SYLLABUS

Discipline name	Modulation Techniques
Profile	Electronics and Telecommunications Engineering
Specialization	Telecommunications Technologies and Systems
Code	51323609
Course leader	Professor Vasile Bota, Ph.D. – Vasile.Bota@com.utcluj.ro
Collaborators	Eng. Anghel Botos, M.Sc, Ph.D. student – Anghel.Botos@com.utcluj.ro
Department	Communications
Faculty	Electronics, Telecommunications and Information Technology

Sem.	Type of discipline	Course	Applications			Course	Applications			Ind. study	TOTAL	Credits	Form of assessment
		[hours/week]				[hours/semester]							
			S	L	P		S	L	P				
5	**Speciality**	**2**	**1**	**2**	**-**	**28**	**14**	**28**	**-**	**80**	**150**	**5**	**Exam**

Acquired competences : Basic notions of analogue modulations; Basic notions of digital modulations; Basic notions regarding the performance evaluation of the studied modulations; Basic knowledge about the employment of the studied modulations in transmission systems

Acquired skills (what the student is able to do):

- To select and set the parameters of the baseband codes
- To select and configure the FSK, PSK, QAM, LM and FM for transmissions across band-limited channels
- To built the structures of transmitters and receivers of the studied modulations
- To evaluate the performance of the studied modulations on transmission channels
- To evaluate the performance of transmission equipments
- To configure the main parameters of transmission systems that employ these modulations
- To know the main applications of these modulations and their domains of applicability

Acquired abilities (what type of equipment/ instruments/ software the student is able to handle):

- To select transmission equipments according to the requirements of a specific application
- To configure transmission equipments
- To evaluate the performance of a transmission equipment

Prerequisites (if necessary):

Basic knowledge of signal theory and digital and analogue integrated circuits

A. Course/Lecture (course/lecture titles)	
1	Linear Modulations. Types of LM. Expression of the LM signals. Spectra of the LM signals. Modulation methods of the LM signals.
2	LM Reception. Demodulation methods of the LM signals. Carrier recovery methods. SNR performances of the LMs.
3	Frequency Modulation. Expression of the FM signals. Spectrum of the FM signal. Modulation methods of the FM signal. Demodulation methods of the FM signals. SNR performances of the FM.
4	Base-band Data Transmissions. BB Codes. Definitions. Spectral properties. Encoding-decoding of the BB codes. SNR performances of BB codes. Applications.
5	Bit-clock Synchronization. Digital dynamic and fast synchronization methods. Structure and parameters of a bit-clock synchronization circuit.
6	Filtering the Data Signals. Defining the ISI. The RC and RRC filtering characteristics. Considerations regarding the implementation of the RC and TTC filtering characteristics.
7	FSK Modulation I. Definition. Parameters. Filtering the FSK signal. FSK modulators. Walsh digital synthesis of the FSK signal. Structure of the FSK transmitter.
8	FSK Modulation II. Demodulation methods of the FSK signals. Bit-clock synchronization. Structure of the FSK receiver. SNR performnces of the FSK modulation. Applications.
9	DPSK Modulation I. Types of PSK modulations. Computation of the bit rate. Modulating methods of the PSK and DPSK signals. Spectra and filtering of the DPSK signals. Structure of the DPSK transmitter.
10	DPSK Modulation II. Symbol-clock recovery and synchronization. Digital DPSK demodulators. Structure of the DPSK receiver. SNR performances of the DPSK modulation. Applications.
11	Quadrature Amplitude Modulation – QAM I. Definition. Modulation- demodulation. QPSK modulation using the QAM technique. QAM transmitter-receiver.
12	Quadrature Amplitude Modulation – QAM II. Carrier recovery methods. Variants of the QPSK. Performances of the QPSK. Applications.
13	A+PSK (QAM) Modulation I. A+PSK Constellations. Generation of the invariant constellations.

	Modulating the A+PSK constellations. Filtering the A+PSK signals. Structure of the A+PSK transmitter.
14	A+PSK (QAM) II. The A+PSK Demodulator (the LPF- variant). Carrier Recovery (the DDCR method). Structure of the A+PSK receiver. SNR performances of the A+PSK modulations. Applications.

B. Applications – **Laboratory** (list of laboratories),	
1	Basic notions of signals' theory. Revision
2	Linear Modulations. Spectral composition.Demodulation. Carrier recovery. SNR performances.
3	Frequency Modulation. Modulation (Armstrong's method). Demodulation. SNR performances
4	Laboratory test LM+FM. Base-band codes. Types. Spectral analysis.
5	BB codes. Encoding-decoding. SNR performances.
6	Bit (symbol)-clock synchronization. Synchronization circuits. Parameters' computation.
7	Laboratory test BB+ synchronization. FSK transmitter. The analogue modulator.
8	FSK transmitter with Walsh digital synthesis. Implementation. Spectral composition.
9	FSK receiver. The "zero-crossings" demodulator. Performances. Bit-clock synchronization.
10	Laboratory test FSK. PSK and APSK digital modulators. Filtering the PSK signals.
11	PSK modulation. Structure of the PSK transmitter. The coherent-differential DPSK demodulator. Symbol-clock recovery. SNR performances.
12	QPSK modulation-demodulation by using the QAM technique.
13	A+PSK modulation. Mapping and modulation method.
14	A+PSK modulation. Demodulation of the A+PSK signals. Computation of the SNR performances.
	Seminars (contents)
1	Linear modulations.
2	Frequency modulation.
3	Base-band codes.
4	FSK modulation.
5	PSK modulation.
6	QAM modulation
7	A+PSK modulation.

C. Individual study (reference study contents, synthesis materials, projects, applications etc.)

6 sets of problems (homework)

Individual study structure	Course study	Problem solving, laboratory, project	Applications preparation	Examination time	Additional reference study	Total no. of individual study hours
Hours	35	14	21	3	7	80

References (Textbooks, courses, laboratory manual, exercise book)

1. Bota V. – Transmisiuni de date, Editura Risoprint, 2004, ISBN 973-656-714-1
2. Rappaport, Th., „Wireless Communications. Principles and Practice", Prentice Hall, 2001
3. Proakis, G. „Digital Communications", Prentice Hall, 2001

On – line references

1. Bota V., - Modulation Techniques, Lecture Notes, http://users.utcluj.ro/~dtl
2. Bota V., Polgar Zs., Varga M. – Tehnici de modulații, Lucrări de laborator, http://users.utcluj.ro/~dtl
3. Bota V., Polgar Zs., Varga M. – Problems for the MT Course, http://users.utcluj.ro/~dtl

Final evaluation	
Evaluation method	Written exam, 4-5 subjects – problems + theory (3 hours). Three laboratory tests after laboratory classes 4, 7, 10.
Mark components	Exam (E: 0…10 points); Laboratory (L); Homework (H); each 1…10 points
Mark computation	$M = 0.75E + +0{,}25\ (L+T)/2$; pass if: $E \geq 5$ and $M \geq 5$

Course leader,

Professor Vasile Bota , Ph.D.

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