SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and information Technology
1.3 Department	Communications
1.4 Field of study	Electronic Engineering, Telecommunications and Information Technologies
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Telecommunications Technologies and Systems/Engineer Applied Electronics/Engineer
1.7 Form of education	Full time
1.8 Subject code	TST-E49.10/EA-E104.00

2. Data about the subject

2.1 Subject name	Data Transmissions						
2.2 Subject area	Theoretical area Methodological area Analytic area						
2.3 Course responsible	Prof. Vasile Bota, Ph.D.						
2.4 Teacher in charge with seminar / laboratory / project	Prof. Vasile Bota, Ph.D.						
2.5 Year of study	IV	2.6 Semester	I	2.7 Assessment	Examination	2.8 Subject category	DS/DO

3. Estimated total time

3.1 Number of hours per week	4	of which: 3.2 course	2	3.3 laboratory	2
3.4 To Total hours in the curriculum	56	of which: 3.5 course	28	3.6 laboratory	28
Distribution of time					hours
Manual, lecture material and notes, bibliography					23
Supplementary study in the library, online specialized platforms and in the field					0
Preparation for seminars / laboratories, homework, reports, portfolios and essays					14
Tutoring					2
Exams and tests					5
Other activities:					0

3.7 Total hours of individual study	44
3.8 Total hours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	The courses on Signal's theory, Modulation techniques and Information and coding theory
4.2 competence	Basic knowledge of modulation techniques and signal theory, operating principles of error-correcting codes.

5. Requirements (where appropriate)

5.1. for the course	Downloading of the lecture notes -available on the course's site
5.2. for the seminars / laboratories / projects	Downloading and study of some laboratory notes - available on the course's site

6. Specific competences

Professional competences	**C4. Conception, implementation and operation of data, voice, video , multimedia services, based on understanding and application of the fundamental and specific concepts from the area of communications and information transmission** C4.1 Identification of the fundamental concepts regarding the information transmission in analog and digital communications C4.3 Explanation and interpretation of the main requirements and specific approach techniques for data, voice, video, multimedia transmissions C4.4 Use of the main specific parameters in evaluations based on the concept of quality of service in communications **C5. Selecting, installing, configuring and operating fixed or mobile telecommunications equipment. Equipping a site with usual telecommunications networks** C5.1 Defining the principles of the main technologies for fixed and mobile telecommunications, through various transmission media C5.2 Explanation and interpretation of the technologies and of fundamental protocols for integrated fixed and mobile communications systems C5.4 Use of evaluation techniques and diagnostics for communications systems and equipment **C6. Solving specific problems of the broadband communications networks: propagation in different environment, circuits and equipment for high frequencies (microwaves and optical).** C6.2 Explaining the specific methods for implementation of the communications techniques
Cross competence	N/A

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

7.1 General objective	Development of professional competences in the area of employment, design, simulation and performance evaluation of the studied modulations and transmission 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 elementary skills and abilities to implement and evaluate the performance of the modulation techniques by using advanced simulation tools (Matlab, Simulink)

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

2. Complements to A+PSK 2 Demodulation with the Hilbert transform; Symbol-clock synchronization; Carrier recovery methods.		available on the laboratory site
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. Block structure of the OFDM transceiver. 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 and a posteriori probabilities. 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 and of SNR thresholds. 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. Performance of FH-SS; Aplications. Scrambler – descrambler; Necessity and 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		
8.2 Laboratory	Teaching methods	Notes
1. A+PSK. Recapitulation	Simulations: Simulators' Configuration, Analysis of results. Case studies. Problems.	Computers, advanced software simulation tools and evaluation tools
2. Main parameters of the radio channels. Impact upon transmissions' parameters		
3. RC and RRC shapping filters. Digital implementation. Characteristics		
4. OFDM 1. Necessity.Digital modulation. Spectral properties.. Guard interval.		
5. OFDM 2. Digital demodulation. Bit rate of an OFDM system. Error performance.		
6. OFDM 3. Synchronizations required in the OFDM receiver. Problems.		
7. DMT. Transmission-reception. Applications in xDSL systems		
8. Coded modulations 1. Performance evaluation. Methodology		
9. Coded modulations 2. The Viterbi decoding algorithm using d_E or a posteriori probabilities. Implementation issues.		
10. Coded modulations 3. Soft decision of non-coded bits. Study of the error performance of the convolutional codes		
11. Coded modulations 4. Case study: the V.32 modem. Structure. Configuration. Performance evaluation. Problems		
12. Adaptive modulations 1. Configuration design. Set of configurations. Evaluation of the average throughput		
13. Adaptive modulations 2. Performance study – simulations. Case study: WiFi – standard IEEE 802.11.a		
14. DS-SS transmissions. SINR performance evaluation. Properties of DS-SS		
Bibliography 1. V. Bota, Data Transmissions, Laboratory Notes and Problems, Use-cases, Universitatea Tehnica 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 discipline content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job (in the field of telecommunications), and the expectations of the national organization for quality assurance (ARACIS). 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 Electronics 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
10.4 Course	The level of acquired theoretical knowledge and practical skills	Written examination Solving 4-5 issues (problems + theory)	80%
10.5 Seminar/ Laboratory	The level of acquired knowledge and abilities	Evaluation during the semester by means of two laboratory tests	20%

10.6 Minimum standard of performance

Qualitative level:

Minimal knowledge:

- ✓ *Basic knowledge of the operating principles and properties of the studied multicarrier, FEC-coded Spread-spectrum transmission techniques and their adaptive use*
- ✓ *Basic knowledge of their block structure*

Minimal competences:

- ✓ Elaboration of the block structure of the transmission equipment using the studied transmission techniques.
- ✓ Capability of evaluation of the performance *(bit rates, error-performance)* provided by the modulation techniques in a given simple transmission environment

Quantitative level:

- ✓ Execution of all laboratory works
- ✓ 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 to the closest integer, if P ≥ 5 and E ≥ 5..
- ✓ Conditions to pass the exam: P ≥ 5 and E ≥ 5.

Date of filling in:	Responsible	Title First name SURNAME	Signature
27.09.2021	Course	Prof. Vasile Bota, Ph.D.	
	Applications	Prof. Vasile Bota, Ph.D.	

Date of approval in the Department of Communications 27.09.2021	Head of Communications Department Prof. Virgil DOBROTA, Ph.D.
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology 27.09.2021	Dean Prof. Gabriel OLTEAN, Ph.D.