SYLLABUS

Discipline name	Switching and Routing Systems
Profile	Electronics and Telecommunications Engineering
Specialization	Telecommunications Technologies and Systems
Code	51324109
Course leader	Professor Virgil Dobrota, Ph.D – virgil.dobrota@com.utcluj.ro
Collaborators	Assistant Professor Tudor Blaga, Ph.D. – tudor.blaga@com.utcluj.ro, Assistant Mihai Vancea – mihai.vancea@com.utcluj.ro
Department	Communications
Faculty	Electronics, Telecommunications and Information Technology

Sem.	Type of discipline	Course	Applications			Course	Applications			Ind. study	TOTAL	Credits	Form of assessment
		[hours/week]				[hours/semester]							
			S	L	P		S	L	P				
6	**Speciality**	**2**	**-**	**2**	**1**	**28**	**-**	**28**	**14**	**80**	**150**	**5**	**Exam**

Acquired competences :
- 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

Acquired skills (what the student is able to do):
- To compare the performances of switching systems based on implementation complexity and blocking probability
- To evaluate the performances of a queuing system based on average waiting time and average number of clients
- To understand the routing principles and to determine the shortest path using routing algorithms and cost function

Acquired abilities (what type of equipment/ instruments/ software the student is able to handle):
- To install and to configure an Asterisk IP-based PBX (Private Branch Exchange) running under Fedora Core 10 or Linux Live
- To implement a dialing plan and major functions of an Asterisk IP-based PBX

Prerequisites (if necessary):

Telephony, Statistical Mathematics, Excel calculus, C programming skills

A. Course/Lecture (course/lecture titles)	
1	Digital switching functions. Single stage space-division dwitch. Classification of multiple stage switches. Multiple stage switch with complete permutation paths (Clos).
2	Strictly non-blocking three-stage Clos switch. Blocking probabilities. Lee's method. Generalization of Clos condition
3	Multiple stage switch with single path (Banyan). Batcher-Banyan switches. Delta and Omega switches. Multiple stage switch with multiple path (Benes).
4	Time-Division Switching (T). Time-Space-Division Switching (TS, STS).
5	Time-Space-Division Switching (TST, TSSST). Examples of Telephone Exchanges and Switch Fabrics. Digital Telephone Exchange Functions: BORSCHT
6	Traffic Analysis. Characteristics of a Queueing System. Models for Clients Arrivals: Bernoulli, Poisson M/M/1/∞ System.
7	M/M/1/N System. M/M/m/∞ System. Erlang C Formula. M/M/m/m System. Erlang B Formula.
8	M/D/m/∞ and M/D/1/∞ Systems. M/G/1/∞ System. Pollaczek-Khinchin Formula. Traffic in Telecommunications Networks. Traffic Intensity. Traffic Processing.
9	NGN - Next Generation Network. Basics of Routing. Datagram-based routing. Virtual circuit-based routing. Definitions: graph, arc, walk, path, cycle, connected graph, sub-graph, tree, spanning-tree. Packet broadcasting methods: flooding, spanning-tree
10	Directed graph, directed arc, directed walk, directed path, arc distance, path length. Determination of the shortest path based on Bellman-Ford algorithm.
11	Determination of the shortest path based on Dijkstra's algorithm.
12	Applications with Bellman-Ford and Dijkstra's algorithms.
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

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B. Applications – **Laboratory** (list of laboratories)	
1	Linux Fedora Core 10 Installation
2	Introduction to Linux. Working with files. vi and joe editors.
3	Strictly Non-Blocking Three-Stage Clos Switch (seminar). 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) (seminar). Software Package for the Simulation of Benes Switches.
6	STS Switch (seminar). Software Package for the Designing of STS Switches
7	TST Switch (seminar). 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	Queuing systems design: M/M/1/∞, M/M/1/N, M/M/m/∞ (seminar)
10	Queuing systems design: M/M/m/m, M/D/1/∞, M/G/1/∞ (seminar)
11	Software Package for Bellman-Ford Algorithm
12	Software Package for Dijkstra's Algorithm
13	Synthesis problems covering all chapters (Digital Switching, Queueing Systems, Routing Basics)
14	Recovered laboratories
B. Applications – **Project** (project contents)	
1	IPv4 Addressing
2	NGN. Configuration of IP PBX Asterisk using Linux Live distributions (AmatixInstantPBX, AstLinux, ST-PBX Live, Slast, CosmoPBX, Medianix, Xorcom_live, AdminsParadise_voip_livecd)
3-5	Implementation of a dial plan for Asterisk with minimum two SIP clients and two IAX clients Implementation of common functions: DIAL, RINGING, ANSWER, HANGUP. Implementation of two particular functions: VOICE-MAIL, CONFERENCING, SAY, PLAY, WAIT, AUTHENTICATE, TIMEOUT, RECORD.
6	Project Recovery
7	Defending the projects.

C. Individual study (reference study contents, synthesis materials, projects, applications etc.)

3 sets of problems (course homework): Efficiency of multi-stage space division switches, Relation between Erlang B and Erlang C Formula, implementation of M/D/m/∞

Individual study structure	Course study	Problem solving, laboratory, project	Applications preparation	Examination time	Additional reference study	Total no. of individual study hours
Hours	28	22	18	3	9	80

References (Textbooks, courses, laboratory manual, exercise book)

1. V.Dobrota, *Retele digitale in telecomunicatii. Volumul 1: Comutatia digitala, Analiza traficului.* Editia a III-a, Editura Mediamira, Cluj-Napoca 2002
2. V.Dobrota, *Retele digitale in telecomunicatii. Volumul 3: OSI si TCP/IP.* Editia a II-a, Editura Mediamira, Cluj-Napoca 2003
3. J.Bellamy, *Digital Telephony,* John Wiley&Sons, 1991
4. D.Bertsekas, R.Gallager, *Data Networks*. Second Edition, Prentice Hall, 1992
5. P.Van Mieghem, *Performance Analysis of Communications Networks and Systems*, Cambridge Univ., 2006
6. J.Van Meggelen, L.Madsen & J.Smith - Asterisk™ The Future of Telephony, 2nd Edition, O'Reilly Media Inc, 2007

On-line References

1. V.Dobrota – Switching and Routing Systems, TUCN 2009, http://el.el.obs.utcluj.ro/scr/en_index.htm

Final evaluation	
Evaluation method	Exam including 2 parts (theory + applications): a test (T) with 9 questions from course and laboratory (1 hour) and a synthesis problem (P2) covering all chapters (1 hour). The mark obtained for the project (P1) represents 50% of the mark for applications.
Mark components	Test (T)= 0...10 p, Problems P=P1+P2=0...10 p, Problem P1=project=0...5 p, Problem P2=0...5 p.
Mark computation	N=(T+P)/2, the credits are obtained if N≥5; T≥5; P≥4.5 (P1 ≥2.5, P2≥2)

Course leader,
Professor Virgil DOBROTA, Ph.D.