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	Master of Science
1.6 Program of study / Qualification	Telecommunications / Master
1.7 Form of education	Full time
1.8 Subject code	TC-E08.00

2. Data about the subject

2.1 Subject name	Fundamentals of High Bit-Rate Data Transmissions						
2.2 Subject area	Theoretical area Methodological area Analytic area						
2.3 Course responsible	Assist. Prof. Mihaly VARGA, Ph.D. Mihaly.Varga@com.utcluj.ro						
2.4 Teacher in charge with seminar / laboratory / project	Assist. Prof. Mihaly VARGA, Ph.D. Mihaly.Varga@com.utcluj.ro						
2.5 Year of study	1	2.6 Semester	12	2.7 Assessment	E	2.8 Subject category	DA/DI

3. Estimated total time

3.1 Number of hours per week	3	of which: 3.2 course	2	3.3 laboratory	1
3.4 To Total hours in the curriculum	42	of which: 3.5 course	28	3.6 laboratory	14

Distribution of time	hours
Manual, lecture material and notes, bibliography	28
Supplementary study in the library, online specialized platforms and in the field	11
Preparation for seminars / laboratories, homework, reports, portfolios and essays	14
Tutoring	2
Exams and tests	3
Other activities:	

3.7 Total hours of individual study	58
3.8 Total hours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	Modulation techniques, Data transmissions, Signal theory, Information and coding theory.
4.2 competence	N. A.

5. Requirements (where appropriate)

5.1. for the course	Video-projector, screen, whiteboard
5.2. for the seminars / laboratories / projects	PCs with Internet access, dedicated devices

6. Specific competences

Professional competences	C4. Design, implementation and operation of data, voice, video and multimedia services. This is based on the understanding and the application of fundamental concepts in telecommunications and transmission of information C5. Selecting, installing, configuring and operating fixed or mobile telecommunications equipment. Equipping a site with usual telecommunications networks C6. Solving specific problems of the broadband communications networks: propagation in different environment, circuits and equipment for high frequencies (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 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 of the studied transmission, FEC-coding and medium-access techniques and regarding the structures, design 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 advanced simulation environments (Matlab, SimulInk) 3. Acquiring the skills and abilities needed to use software tools for analysis, simulation and performance evaluation of the studied transmission techniques.

8. Contents

8.1 Lecture (syllabus)	**Teaching methods**	**Notes**
1. Parameters of the radio channels (fixed or mobile). Parameters of the wired channels	Presentation, discussions	Video projector
2. Orthogonal Frequency Division Multiplex (OFDM) (I): Operational principles. IFFT-based generation. Guard interval Translation on the channel-carrier. Spectral properties.		
3. OFDM (II): 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 (II). Decoding with Message-Passing algorithm. SNR performance.		
9. Coded modulations. Transmission configurations. 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 systems.		

Bibliography

1. V. Bota, "Fundamentals of High Bit-Rate Data Transmissions", Lecture Notes, Technical University of Cluj-Napoca, 2024, Available: https://users.utcluj.ro/~dtl
2. V. Bota, "Data Transmissions", Lecture Notes, Technical University of Cluj-Napoca, 2024, Available: https://users.utcluj.ro/~dtl
3. V. Bota, "Modulation Techniques", Lecture Notes, Technical University of Cluj-Napoca, 2024, Available: https://users.utcluj.ro/~dtl
4. ETSI standards regarding ADSL and OFDM transmissions. Available in the laboratory.
5. T. Rappaport, „Wireless Communications. Principles and Practice", Prentice Hall, 2001- available in the laboratory
6. G. Proakis, „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

Online references

9. Various journal and conference proceedings articles - available in the laboratory

8.2 Laboratory	**Teaching methods**	**Notes**
1. QAM Modulations. Review.	Practical experiments on physical, virtual, cloud and emulator equipment.	N/A
2. Parameters 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.		

Bibliography

1. V. Bota, Laboratory works, 2024, Available: https://users.utcluj.ro/~dtl/BTDDBR/laboratoare_btddbr.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 according with the expectations of the professional 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. 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 exam (3 hours): solving 4-5 subjects (problems + theory), E = 1...10	E ↔ 80%
10.5 Seminar/ Laboratory	The level of acquired knowledge and abilities	Homework and laboratory activity, score L= 1...10. Evaluated during the semester within the lab classes	L ↔ 20%
10.6 Minimum standard of performance			

Qualitative point of view

Minimal theoretical and practical knowledge:

- ✓ Knowledge of the operating principles of the studied transmission techniques
- ✓ Knowledge of the performance evaluation methods of the studied transmission techniques

Minimal acquired competences:

- ✓ Elaboration of block diagrams of equipment that use the studied transmission techniques
- ✓ Configuring the parameters of the studied transmission techniques to ensure the required performance

Quantitative point of view

- ✓ 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 of filling in:	**Responsible**	**Title First Name SURNAME**	**Signature**
20.06.2024	Course	Assist. Professor Mihaly VARGA, Ph.D.	
	Applications	Assist. Professor Mihaly VARGA, Ph.D.	

Date of approval in the Council of the Communications Department 10.07.2024	Head of Communications Department Prof. Virgil DOBROTA, Ph.D.
Date of approval in the Council of the Faculty of Electronics, Telecommunications and Information Technology 11.07.2024	Dean Prof. Ovidiu POP, Ph.D.