SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Faculty of 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-E49.10

2. Data about the subject

2.1	Subject name			Data Transmissions			
2.2	Subject area			Electronics and Telecommunications Engineering			
2.3	Course responsible/lecturer			Prof. dr. eng. Vasile Bota			
2.4	Teachers in charge of applications			Prof. dr. eng. Vasile Bota			
2.5 Year of study	IV	2.6 Semester	I	2.7 Assessment	Examination	2.8 Subject category	DS/DOP

3. Estimated total time

3.1 Number of hours per week	4	3.2 of which, course:	2	3.3 applications:	2
3.4 Total hours in the curriculum	56	3.5 of which, course:	28	3.6 applications:	28

Individual study	hours
Manual, lecture material and notes, bibliography	15
Supplementary study in the library, online and in the field	10
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	15
Tutoring	3
Exams and tests	5
Other activities	0

3.7	Total hours of individual study	48
3.8	Total hours per semester	130
3.9	Number of credit points	4

4. Pre-requisites (where appropriate)

4.1	Curriculum	Not applicable
4.2	Competence	Basic knowledge of signal theory, basic knowledge of modulation techniques, elementary knowledge of information theory

5. Requirements (where appropriate)

5.1	For the course	Downloading of the lecture notes -available on the course's site
5.2	For the applications	Downloading and study of some laboratory notes - available on the course's site

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. C6. To solve wide-band telecommunications networks' specific problems: propagation in various transmission media, high frequency circuits and equipment (microwaves and optical).
Cross competences	N.A.

7. Discipline objectives (as results from the *key competences gained*)

7.1	General objective	Development of professional competences in the area of emplyment, design, simulation and performance evaluation of the studied modulation techniques in transmission systems.		
7.2	Specific objectives	1. Assimilation of theoretical knowledge regarding the structure, design, simulation, performance evaluation and applicability of the modulation techniques studied 2. Acquiring the skills and abilities to use transmission measuremnt and analysis equipment. 3. Acquiring the elementary skills and abilities to implement and evaluate the performance of the modulation techniques by using advanced simulation tools		

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1.	Introduction. Complements to A+PSK 1 Non-uniform A+PSK constellations employed on radio channels with non-linear amplifiers.	Exposition, discussions	Video-projector, employment of the lecture notes available on the laboratory site
2.	Complements to A+PSK 2 Demodulation with the Hilbert transform; Symbol-clock synchronization; Carrier recovery methods.		
3.	Orthogonal Frequency Division Multiplex (OFDM) 1 Parameters of the radio channels (fixed or mobile). Necessity. Definition. Digital modulation-demodulation by IFFT-FFT.		
4.	Orthogonal Frequency Division Multiplex (OFDM) 2 Guard Interval. Bit-loading and bit-rate computation. Frequency band and spectral properties. Spectral efficiency. Synchronization issues. Performance. Applications.		
5.	Discrete MultiTone (DMT) DMT - a particular case of OFDM for cable transmissions. DMT modulation-demodulation. Guard interval. Spectral properties. Bit-loading and bit-rate computation. Performance. Applications.		
6.	Coded Modulations 1: Types of CM; Systematical and recursive convolutional codes; Trellis Coded Modulation (TCM); Coding gain = TCM 1/2		
7.	Coded Modulations 2:		

