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-E11.20/ TC-E08.00

2. Discipline

2.1	Discipline name						Fundamentals of High Bit-Rate Data Transmissions				
2.2	Subject area						Electronics and Telecommunications Engineering				
2.3	Responsible						Professor Vasile Bota, Ph.D. Vasile.Bota@com.utcluj.ro				
2.4	Titular						Professor Vasile Bota, Ph.D. Vasile.Bota@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 [hours/week]				Indiv. study	TOTAL	ECTS
			C	S	L	P		S	L	P							
II/3	Fundamentals of High Bit Rate Data Transmissions	14	2	0	1	0	28	0	14	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 lecture notes	28
Supplementary documentation based on manuals and references in libraries, electronic platforms	28
Preparation of seminars/laboratories	14
Preparation of homework, essays	15
Assessments	3
Other activities	0

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	Digital modulations, Error-correcting codes (block and convolutional), signal theory
4.2	Competences	

1. Requisites (if necessary)

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

6 Specific competences acquired

Professional competences	Theoretical knowledge (What do the student should know)	The students will know: The main parameters and basic structures of the transmitters-receivers of the studied transmission techniques (OFDM, DMT, CDMA). The principles, encoding-decoding methods and parameters of turbo and LDPC codes. Principles and parameters of the H-ARQ mechanisms Principles and parameters of the medium-access techniques.
	Acquired skills (What the student is able to do)	The students will be able to: Evaluate the parameters of the transmission channels and their impacts upon various types of transmissions. Configure the OFDM, DMT and CDMA transmission techniques and basically design the OFDM and DMT transmitters-receivers. Configure and establish the parameters of turbo and LDPC codes for various transmission requirements. Design a set of coded modulations to be used adaptively over a given channel. Configure the H-ARQ-type protocols Set the parameters of the medium-access methods. Make an approximate evaluation of the reliability and throughput performance provided by the studied transmission techniques
	Acquired abilities (what equipment/ instruments/ software the student is able to handle)	The students will be able to use: Some transmission equipment Simulators (Matlab, Simulink)
Transversal competences		CT3 Adapting to new technologies, professional and personal development through continuing education using electronic documentation and printed sources, in English. Development of capabilities to analyse, design and optimize transmission systems. Flexibility in thinking and ability to work with several concepts and tools, under contradictory requirements.

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

7.1	General objective	Development of professional competences in designing, simulation, configuration and performance evaluation of the studied transmission techniques (modulation, channel-coding, medium-access).
7.2	Specific objectives	1. Assimilation of theoretical knowledge regarding the operational principles ofthe studied transmission, FEC-coding and medium-access techniques and regarding the structures, sesign and simulation of the transmitters-receivers that implement these techniques.Assimilation of knowledge regarding the configuration, adaptive employment and performance evaluation of the studied modulation and FEC-coding techniques. 2. Acquiring the skills and abilities needed to implement the studied transmission techniques using adavnced simulation environments (MatLab, SimulInk) 3. Acquiring the skills and abilities needed to use sotware tools for analysis, simulation and performance evaluation of the studied transmission techniques.

