

Printed Pages: 3

NEC031

Paper Id 

1	3	0	8	1	9
---	---	---	---	---	---

Roll No. 

--	--	--	--	--	--	--	--	--	--

**B. TECH**  
**(SEM-VII) THEORY EXAMINATION 2018-19**  
**INFORMATION THEORY AND CODING**

Time : 3 Hours

Max. Marks : 100

Note : Be precise in your answer. In case of numerical problem assume data wherever not provided

**SECTION – A**

1. Attempt all parts of the following questions: 2×10=20
- What is Entropy? List the properties of Entropy.
  - What is the minimum value of  $(p_1, p_2, p_3, \dots, p_n) = H(p)$  as  $p$  ranges over the set of  $n$ -dimensional probability vector? Find all  $p$ 's that which achieve this minimum.
  - State Log-sum inequality.
  - Define typical set and write its properties.
  - Write the consequences of AEP.
  - State Source Coding theorem.
  - Show that the expected length  $L$  of any instantaneous  $D$ -ary code for a random variable  $X$  is greater than or equal to the entropy  $H_D(X)$ , that is  $L \geq H_D(X)$ , with equality if and only if  $D^{-l_i} = p_i$ .
  - What do you mean by Binary symmetric channel?
  - Differentiate between block codes and convolutional codes.
  - Given the  $(5, 4)$  even parity block code. Find the codewords corresponding to  $i_1 = (1011)$  and  $i_2 = (1010)$  ?

**SECTION B**

2. Attempt any three parts of the following questions: 3×10=30
- For the systematic  $(6,3)$  code with
 
$$P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$
 Detect and correct the single error that occurred due to noise. Draw its syndrome calculation circuit.
  - Explain soft-decision decoding with example. Also give benefits of soft decoding.
  - What is channel? Classify channels into different groups. Explain each type briefly and also calculate the channel capacity of each type.
  - Find the (a) binary and (b) ternary Huffman codes for the random variable  $X$  with probabilities  $p = (\frac{1}{21}, \frac{2}{21}, \frac{3}{21}, \frac{4}{21}, \frac{5}{21}, \frac{6}{21})$ . Also calculate  $L = \sum p_i l_i$  in each case.

(e) The convolutional encoder has the following two generator sequences each of length 3 (the same as the constraint length  $K=3$ ):

- 1) Input-top adder output path  
 $(g_0^{(1)}, g_1^{(1)}, g_2^{(1)}) = (1, 1, 1)$
- 2) Input-bottom adder output path  
 $(g_0^{(2)}, g_1^{(2)}, g_2^{(2)}) = (1, 0, 1)$

The impulse response of either input-output path of the encoder is the same as the corresponding sequence of connections from the shift register to the pertinent adder, with a '1' representing a connection and a '0' representing no connection.

Find the following:-

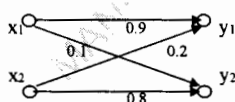
- (i) Draw the encoder diagram
- (ii) Top and bottom output sequences for input sequence 10011.
- (iii) Find the codeword for input message sequence 10011 using transform domain approach.

### SECTION C

Attempt any one part of the following question:

1×10=10

3. (a) What do you mean by relative entropy and mutual information? State the properties of relative entropy and mutual information.
- (b) Given a binary channel shown in the figure below:



- (i) Find the channel transition matrix.
- (ii) Find  $P(y_1)$  and  $P(y_2)$  when  $P(x_1)=P(x_2)=0.5$ .
- (iii) Calculate  $H(X)$ ,  $H(Y)$ ,  $H(Y/X)$ ,  $H(X/Y)$  and  $I(X; Y)$ .

Attempt any one part of the following question:

1×10=10

4. (a) State and prove Channel coding theorem.
- (b) For the (6, 3) Hamming code, the parity check matrix  $H$  is given by

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

- (i) Construct the generator matrix.
- (ii) Determine the codeword that begins with 110.