

2E9202

Roll No. _____

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M. Tech. II Sem. (Main & Back) Exam., July 2013

Digital Communication

2MDC2 Information Theory & Coding

Time: 2 Hours

Maximum Marks: 100
Min. Passing Marks: 33

Instructions to Candidates:

Attempt any five questions. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitably if any & specify the same.

Use of following supporting material is permitted during examination. (Mentioned in form No.205)

1. _____

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2. _____

Q.1. (a) A message source generates one of four messages randomly every microsecond. The probabilities of these messages are 0.4, 0.3, 0.2 and 0.1 each emitted message is independent of the other message in the sequence.

- (i) What is the source entropy?
(ii) What is the rate of information generated by this source (in bit per second)?

[5x2=10]

Q.2. Consider a binary memoryless source X with two symbols X_1 and X_2 , show that $H(x)$ is maximum when both x_1 and x_2 are equiprobable. [10]

Q.2. A binary channel matrix is given by

	Outputs	
	y_1	y_2
Input x_1	2/3	1/3
x_2	1/10	9/10

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This means $p_{y/x}(y_1/x_1) = 2/3$, $p_{y/x}(y_2/x_1) = 1/3$, etc. you are also given that $p_x(x_1) = 1/3$ and $p_x(x_2) = 2/3$. Determine $H(x)$, $H(x/y)$, $H(y)$, and $I(x;y)$ [4x5=20]

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Q.3. Prove the following equations.

- (i) $H(x,y) = H(x/y) + H(y)$
(ii) $I(x;y) = I(y;x)$
(iii) $I(x;y) \geq 0$
(iv) $H(x/y) = 0$ for a lossless channel

[4x5=20]

Q.4. (a) Prove that the information capacity can be expressed as

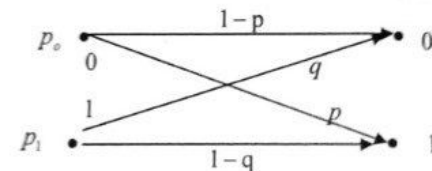
$$C = w \log_2 \left(1 + \frac{P}{N_0 w} \right) \text{ bits per second.}$$

Where w is bandwidth in Hz.

[10]

(b) Consider the binary channel in fig. shown below. Let the a-priori probabilities of sending the binary symbol be p_0 and p_1 , where $p_0 + p_1 = 1$, Find the a-posteriori probabilities

$$P(x=0/y=0) \text{ and } P(x=1/y=1)$$



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[10]

Q.5. (a) Write down the basic properties of Galois field.

[10]

(b) Consider the following code vectors:

$$C_1 = [1 \ 0 \ 0 \ 1 \ 0]$$

$$C_2 = [0 \ 1 \ 1 \ 0 \ 1]$$

$$C_3 = [1 \ 1 \ 0 \ 0 \ 1]$$

- (i) Find $d(c_1, c_2)$, $d(c_1, c_3)$, and $d(c_2, c_3)$
(ii) Show that

$$d(c_1, c_2) + d(c_2, c_3) \geq d(c_1, c_3)$$

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[5x2=10]

Q.6. (a) For (6,3) code, the generator matrix G is

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

$\underbrace{\hspace{2cm}}_{I_k} \quad \underbrace{\hspace{2cm}}_P$

For all eight possible data words, find the corresponding code words, and verify that this code is a single - error correcting code. [10]

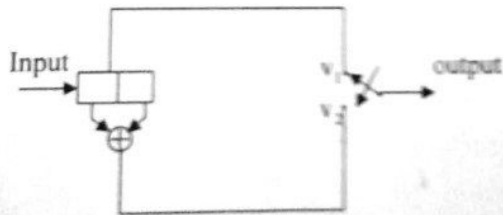
(b) Suppose we wish to increase reliability by repeating a message three time, e.g. by transmitting data 0 by 000 and 1 by 111. This is a (3, 1) code

(i) Is this a systematic code?

(ii) If so, find the generating matrix G.

[5x2 = 10]

Q.7. (a) Consider the convolution encoder shown in Figure below



(i) Find the impulse response of the encoder.

(ii) Using the impulse response, determine the output code words for input data $d = (101)$ [5x2 = 10]

(b) Prove that a Reed- Solomon code is a maximum distance separable (MDS) code and its minimum distance is $n-k+1$. [10]