



SYLLABUS

1. Data about the program of study

Technical University of Cluj-Napoca
Faculty of Electronics, Telecommunications and Information
Technology
Communications
Electronic Engineering, Telecommunications and Information
Technologies
Bachelor of Science
Telecommunications Technologies and Systems/ Engineer
Applied Electronics/Engineer
Full time
TST-E39.00/EA-E108.00

2. Data about the subject

2.1 Subject name Switching			ng a	and R	outing Systems			
		eoretical area						
		Methodological area						
Analyt			lytic area					
2.3 Course responsible			Professor Virgil DOBROTA, Ph.D, Virgil.Dobrota@com.utcluj.ro					
2.4 Teacher in charge with seminar /		Assist. Prof. Andrei Bogdan RUS, Ph.D, <u>Bogdan.Rus@com.utcluj.ro</u>				itcluj.ro		
laboratory / project			As	sist. I	Robert BOTEZ, Ph.D stu	der	nt, <u>Robert.Botez@com.ut</u>	cluj.ro
2.5 Year of study	3	2.6 Semeste	er	6	2.7 Assessment	Е	2.8 Subject category	DS/DI

3. Estimated total time

3.1 Number of hours per week	4	of which: 3.2 c	ourse	2	3.3 laboratory + project	3
3.4 To Total hours in the curriculum	100	of which: 3.5 c	ourse	28	3.6 laboratory + project	42
Distribution of time						hours
Manual, lecture material and notes, b	oibliogr	aphy				14
Supplementary study in the library, online specialized platforms and in the field					-	
Preparation for seminars / laboratories, homework, reports, portfolios and essays					10	
Tutoring						3
Exams and tests					3	
Other activities:					0	
3.7 Total hours of individual study		80				
3.8 Total hours per semester 100						

5.6 Total nours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	N. A.
4.2 competence	Graph theory, Mathematical statistics

Universitatea Tehnică din Cluj-Napoca • Facultatea de Electronică, Telecomunicații și Tehnologia Informației Str. George Barițiu nr. 26-28, 400027, Cluj-Napoca, Tel: 0264-401224, Tel/Fax: 0264-591689, http://www.etti.utcluj.ro





5. Requirements (where appropriate)

5.1. for the course	Cluj-Napoca
5.2. for the seminars / laboratories / projects	Cluj-Napoca

6. Specific competences

competences	 C4. Design, implementation and operation of data, voice, video and multimedia services. This is based on the understanding and the application of fundamental concepts in telecommunications and transmission of information C4.3 Explanation and interpretation of the main requirements and specific approach techniques for data, voice, video, multimedia transmissions C4.4 Use of the main specific parameters in evaluations based on the concept of quality of service in communications C4.5 Development of simple communications services C5. Selecting, installing, configuring and operating fixed or mobile telecommunications equipment. Equipping a site with usual telecommunications
Professional competences	 telecommunications equipment. Equipping a site with usual telecommunications networks C5.1 Defining the principles of the main technologies for fixed and mobile telecommunications, through various transmission media C5.2 Explanation and interpretation of the technologies and of fundamental protocols for integrated fixed and mobile communications systems C5.3 Installation, configuration and exploiting of communications networks C5.4 Use of evaluation techniques and diagnostics for communications systems and equipment C5.5 Endowment with communications means of a location with a small/ medium degree of complexity
Transversal competences	N/A

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

7.1 General objective	Development of competences regarding switching and routing in telecommunications networks
7.2 Specific objectives	 Understanding the basic concepts regarding switching and routing algorithms Development of skills and abilities for configuring IP-Based Asterisk telephone exchange Development of skills for virtualization of switches and routers and their cloud applications





