Universidad
Carlos III de Madrid
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COURSE: Digital Communications		
Bachelor Degree: Bachelor in Telecommunication Technologies	YEAR: 3º	SEMESTER: 1º

WEEKLY PROGRAMM DESCRIPTION

Week	Session	SESSION DESCRIPTION	Groups LECTURE	Groups SEMINAR	Special room for session (Computer class room, audio-visual class room)	Session needs 2 teachers YES/NO	WEEKLY PROGRAMMING FOR STUDENT DESCRIPTION	CLASS HOURS	HOMEWORK HOURS (Max. 7h week)
1	1	Chapter 1 - Introduction ▪ Presentation of the course: objectives and contents ▪ Definition of a communication system ▪ Advantages of digital communication systems ▪ Digital communication model	X			No	Review of basic concepts of previous related courses such as stochastic processes in the frequency domain, optimal digital transmitter and receiver, calculation of probabilities of error and analog amplitude modulation (AM) seen in *Communication Theory*.)	1,66	
1	2	Chapter 2 - Linear modulations ▪ Baseband PAM modulations ▪ Constellations and pulses ▪ Spectrum of a baseband PAM signal ▪ Transmission through Gaussian channels ? Equivalent discrete channel ▪ Definition of intersymbol interference (ISI)		X		No	Understanding of the generation of baseband PAM signals, and of the role of constellations and pulses. Establishment of parameters determining the spectrum of the baseband PAM signals. Understanding of the intersymbol interference and of the factors that determine it.	1,66	3
2	3	Chapter 2 - Linear modulations ▪ Maximum transmission rate without ISI in a baseband PAM ▪ Pulses accomplishing Nyquist criterion - raised cosine pulses ▪ Transmission through linear channels ▪ Noise characteristics at the receiver ▪ Error probability computation	X			No	Establishment of the maximum symbol rate without ISI in a system with a given bandwidth and relationship between binary rate and symbol rate. Understanding of the effect of the channel in the design of the receiver filter and its effect over noise and ISI.	1,66	
2	4	Chapter 2 - Linear modulations ▪ Bandpass PAM modulation by AM modulation ▪ Bandpass PAM modulation by quadrature carriers ▪ Constellations for bandpass PAM ▪ Spectrum of bandpass PAM modulations	X		Extra Weakly class (29). Need for classroom with capacity for lecture group	No	Review of analog amplitude modulations (AM). Understanding the generation process through quadrature carriers, the meaning and implications of choosing a constellation and of the parameters that define the bandwidth and its realtion with the transmission rate and ISI.	1,66	
2	5	Chapter 2 - Linear modulations ▪ Receivers for bandpass PAM modulations ▪ Equivalent discrete channel for bandpass PAM ▪ Noise characteristics at the receiver ▪ Error probability computation		X		No	Study and understanding of the different possible designs for the demodulation of bandpass signals. Performance evaluation in systems with bidimensional constellations. Channel effects in bandpass modulations.	1,66	3

3	6	Chapter 3 - Detection under intersymbol interference ▪ Intersymbol interference detection ▪ Memoryless symbol by symbol detection - optimal delay ▪ Maximum likelihood sequence detector (MLSD)	X			No	Review of maximum likelihood detection. Determining the optimal delay for the memoryless symbol detection and error probability computation with ISI.	1,66	
3	7	Chapter 2 - Linear modulations ▪ Exercise class		X		No	Working on the exercises to be done in the exercise class and preparation for the activity related with the continuous assessment procedure.	1,66	6
4	8	**Continuous assessment** - Partial activity (1/3) Chapter 3 - Detection under intersymbol interference ▪ System representation with the Trellis diagram ▪ Trellis diagram for MLSD - Viterbi algorithm	X			No	Understandign the communication system representation under ISI through a state machine and trellis diagram. Application of the full and truncated versions of the Viterbi algorithms.	1,66	
4	9	Chapter 3 - Detection under intersymbol interference ▪ Perfromance of MLSD ▪ Linear equalizers (suboptimal receivers) ▪ Design criteria for linear equalizers ▪ Unconstrained design of linear equalizers.		X		No	Minimum euclidean distance between noiseless sequences and the effect on the error probability in the MLSD. Study of channel equalizers as a suboptimal solution for ISI detection. Understanding the different cost functions for the design of linear equalizers.	1,66	4
5	10	Chapter 3 - Detection under intersymbol interference ▪ Constrained design of linear equalizers. ▪ Asymptotic performance for linear equalizers ▪ Performance of constrained linear equalizers	X			No	Cálculo de los coeficientes de igualadores asintóticamente en el dominio de la frecuencia y con un número concreto de coeficientes en el dominio temporal. Comprensión de los sistemas de ecuaciones y métodos de resolución de los mismos. Cálculo de las prestaciones para igualadores lineales, tanto asintóticas como para un igualador con unos coeficientes dados.	1,66	
5	11	Chapter 3 - Detection under intersymbol interference ▪ Exercise class		X		No	Solving the exercises for the class and comparing the results with the class solving.	1,66	4
6	12	Chapter 4 - Non linear (angle) modulations ▪ Phase modulations - PSK, QPSK and OQPSK modulations ▪ Differential phase modulations ▪ Frequency modulations - CPFSK modulation ▪ Minimum shift keying modulation (MSK)	X			No	Identification of waveforms for different phase modulations, of what is the way to overcome 180^{o} phase shifts, of how these shifts affect the spectrum and the procedure for differential encoding to facilitate non-coherent receivers. Understanding frequency modulations and the relation between bandwidth and transmission rate.	1,66	
6	13	Chapter 3 - Detection under intersymbol interference ▪ Exercise class (II)		X		No	Working on the exercises to be done in the exercise class and preparation for the activity related with the continuous assessment procedure.	1,66	6
7	14	**Continuous assessment** - Partial activity (2/4) Chapter 4 - Non linear (angle) modulations ▪ Continuous phase modulation (CPM) ▪ CPM representation by phase trees	X			No	Continuous phase modulations, pulse shaping for CPM and its effect on the bandwidth and phase evolution on the phase tree.	1,66	
7	15	**Laboratory** - Session 1		X	Computer Room. 2 slots per seminar group	No	Preparation of exercises for laboratory session 1	1,66	5

