Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2019

EC3EL05 / EI3EL05 Information Theory and Coding

Programme: B.Tech. Branch/Specialisation: EC/EI

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. The unit of average mutual information is **1**

(a) Bits (b) Bytes

(c) Bits per symbol (d) Bytes per symbol

ii. The relation between entropy and mutual information is **1**

(a) I(X;Y) = H(X) - H(X/Y) (b) I(X;Y) = H(X/Y) - H(Y/X)

(c) I(X;Y) = H(X) - H(Y) (d) I(X;Y) = H(Y) - H(X)

iii. The capacity of Gaussian channel is **1**

(a) $C = 2B(1+S/N)$ bits/s (b) $C = B^2(1+S/N)$ bits/s

(c) $C = B(1+S/N)$ bits/s (d) $C = B(1+S/N)^2$ bits/s

iv. The channel capacity is **1**

(a) The maximum information transmitted by one symbol over the channel

(b) Information contained in a signal

(c) The amplitude of the modulated signal

(d) All of these

v. Huffman coding technique is adopted for constructing the source code with _____ redundancy **1**

(a) Maximum (b) Constant (c) Minimum (d) Unpredictable

vi. A code is a mapping from **1**

(a) Binary sequence to discrete set of symbols

(b) Discrete set of symbols to binary sequence

(c) All of these

(d) None of these

P.T.O.

vii. Which among the following is/are the essential condition/s for a good error control coding technique?
(a) Faster coding & decoding methods
(b) Better error correcting capability
(c) Maximum transfer of information in bits/sec
(d) All of these

viii. In a linear code, the minimum Hamming distance between any two code words is _____minimum weight of any non-zero code word. **1**
(a) Less than (b) Greater than
(c) Equal to (d) None of these

ix. For designing of (4,1) cyclic repetition code, what would be the order of the generator polynomial g(x)? **1**
(a) 1 (b) 3 (c) 4 (d) 5

x. In Viterbi's algorithm, which metric is adopted for decision making? **1**
(a) Hamming distance (b) Galois Field
(c) Hamming bound (d) Parity-check

Q.2 i. Explain the concept of binary information. **2**

ii. Describe the concept of Entropy. **3**

iii. Consider a source having two symbols x & y. Duration of x is 0.2 s. The duration of y is 3 times the duration of x. The probability of occurrence of x is twice that of y. The time between x & y is 0.2 s. Calculate information rate of the source in bits/s. **5**

OR iv. List out the properties of mutual information and prove any three properties. **5**

Q.3 i. Define channel capacity and explain the concept of channel capacity. **2**

ii. Consider a BSC with p(x1)=a. Show that mutual information $I(X;Y)=H(Y)+p\log_2 p+(1-p)\log_2(1-p)$. Calculate mutual information for a=p=0.5. Give justification on the result. **8**

OR iii. An anolog signal having 4 kHz bandwidth is sampled at 1.25 times the Nyquist rate, and each sample is quantized into one of 256 equally likely levels. **8**
(a) What is the source information rate?
(b) Can the output of the source be transmitted without error over an AWGN channel with a bandwidth of 10 kHz and SNR of 20dB?
(c) What is the SNR required for error-free transmission for part B?

Q.4 i. State Source Coding Theorem and define Code Efficiency. **3**

ii. Classify various codes of source coding. **7**

OR iii. A DMS has five symbols X1, X2, X3, x4 and x5 with probabilities p(X1)=0.4, p(X2)=0.19, p(X3)=0.16, p(X4)=0.15 and p(X5)=0.1 **7**
(a) Construct a Shannon-Fano code for X and calculate the code efficiency.
(b) Repeat by Huffman code and compare the results.

