MINISTRY OF NATIONAL EDUCATION

TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

SYLLABUS

1. Study Program

1.1	Higher Education Institute	Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Communications
1.4	Study domain	Electronics and Telecommunications Engineering
1.5	Study level	Master
1.6	Study program/ Qualification	Multimedia Technologies/ Telecommunications/ Master
1.7	Type of education	IF (Full-time learning)
1.8	Discipline code	TM-E11.50/ TC-E11.10

2. Discipline

2.1	Discipline name					Quality of Services in Next Generation Networks					
2.2	Subject area					Electronics and Telecommunications Engineering					
2.3	Responsible					Assistant Professor Andrei Bogdan RUS, Ph.D. Bogdan.Rus@com.utcluj.ro Eng. Gabriel Lazar, Gabriel.Lazar@com.utcluj.ro					
2.4	Titular					Assistant Professor Andrei Bogdan RUS, Ph.D. Bogdan.Rus@com.utcluj.ro					
2.5	Year of study	I	2.6	Semester	2	2.7	Evaluation	Exam	2.8	Type of discipline	DS/DO

3. Total estimated time

Year/ Sem	Discipline name	No. of weeks	Course [hours/week]				Applications [hours/week]				Course	Applications	Indiv. study	TOTAL	ECTS
			C	S	L	P		S	L	P					
I/2	Quality of Services in NGN	14	2		1		28		14		58	100	4		

3.1	Number of hours per week	4	3.2	course	2	3.3	applications	1
3.4	Total hours per curriculum	56	3.5	course	28	3.6	applications	14

Individual study	Hours
Study based on manuals, course materials, references and notes	18
Supplementary documentation in libraries, electronic platforms and on field	12
Preparation of seminars/laboratories, homework, essays, portfolios	10
Tutorial work	12
Assessments	2
Other activities	4

3.7	Total hours of individual study	58
3.8	Total hours per semester	100
3.9	ECTS	4

4. Prerequisites (if necessary)

4.1	Curriculum	Computer networks, Switching and routing systems
4.2	Competences	NO

1. Requisites (if necessary)

5.1	Course	Video-projector, screen, whiteboard
5.2	Applications	PCs with Internet access

6 Specific competences acquired

Professional competences	Theoretical knowledge (What do the student should know)	The students will know: - The most important packet switching WAN technologies available today - The most important routing protocols - The QoS parameters associated with the IP traffic - Basic knowledge regarding Linux operating system
	Acquired skills (What the student is able to do)	The students will be able to: - Evaluated the performance of existing QoS mechanisms - Identify the needed devices when implementing QoS techniques into an IP network - Understand the major traffic modeling algorithms - Understand the queue management features - Know the configuration commands needed to configure QoS mechanisms on Cisco and Linux devices
	Acquired abilities (what equipment/ instruments/ software the student is able to handle)	The students will be able to use: - The command line of Cisco 2011, 1750 routers and Linux PCs with Fedora Core distribution - Packet analyzers like Wireshark and Analyzer - IPROUTE2 tools embedded into Fedora Core Linux distribution - The most important parameters available in any QoS enabled system
Transversal competences		CT3 Adapting to new technologies, professional and personal development through continuing education using electronic documentation and printed sources, in Romanian and in at least one international language (English). Competencies for analysis and synthesis and optimization systems thinking. Flexibility in thinking and ability to work with interdisciplinary concepts and tools.

7 Discipline objectives (based on the grid of specific competences acquired)

7.1	General objective	Develop competences in the field of New Generation Networks (NGN)
7.2	Specific objectives	1. Assimilate theoretical knowledge regarding communications architecture, including QoS mechanisms; 2. Obtain configuration skills for IP networks

8. Contents

8.1. Course (titles)		Teaching methods	Obser-vations
1	Overview of Cross-Layer Techniques	Presentation, discussions	Videoprojector
2	QoS Measurements		
3	Applications Using Cross-Layer QoS		
4	QoS on Cisco Devices – Part1		
5	QoS on Cisco Devices – Part2		
6	QoS on Cisco Devices – Part3		
7	QoS on Cisco Devices – Part4		
8	Best-Effort Networks. QoS implementation necessities. QoS		

	definitions and components.		
9	Components of a generic router. Best-Effort routers. QoS-enabled routers. Traffic classification at Data-Link, Network and Transport Layers.		
10	Traffic shaping. Leaky Bucket and Token Buket algorithms. TCP congestion control.		
11	Waiting queues management policies. FIFO – First In First Out. RED – Random Early Detection. WRED – Weighted Random Early Detection.		
12	Packet Schedulers. Simple schedulers. FIFO. SP - Strict Priority. RR – Round-Robin. Adaptive schedulers. DRR, WRR, GPS, PFQ, WFQ, WF2Q.		
13	QoS Architectures. Differentiated Services (DiffServ). DiffServ field in the IPv4 header. PHB. EF, AF and Default PHB. DiffServ field in the IPv6 header.		
14	QoS Architectures. Integrated Services (IntServ). CL – Controlled Load. GS – Guaranteed Service. IntServ signaling - RSVP.		
8.2. Applications (laboratory work)		Teaching methods	Obser-vations
1	Generating and receiving traffic TCP, UDP and ICMP with the iperf command.	Simulations, experiments	PC, simulator
2	Configuring Linux as router – using virtual machines, text editors, network configuration (the ip command).		
3	Linux commands for traffic control. The tc command – classification, managment and queue disciplines configuration. Example: the netem queuing discipline.		
4	Admission control and traffic shaping using the netfilter framework. Experiments with the iptables command. Admission control for TCP connections.		
5	Rate distribution of multiple TCP connections (TCP fairness). Queue management. Examples with the FIFO discipline.		
6	Scheduling in Linux. Configure PRIO (SP algorithm) with tc. SFQ (RR algorithm).		
7	HTB – Hierarchical Token Bucket using tc. The RED queuing discipline.		
8	Miniproject: Assign taks, establish teams, source documentation		
9	Miniproject: Configure Linux as router		
10	Miniproject: Configure QoS mechanisms (part 1)		
11	Miniproject: Configure QoS mechanisms (part 2)		
12	Miniproject: Define and implement testing scenarios		
13	Miniproject: Interpret results (packet capture and visualisation)		
14	Retake of missed practical activities		
References: 1. Other information:			

9. Discipline content corroborated with the expectations of the epistemic community representatives, associations, professional and related program employers

Acquired skills will be needed in the following possible COR occupations: electronics engineer, telecommunications engineer, system and computer design engineer, or new occupations proposed to be included in COR (sales support engineer, developer of multimedia applications, network operating engineer, test engineer, project manager, traffic engineer, communications system consultant.

10. Assessment

Type of activity	10.1	Evaluation criteria	10.2	Evaluation method	10.3	The weight of the final grade
Course		Written test (T = 1...10)		Written test that should be solved in 2 hours.		T = 75%
Applicatio ns		Project developed during the semester in the laboratory (P = 0 ... 10)		Project defended at the end of semester		P = 25%
10.4 Minimum performance standard						
The final grade (N) is calculated as the sum T+P. The condition for obtaining the ECTS credits is that						

the final grade to be higher than or equal to 5 (five).

Date	Titular	Responsible
24.06.2020	Assistant Professor Andrei Bogdan RUS, Ph.D.	Assistant Professor Andrei Bogdan RUS, Ph.D.

Date of approval	Head of Department
24.06.2020	Professor Virgil Dobrota, Ph.D.