**B.TECH/IT/4TH SEM/INFO 2203/2019**

**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 maximum number of encoder outputs that can be affected by a single input is known as

(a) constraint length (b) code length

(c) code rate (d) Hamming weight.

 (ii) Basically, Galois field consists of \_\_\_\_\_\_ number of elements

(a) finite (b) infinite

(c) both (a) and (b) (d) none of the above.

 (iii) If t is the error correction capability of BCH code, what is the minimum distance of the code?

(a) 2t (b) 2t + 1 (c) 2t-1 (d) None of these.

 (iv) For BCH code if the received vector and the computed vector are r(x) and e(x) respectively, then the error free code vector is\_\_\_\_\_\_\_\_\_\_\_.

(a) r(x) \*e(x) (b) r(x)/e(x)

(c) r(x) + e(x) (d) none of these.

 (v) The length of the output for a (2, 1, 3) convolution code for the message 1101 is

(a) 12 (b) 14 (c) 10 (d) 16.

 (vi) Entropy is \_\_\_\_\_\_\_\_\_\_

(a) an average information per message (b) the information in a signal

(c) an amplitude of signal (d) none of the above.

 (vii) An image uses 512 × 512 picture elements. Each of the picture elements can take any of the eight distinguishable intensity levels. The maximum entropy in the above image will be

(a) 2097152 bits (b) 786432 bits

(c) 648 bits (d) 144 bits.

 (viii) The capacity of Gaussian channel is

(a) C = 2B(1+S/N) bits/s (b) C = B2(1+S/N) bits/s

(c) C = B(1+S/N) bits/s (d) C = B(1+S/N)2 bits/s.

 (ix) Encoder circuit of \_\_\_\_\_\_\_\_\_\_\_ is used a linear feed-forward shift register.

(a) Huffman code (b) convolutional code

(c) block code (d) cyclic code.

 (x) If R is a codeword and H is a parity check matrix, then which of the following is true for correctly received codeword?

(a) RH = 0 (b) RHt ≠ 0 (c) RtH = 0 (d) RHt = 0.

**Group – B**

2. (a) If I(x1) is the information carried by symbol x1 and I(x2) is the information carried by message x2, then prove that the amount of information carried compositely due to x1 and x2 is I(x1,x2) = I(x1) + I(x2).

 (b) A discrete source emits one of five symbols once every millisecond with probabilities P(x1) = 1/2, P(x2) = 1/4 , P(x3) = 1/8 , P(x4) = 1/16 , P(x5) = 1/16. Determine the source entropy and information rate.

**6 + 6 = 12**

3. (a) Verify the following expressions: H(X,Y) = H(X/Y) + H(Y).

 (b) A DMS X has five symbols x1, x2, x3, x4 and x5 with P(x1) = 0.4, P(x2) = 0.19, P(x3) = 0.16, P(x4) = 0.15, P(x5) = 0.1. Construct a Huffman code for X and calculate the efficiency of the code.

**6 + 6 = 12**

**Group – C**

4. Consider a (6,3) linear block code defined by the generator matrix

$$G =\left(\begin{array}{c}1 0 0 1 1 0\\0 1 0 0 1 1\\0 0 1 1 0 1\end{array}\right)$$

(i) Find the parity check matrix (H) of the code in systematic form.

(ii) How many errors can the code detect? How many errors can the code correct?

(iii) Draw the hardware syndrome generator diagram.

(iv) Find all the code vectors.

(v) Suppose c = 1 1 1 0 0 0 is sent and r = 1 1 1 0 0 1 is received. Show how the code can correct this error.

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

5. Make a comparative study between linear block code and convolutional code.

 Consider the message sequence is 10110011101 and the divisor polynomial is x3 + x2 + 1. Find the sent codeword corresponding to the message. The error is occurred in 4th bit from LSB in sent codeword. Show that receiver can detect the error using CRC.

**[2 + (5 + 5)] = 12**

**Group – D**

6. (a) Find the conjugates for the field element αin GF (25).

 (b) Find (i) α2 + α9 (ii) α3 + α7 + α11 (iii) α13 + α2 in GF(24).

 (c) State the properties of Galois Field.

**3 + 6 + 3 = 12**

7. (a) Find the generator polynomial g(x) for a single error correcting binary BCH code of block length 31 over GF (25). Use primitive polynomial p(x) = x5 + x2 + 1.

 (b) Find the minimal polynomial for the field element α in GF (24). Use the primitive polynomial p (x) = x4 + x + 1 to construct GF (24).

**8 + 4 = 12**

**Group – E**

8. (a) Consider the (3, 1, 2) convolutional encoder with impulse response

 gi(1) = {1 1 1}, gi(2) = {1 0 1}, gi(3) = {1 1 0}

(i) Draw the encoder circuit.

(ii) Find the generator matrix and codeword for m = {11001}

(iii) Find the codeword corresponding to the message m using time domain approach.

(iv) Find the codeword corresponding to the message m using transfer domain approach.

**(2 + 3 + 4 + 3) = 12**

9. A rate 1/3 convolution encoder has generator vectors as

 gi(1) = {1 0 0}, gi(2) = {1 1 1}, gi(3) = {1 0 1}

(i) Draw the code tree and state diagram.

(ii) Draw the Trellis diagram and decode the received message r, using Viterbi algorithm, where r = {101110101010101110011}.

**6 + 6 = 12**