Q.5 i. Why are Hamming Distance and Hamming Weight important for Linear Block Codes? **3**

ii. What are the conditions for a code to be classified as a Hamming code and as a perfect code? **7**

OR iii. Explain the concept of syndrome decoding in detail. **7**

Q.6 i. Cyclic codes are a subclass of linear block codes. Justify this statement. **3**

ii. Show that Convolution codes are linear codes by the help of an example. Also justify the name “Convolution code” given to these codes. How can one construct a systematic cycle code? **7**

OR iii. Compare Maximum Likelihood decoding and Viterbi’s decoding algorithms with suitable example. **7**

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Marking Scheme
EC3EL05 / EI3EL05 Information Theory and Coding

Q.1	i.	The unit of average mutual information is (c) Bits per symbol	**1**
	ii.	The relation between entropy and mutual information is (a) I(X;Y) = H(X) - H(X/Y)	**1**
	iii.	The capacity of Gaussian channel is (c) C = B(1+S/N) bits/s	**1**
	iv.	The channel capacity is (a) The maximum information transmitted by one symbol over the channel	**1**
	v.	Huffman coding technique is adopted for constructing the source code with _____ redundancy (c) Minimum	**1**
	vi.	A code is a mapping from (b) Discrete set of symbols to binary sequence	**1**
	vii.	Which among the following is/are the essential condition/s for a good error control coding technique? (d) All of these	**1**
	viii.	In a linear code, the minimum Hamming distance between any two code words is _____minimum weight of any non-zero code word. (c) Equal to	**1**
	ix.	For designing of (4,1) cyclic repetition code, what would be the order of the generator polynomial g(x)? (b) 3	**1**
	x.	In Viterbi's algorithm, which metric is adopted for decision making? (a) Hamming distance	**1**

Q.2	i.	Concept of binary information		**2**
		Definition & formula	1 mark	
		Example	1 mark	
	ii.	Concept of Entropy		**3**
		Definition & formula	1 mark	
		Example	1 mark	
	iii.	Calculate information rate of the source in bits/s.		**5**
		R=1.725 bits/sec	1 mark	
		r=1.875 symbols/sec	2 marks	
		H(X)= 0.92 bits/symbol	2 marks	
OR	iv.	List of five properties of mutual information	2 marks	**5**
		Proof of any three properties	3 marks	

Q.3	i.	Channel capacity		**2**
		Definition & formula	1 mark	
		Example	1 mark	
	ii.	Calculate mutual information for a=p=0.5.		**8**
		Derivation and proof	4 marks	
		Mutual information calculation	2 marks	
		Comment (No information is being transmitted)	2 marks	
OR	iii.	(a) R=80 kbps (b) No R(=80 kbps)>C(=66.66 kbps) (c) SNR=255(=24.1 dB) Stepwise marking		**8**

Q.4	i.	Source Coding Theorem		**3**
		Statement of theorem	2 marks	
		Definition and formula of Code Efficiency	1 mark	
	ii.	Seven different codes of source coding.		**7**
		1 mark for each	(1 mark *7)	
OR	iii.	A DMS has five symbols X1, X2, X3, x4 and x5 with probabilities p(X1)=0.4, p(X2)=0.19, p(X3)=0.16, p(X4)=0.15 and p(X5)=0.1		**7**
		(a) Construct a Shannon-Fano code for X	2 marks	
		Calculate the code efficiency	1 mark	
		(b) Huffman coding	2 marks	
		Efficiency calculation	1 mark	
		Comparison	1 mark	

Q.5	i.	Hamming Distance and Hamming Weight important for Linear Block Codes		**3**
	ii.	Conditions for Hamming code	3 marks	**7**
		Conditions for perfect code	4 marks	

OR	iii.	Concept of syndrome decoding		**7**
		Generation/coding	4 marks	
		Decoding	3 marks	
Q.6	i.	Cyclic codes are a subclass of linear block codes.		**3**
		Justification		
	ii.	Showing by example	2 marks	**7**
		Justification of name	1 mark	
		Construction of systematic cyclic code	4 marks	
OR	iii.	Compare Maximum Likelihood decoding and Viterbi's decoding algorithms		**7**
		Stepwise marking		

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