M.Tech. Electronics & Communication Engineering CBCS Pattern Semester-I

PECS141 - Information Theory and Coding

P. Pages : 2 **GUG/W/23/10982**

Time : Three Hours * 6 0 6 6 * Max. Marks : 70

Notes : 1. All questions carry marks as indicated.
2. Answer **any five** questions.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.

1. a) What is mutual information? Mention its properties and prove that **7**
$I(X:Y) = H(X) - H(X/Y);\ I(X:Y) = H(Y) - H(Y/X)$

b) Consider that two sources emits messages x_1, x_2, x_3 and y_1, y_2, y_3 with the joint **7**
probabilities P(X, Y) as shown in the matrix form.

$$P(X,Y) = \begin{bmatrix} 3/40 & 1/40 & 1/40 \\ 1/20 & 3/20 & 1/20 \\ 1/8 & 1/8 & 3/8 \end{bmatrix}$$

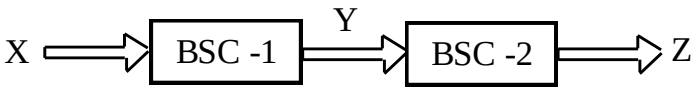
i) Calculate the entropies of x and y.

ii) Calculate the joint and conditional entropies $H(x, y)$, $H(x/y)$, $H(y/x)$ between x and y.

iii) Calculate the average mutual information I(x;y)

2. a) From channel capacity theorem find the capacity of channel with infinite bandwidth and **7**
explain.

b) Two binary symmetric channel with error probability 0.1, are cascaded as show below **7**
P(0) = 0.25. Calculate I(X, Y) and I(X, Z).



3. a) Given $X_i = \{x_1, x_2, x_3, x_4, x_5, x_6\}$ with probabilities **7**
$p(x_i) = \{0.3, 0.25, 0.2, 0.12, 0.08, 0.05\}$. Make Huffman code. Find efficiency of this code.

b) State and prove Kraft McMillan inequality. **7**

4. a) A memory less source emits six messages with probabilities {0.4, 0.2, 0.2, 0.1, 0.1} . find **7**
the Shanon-Fano code and determine its efficiency.

b) Construct the Huffman code with minimum code variance for the following probabilities **7**
and also determine the code variance and code efficiency:
{0.25, 0.25, 0.125, 0.125, 0.125, 0.0625, 0.0625}

5. a) Consider a (6, 3) linear block code whose generator matrix is given by **7**

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

i) Find the parity check matrix.
ii) Find the minimum distance of code.

b) A(7, 4) cyclic code has a generator polynomial: $g(X) = X^3 + X + 1$. **7**

i) Draw the block diagram of encoder and syndrome calculator.
ii) Find generator and parity check matrix in systematic form.

6. a) Explain the maximum likelihood decoding and Viterbi decoding algorithms of a convolutional encoder. **7**

b) Describe about block and convolutional interleaving. **7**

7. a) Consider a (3, 1, 2) convolutional encoder with $g^{(1)} = 110, g^{(2)} = 101$, and $g^{(3)} = 111$. **7**

i) Draw the encoder diagram.
ii) Find the code word for message sequence (11101) using Generator matrix and Transfer domain approach.

b) Define BCH code and brief about Reed-Solomon code. **7**

8. a) Briefly describe the steps of Viterbi algorithm. **7**

b) Consider the rate $r = \frac{1}{2}$ and constraint length k = 2 convolution encoder shown in fig. (1) given below. **7**

i) Draw the state diagram
ii) Draw the code tree
iii) Draw Trellis diagram

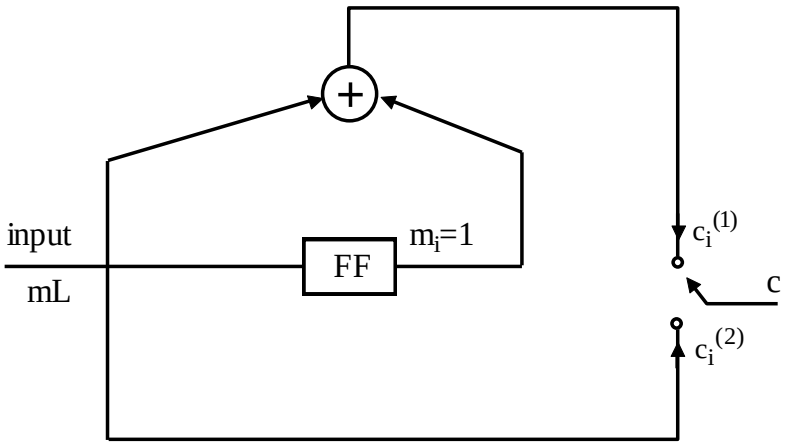


Fig. (1)

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