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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2017

Department of Electronics and Communication Engineering

M. Tech in Communication Engineering & Signal processing

07EC 6205 INFORMATION THEORY- SCHEME OF VALUATION

Max.marks: 60 **Time: 3 hours**

Answer all six questions. Part 'a' of each question is compulsory.

Answer either part 'b' or part 'c' of each question

Q.no.	Module 1	Marks
1a	Define an information source S and its entropy H(S)-(2marks) For two random variables X and Y, define joint entropy and conditional entropy(2marks)	**4**
	Answer b or c	
b	Give an example of second order binary Markov source. (1mark). Show its state diagram- (1mark). The expression for its entropy in terms of the stationary distribution of the states and the conditional symbol probabilities (3marks).	**5**
c	Define extension of a zero memory source (2marks) Show how is the entropy of the n^{th} order extension related to the entropy of the original source(3 marks)	**5**

Q.no.	Module 2	Marks
2a	Define instantaneous cod.(1.5marks) . For a source having 5 symbol alphabet, give example for binary codes which are instantaneous -(1.5 marks). Check whether they satisfy the constraint of Krafts inequality (2marks).	**4**
	Answer b or c	
b	Distinguish between the statements of Krafts inequality and McMillan's inequality on the lengths of codes for a discrete source (2marks). Prove the sufficiency part of this of Krafts inequality (3marks).	**5**
c	State and prove the McMillans inequality constraint on the lengths of uniquely decodable codes for a discrete source - Prove the sufficiency part-(2marks) Necessity part of proof(3marks)	**5**

Q.no.	Module 3	Marks
3a	Define code efficiency (1mark) and redundancy (1mark)of a source code. Code efficiency of Shannon code for a source $S = \{s_1, s_2, s_3, s_4, s_5, s_6\}$ with the probabilities $P(S) = \{0.2, 0.15, 0.05, 0.3, 0.18.0.12\}$ - (3marks)	4
	Answer b or c	
b	For a discrete information source $X = \{x_1, x_2, \dots x_q\}$, consider a binary code using the binary representation of the distribution function $\tilde{F}(x_i) = \sum_{\alpha<i} p(x_i) + \frac{p(x_i)}{2}$. If the lengths of representation for $\tilde{F}(x_i)$ is l_i binits, Find the relation between l_i and $p(x_i)$ such that the code is instantaneous. (2 marks) What is the upper and lower bounds for the average length of such a code (3marks)	5
c	State and prove Shannon's source coding theorem. Lower bound of of average length L-1mark Upper bound of L -(1mark) Bounds for coding nth extension of the source, how does it improves average length of code per source symbol-(3mark)	5

Q.no.	Module 4	Marks
4a	Define noiseless discrete channel (1.5marks) and deterministic discrete channel(1.5marks). Give typical examples for channel matrix in each case with channel diagrams(2marks).	4
	Answer b or c	
b	Define noisy, noiseless and deterministic channels (2 marks) and give examples for each with 3 inputs and 3 outputs (3marks)	5
c	Calculate the mutual information for a binary symmetric channel with input a priori probabilities p(0) = 3/4, p(1)=1/4 and channel matrix, $P = \begin{bmatrix} \frac{2}{3} & \frac{1}{3} \\ \frac{1}{10} & \frac{9}{10} \end{bmatrix}$. $I\,(A; B) = H(B) - H(B/A)$ -(1 mark) H(B) (2marks) $H(B/A)$ (2marks)	5

Q.no.	Module 5	Marks
5a	State Shannon's second theorem for a channel with inputs $A = \{a_i\}$, $i = 1,2, \dots r$. and outputs $B = \{b_j\}$, $j = 1,2, \dots s$.(2marks) Consider transmitting M messages consisting of symbol sequences of size n through the n^{th} extension of the channel. State the rule for maximum likelihood decision at the output (3marks).	5

Answer b or c

b	Consider a channel with input symbols $A = \{a_i\}$, $i = 1,2, \ldots r$. and outputs $B = \{b_j\}$, $j = 1,2, \ldots s$. Decision rule for transmitting M messages consisting of symbol sequences of size n through the n^{th} extension of the channel (2marks) Find an upper bound for error probability P_E (5marks).	**7**
c	State Shannon's second theorem for the binary symmetric channel (2marks). Proof-upper bound on P_E –(2marks) Completing the evaluation of the upper bound considering Random coding to of the input set of messages (3marks)	**7**

Q.no.	**Module 6**	**Marks**
6a	Define differential entropy between two continuous random variables X and Y (2marks) . Define mutual information $I(X,Y)$ (3marks).	**5**
	Answer b or c	
b	Define joint entropy $h(X,Y)$(2marks) and conditional differential entropy $h(X/Y)$ (2marks) of two continuous random variables X and Y. Calculate the differential entropy of a random variable having normal distribution with zero mean. (3marks)	**7**
c	Consider a Gaussian channel with a power constraint P for which there exist a sequence of 2^{nR} codes of length n, with the codeword satisfying power constraint such that the maximal probability of error tend to zero. Statement description of terms –(2marks) Prove that there exists a code which achieves a rate R arbitrarily close to its supremum value $C = \frac{1}{2}\log\left(1 + \frac{P}{N}\right)$ –(5marks)	**7**