uc3m | Universidad Carlos III de Madrid

COURSE: Digital Communications		
Bachelor Degree: Bachelor in Communication System Engineering	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 0 - 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 1 - 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 1 - Linear modulations ▪ Effects of the ISI: transmission rate and extended contellation ▪ Nyquist criterion for zero ISI ▪ Spectrum shaping - Raised cosine pulses ▪ Noise characteristics at the receiver	X			No	Analysis of the effect of the ISI, and determination of the maximum symbol rate without ISI in a system with a given bandwidth and relationship between binary rate and symbol rate. Transmission rate using raised cosine filters. 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 1 - 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), which were introduced in *Communication Theory*. 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 1 - Linear modulations ▪ In-class exercises (I)		X		No	Working on the exercises to be done in the class and solution of these exercises.	1,66	4

3	6	Chapter 1 - Linear modulations ▪ Receivers for bandpass PAM modulations ▪ Equivalent discrete channel for bandpass PAM ▪ Noise characteristics at the receiver ▪ Computation of the probability of error	X			No	Review of maximum likelihood detection. Determining the optimal delay for the memoryless symbol detection and computation of the probability of error with ISI.	1,66	
3	7	Chapter 1 - Linear modulations ▪ In-class exercises (II)		X		No	Working on the exercises to be done in the class and solution of these exercises.	1,66	5
4	8	Chapter 2 - Detection under intersymbol interference ▪ Detection under intersymbol interference (ISI) - Statement ▪ Memoryless symbol by symbol detection - Optimal delay ▪ Maximum likelihood sequence detector (MLSD)	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's algorithm.	1,66	
4	9	Chapter 2 - Detection under intersymbol interference ▪ System representation with the Trellis diagram ▪ Trellis diagram for MLSD - Viterbi's algorithm		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	**Continuous assessment** - Partial activity (1/4) Chapter 2 - Detection under intersymbol interference ▪ Constrained design of linear equalizers. ▪ Asymptotic performance for linear equalizers ▪ Performance of constrained linear equalizers	X			No	Solution for coefficients of unconstrained equalizers in the frequency domain, and for constrained equalizers in the time domain. Analysis of the equation systems and solution of these systems. Evaluation of performance for linear equalizers: asymptotic performance as well as performance for some specific coefficients.	1,66	
5	11	Chapter 2 - Detection under intersymbol interference ▪ In-class exercises (I)		X		No	Working on the exercises to be done in the class and solution of these exercises.	1,66	6
6	12	Chapter 2 - Detection under intersymbol interference ▪ Constrained design of linear equalizers. ▪ Asymptotic performance for linear equalizers ▪ Performance of constrained linear equalizers	X			No	Analysis 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 2 - Detection under intersymbol interference ▪ In-class exercises (II)		X		No	Working on the exercises to be done in the class and solution of these exercises.	1,66	4
7	14	Chapter 3 - Non linear (angle) modulations ▪ Phase modulations - PSK, QPSK and OQPSK modulations ▪ Differential phase modulations (DPSK) ▪ Continuous phase frequency shift keying modulation (CPFSK) ▪ Minimum shift keying modulation (MSK)	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	**Continuous assessment** - Partial activity (2/4) Chapter 3 - 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	
8	17	**Laboratory** - Session 2		X	4.2.B01A. 2 slots per reduced group	No	Preparation of exercises for laboratory session 2	1,66	5
9	18	Chapter 4 - Multipulse modulations ▪ Spread spectrum modulations - Basic definitions ▪ Direct sequence spread spectrum (DS-SS) ▪ Generation and demodulation of DS-SS signals	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	
9	19	Chapter 4 - Multipulse modulations ▪ Efect of ISI in DS-SS modulations - Equivalent discrete channel ▪ Spectrim of DS-SS modulations ▪ Multiple access based in spread spectrum ▪ Transmission scheme with multiple carriers - FDM		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.	1,66	3
10	20	Chapter 4 - Multipulse modulations ▪ FDM orthogonal modulation (OFDM) en tiempo continuo ▪ Discrete time orthogonal FFDM orthogonal (OFDM) ▪ Discrete time OFDM implementation ▪ Equivalent discrete channels in OFDM and ISI effect - Cyclic prefix	X			No	Introduction to the OFDM modulation and analysis of the different implementations of discrete time OFDM and 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	
10	21	Chapter 4 - Multipulse modulations ▪ In-class exercises		X		No	Working on the exercises to be done in the class and solution of these exercises.	1,66	4
11	22	Chapter 5 - 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 the main parameters of a block code and analysis of the optimal detectors.	1,66	
11	23	Chapter 5 - Channel coding for error protection ▪ Linear block codes - Generation - Generation matrix ▪ Parity check matrix ▪ Syndrome based decoding technique		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	5

12	24	**Continuous assessment** - Partial activity (3/4) Chapter 5 - Channel coding for error protection ▪ Hamming limit - Perfect codes - Examples ▪ Performance of linear block codes ▪ Convolutional codes - Definitions and representations ▪ Definition of state and Trellis diagram	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. Definition of convolutional codes and analysis of their representations. Definition of the state of a convolutional encoded and Trellis diagram.	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 5 - Channel coding for error protection ▪ Decoding algorithm - Viterbi's algorithm ▪ Performance of convolutional codes	X			No	Viterbi's 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 5 - Channel coding for error protection ▪ In-class exercises (I)	X			No	Working on the exercises to be done in the class and solution of these exercises.	1,66	
14	29	Chapter 5 - Channel coding for error protection ▪ In-class exercises (II)		X		No	Working on the exercises to be done in the class and solution of these exercises.	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 160 hours)	**138,33 horas**