8. Contents

8.1. Course (titles)		Teaching methods	Obser-vations
1	Parameters of the radio channels (fixed or mobile). Parameters of the wired channels	Presentation, discussions	Video projector
2	Orthogonal Frequency Division Multiplex (OFDM) 1 Operational principles. IFFT-based generation. Guard interval Translation on the channel-carrier. Spectral properties.		
3	OFDM 2. FFT-based demodulation. Syncronizations in the OFDM receiver. Channel equalization in the frequency domain. Computation of the bit rates provided. SNR performance. SC-FDMA. Applications.		
4	DMT transmission technique for wired channels. Operational principles, modulation-demodulation, synchronizations, performance. Applications in xDSL transmissions.		
5	Convolutional code: types, puncturing, encoding. Decoding with MAP algorithms (BCRJ). Comparison to the Viterbi algorithm.		
6	Turbocodes. Types, encoding-decoding. Exit-charts. BER and BLER performance.		
7	LDPC codes I. Types. Construction of the check matrix. Encoding. Shortening.		
8	LDPC codes 2. Decoding with Message-Passing algorithm. SNR performance.		
9	Coded modulations. Transmission conf\igurations. Mapping of coded and non-coded bits. Decision of the non-coded bits. Computation of the bit rate and evaluation of SNR performance provided by a transmission configuration.		
10	Adaptive coded odulations. Design of a set of coded QAM configurations. Methods of adaptivity. Computation of the SNR domains and of criteria of setting the SNR thresholds. OFDMA. Performance (BER, throughput, spectral efficiency) estimation of the adaptive coded modulations.		
11	H-ARQ protocols. Efficiency of a generic ARQ protocol. Types of H-ARQ protocols		
12	H-ARQ protocols with incremental redundancy. H-ARQ protocols with adaptive coding rate. Efficiency computation.		
13	H-ARQ protocols: parameter configuration in terms of the QoS requirements. CDMA (DS-SS) Technique I. Spreading sequences: types and properties. DS-SS operating principle: spreading-despreading.		
14	CDMA (DS-SS) Technique II. Properties: interference suppression, the „ near-far„ effect, “soft-capacity”. SINR performance. Spreading sequences with variable length. Applications in cellular sistems.		
8.2. Applications (laboratory work)		Teaching methods	Obser-vations
1	QAM Modulations. Revision.	Simulations, experiments	PC, simulator
2	Parametrs of the wireless transmission channels.		
3	OFDM. Modulation-demodulation. Frequency spectrum. Equalization in the frequency domain.		
4	Synchronizations in the OFDM receiver I : sampling frequency and OFDM-symbol		
5	Synchronizations in the OFDM receiver II: Performance of OFDM.		
6	DMT transmission technique. Synchronizations. Performance evaluation.		
7	Turbocodes. SNR performance evaluation. Exit-charts.		
8	LDPC codes. SNR performance evaluation.		
9	Comparison between the performance provided by LDPC and convolutional codes.		
10	Adaptive coded modulations I. Study of the design and performance of a set of configurations. Inflence of access method upon the performance.		

11	Adaptive coded modulations II Case-study: theoretical evaluation of the SNR performance provided by the 802.11a transmission.		
12	Study of the efficiency of the ARQ and H-ARQ algorithms.		
13	Evaluation of the average performance of the adaptive coded modulations governed by H-ARQ algorithms.		
14	Study of the SINR performance of the DS-SS techique.		

References:

1. V.Bota – Fundamentals of of High Bit-Rate Data Transmissions, lecture notes, http://users.utcluj.ro/~dtl
2. V. Bota - Data Transmissions, lecture notes, http://users.utcluj.ro/~dtl
3. V. Bota - Modulation Techniques, lecture notes, http://users.utcluj.ro/~dtl
4. ETSI standards regarding ADSL and OFDM transmissions– available in the laboratory
5. Rappaport, Th., „Wireless Communications. Principles and Practice", Prentice Hall, 2001- available in the laboratory
6. Proakis, G. „Digital Communications", Prentice Hall, 2001 - available in the laboratory
7. Tzi-Dar Chiueh, Pei-Yun Tsai, "OFDM Baseband Receiver Design for Wireless Communications", Wiley, 2007 - available in the laboratory
8. Junyi Li, Xinzhou Wu, Rajiv Laroia;" OFDMA Mobile Broadband Communications: A Systems Approach", Cambridge University Press, 2013 - available in the laboratory
10. Various journal and conference proceedings articles - available in the laboratory

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

The acquired skills will be needed in the following possible COR occupations (jobs): 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 within the final grade
Course		Solving 4-5 subjects (problems+theory), score E = 1,...10		Written examination (3 hours)		E ↔ 80%
Applications		Homework and laboratory activity, score L= 1,,…,10.		Evaluated during the semester within the lab classes		L ↔ 20%
10.4 Minimum performance standard						
The final grade (N) is calculated by rounding to the closest integer the weighted average of the scores E and L, i.e., by rounding E*0.8+L*0.2 The condition for obtaining the ECTS credits is that both scores composing the final grade to be greater than or equal to 5 (five).						

Date
24.06.2020

Titular
Professor
Vasile Bota, Ph.D.

Responsible
Professor Vasile Bota, Ph.D.

Date of approval

Head of Department
Professor Virgil Dobrota, Ph.D.