SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Bachelor of Science
1.6 Program of study/Qualification	Computer science/ Engineer
1.7 Form of education	Full time
1.8 Subject code	3.

2. Data about the subject

2.1 Subject name	***Special Mathematics I***				
2.2 Course responsible/lecturer	Prof. dr. Daniela ROŞCA Daniela.Rosca@math.utcluj.ro				
2.3 Teachers in charge of seminars/ laboratory/ project	Prof. dr. Daniela ROŞCA Daniela.Rosca@math.utcluj.ro				
2.4 Year of study	I	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V - verification)	E
2.7 Subject category	*DF – fundamentală, DD – în domeniu, DS – de specialitate, DC – complementară*				DF
	DI – Impusă, DOp – opțională, DFac – facultativă				DI

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	Seminars	2	Laboratory		Project	
3.2 Number of hours per semester	56	of which:	Course	28	Seminars	28	Laboratory		Project	

3.3 Individual study:	
(a) Manual, lecture material and notes, bibliography	12
(b) Supplementary study in the library, online and in the field	28
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	14
(d) Tutoring	11
(e) Exams and tests	4
(f) Other activities:	0

3.4 Total hours of individual study (suma (3.3(a)...3.3(f)))	69
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	High school maths, real
4.2 Competence	Combinatorics (arrangements, permutations, combinations); sets and operations with sets; mathematical logic; induction method; calculus with matrices

5. Requirements (where appropriate)

5.1. For the course	Blackboard, videoprojector, computer
5.2. For the applications	Blackboard, videoprojector, computer

6. Specific competence

6.1 Professional competences	**C1 –** Operating with basic Mathematical, Engineering and Computer Science concepts **C1.1 -** Recognizing and describing specific concepts to calculability, complexity, programming paradigms and modeling of computing and communication systems **C1.2 -** Using specific theories and tools (algorithms, schemes, models,

	protocols, etc.) for explaining the structure and the functioning of hardware, software and communication systems **C1.3 -** Building models for various components of computing systems **C1.4 -** Formal evaluation of the functional and non-functional characteristics of computing systems **C1.5 -** Providing theoretical background for the characteristics of the designed systems
6.2 Cross competences	N/A

7. Discipline objective (as results from the *key competences gained*)

7.1 General objective	Description of the concepts, notions and fundamental methods used in counting and in discrete probabilities theory Presentation of basic notions and properties in graphs theory, algorithms and basis theorems in graphs theory and their proofs.
7.2 Specific objectives	Developing strategies for solving and applying reasoning methods for solving combinatorial problems; Identifying combinatorial (pattern) models when solving counting problems; Modeling and formulating, in terms and notations specific to probability theory, specific problems in which random experiments and processes occur; Identification of classical (standard) probabilistic models and distributions of discrete type when solving probability problems; Interpretation of numerical results obtained in problems modeled using random variables; Modeling specific problems, using notions and concepts from graph theory; Application of specific algorithms to classical problems modeled by graph theory (construction of minimum spanning trees, coding and decoding using binary trees, construction of Eulerian and Hamiltonian walks, the Chinese postman problem, flow problems, etc.).

8. Contents

8.1 Lectures	Hours	Teaching methods	Notes
Combinatorics: counting principles and methods	2	Presentation, demonstration, exemplification Multimedia – graphic tablet, videoprojector, blackboard	
Counting problems using recurrence relations. Recurrence and generation functions.	2		
Discrete probabilities (1): Axiomatic introduction in probability theory. General formulas and properties. Interpretation of probabilities. Examples.	2		
Discrete probabilities (2): Conditional probabilities. Formula on total probability and Bayes formula. Classic probability schemes	2		
Discrete probabilities (3): Discrete random variables. Expected value, variance. Examples of discrete random variables.	2		
Discrete probabilities (4): Cebyshev inequality. Poisson theorem.	2		
Discrete probabilities (5): Weak law of large numbers. Markov theorem, Chebyshev theorem, Poisson theorem. Examples and applications.	2		
Graph theory (1): Directed and undirected graphs: definitions, notations, general properties. Examples of problems which can be solved with graphs. Euler's theorem.	2		
Graph theory (2): Walks, trails, paths, cycles. Connectivity in graphs. Trees: general properties.	2		
Graph theory (3): Trees, directed trees, rooted trees, spanning trees, minimum spanning trees (MST). Algorithms for (MST): Prim, Kruskal, Edmonds – Chu-Liu.	2		
Graph theory (4): DFS (depth-first-search) and BFS (breadth-first-search) trees. Properties of BFS trees. Minimum path, Dijkstra's algorithm.	2		
Graph theory (5): Binary trees, Huffman's algorithm. Greedy	2		

algorithms. Property of matroid.			
Graph theory (6): Matchings. Bipartite graphs. Matching in bipartite graphs. Maximum matching and complete matching: Hall's and Berge's theorems.	2		
Graph theory (7): Transportation networks. Flows and cuts. Max flow min cut theorem.	2		

Bibliography

[1] Daniela Roşca – *Discrete Mathematics*, Editura Mediamira, 2008.
[2] Sheldon Ross - *A first course in probability,5th ed.*, Prentice Hall, 1997.
[3] Norman L. Biggs- *Discrete Mathematics*, Oxford University Press, 2005.
[4] Martin Aigner - *Discrete Mathematics,* American Mathematical Society, 2007.
[5] Daniela Rosca – *Special Mathematics,* online.

8.2 Applications – Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Counting problems: Dirichlet's principle, sieve principle, selections.	2		
Counting problems: permutations, arrangements, combinations, with and without repetitions, derangements.	2		
Counting problems: partitions, integer partitions, distributions, Stirling numbers.	2		
Combinatorial identities by double counting	2		
Elementary problems in discrete probabilities, reduced to counting problems, Classical examples with unexpected results. Conditional probabilities. Applications of Bayes' formula with interpretation of the results.	2		
Problems reduced to classical probabilities schemes. Discrete random variables.	2		
Calculation of expected value for discrete random variables. Application of Chebyshev inequality.	2		
Elementary problems with directed and undirected graphs.	2		
Graphs representation: adjacency and incidence matrices. Connectivity and adjacency matrices; Foulkes method for finding the connected components.	2		
Rooted trees, decision trees, sorting trees. Applications.	2		
Isomorphic graphs.	2		
Greedy algorithms: vertex colouring, the four colors theorem	2		
Eulerian and hamiltonian graphs.The Chinese postman problem.	2		
Activities networks, critical path. Transportation networks: flows and cuts.	2		

Bibliography

[1] Hannelore Lisei, Sanda Micula, Anna Soos, *Probability Theory through Problems and applications*, Cluj University Press, 2006.
[2] Daniela Rosca – *Special Mathematics*, online.

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Knowing basic notions, solving problems	Written examination	50%
Seminar	Solving problems	Continuous evaluation during the semester	50%
Laboratory			
Project			
Minimum standard of performance:			

Final mark=1 point + A+B, A= mark for counting and probability theory (max=4.5), B= mark for graph theory (max=4.5). Minimum standard: A>=0.5, B>=0.5, A+B>=4.

Date of filling in:	**Titulari**	**Titlu Prenume NUME**	**Semnătura**
	Course	Prof.dr.math. Daniela Rosca	
	Applications	Prof.dr.math. Daniela Rosca	

Date of approval in the department **Sept. 15, 2022**	Head of department Prof.dr. Dorian Popa
Date of approval in the Faculty Council Sept. 20, 2022	Dean Prof.dr.ing. Liviu Miclea