

## SYLLABUS

### 1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Communications
1.4	Field of study	Electronics and Telecommunications Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/Qualification	Telecommunications Technologies and Systems/ Engineer
1.7	Form of education	Full time
1.8	Subject code	TST-E41.00

### 2. Data about the subject

2.1	Subject name	Switching and Routing Systems										
2.2	Subject area	Electronics and Telecommunications Engineering										
2.3	Course responsible/lecturer	Professor Virgil DOBROTA, Ph.D										
2.4	Teachers in charge of applications	Assistant Professor Bogdan RUS, Ph.D										
2.5	Year of study	III	2.6	Semester	2	2.7	Assessment	Exam	2.8	Subject category	DS/DOB	

### 3. Estimated total time

Year/ Sem.	Subject name	No. of weeks	Course			Applications			Indiv. study	TOTAL	Credits		
			[hours/ week]			[hours/ semester]							
				S	L	P		S				L	P
III/2	Switching and Routing Systems	14	2		2	1	28		28	14	60	130	5

3.1	Number of hours per week	5	3.2	of which, course	2	3.3	applications	3	
3.4	Total hours in the curriculum	70	3.5	of which, course	28	3.6	applications	42	
Individual study									Hours
Manual, lecture material and notes, bibliography									26
Supplementary study in the library, online and in the field									-
Preparation for seminars/laboratory works, homework, reports, portfolios, essays									28
Tutoring									3
Exams and tests									3
Other activities									
3.7	Total hours of individual study	60							
3.8	Total hours per semester	130							
3.9	Number of credit points	5							

#### 4. Pre-requisites (where appropriate)

4.1	Curriculum	N.A.
4.2	Competence	To know the space-division and time-division switches; To understand the principles of circuit switching and packet switching; To get basic knowledge of queueing systems as major mathematical models for network design; To know the principles of next generation networks from routing point of view

#### 5. Requirements (where appropriate)

5.1	For the course	Cluj-Napoca
5.2	For the applications	Cluj-Napoca

#### 6. Specific competences

Professional competences	C4. To design, implement and operate data, voice, video and multimedia services, based on the understanding and application of fundamental concepts from the field of communications and information transmission.  C5. To select, install, configure and exploit fixed and mobile telecommunications equipment. To equip a site with common telecommunications networks.
Cross competences	N.A.

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

7.1	General objectives	Developing the competences regarding the switching and routing in telecommunications networks
7.2	Specific objectives	1. Developing skills and abilities to design and to simulate switches and routing algorithms using programs developed within the laboratory. 2. Developing skills and abilities to install and to configure an Asterisk-based software switch.

#### 8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1	Digital Switching Functions. Single Stage Space-Division Switch. Classification of Multiple Stage Switches	Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, formative evaluation	Use of .ppt presentation, projector, blackboard
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		
3	Multiple Stage Switches with Single Path (Banyan). Batchier-Banyan Switches. Software Package for the Simulation of Batchier-Banyan Switches		
4	Multiple Stage Switches with Multiple Path. Time-Division Switching: T. Time-Space-Division Switching: TS		
5	STS Switch. TST Switch. TSSST Switch. Examples of Telephone Exchanges and Switch Fabrics (optional). Switches in cloud		
6	Traffic Analysis. Characteristics of a Queueing System. Models for Clients Arrivals: Bernoulli, Poisson		

