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 Computer Science**
1.4 Field of study	**Computer Science**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Cyber Security**

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			**Complex Networks in Security** **Rețele Complexe în Securitate**				
2.2 Course coordinator			**Prof. Dr. Camelia Chira**				
2.3 Seminar coordinator			**Prof. Dr. Camelia Chira**				
2.4. Year of study	**1**	2.5 Semester	**2**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Optional**
2.8 Code of the discipline		**MME8198**					

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	1 lab + 1 project
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					32
Additional documentation (in libraries, on electronic platforms, field documentation)					32
Preparation for seminars/labs, homework, papers, portfolios and essays					36
Tutorship					5
Evaluations					14
Other activities:					-

3.7 Total individual study hours	119
3.8 Total hours per semester	175
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	· Algorithms and Programming, OOP
4.2. competencies	· Good programming skills

5. Conditions (if necessary)

5.1. for the course	· Projector
5.2. for the seminar /lab activities	· Computers, Network visualization tools, Python/Java/C++ programming environment

6. Specific competencies acquired

Professional competencies	C3.1 Description of concepts, theories and models used in the application domain C3.3 Use of models and instruments from computer science and mathematics to solve specific problems from the application domain CE1.3 Use of models, techniques and algorithms from Artificial Intelligence to model solutions for classes of problems CE1.5 Integration of models and solutions specific to Artificial Intelligence in dedicated applications
Transversal competencies	Professional communication skills; concise and precise description, both oral and written, of professional results; Ethic and fair behaviour, commitment to professional deontology; Applying the norms of organized and efficient work, responsibility and reliability of the work performed both individually and within a team; Good English communication skills.

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

7.1 General objective of the discipline	· Introduce the interdisciplinary academic field of network science and the modern theory and applications of complex networks in cyber security.
7.2 Specific objective of the discipline	· Describe the concepts and methods used in network science, define network models (scale-free, small-world, power-law) and processes on networks, theory and modelling of complex networks, analysis of real-world network datasets.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction to Complexity and Network Science. Real-world networks: concepts, challenges	· Interactive exposure · Presentation · Explanation · Practical examples · Case-study discussions	

2. Network theory: node degree, paths, degree distribution, network properties, basic definitions		
3. Network metrics and centrality measures		
4. Random networks		
5. Small world networks		
6. Scale-free networks		
7. Growth and preferential attachment in networks		
8. Community detection in networks		
9. Spreading phenomena in networks		
10. Epidemic models over networks		
11. Complex networks in cybersecurity problems		
12. Applications and practical examples from cybersecurity domain		
13. -14. Student presentations		

Bibliography

1. Albert-Laszlo Barabasi, Network Science, Cambridge University Press, 2016.
2. Mark Newman, Networks: An Introduction, Oxford University Press, 2010.
3. David Easley, Jon Kleinberg, Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010.
4. Ernesto Estrada, The Structure of Complex Networks Theory and Applications, Oxford University Press, 2011.
5. Melanie Mitchell, Complexity: A Guided Tour, Oxford University Press, 2009.
6. Robert A. Hanneman, Mark Riddle. 2005. Introduction to social network methods. Riverside, CA: University of California, Riverside (published in digital form at http://faculty.ucr.edu/~hanneman)
7. D. J. Watts, P. S. Dodds, M. E. J. Newman. Identity and Search in Social Networks. Science, 296, 1302-1305, 2002.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Graph representation of networks. Network analysis tools	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
2. Network analysis and visualization: degree distribution, clustering coefficient, centralities		.
3. Network models: random, small worlds, scale-free		.
4. Network analysis project I: topic selection, basic analysis		.
5. Network analysis project II: visualization, network properties, important nodes		.
6. Network analysis project III: network dynamics, communities		.
7. Student presentations		.

Bibliography

1. Albert-Laszlo Barabasi, Network Science, Cambridge University Press, 2016.
2. Mark Newman, Networks: An Introduction, Oxford University Press, 2010.
3. David Easley and Jon Kleinberg, Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010.
4. Ernesto Estrada, The Structure of Complex Networks Theory and Applications, Oxford University Press, 2011.
5. Jure Leskovec, Andrej Krevl, SNAP Datasets: Stanford Large Network Dataset Collection, http://snap.stanford.edu/data, 2014.

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 exists in the studying program of all major universities abroad;

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Know basic concepts, models and theories on network science; Appy known concepts to perform network analysis	Written exam / Research paper and presentation	50%
10.5 Seminar/lab activities	Specify, design, implement and test network analysis methods	Project implementation and presentation	50%
10.6 Minimum performance standards			
Each student should obtain minimum 5 for the written exam /research paper and presentation, as well as for the final grade.			

Date	Signature of course coordinator	Signature of seminar coordinator
11.05.2022	**Prof. dr. Camelia Chira**	**Prof. dr. Camelia Chira**

Date of approval

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Signature of the head of department

Prof. dr. Laura Dioşan