8. Contents

Clients Arrivals: Bernoulli, Poisson Clients Arrivals: Bernoulli, Poisson Clients Arrivals: Bernoulli, Poisson 7. M/M/1/infinite System. M/M/1/N System M/M/m/m System. Erlang B Clients Arrivals: Bernoulli, M/M/m/m System. Erlang B 8. M/M/m/m System. Erlang C Formula. M/M/m/m System. Pollaczek- Khinchin Formula. Traffic Processing in Telecommunications Formula. 9. M/D/m/m and M/D/1/m System. Saics of Routing: Definitions Formula. Formula. 11. Bellman-Ford Algorithm. Dijkstra's Algorithm Formula. Formula. 12. Floyd-Warshall Routing Algorithm. Comparison between Bellman-Ford, Dijkstra's and Floyd-Warshall Routing Algorithms. Cost function. Formula. 13. Optimal routing. Link capacity. Latency. Link flow. Round-trip delay. Cost function. Minimizing the cost function. Randomization and metering methods. Formula. 14. Review. Examples of subjects given in the previous academic year References 1. V. Dobrota, Retele digitale in telecomunicatii. Volumul I: Comutatia digitala, Analiza traficului. Editia a III-a, Editura Mediamira, Cluj-Napoca 2002 P. Van Mieghem, Performance Analysis of Communications Networks and Systems. Cambridge University Press, 2014 On-line references: 3. V. Dobrota, Retele digitale and Routing Systems. Technical University of Cluj-Napoca, 2022-2023 https://el.el.obs.utcluj.ro/scr/en_index.htm 8.2 Laboratory Teaching methods Notes		Lecture (syllabus)	Teaching methods	Notes	
2. Multiple Stage Switch with Complete Permutation Paths (Clos). Strictly Non-Blocking Three-Stage Clos Switch. Blocking Probabilities. Lee's Method. Generalization of Clos Condition	1.	Digital Switching Functions. Single Stage Space-Division Switch.			
Strictly Non-Blocking Three-Stage Clos Switch. Blocking in Probabilities. Lee's Method. Generalization of Clos Condition orgeneralization of Clos Condition 3. Multiple Stage Switches with Multiple Path. (Banyan). Batcher-Banyan Switches. Software Package for the Simulation of Batcher-Banyan Switches orgeneralization of Clos Condition 4. Multiple Stage Switches with Multiple Path. Time-Division Switching: T. Time-Space-Division Switching: TS orgeneralization of Batcher-Banyan Switches Switch. TSS ST Switch. Examples of Telephone Exchanges and Switch Fabrics (optional). Switches in cloud orgeneralization of Clos Could Cloud System. Erlang B Formula. 6. Trafic Analysis. Characteristics of a Queueing System. Pollaczek-Khinchin Formula. Traffic Processing in Telecommunications orgeneralization of Clos Could Gloud Cloud Clou					
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9. Problems within Chapter 2 (Traffic Analysis)		
10. Problems within Chapter 1 (Digital Switching) + Chapter 2 (Traffic		
Analysis)	_	
11. Software Package for Bellman-Ford Algorithm		
12. Software Package for Dijkstra's Algorithm		
13. Floyd-Warshall Algorithm. Software Package for Floyd-Warshall		
Algorithm	_	
14. Recovery Laboratory. Questions		
On-line references:		
1. V. Dobrota, Switching and Routing Systems. Technical University	sity of Cluj-Napo	ca, 2022-2023
https://el.el.obs.utcluj.ro/scr/en_index.htm		
	Teaching	
8.3. Project	methods	Notes
1. Adrese IPv4		
1. IPv4 Addressing	1	-
2. Create a dial plan for an AsteriskNOW IP PBX installed on a	1	s, on
CentOS virtual machine, with at least two SIP subscribers and at		ter
least two IAX2 subscribers. The mandatory part for managing phone	l q X	trumentatio computers,
calls will be implemented (DIAL, RINGING, ANSWER and HANGUP	w c	ĔĔ
functions). Implementation of two particular functions (e.g. VOICE-	L L L	S tr
MAIL, CONFERENCING, SAY, PLAY, WAIT, AUTHENTICATE,	tea	ds, ds
TIMEOUT, RECORD).	and experimental proof, exercise, team work	laboratory instrumentation, iental boards, computers, ic board
3. Working for project: Call one SIP subscriber, one IAX subscriber	cis ex	atc I bc ard
4. Working for project: Implementation of SIP functions	xer	bo
5. Working for project: Implementation of IAX2 functions		lal tic
6. Working for project: Integrate SIP and IAX functions. Optional:	Didactic	Use of laboratory ins experimental boards, magnetic board
testing in OpenStack-based cloud	ida	Use expe magi
7. Project defending	ספ	J © E
References		
1. J.Van Meggelen, R.Bryant, L.Madsen, Asterisk: The Definitive Gui	de. Fifth Edition.	O'Reilly Media,

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

The discipline content and the acquired skills are in agreement with the expectations of the professional Competences acquired will be used in the following COR occupations (Electronics Engineer; Telecommunications Engineer; Electronics Design Engineer; System and Computer Design Engineer; Communications Design Engineer) or in the new occupations proposed to be included in COR (Sale Support Engineer; Multimedia Applications Developer; Network Engineer; Communications Systems Test Engineer; Project Manager; Traffic Engineer; Communications Systems Consultant).

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	The level of acquired theoretical knowledge and practical skills	Theoretical Test (mark T) : 9 questions	T, max 10 pts. 50%
10.5 Laboratory/Project	The level of acquired	Project (P1): oral and practical exam based on laboratory and project work Problem (P2) written exam to solve a problem covering all chapters	P1, max. 5 pts. 25% P2, max. 5 pts 25%





10.6 Minimum standard of performance

Qualitative point of view

Minimal theoretical and practical knowledge:

- ✓ 1. Understanding the basic concepts regarding switching and routing algorithms
- ✓ 2. Development of skills and abilities for configuring IP-Based Asterisk telephone exchange Minimal acquired competences:
 - ✓ Ability to develop simple private branch exchange (PBX) applications
 - ✓ Ability to analyze and improve performance of a switching and routing systems
- Quantitative point of view
 - ✓ T≥5
 - ✓ P=P1+P2 ≥ 5, P2≥1.5
 - ✓ (T+P)/2≥ 4.5

Data of filling in:	Responsible	Title First name SURNAME	Signature
20.06.2023	Course Applications	Professor Virgil DOBROTA, Ph.D.	
		Professor Virgil DOBROTA, Ph.D.	
		Assist. Prof. Andrei Bogdan RUS, Ph.D.	
		Assist. Robert BOTEZ, Ph.D. student	

Date of approval in the Council of the Communications Department 11.07.2023 Head of Communications Department Prof. Virgil DOBROTA, Ph.D.

Date of approval in the Council of the Faculty of Electronics, Telecommunications and Information Technology 12.07.2023 Dean Prof. Ovidiu POP, Ph.D.