

ME-ICE, Part I, 1st Semester Final Semester Examination, December 12
 Paper Code: Information Theory and Coding (ICE 902)
 (Answer any Five questions)

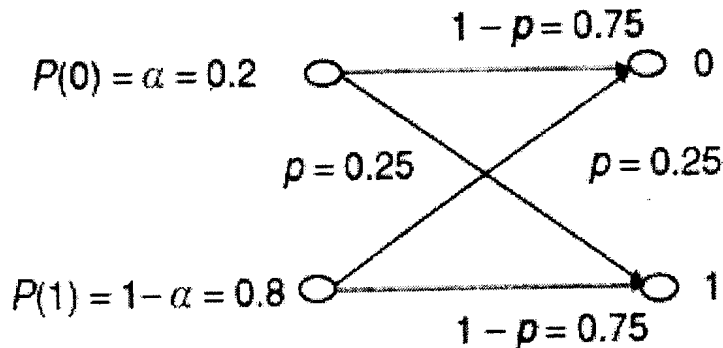
Full Marks: 70

Time: 3 Hrs.

1. (a) A source characterized in the frequency domain with a bandwidth of $W = 4000$ Hz is sampled at the Nyquist rate, generating a sequence of values taken from the range $A = \{-2, -1, 0, 1, 2\}$ with the following corresponding set of probabilities $\{1/2, 1/4, 1/8, 1/16, 1/16\}$. Calculate the source rate in bits per second. (Essential of error pg - 5).
 (b) Construct order 2 extension of the source emitting four symbols with probabilities $P(X = x_1) = 1/2, P(X = x_2) = P(X = x_3) = 1/8$ and $P(X = x_4) = 1/4$. Find entropy of the source.
 (c) Write different units to measure information and relation between them.

$$4 + 6 + 4 = 14$$

2. (a) Calculate source entropy, average mutual information and channel capacity for the following BSC

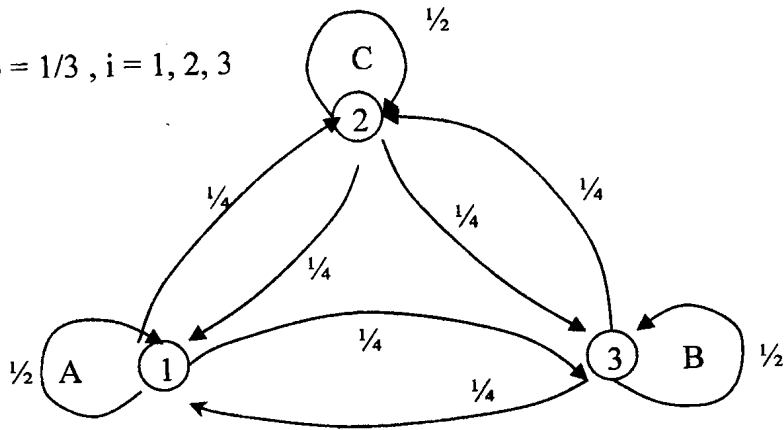


- (b) Find a priori and a posteriori entropies for the above channel.

$$8 + 6 = 14$$

3. (a) Describe channel capacity for a noiseless channel and explain channel loss diagram.
 (b) What is the maximum possible source entropy for a BSC. Justify your answer.
 (c) Find average information content per symbol in messages containing two symbols for the following Markov source.

$P(\text{State } i) = 1/3, i = 1, 2, 3$



$4 + 4 + 6 = 14$

4. (a) Find Hamming bound of a linear block code
 (b) For a (7, 4) linear block code generator matrix $G(P, I_k)$ is given as follows

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

Find the systematic form of the generator matrix, and corresponding parity check equations.

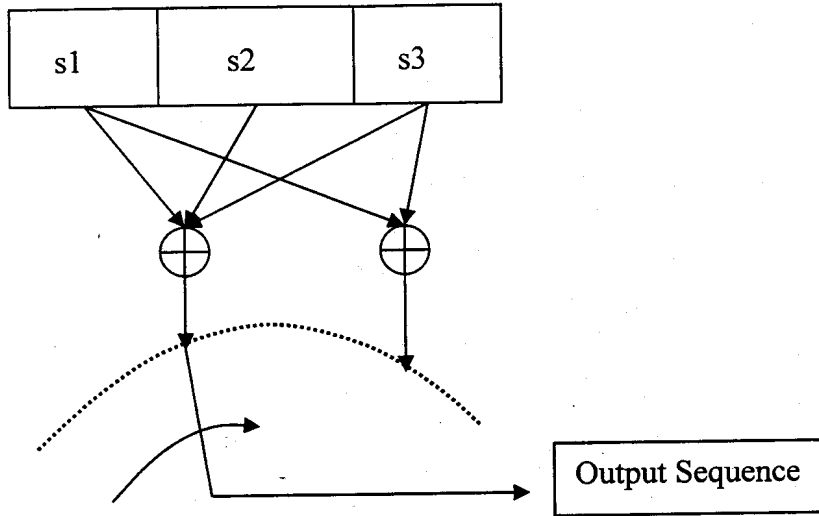
- (c) What is a perfect code?

$4 + 8 + 2 = 14$

5. (a) The generator polynomial is $g(x) = x^3 + x^2 + 1$ for the (7, 4) systematic code. Generate the code words for the (7, 4) Hamming Code. Find its code rate and design the encoder.
 (b) A file containing the two bytes $d_0 = 56 = 38_{16}$ and $d_1 = 125 = 7D_{16}$ is to be CRC encoded using the CRC-ANSI generator polynomial. Find the encoded data polynomial.

$10 + 4 = 14$

6. (a) For the following convolutional encoder, the received bits are 01 00 01
 00 10 11 11 00.
 1. Draw Trellis and state diagram
 2. Decode this sequence using Viterbi's algorithm.



(b) What is constraint length of the above convolutional encoder?

$$12(8 + 4) + 2 = 14$$

7. (a) What do you understand by narrow sense BCH code?
 (b) Find conjugacy classes in $GF(2^4)$ with respect to $GF(2)$.
 (c) Find the generator polynomial for narrow sense three error correcting BCH code in $GF(2^4)$.

$$2 + 8 + 4 = 14$$

8. (a) Design the multiplication hardware for two polynomials with high speed operation.
 (b) What is LFSR?
 (c) Perform STC for MIMO channel.

$$6 + 2 + 6 = 14$$