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
1.6 Program of study / Qualification	Data Science / Master
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	*Complex Networks*				Subject code		**15.20**	
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 Type of assessment (E - exam, C - colloquium, V – verification)				E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary							DA
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)							DO

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	1	Seminars	0	Laboratory	1	Project	1
3.2 Number of hours per semester	52	of which:	Course	14	Seminars	0	Laboratory	14	Project	14

3.3 Individual study:	
(a) Manual, lecture material and notes, bibliography	15
(b) Supplementary study in the library, online and in the field	15
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	15
(d) Tutoring	10
(e) Exams and tests	3
(f) Other activities:	

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	58
3.5 Total hours per semester (3.2+3.4)	100
3.6 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	N/A
4.2 Competence	Operating with fundamental computer science concepts, 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, PC MS Teams Platform, Moodle Platform
5.2. For the applications	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 competence

6.1 Professional competences	Analyse big data
	Analyse business processes
	Analyse decentralised applications
	Build predictive models
	Create data models
	Define technical requirements
	Develop software prototype
	Develop with cloud services
	Interpret technical requirements
	Manage cloud data and storage
	Perform data cleansing
	Perform data mining
	Perform scientific research
	Provide technical documentation
	Use data processing techniques
	Use software libraries
	Utilise computer-aided software engineering tools
	Utilise machine learning
6.2 Cross competences	Develop an analytical approach
	Taking a proactive approach
	Developing strategies to solve problems
	Being open minded
	Coordinate engineering teams

7. Expected Learning Outcomes

	The student has knowledge of:
Knowledge	- cloud technologies - computer science - data analytics - data models - data storage - data warehouse - database management systems (DBMS) - digital data processing - statistics - ICT debugging tools - computer programming - decentralized application frameworks - digital identity management - game theory - software components - software libraries - cloud technologies - data analytics - service-oriented modelling

Skills	The student is able to: • create data sets • develop data processing applications • establish data processes • manage ICT data architecture • manage data • manage quantitative data • manage research data • perform dimensionality reduction • process data • store digital data and systems • use data processing techniques • use databases • create data models • analyse decentralised applications • debug software • interpret technical requirements • use software libraries • utilise computer-aided software engineering (CASE) tools • adapt to changes in technological development plans	
Responsibilities and autonomy	The student has the ability to work independently in order to: • develop an analytical approach • take a proactive approach • develop strategies to solve problems • be open minded • coordinate engineering teams	

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

8.1 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.
8.2 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

9. Contents

9.1 Lectures	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		

	Hours	Teaching methods	Notes
Infrastructure management using SDN and NFV	1	style, offering programs for self-testing, involvement in research contracts, consultations. Collaborative platforms (Teams, Moodle, Skype, etc.)	
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:

- Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach (The Morgan Kaufmann Series in Networking) 6th Edition, Morgan Kaufmann, 2021.
- 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.
- Larry L. Peterson, Carmelo Cascone, Brian O'Connor, Thomas Vachuska, Bruce Davie, Software-Defined Networks: A Systems Approach, Systems Approach LLC, 2021.
- 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.

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Review of computer networking basics. Advanced computer networks configurations	2	Oral presentation using slides, discutions (Q&A). 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

- Omar Santos, CCNA Security 210-260 Official Cert Guide Cisco Press, 2015.
- Omar Santos, Cisco CyberOps Associate CBROPS 200-201 Official Cert Guide, Cisco Press, 2020.
- 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.
- Jose Manuel Ortega, Python for Security and Networking: Leverage Python modules and tools in securing your network and applications, 3rd Edition, Packt Publishing, 2023.
- Cisco Networking Academy, https://www.netacad.com/

Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.

10. 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 aligned 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, intermediary and final written examinations	Written exam – intermediary and summative	50%
Seminar	-	-	-
Laboratory	Quality of practical work, participation	Written examination, demo,	25%

		report -continuous and summative	
Project	Quality of project work, participation	Oral examination, demo, report - continuous and summative	25%

Minimum standard of performance:
Grade calculus: 50% laboratory and project + 50% final exam
Conditions for participating in the final exam: Laboratory and project ≥ 5
Conditions for promotion: grade ≥ 5

Date of filling in: 01.09.2025	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 17.09.2025	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 19.09.2025	Dean, Prof.dr.eng. Vlad Mureşan