Universidad Carlos III de Madrid

SUBJECT: Information Theory		
MASTER DEGREE: Multimedia and Communications Lecturer: Tobias Koch	ECTS: 6	QUARTER: 1st

TIMETABLE FOR THE SUBJECT

WEEK	SESSION	DESCRIPTION OF EACH SESSION	GROUP (X mark)		Indicate if a different lecture room is needed (computer, audiovisual, etc.)	HOMEWORK PER WEEK		
			1	2		DESCRIPTION	ATTENDING HOURS	HOMEWORK Max. 7H/WEEK
1	1	Introduction, block diagram of a communication system, examples of data compression and data transmission problems.	X			Reinforcing course material at home.	1.5	4
	2	Entropy, relative entropy, and mutual information.	X			Reinforcing course material at home.	1.5	4
2	3	Conditional mutual information, Jensen's inequality.	X			Reinforcing course material at home, homework exercise 1 (to be handed in in Session 8).	1.5	4
	4	Properties of relative entropy, entropy, and mutual information, log-sum inequality, data processing inequality.	X			Reinforcing course material at home, homework exercise 1 (to be handed in in Session 8).	1.5	4

3	5	Introduction to data compression, expected length of non-singular source codes.	X			Reinforcing course material at home, homework exercise 1 (to be handed in in Session 8).	1.5	4
	6	Kraft's inequality for prefix-free codes.	X			Reinforcing course material at home, homework exercise 1 (to be handed in in Session 8).	1.5	4
4	7	Bounds on the expected length of prefix-free codes, mismatch, McMillan's inequality for uniquely-decodable codes.	X			Reinforcing course material at home, homework exercise 1 (to be handed in in Session 8).	1.5	4
	8	Huffman codes and proof of their optimality.	X			Reinforcing course material at home, hand in homework exercise 1.	1.5	4
5	9	Almost lossless source coding.	X			Reinforcing course material at home, homework exercise 2 (to be handed in in Session 12).	1.5	4

	10	Introduction to data transmission, key quantities in a communication system.	X			Reinforcing course material at home, homework exercise 2 (to be handed in in Session 12).	1.5	4
6	11	Calculation of channel capacity for simple channels: noiseless channel, binary symmetric channel (BSC), binary erasure channel (BEC)	X			Reinforcing course material at home, homework exercise 2 (to be handed in in Session 12).	1.5	4
	12	Symmetry considerations for the calculation of channel capacity, Karush-Kuhn-Tucker (KKT) conditions.	X			Reinforcing course material at home, hand in homework exercise 2.	1.5	4
7	13	Example on how to apply KKT conditions: BEC. Introduction and statement of the Channel Coding Theorem for memoryless channels.	X			Reinforcing course material at home, homework exercise 3 (to be handed in in Session 18).	1.5	4
	14	The converse to the Channel Coding Theorem via Fano's inequality.	X			Reinforcing course material at home, homework exercise 3 (to be handed in in Session 18).	1.5	4

8	15	The achievability of the Channel Coding Theorem: random coding argument, threshold decoders, and analysis of their performance.	X			Reinforcing course material at home, homework exercise 3 (to be handed in in Session 18).	1.5	4
	16	Channel capacity of channels with feedback.	X			Reinforcing course material at home, homework exercise 3 (to be handed in in Session 18).	1.5	4
9	17	Joint source-channel coding and the optimality of separation.	X			Reinforcing course material at home, homework exercise 3 (to be handed in in Session 18).	1.5	4
	18	Introduction to continuous-valued random variables: differential entropy and its connection to entropy.	X			Reinforcing course material at home, hand in homework exercise 3.	1.5	4
10	19	Relative entropy and mutual information for continuous-valued random variables.	X			Reinforcing course material at home, homework exercise 4 (to be handed in in Session 24).	1.5	4

	20	Properties of differential entropy, relative entropy, and mutual information for continuous-valued random variables.	X			Reinforcing course material at home, homework exercise 4 (to be handed in in Session 24).	1.5	4
11	21	Maximum entropy distributions.	X			Reinforcing course material at home, homework exercise 4 (to be handed in in Session 24).	1.5	4
	22	The Gaussian channel and its capacity.	X			Reinforcing course material at home, homework exercise 4 (to be handed in in Session 24).	1.5	4
12	23	Proof of the Channel Coding Theorem for the Gaussian channel: converse part via Fano's inequality.	X			Reinforcing course material at home, homework exercise 4 (to be handed in in Session 24).	1.5	4
	24	Proof of the Channel Coding Theorem for the Gaussian channel: achievability part via random coding arguments and the analysis of a threshold decoder.	X			Reinforcing course material at home, hand in homework exercise 4.	1.5	4

13	25	A brief introduction to rate-distortion theory – Part 1.	X			Reinforcing course material at home, prepare for final exam.	1.5	4
	26	A brief introduction to rate-distortion theory – Part 2.	X			Reinforcing course material at home, prepare for final exam.	1.5	4
14	27	Preparation final exam	X			Reinforcing course material at home, prepare for final exam.	1.5	4
	28	Final exam	X			Reinforcing course material at home, prepare for final exam.	1.5	
TOTAL HOURS							**42**	**108**