

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	Master of Science
1.6 Program of study/Qualification	Data Science/Master of Science
1.7 Form of education	Full time
1.8 Subject code	15.2

2. Data about the subject

2.1 Subject name	Complex Networks					
2.2 Course responsible/lecturer	Assoc. prof. dr .eng. Adrian Peculea - Adrian.Peculea@cs.utcluj.ro Assoc. prof. dr. eng. Bogdan Iancu - Bogdan.Iancu@cs.utcluj.ro					
2.3 Teachers in charge of seminars/laboratory/project	Assoc. prof. dr. eng. Adrian Peculea - Adrian.Peculea@cs.utcluj.ro Assoc. prof. dr. eng. Bogdan Iancu - Bogdan.Iancu@cs.utcluj.ro					
2.4 Year of study	II	2.5 Semester	1	2.6 Assessment	(E - exam, C - colloquium, V – verification)	E
2.7 Subject category	DA – aprofundare, DS – de specialitate, DC – complementară					DA
	DI – Impusă, DO – opțională, DF – facultativă					DO

3. Estimated total time

3.1 Number of hours per week	3	of which	Course	1	Seminar	-	Laboratory	1	Project	1
3.2 Total hours in the curriculum	42	of which	Course	14	Seminar	-	Laboratory	14	Project	14
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										16
(b) Supplementary study in the library, online and in the field										16
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										14
(d) Tutoring										10
(e) Exams and tests										3
(f) Other activities										
3.4 Total hours of individual study (sum(3.7(a)...3.7(f)))					59					
3.5 Total hours per semester (3.4+3.8)					100					
3.6 Number of credit points					4					

4. Pre-requisites (where appropriate)

4.1 Curriculum	N/A
4.2 Competence	TCP/IP networking, Basic knowledge in Software development (C, Java, C#, Python), Computer architecture, Operating systems

5. Requirements (where appropriate)

5.1 For the course	Blackboard, projector, computer
5.2 For the applications seminar / laboratory / project	Classroom, PC with internet access, Computer networks equipment and software (simulators, emulators, network analysis tools, development boards, VMs). Laboratory and project attendance is mandatory

6. Specific competences

6.1 Professional competences	Working with advanced mathematical methods and models, engineering and computing specific techniques and technologies. Development of advanced techniques, methods and methodologies in the domains of software design, programming systems and environments and their applications. Contextual integration and exploitation of dedicated information systems. Creative pooling of multidisciplinary knowledge in the field of computers and information technology for research, design, optimization, implementation and testing of theories, algorithms and original methods specific to artificial intelligence and computer vision systems. Design and integration of IT systems, including specification development and systems life cycle management. Testing and qualitative evaluation of the functional and non-functional characteristics of IT systems, based on specific criteria. Development of systems and applications for the maintenance and use of hardware, software and communications systems.
6.2 Cross competences	Proof of knowledge for the economic, ethical, legal and social context associated with the profession, for correct task identification, schedule of activities, responsible decisions, with the final goal the design, preparation and presentation of a scientific paper. Clear and concise description of professional activity flows, tasks and outcomes obtained by assuming the role of leader / project manager or as a member of a research team, as result of personal skills of domain specific information synthesis, global vision, communication skills with collaborators, ability of task stages identification. Exercising the skill of continuous self-education and demonstrating critical, innovative and research abilities.

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

7.1 General objective	Gain a deep understanding of the fundamental principles and advanced concepts in networking technologies. Develop skills for designing, implementing and configuring complex network and large-scale network infrastructures and services. Understand the challenges and techniques associated with scaling network infrastructures. Understand strategies for ensuring the security and reliability of large-scale networks. Explore latest trends and emerging technologies for complex network and large-scale network infrastructures and services.
7.2 Specific objectives	Understanding foundational principles, gaining advanced research skills and practical skills, covering: - protocols and configuration of large-scale networks infrastructures - security protocols and mechanisms for protecting large-scale networks - visualization and exploration of complex networks - network automation and orchestration - investigating case-studies for data centers, IoT and CDN

