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-E11.10/ TC-E11.50

2. Discipline

2.1	Discipline name					Advanced coding and data flow control techniques in telecommunication networks					
2.2	Subject area					Electronics and Telecommunications Engineering					
2.3	Responsible					Assistant Professor Mihaly Varga, Ph.D. Mihaly.Varga@com.utcluj.ro					
2.4	Titular					Assistant Professor Mihaly Varga, Ph.D.					
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 [hours/week]				Applications [hours/week]				Indiv. study	TOTAL	ECTS
			C	S	L	P		S	L	P											
I/2	Advanced coding and data flow control techniques in telecommunication networks	14	1	0	2	0		14	0	28	0								58	100	4

3.1	Number of hours per week	3	3.2	course	2	3.3	applications	1
3.4	Total hours per curriculum	42	3.5	course	28	3.6	applications	14

Individual study	Hours
Study based on manuals, course materials, references and notes	14
Supplementary documentation in libraries, electronic platforms and on field	10
Preparation of seminars/laboratories, homeworks, essays, portfolios	12
Tutorial work	5
Assesments	3
Other activities	14

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	- basic knowledge of Information Theory. - basic knowledge of Computer Networks. - basic knowledge of Internet protocols. - basic knowledge of wireless communications.
4.2	Competences	Matlab and C programming

5. 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: – Digital Fountain encoding techniques and the application of these codes to flow control protocols. – Network Coding encoding techniques used in wireless mesh networks, overlay networks, and transport network routers. – Swarm cooperation techniques. Combining swarm cooperation techniques with NC coding techniques. Use of swarm cooperation in real time applications and in delay-tolerant applications. – cooperative and coding techniques used in mesh wireless networks.
	Acquired skills (What the student is able to do)	The students will be able to: – understand how to generate rateless codes and use them in flow control algorithms. – understand different coding techniques such as Network Coding and identify the advantages and disadvantages of these coding techniques; understand how to integrate these coding techniques into flow control algorithms. – understand the principle of swarm cooperation techniques and use these cooperation techniques in real-time and delay tolerant applications. – understand the principle of mesh cooperative wireless networks and be able to identify the operations and resources required by the cooperation of wireless terminals.
	Acquired abilities (what equipment/ instruments/ softwares the student is able to handle)	The students will be able to: - use/ configure network simulator tools/ softwares. - configure appropriately the parameters of flow control protocols.
Transversal competences		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	Knowledge of the modern coding and data flow control techniques and mechanisms used in the latest generation networks. Knowledge of cooperation techniques applicable in wired and wireless networks.
7.2	Specific objectives	Study of the implementation methods of DF and NC coding techniques. Study of flow control mechanisms based on DF and NC coding. Study of information dissemination methods in networks with large number of users. Study of the implementation of cooperation mechanisms in wireless networks.

8. Contents

8.1. Course (titles)		Teaching methods	Remarks
1	Digital Fountain (DF) coding techniques. Theoretical fundamentals. The Luby Transform (LT).	Presentation, discussions	Videoprojector
2	Tornado and Raptor codes. Coding and decoding algorithms.		
3	Implementation of the DF concept using finite rate codes. Using LDPC codes for implementing the DF concept.		

4	Multimedia Broadcast Multicast (MBMS) services. Usage of Raptor Codes in these applications. Practical coding and decoding algorithms for Raptor codes.		
5	Use of layered coding techniques in data flow control in multicast applications.		
6	TCP flow control techniques combined with DF codes.		
7	Network Coding encoding techniques. Theoretical fundamentals. Systematic and random liniar NC codes.		
8	Generating and optimizing the Network Coding network. Optimization algorithms.		
9	Usage of NC coding techniques in error correction.		
10	Swarm communications. Structured and unstructured swarm communication systems.		
11	Linear NC codes used in swarm communication systems. Performance and complexity.		
12	Performance of Random Network Coding techniques. Selection of coefficients and the effect of errors/ erasures.		
13	NC coding techniques used in mesh wireless networks. "XOR in the Air" coding techniques. Theoretical fundamentals, performance, integration into real-time services		
14	IP data transmission (IP Datacast) in the DVB-H system. Content delivery protocols. The FLUTE protocol. Layered Coding Transport techniques.		
8.2. Applications (laboratory work)		Teaching methods	Remarks
1	Digital Fountain codes (Coduri LT, Tornado, Raptor). Coding techniques.	Simulations, experiments	PC, network simulator
2	Digital Fountain codes (Coduri LT, Tornado, Raptor). Decoding techniques.		
3	Study of Digital Fountain Code performance.		
4	Study of Digital Fountain Code performance - continued.		
5	Network Coding techniques. Coding mechanisms.		
6	Network Coding techniques. Decoding mechanisms.		
7	Network Coding techniques. Performance evaluation.		
8	Network Coding techniques. Performance evaluation - continued.		
9	Evaluation of DF and NC coding techniques in swarm type communication systems.		
10	Evaluation of DF and NC coding techniques in swarm type communication systems - continued.		
11	Implementation of the "XOR in the Air" cooperation mechanisms.		
12	Simulation, experimentation of "XOR in the Air" coding techniques.		
13	Simulation, experimentation of "XOR in the Air" coding techniques - continued		
14	Recapitulation, conclusions, completion of the lab activities.		

References:
1. M. Luby, M. Mitzenmacher, A. Shokrollahil, A. Spielman, V. Stemann, “Practical Loss-Resilient Codes”, Proc. of *ACM Symposium on Theory of Computing*, 1997, El Passo, Texas, USA.
2. Michael Mitzenmacher, “Digital Fountains: A Survey and Look Forward”, http://www.eecs.harvard.edu/~michaelm/postscripts/itw2004.pdf.
3. S.-Y. R. Li, R. W. Yeung, N. Cai and Z. Zhang. Network coding theory. 2006. iest2.ie.cuhk.edu.hk/~whyeung/publications/tutorial.pdf.
4. Shenghao Yang, Raymond W. Yeung, Characterizations of Network Error Correction/Detection and Erasure Correction, http://ita.ucsd.edu/workshop/07/files/paper/paper_309.pdf.
5. Christina Fragouli, Dina Katabi, Athina Markopoulou, Muriel Medard, Hariharan Rahul, Wireless Network Coding: Opportunities & Challenges, http://people.csail.mit.edu/rahul/papers/nc-milcom2007.pdf.

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 with several theoretical questions and 2-3 problems (E = 1...10)		Written test		E = 70%
Applications		Project developed during the semester in the laboratory (P = 1 ... 10)		Project defended at the end of semester		P = 30%
10.4 Minimum performance standard						
The final grade (N) is calculated as the weighted sum of marks obtained in the evaluation, as presented above: N = 0.7·E + 0.3·P. The condition for obtaining the ECTS credits is: N > 5, E > 5 and P > 5.						

Date
25.05.2018

Titular
Assistant Professor
Mihaly Varga, Ph.D.

Responsible
Assistant Professor
Mihaly Varga, Ph.D.

Date of approval
31.05.2018

Head of Departament
Professor Virgil Dobrota, Ph.D.