	TCM of rate m/(m+1); Mapping by Set partitioning; TCM with non-coded bits		
8.	Coded Modulations 3: Viterbi algorithm with d_E. Soft-decoding of the non-coded bits. Applications of TCM.		
9.	Coded Modulations 4: Coded Modulations with Extended Bandwidth (CMEB). Principles; Bit-rate computation. Performance. Applications		
10.	Adaptive Modulations (AM) Parameters of a configuration. Criteria of selecting the AM set. Computation of the average throughput. Applications.		
11.	Gaussian Minimum Shift Keying (GMSK) 1 Necessity; MSK: definition, parameters, modulation-demodulation. Gaussian filtering characteristic. GMSK-definition, parameters and spectral properties		
12.	Gaussian Minimum Shift Keying (GMSK) 2 GMSK modulation; modulation-demodulation methods, carrier and symbol clock recovery. Performances. Application in the GSM system		
13.	Spread Spectrum techniques 1 Spreading sequences. Direct-sequence spread spectrum (DS-SS). Spectrum. Generation and demodulation of DS-SS. Properties of DS-SS („near-far", „soft-capacity"). SINR performance of DS-SS. Applications.		
14.	Spread Spectrum techniques 2 Frequency-hopping spread spectrum (FH-SS); Generation and demodulation of FH-SS. Producerea şi demodularea FH-SS; SINR performance of FH-SS; Aplications. Scrambler – descrambler; Necessity anf functionalities.		

Bibliography

1. Proakis, J.G., Digital Communications, 4th edition, McGraw-Hill
2. Fuqin Xiong, Digital modulation Techniques, Artech House

Multimedia teaching materials::

1. V. Bota, Data Transmission. Lecture Notes, Universitatea Tehnica din Cluj-Napoca, http://users.utcluj.ro/~dtl/TD/cursuri_td.html
2. V. Bota, Data Transmissions, Laboratory Notes and Problems, Use-cases, Universitatea Tehnica din Cluj-Napoca, http://users.utcluj.ro/~dtl/TD/laboratoare_td.html

8.2. Applications/Laboratory		Teaching methods	Notes
1.	A+PSK. Recapitulation	Simulations: Simulators' Configuration, Analysis of results.Case studies. Problems.	Computers, advanced software simulation tools, experimental laboratory circuits, specific measuring equipment
2.	Radio channel models. Parameters		
3.	RC and RRC shapping filters. Digital implementation. Characteristics		
4.	OFDM 1. Digital modulation-demodulation. Bit rate and spectral efficiency.		
5.	OFDM 2. Effects of imperfect synchronizations		
6.	DMT		
7.	Coded modulations 1. Performance evaluation. Methodology		
8.	Coded modulations 2. The Viterbi decoding algorithm using d_E . Implementation issues.		
9.	Coded modulations 3. The Viterbi decoding algorithm using a posteriori probabilities. Sof decision of non-coded bits.		
10.	Coded modulations 4. SNR performance of the convolutional codes		
11.	TCM. Case study: the V.32 modem. Structure. Configuration.		

	Performance evaluation		
12.	Adaptive modulations 1. Configuration design. Set of configurations. Average throughput evaluation..		
13.	Adaptive modulations 2. Performance study – simulations. Case studyȘ 802.11.a		
14.	DS-SS transmissions. SINR performance evaluation		

Bibliography

V. Bota, M. Varga, Lab works, case-studies and problems. Universitatea Tehnică din Cluj-Napoca, http://users.utcluj.ro/~dtl/TD/laboratoare_td.html

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The acquired competences would be useful to the employees in the following possible jobs, according to COR: Transmission engineer, Electronics, transportation, telecommunications engineer, R&D Electrinics engineer, Computer networks design Communications design engineer, Sales support engineer, Multimedia applications developer, Network operation engineer, Communications systems testing engineer, Project manager, Traffic engineer, Consultant in communications systems

10. Evaluation

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	- Summative evaluation written exam (theory and problems)	80%
Applications (laboratory)	The level of acquired abilities	- Continuous formative evaluation - 2 written tests to evaluate the knowledge acquired in the lab works	20%
10.4 Minimum standard of performance			
The final mark (N) is composed of the exam score (E) and the arithmetic average of the lab tests' scores (L). The final mark N will be computed by rounding the weighted score P = 0.8*E+0.2*L, by N = [P+0.5], provided that: P ≥ 5 and E ≥ 5, these being the condition to pass the exam.			

Date of filling in
01.10.2014

Course responsible
Professor
Vasile BOTA, PhD

Teachers in charge of applications
Professor
Vasile BOTA, PhD

Date of approval in the department
01.10.2014

Head of Communications Department
Professor Virgil DOBROTA, PhD