(vii) If there are 'M' number of equally likely messages, the entropy of the source is _____
(a) log2(M + 1) (b) log2M + 1
(c) log2(M/2) (d) log2M.

(viii) The generator polynomial g(x) of (n,k) cycle code is a factor of ____
(a) Xn + 1 (b) Xk + 1
(c) Xn-k + 1 (d) Xn+k + 1.

(ix) For a linear block code, the syndrome depends only on _____
(a) transmitted codeword (b) received message
(c) error pattern (d) hamming distance.

(x) Mutual information of the channel is
(a) H(A) + H(A/B) (b) H(A) / H(A/ B)
(c) H(A) - H(A/B) (d) H(A) . H(A/B).

Group - B

2. (a) The input source to a noisy communication channel is a random variable X over the four symbols a, b, c, d. The output from this channel is a random variable Y over these same four symbols. The joint distribution of these two random variables is as follows:

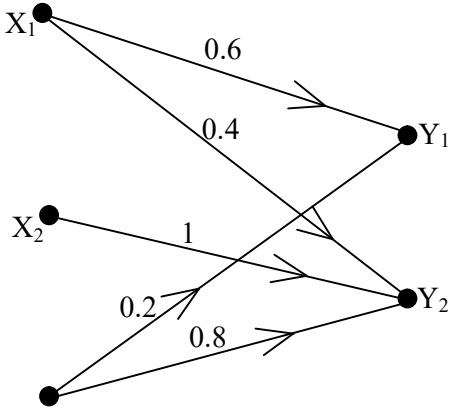
	x = a	x = b	x = c	x = d
y = a	1/8	1/16	1/16	1/4
y = b	1/16	1/8	1/16	0
y = c	1/32	1/32	1/16	0
y = d	1/32	1/32	1/16	0

(i) Write down the marginal distribution for X and compute the marginal entropy H(X) in bits.
(ii) Write down the marginal distribution for Y and compute the marginal entropy H(Y) in bits.
(iii) What is the joint entropy H(X,Y) of the two random variables in bits?
(iv) What is the conditional entropy H(Y|X) and H(X|Y)in bits?
(v) What is the mutual information I(X; Y) between the two random variables in bits?

(b) Show that I (X;Y) = H (X)+ H (Y) - H (X,Y).

(1+1+2+3 +2) + 3 = 12

3. A discrete memory less source with three symbols, with probabilities $P(X_1) = P(X_3)$ and $P(X_2) = \alpha$, feeds into discrete memory less channel shown in the figure below:



i) Determine maximum value of H(X).
ii) Determine the transition matrix for discrete memoryless channel.
iii) Determine the maximum value of entropy H(Y) at the channel output.

5 + 2 + 5 = 12

Group - C

4. (a) For a linear block code, prove with example that "All error patterns that differ by a codeword have the same syndrome".

(b) Consider a (6,3) linear block code whose generator matrix is given by

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

(i) Find the parity check matrix.
(ii) Find the minimum distance of the code.
(iii) Draw the encoder and syndrome computation circuit.

4 + (2 + 2 + 4) = 12

5. (a) Determine the encoded message for the 8-bit data codes, 0101111, using the following CRC generating polynomial g(x) = x4 + x3 + 1

(b) For a (7, 4) cyclic code with generator polynomial x3 + x2 + 1, Determine the generator matrix (G).

6 + 6 = 12

Group - D

6. (a) Prove that, a BCH code obtained by considering the first d powers of α has distance d +1.

   (b) Explain the steps for decoding BCH codes.

4 + 8 = 12

7. Find the generator polynomial g(x) for a single error correcting binary BCH code of block-length 31. Use the primitive polynomial p(x) = x5 + x2 + 1 to construct GF(32). What is the minimum distance of this code?

(5 + 5 + 2) = 12

Group - E

8. For the convolution encoder of figure 1, determine the following:
   (i) Dimension of the code
   (ii) Code rate
   (iii) Generating sequences (impulse responses)
   (iv) Output sequence for message sequence of 10011

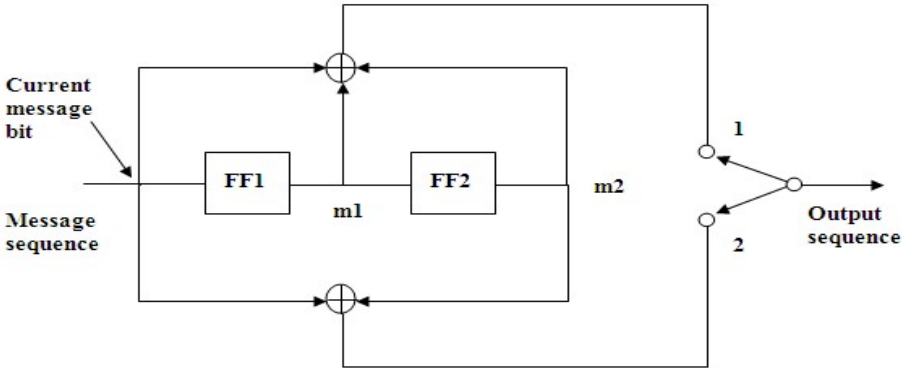


Figure 1

1 + 1 + 3 + 7 = 12

9. A rate 1/3 convolutional coder with constraint length of '3' uses the generating vectors
   $g_1 = (1\ 0\ 0)$, $g_2 = (1\ 0\ 1)$ and $g_3 = (1\ 1\ 1)$
   i) Sketch encoder configuration and prepare the logic table.
   ii) Draw the state diagram for the coder.
   iii) Determine the d_{free} distance of the coder.

(2+2) + 3+ 5 = 12

2016

INFORMATION THEORY AND CODING
(INFO 2203)

Time Allotted : 3 hrs **Full Marks :**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each gro

Candidates are required to give answer in their own words as far practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following: **10 x**

   (i) The capacity of a Binary Symmetric Channel (BSC) with cross probability 0.5 is
   (a) 1 (b) 0 (c) 2 (d) 1.5.

   (ii) A source produces 4 symbols with probability 1/2, 1/4, 1/8, 1/ this source, a practical coding scheme has an average code length of 2 bits/symbols. The efficiency of the code is
   (a) 1 (b) 7/8 (c) 1/2 (d) 1/

   (iii) Entropy of a binary source with probabilities P = {7/16, 9/16} i
   (a) 0.389 (b) 0.689 (c) 0.989 (d) 0.58

   (iv) Hamming weight of a code vector is the number of _____ compo of Codeword.
   (a) Zero (b) Non-zero
   (c) Zero and non-zero (d) None.

   (v) The mutual information (I) is always _____
   (a) 0 (b) > 0 (c) ≥ 0 (d) ≤ 0.

   (vi) A (n, k) block code consists of _____ number of check bits ad k number of information bits.
   (a) n+k (b) n (c) n/k (d) r