8	16	Chapter 5 - Multipulse modulations ▪ Spread spectrum modulations - Basic definitions ▪ Direct sequence spread spectrum (DS-SS) ▪ Generation and demodulation of DS-SS signals ▪ Efect of ISI in DS-SS modulations - Equivalent discrete channel	X			No	Understanding of the spead spectrum concept. Analysis of the main parameters defining the characteristics of the direct sequence spread spectrum signal, and understanding of the practical structures used in the transmitter and receiver and based on discrete-time processing.	1,66	
8	17	**Laboratory** - Session 2		X	Computer Room. 2 slots per seminar group	No	Preparation of exercises for laboratory session 2	1,66	5
9	18	Chapter 5 - Multipulse modulations ▪ Spread spectrum modulations DS-SS ▪ Multiple access based in spread spectrum ▪ Transmission scheme with multiple carriers - FDM ▪ FDM orthogonal modulation (OFDM) en tiempo continuo ▪ Discrete time orthogonal FFDM orthogonal (OFDM)	X			No	Understanding the effect of the spreading sequence in the DS-SS signal and of the use of this type of modulation for allowing different users access. Understanding schemes with mutiple carriers ond of OFDM modulation.	1,66	
9	19	Chapter 5 - Multipulse modulations ▪ Discrete time OFDM implementation ▪ Equivalent discrete channels in OFDM and ISI effect - Cyclic prefix		X		No	Understanding the different implementations o discrete time OFDM of the cyclic prefix mechanism to avoid intersymbol and intercarrier interference and relation of the modulation parameters, cyclic prefix length and an efficient transmission rate.	1,66	3
10	20	Chapter 6 - Channel coding for error protection ▪ Introduction to channel coding and definitions ▪ Block codes - Basic definitions ▪ Optimal estimators for block codes (hard and soft output)	X			No	Review of Shannon channel coding theorem and understanding of the basic parameters of a generic channel coder. Establishment of main parameters of a block code and the optimal detectors.	1,66	
10	21	Chapter 5 - Multipulse modulations ▪ Exercise class		X		No	Working on the exercises to be done in the exercise class.	1,66	4
11	22	Chapter 6 - Channel coding for error protection ▪ Linear block codes - Generation - Generation matrix ▪ Parity check matrix ▪ Syndrome decoding	X			No	Obtaining the codewords, understanding the concept of minimum distance and the relation with the code performance and measurement of that parameter for linear block codes. Obtaining the syndrome table and understanding of the decoding algorithm based on the syndromes.	1,66	
11	23	Chapter 6 - Channel coding for error protection ▪ Examples of generation and decoding ▪ Hamming limit - Perfect codes - Examples ▪ Performance of linear block codes - Examples		X		No	Identification of a perfect code and understanding the special characteristic of this type of codes. Performance evaluation for block codes with hard and soft decoding.	1,66	5
12	24	**Continuous assessment** - Partial activity (3/4) Chapter 6 - Channel coding for error protection ▪ Convolutional codes - Definitions and representations ▪ States and trellis diagram for convolutional codes	X			No	Relationship between different representations of convolutional codes, establishment of the trellis diagram for the encoder.	1,66	
12	25	**Laboratory** - Session 3		X	4.2.B01A. 2 slots per reduced group	No	Preparation of exercises for laboratory session 3	1,66	5

13	26	Chapter 6 - Channel coding for error protection ▪ Decoding algorithm - Viterbi algorithm ▪ Performance of convolutional codes	X			No	Viterbi algorithm representation for hard decoding and soft decoding. Performance evaluation in both cases.	1,66	
13	27	**Laboratory** - Session 4		X	4.2.B01A. 2 slots per reduced group	No	Preparation of exercises for laboratory session 4	1,66	5
14	28	Chapter 6 - Channel coding for error protection ▪ Exercise class	X			No	Solving the exercices to be delivered in the exercise class.	1,66	
14	29	Chapter 6 - Channel coding for error protection ▪ Exercise class (II)		X		No	Working on the exercises to be done in the exercise class and preparation for the last activity related with the continuous assessment procedure.	1,66	6
							Subtotal 1 - 112,33 hours	**48,33**	**64**

15		**Continuous assessment** - Partial activity (4/4) Extra clasess, tutoring class, homework handling in, etc.						0,5	1,5
16 17 18		Preparing for the evaluation and exam						3	21
							Subtotal 2 - 26 hours	**3,5**	**22,5**

TOTAL(Total 1 + Total 2. Maximum 180 hours)	**138,33 horas**