Editura Didactică şi Pedagogică, Bucureşti, 1982
6. YAGLOM A. M., YAGLOM I. M.: Challenging Mathematical Problems with Elementary Solutions. Dover, Vol. I 1964, Vol. II 1967
7. TRIF T.: Teme pentru perfecţionarea profesorilor de matematică. Vol. 3. Analiză matematică. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2017
8. www.imc-**math**.org/
9. www.edumanager.ro/community/documente/concursuri_internationale_vol_1.pdf
10. www.edumanager.ro/community/documente/concursuri_internationale_vol_2.pdf

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

- The advanced problem solving methods and techniques will be helpful to the future mathematics teacher in preparing his students for mathematical competitions

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in grade
10.4 Course			
10.5 Seminar/lab	Knowing some advanced problem solving methods and techniques	Solving problems during the semester	100%
10.6 Minimum performance standards **5**			

Date	Signature of course coordinator	Signature of seminar coordinator
30.4.2020	.....	.....

Date of approval	Signature of the head of departament
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