8. Contents

8.1. Lecture (syllabus)	Hours	Teaching methods	Notes
Introduction to computer networks	1	Presentation on the blackboard, presentation of slides, discussions (Q&A), consultations. The use of multimedia means, interactive teaching	
Introduction to large-scale infrastructures	1		
Communication protocols	1		
High Availability	1		
Introduction to cybersecurity	1		
Cybersecurity concepts for large-scale network infrastructures and services	1		

Introduction to complex networks	1	style, offering programs for self-testing, involvement in research contracts, consultations. Collaborative platforms (Teams, Moodle, Skype, etc.)	
Infrastructure management using SDN and NFV	1		
Cloud computing infrastructure	1		
Large-scale infrastructures for big data analytics and visualization	1		
Large-scale infrastructures for data centers	1		
Large-scale infrastructures for massive IoT	1		
Content delivery networks	1		
Future trends	1		
Bibliography:			
1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach (The Morgan Kaufmann Series in Networking) 6th Edition, Morgan Kaufmann, 2021.			
2. Matt Oswalt, Christian Adell, Scott Lowe, Jason Edelman, Network Programmability and Automation: Skills for the Next-Generation Network Engineer 2nd Edition, O'Reilly Media, 2018 and 2023.			
3. Larry L. Peterson, Carmelo Cascone, Brian O'Connor, Thomas Vachuska, Bruce Davie, Software-Defined Networks: A Systems Approach, Systems Approach LLC, 2021.			
4. Vito Latora, Vincenzo Nicosia, Giovanni Russo, Complex Networks: Principles, Methods and Applications, Cambridge University Press, 2017.			
5. Perry Lea, IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition, Packt Publishing, 2020.			
8.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Notes
Review of computer networking basics. Advanced computer networks configurations	2	Practical exercises Presentation of possible solutions Self-testing programme	
Network Protocol Analysers. Network Management Systems	2		
Snort and firewall rules. Security solutions for cloud	2		
Visualization and exploration software for complex networks	2		
Network automation. DevOps/NetOps on AWS / Azure	2		
Data center case-study	2		
CDN case-study	2		
Bibliography:			
1. Omar Santos, CCNA Security 210-260 Official Cert Guide Cisco Press, 2015.			
2. Omar Santos, Cisco CyberOps Associate CBROPS 200-201 Official Cert Guide, Cisco Press, 2020.			
3. Perry Lea, IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition, Packt Publishing, 2020.			
4. Jose Manuel Ortega, Python for Security and Networking: Leverage Python modules and tools in securing your network and applications, 3rd Edition, Packt Publishing, 2023.			
5. Skills for All with Cisco, https://skillsforall.com/			

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

Course content is kept state of the art by using latest protocols and devices available on the market. The discipline is a domain discipline in Computers and Information Technology, its content being both classic and modern, familiarizing students with design and operation principles for complex networks and large-scale network infrastructures and services. The content of the discipline was discussed with other universities and important companies from Romania, Europe and the USA and evaluated by Romanian government agencies.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Interactivity and initial preparation, attendance, activity during lectures, written examination	Written exam	50%

Seminars/Laboratory/ Project	Interactivity and initial preparation, quality of practical work, ability to solve problems specific to the field, attendance, activity during classes	Continuous assessment, projects' presentation, final written assessment	50%
Minimum standard of performance: Grade calculus: 50% laboratory, project + 50% final exam Conditions for participating in the final exam: Laboratory, Project ≥ 5 Conditions for promotion: grade ≥ 5			

Date of filling in: 26.02.2025	Responsible	Title First name Last name	Signature
	Course	Assoc.prof.dr.eng. Adrian PECULEA	
		Assoc.prof.dr.eng. Bogdan IANCU	
	Applications	Assoc.prof.dr.eng. Adrian PECULEA	
		Assoc.prof.dr.eng. Bogdan IANCU	

Date of approval in the department	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council	Dean, Prof.dr.eng. Vlad Mureșan