

SYLLABUS

1. Data about the program of study

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|-----|--------------------------------|--|
| 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 Assistant Professor Tudor BLAGA, 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)

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|-----|---------------------|---|
| 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). Batcher-Banyan Switches. Software Package for the Simulation of Batcher-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). Digital Telephone Exchange Functions: BORSCHT | | |

| | | | |
|-----------------------------|--|---|---|
| 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/ ∞ System. Erlang C Formula. M/M/m/m System. Erlang B Formula. | | |
| 9 | M/D/m/ ∞ and M/D/1/ ∞ Systems. M/G/1/ ∞ 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 | Project subject using Xorcom, version 2.1.0, with DAHDI modules enabled or Debian Live Project- based Asterisk version 1.6.2.9-2. Configuration of Asterisk IP-Based PBX and VoIP terminals: X-Lite and Zoiper | | |
| 3 | Working for project: 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 (e.g. VOICE-MAIL, CONFERENCING, SAY, PLAY, WAIT, AUTHENTICATE, TIMEOUT, RECORD). | | |
| 4 | Working for project: Implementation of SIP functions | | |
| 5 | Working for project: Implementation of IAX2 functions | | |
| 6 | Working for project: Integration of SIP and IAX2 functions | | |
| 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
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
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, 2015
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
01.10.2014

Course responsible
Professor
Virgil DOBROTA, PhD

Teachers in charge of applications
Assistant Professor
Andrei Bogdan RUS, PhD
Assistant Professor
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Date of approval
in the department
01.10.2014

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Department
Professor Virgil DOBROTA, PhD