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-E36.00

2. Data about the subject

2.1	Subject name			Modulation Techniques			
2.2	Subject area			Electronics and Telecommunications Engineering			
2.3	Course responsible/lecturer			Prof. Vasile Bota, Ph.D			
2.4	Teachers in charge of applications			Prof. Vasile Bota, Ph.D, Anghel Botos, PhD			
2.5 Year of study	III	2.6 Semester	I	2.7 Assessment	Examination	2.8 Subject category	compulsory

3. Estimated total time

3.1 Number of hours per week	5	3.2 of which, course:	2	3.3 applications:	3
3.4 Total hours in the curriculum	70	3.5 of which, course:	28	3.6 applications:	42

Individual study	hours
Manual, lecture material and notes, bibliography	36
Supplementary study in the library, online and in the field	4
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	11
Tutoring	4
Exams and tests	5
Other activities	0

3.7	Total hours of individual study	60
3.8	Total hours per semester	130
3.9	Number of credit points	5

4. Pre-requisites (where appropriate)

4.1	Curriculum	Not applicable
4.2	Competence	Basic knowledge of signal theory; basic knowledge of digital circuits

5. Requirements (where appropriate)

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

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 measurement 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.	Linear Modulations (LM) I. Types of LM. Quadrature Amplitude Modulation (QAM). Expression and spectra of the LM signals. Modulation methods of the LM signals.	Exposition, discussions	Video-projector, employment of the lecture notes available on
2.	Linear Modulations (LM) II. LM receivers. Demodulation methods of the LM signals.		

	Carrier recovery methods. SNR performance of the LMs		the laboratory site
3.	Frequency Modulation Expression and spectrum of the FM signal. Modulation methods of the FM signal. Demodulation methods of the FM signals. SNR performance of the FM		
4.	Base-band Data Transmissions (BB) I. BB Codes. Definitions. Spectral properties. Encoding-decoding of the BB codes.		
5.	Base-band Data Transmissions (BB) II SNR performances of BB codes. Applications. Elementary notions on PLL circuits. Digital methods for fast and dynamic bit-clock synchronization		
6.	Pulse-Amplitude Modulation (PAM). Definition. Spectrum. SNR performance. Filtering the Data Signals. Defining the ISI. The RC and RRC filtering characteristics..		
7.	Amplitude Shift Keying (ASK) Definition. Spectrum. Modulation-demodulation. SNR performance. QAM with digital modulating signals Definition. Spectrum. Modulation-demodulation		
8.	Phase Shift Keying (PSK) I. Expression of the PSK signal. Signal constellations. QAM-based generation of the PSK and DPSK signals. Spectra and filtering of the DPSK signals. Structure of the DPSK transmitter.		
9.	Phase Shift Keying (PSK) II. QAM-based DPSK demodulators. Carrier and symbol-clock recovery and synchronization. Structure of the DPSK receiver.		
10.	Phase Shift Keying (PSK) III. SNR performance of the DPSK modulation. Variants of QPSK– OQPSK, π/4-QPSK. Applications.		
11.	A+PSK (QAM) Modulation I Definitions. A+PSK constellations. Bit-mapping and generation of the invariant constellations. Modulating the A+PSK constellations. Filtering the A+PSK signals. Structure of the A+PSK transmitter.		
12.	A+PSK (QAM) Demodulation II The A+PSK Demodulator (the LPF- variant). Carrier Recovery (the DDCR method). Structure of the A+PSK receiver. SNR performance of the A+PSK modulations. Applications.		
13.	Frequency Shift Keying (FSK) I. Parameters and spectrum of FSK signals. Digital FSK modulators. Filtering the FSK signal. Structure of the FSK transmitter.		
14.	Frequency Shift Keying (FSK) II. Demodulation of the FSK signals. Bit-clock synchronization. Structure of the FSK receiver. SNR performance. Applications.		
Bibliography			

1. Proakis, J.G., Digital Communications, 4th edition, McGraw-Hill 2. Fuqin Xiong, Digital modulation Techniques, Artech House Internet teaching materials: 1. V. Bota, M. Varga, Modulation Techniques. Lecture Notes (in English), Universitatea Tehnică din Cluj-Napoca, http://users.utcluj.ro/~dtl/TM/cursuri_tm.html			
8.2. Applications/Laboratory		Teaching methods	Notes
1.	Introduction. Basic notions of signals' theory - revision	Configuration of advanced simulators, performing measurements and the interpretation of the results obtained. Case studies.	Computers, advanced software simulation tools, experimental laboratory circuits, specific measuring equipment
2.	Linear Modulations I. Spectral composition. Transmission.		
3.	Linear Modulations II. Demodulation. Carrier recovery. SNR performance.		
4.	Frequency Modulation. Modulation. Demodulation. SNR performance.		
5.	Base-band Data Transmissions I. BB codes.		
6.	Base-band Data Transmissions II. Digital synchronization of the bit-clock		
7.	Filtering of data signals.		
8.	PAM. ASK		
9.	PSK I. Transmitter. Receiver.		
10.	PSK II. Error performance of PSK		
11.	A+PSK I. Transmitter. Receiver.		
12.	A+PSK II. Local carrier synchronization. Error probability of A+PSK. Comparison to the performance of PSK.and ASK		
13.	FSK.I Spectrum. Transmitter..		
14.	FSK II Receiver. Bit-clock synchronization. Bit-error probability.		
8.3 Applications/Seminar			
1.	Linear modulations	Solving problems. Case studies	Sets of problems available on the laboratory site: http://users.utcluj.ro/~dtl/TM/seminar_tm.html
2.	Frequency modulation		
3.	Baseband transmissions		
4.	PAM and ASK		
5.	PSK		
6.	A+PSK		
7.	FSK		
Bibliography V. Bota, M. Varga, Modulation Techniques. Problems, Universitatea Tehnică din Cluj-Napoca, http://users.utcluj.ro/~dtl/TM/seminar_tm.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 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
Course	Solving 4-5 subjects (problems+theory) (3 hours)	Written examination	75%
Applications	3 written tests to evaluate the knowledge acquired in the lab works	Evaluation during the semester	25%
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 = 0.75*E+0.25*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
Anghel BOTOS, PhD

Date of approval in the department
01.10.2014

Head of Communications Department
Professor Virgil DOBROTA, PhD