7	M/M/1/infinite System. M/M/1/N System		
8	M/M/m/ $\infty$ System. Erlang C Formula. M/M/m/m System. Erlang B Formula.		
9	M/D/m/ $\infty$ and M/D/1/ $\infty$ Systems. M/G/1/ $\infty$ System. Pollaczek-Khinchin Formula. Traffic Processing in Telecommunications		
10	Routing Algorithms. Basics of Routing: Definitions		
11	Bellman-Ford Algorithm. Dijkstra's Algorithm		
12	Floyd-Warshall Algorithm. Comparison between Bellman-Ford, Dijkstra's and Floyd-Warshall Routing Algorithms. Cost function		
13	Optimal routing. Link capacity. Latency. Link flow. Round-trip delay. Cost function. Minimizing the cost function. Randomization and metering methods.		
14	Review. Examples of subjects given in the previous academic year		
8.2. Applications (lab)		Teaching methods	Notes
1	Linux Fedora Core Installation	Didactic and experimental proof, didactic exercise, team work	Use of laboratory instrumentation, experimental boards, computers, magnetic board
2	Introduction to Linux. Working with files.		
3	Strictly Non-Blocking Three-Stage Clos Switch. Software Package for Designing of Clos Switches		
4	Software Package for the Simulation of Rectangular Delta Switches. Software Package for the Simulation of Rectangular Omega Switches		
5	Multiple Stage Switches with Multiple Paths (Benes). Software Package for the Simulation of Benes Switches.		
6	STS Switch. Software Package for the Designing of STS Switches		
7	TST Switch. Software Package for the Designing of TST Switches		
8	Software Package for the Calculation of Binomial Bernoulli, Normal Laplace-Gauss and Poisson Distributions. Software Package for the Calculation of Erlang B and Erlang C Formulas		
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		
8.3. Applications (project)		Teaching methods	Notes
1	IPv4 Addressing	Didactic and experimental proof, didactic exercise, team work	Use of laboratory instrumentation, experimental boards, computers, magnetic board
2	Create a dial plan for an AsteriskNOW IP PBX installed on a CentOS virtual machine, with at least two SIP subscribers and at least two IAX2 subscribers. The mandatory part for managing phone calls will be implemented (DIAL, RINGING, ANSWER and HANGUP functions). Implementation of two particular functions (e.g. VOICEMAIL, CONFERENCING, SAY, PLAY, WAIT, AUTHENTICATE, TIMEOUT, RECORD).		
3	Working for project: Call one SIP subscriber, one IAX subscriber		
4	Working for project: Implementation of SIP functions		
5	Working for project: Implementation of IAX2 functions		
6	Working for project: Integrate SIP and IAX functions. Optional: testing in OpenStack-based cloud		
7	Project Defending		

## Bibliography

1. V. Dobrota, *Rețele digitale în telecomunicații. Volumul I: Comutatie digitală. Analiza traficului. Editia a III-a*, Editura Mediamira, Cluj-Napoca 2002
2. J. Bellamy, *Digital Telephony*. Third Edition. John Wiley & Sons, Inc. USA 2000  
[http://el.el.obs.utcluj.ro/scr/pdf/Digital\\_Telephony.pdf](http://el.el.obs.utcluj.ro/scr/pdf/Digital_Telephony.pdf)
3. D. Bertsekas, R. Gallager, *Data Networks*. Second Edition. Prentice-Hall Inc., USA 1992  
<http://web.mit.edu/dimitrib/www/datanets.html>
4. R. Bryant, L. Madsen & J. Van Meggelen, *Asterisk™: The Definitive Guide*. Fourth Edition. O'Reilly Media Inc, 2013, [http://el.el.obs.utcluj.ro/scr/pdf/Asterisk\\_The\\_Definitive\\_Guide\\_2013.pdf](http://el.el.obs.utcluj.ro/scr/pdf/Asterisk_The_Definitive_Guide_2013.pdf)
5. Van Mieghem, *Performance Analysis of Complex Networks and Systems*, Cambridge University Press, 2014, <http://www.nas.its.tudelft.nl/people/Piet/bookPA.html>

## On-line references

1. V. Dobrota, *Switching and Routing Systems*. Technical University of Cluj-Napoca, 2018  
[http://el.el.obs.utcluj.ro/scr/en\\_index.htm](http://el.el.obs.utcluj.ro/scr/en_index.htm)

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

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. Evaluations

Activity type	10.1	Assessment criteria	10.2	Assessment methods	10.3	Weight in the final grade
Course		The level of acquired theoretical knowledge and practical skills		Theoretical Test (mark T) : 9 questions		T, max 10 pts. 50%
Applications		The level of acquired abilities		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%
10.4 Minimum standard of performance						
$T \geq 5$ and $P=P1+P2 \geq 5$ and $(T +P)/2 \geq 4.5$						

Date of filling in  
01.10.2018

Course responsible  
Professor  
Virgil DOBROTA, PhD

Teachers in charge of applications  
Assistant Professor  
Andrei Bogdan RUS, PhD