(vii) In minimal polynomial, _____ degree polynomial is present with coefficients in the base field along with the zeros in extension field.
(a) largest (b) constant
(c) smallest (d) unpredictable.

(viii) The Hamming distance between 1100001011 and 1001101001 is
(a) 1 (b) 5 (c) 4 (d) 3.

(ix) The minimum distance (d_{min}) of a code is 5. How many errors can it correct?
(a) 1 (b) 2 (c) 4 (d) 3.

(x) A (7, 4) linear block code has a rate of
(a) 7 (b) 1.75 (c) 4 (d) .57.

Group – B

2. (a) A Memory less source emits six messages with probabilities {0.4, 0.2, 0.2, 0.1, 0.1}. Find the Shannon – Fano – Elias code and determine efficiency and redundancy of the code.

(b) Prove that H(X, Y) = H(X|Y) + H(Y).

(c) State the Shannon's third theorem.

6 + 4 + 2 = 12

3. (a) Apply the Huffman coding for a DMS with the following source symbols and the given occurrence probabilities:

X	X_1	X_2	X_3	X_4	X_5	X_6	X_7
$P(x_i)$	0.4	0.2	0.12	0.08	0.08	0.06	0.06

(i) Draw the Huffman tree.
(ii) Calculate its efficiency.

(b) Consider a binary memoryless source X with two symbols X_1 and X_2. Prove that entropy of the source H(X) is maximum when both X_1 and X_2 are equiprobable.

(c) Show that I (X;Y) = I(Y;X) , where I() represents mutual information.

(4 + 2) + 3 + 3 = 12

Group – C

4. (a) For systematic (7, 4) cyclic code, determine the generator matrix and parity check matrix, where generator polynomial is $G(x) = p^3 + p + 1$.

(b) A generator matrix of (6, 3) linear block code is given below:

$$H = \begin{bmatrix} 100111 \\ 010110 \\ 001011 \end{bmatrix}$$

(i) Determine the d_{min} for the above code.
(ii) If the received codeword is 101101, determine the message bit sequence.

6 + (3 + 3) = 12

5. (a) The receiver use CRC for detecting errors in the received codeword, where the divisor polynomial is $x^3 + 1$. The received codeword is 1101110100101. Determine whether the received code is error free or not.

(b) The parity check matrix of a (7, 4) Hamming code is given below:

$$H = \begin{bmatrix} 1110100 \\ 0111010 \\ 1101001 \end{bmatrix}$$

Calculate the syndrome vector for single bit error.

6 + 6 = 12

Group – D

6. (a) Determine the conjugates for the field element α in GF(2^4).

(b) Find the generator polynomial g(x) for a single error correcting binary BCH code of block length 15 over GF (16). Use primitive polynomial $p(x) = x^5 + x + 1$.

4 + 8 = 12

7. (a) A codeword c(x) of the (15, 9) triple error correcting BCH code incurs errors so as to give $v(x) = x^{10} + \alpha^3 x^8 + \alpha^{11} x^7 + \alpha^8 x^6 + \alpha^6 x^5 + \alpha^4 x^4 + \alpha^5 x^2 + \alpha^9 x + \alpha^6$. Determine error location polynomial using Reed – Solomon code.

(b) Find the Minimal Polynomial for the field element α^3 in GF (2^4). Use the primitive polynomial $p(z) = z^4 + z + 1$ to construct GF(2^4).

8 + 4 = 12

Group – E

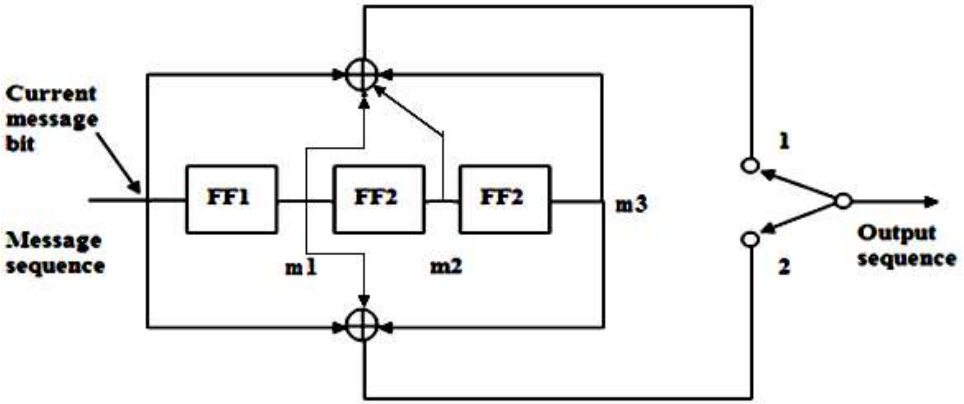
8 The following figure shows the encoder for a rate r = ½, constraint length K = 4 convolutional code.

(i) Determine the encoder output produced by the message sequence 10111……

(ii) Construct the code tree for the encoder.

(iii) Trace the path through the tree that corresponds to the message sequence 10111….

(iv) Compare the resulting encoder output with that found in part (i).



(4 + 5 + 2 + 1) = 12

9. (a) Make a comparative study between code tree and trellis diagram.

(b) Consider the (3, 1, 2) convolutional encoder with impulse response,

$g^1 = \{1\ 1\ 0\}$, $g^2 = \{1\ 0\ 1\}$, $g^3 = \{1\ 1\ 1\}$

(i) Draw the encoder block diagram.

(ii) Find the generator matrix and output code vector for input message m = {1 1 1 0 1}.

3 + (3 + 6) = 12

INFORMATION THEORY & CODING
(INFO 2203)

Time Allotted : 3 hrs **Full Marks : 70**

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 group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The value of leading coefficient of a monic polynomial is
(a) 0.5 (b) 1 (c) 4 (d) 16.

(ii) Coding efficiency for source with entropy H(S) and average length L is
(a) H(S). L (b) H(S) - L
(c) H(S) + L (d) H(S) / L.

(iii) The channel capacity is a measure of
(a) entropy rate
(b) maximum rate of information a channel can handle
(c) information contents of messages transmitted in a channel
(d) none of these.

(iv) What is the mutual information of a channel with independent inputs?
(a) Zero (b) Constant
(c) Variable (d) Infinity.

(v) The binary symbols 0 & 1 are transmitted with probabilities 1/4 & 3/4 respectively. The corresponding self informations are
(a) 2 bits & 0.415 bits (b) 0 & 1 bits
(c) 1 & 0 bits (d) 0 & 0 bits.

(vi) A voice grade telephone channel has a bandwidth of 3400Hz. If the signal to noise ratio (SNR) on the channel is 30dB, the capacity of the channel is
(a) 35.88 kbits/sec (b) 32.88 kbits/sec
(c) 34.88 kbits/sec (d) 33.88 kbits/sec.