SIDDHARTH GROUP OF INSTITUTIONS :: PUTTUR
Siddharth Nagar, Narayanavanam Road – 517583

QUESTION BANK (DESCRIPTIVE)

Subject with Code : CODING THEORY & TECHNIQUES(16EC3810)

Course & Branch: M.Tech - DECS **Year & Sem:** I-M.Tech & II-Sem

Regulation: R16

UNIT –I

1a) Explain the concept of mathematical and logarithmic measure of information with example. [5M]

b) For a binary memory source with two symbols x_1 and x_2 , show that entropy H(X) is maximum when both x_1 and x_2 are equiprobable.What are the lower and upper bounds on H(X)? [7M]

2a) The channel transition matrix $\begin{bmatrix} 0.9 & 0.1 \\ 0.2 & 0.8 \end{bmatrix}$.Draw the channel diagram and determine the probabilities associated with outputs assuming equiprobable inputs. Also find Mutual Information I(X;Y) for the channel. [6M]

b) Explain the following:

i. Entropy [3M]

ii. Mutual Information [3M]

3a) For a discrete memoryless source with K equiprobable symbols, use of fixed length code will provide same efficiency as any other coding technique. Justify the above statement. State the condition to be satisfied by K for achieving 100% efficiency. [8M]

b) Explain about prefix coding. [4M]

4a) State and prove properties of Entropy [6M]

b) Explain about fixed length and variable length coding. [6M]

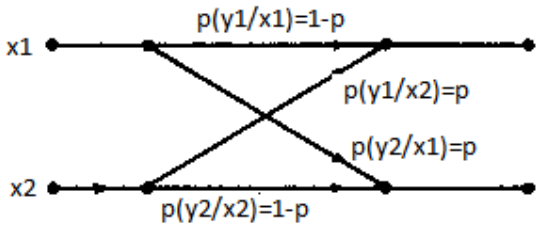
5. Consider a telegraph source having two symbols dot and dash. The dot duration is 0.2 sec; and the dash duration is 3 times of the dot duration. The probability of the dot's occurring is twice that of dash, and the time between symbols is 0.2sec. Calculate information rate of the telegraph source. [12M]

6a) Write a short note on source coding theorem. [6M]

b) Prove that H(X, Y) =H(X/Y) +H(Y)

=H(Y/X) +H(X) [6M]

7.For a binary symmetric channel shown in figure, $P(x_1)= \beta$.Show that the mutual information I(X;Y) is given by, [12M]

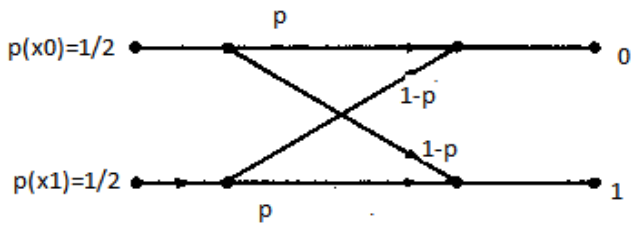


$I(X;Y)=H(Y)+P\log_2 P+(1-P)\log_2(1-P)$.Determine I(X;Y)for p=0.1,β=0.5.

8a) The channel transition matrix $\begin{bmatrix}0.2 & 0.8\\ 0.7 & 0.3\end{bmatrix}$.Draw the channel diagram and determine the probabilities associated with outputs assuming equiprobable inputs. Also find Mutual Information I(X;Y) for the channel. [7M]

b) State and prove properties of information. [5M]

9. The binary symmetric channel is shown below. Find rate of information transmission across this channel for p=0.8 and 0.6. The symbols are generated at the rate of 1000 per second. P(x0)=P(x1) =1/2.Also find channel information rate. [12M]



10a) A source emits one of four symbols S0, S1, S2 and S3 with probabilities 1/3, 1/4, 1/6 and 1/4 respectively. The successive symbols emitted by the source are stability independent. Calculate entropy of the source. [7M]

b) Explain Shannon's second fundamental theorem on coding for memory less noise channels. [5M]

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UNIT –II

1. A discrete memoryless source have five symbols x_1,x_2,x_3,x_4 and x_5 with probabilities 0.4,0.19,0.16,0.15,& 0.15 respectively attached to every symbol. Construct a Shannon-fano code for the source and calculate Code efficiency. [12M]

2a) The generator matrix for a (6,3) block code is given below.Find all code vectors of this code. [7M]

$$G=\left[\begin{array}{cccccc} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{array}\right]$$

b) Explain the concept of Syndrome decoding. [5M]

3. For a systematic linear block code, the three parity check digits C_4, C_5, C_6 are given by, [12M]

$C_4 = d1 \oplus d2 \oplus d3$

$C_5 = d1 \oplus d2$

$C_6 = d1 \oplus d3$

i) Construct generator matrix.

ii) Construct code generated by this matrix.

iii) Determine error correcting capability.

iv) Prepare a suitable decoding table.

4. A DMS has following alphabet with probability of occurrence as shown below: [12M]

Symbol	S0	S1	S2	S3	S4	S5	S6
Probability	0.125	0.0625	0.25	0.0625	0.125	0.125	0.25

Generate the Huffman code with minimum code variance. Determine code variance and code efficiency.

5a) Explain error detecting and correcting capability of Linear block codes. [6M]

b) Explain matrix description of linear block code with example. [6M]

6. The parity check matrix of a particular (7,4) linear block code is given by, [12M]

$$[H] = \begin{bmatrix} 1 & 1 & 101 & 0 & 0 \\ 1 & 1 & 010 & 1 & 0 \\ 1 & 0 & 110 & 0 & 1 \end{bmatrix}$$

i) Find generator matrix (G).

ii) List all code vectors

iii) What is the minimum distance between code vectors?

iv) How many errors can be detected? How many errors can be corrected?

7a) Compare Huffman coding and Shannon-Fano coding with an example. [7M]

b) Explain encoder implementation of linear block codes. [5M]

8. A DMS consists of three symbols x1, x2, x3 with probabilities 0.45, 0.35, 0.2 respectively. Determine the minimum variance Huffman codes for symbol by symbol occurrence. [12M]

9a) Explain the algorithm for Huffman code applied for pair of symbols. [6M]

b) Distinguish systematic and non-systematic codes. [6M]

10. Explain the following:

i) Syndrome testing [6M]

ii) Lempel-Ziv codes [6M]

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UNIT –III

1. The polynomial $g(x)= x^4+x+1$ is the generator polynomial for the (15, 11) Hamming binary code.
   (i) Determine the generator matrix of this code in systematic form. [6M]
   (ii) Determine the generator polynomial for the dual code. [6M]

2.The generator polynomial over the binary field is $g(x)= x^8+x^6+x^4+x^2+1$,
   (i) Find the lowest rate cyclic code where generator polynomial is g(x). [8M]
   (ii) What is the rate of this code? [4M]

3. Form a parity check matrix for a (15, 11) systematic Hamming code. Draw the encoding and decoding circuits. [12M]

4(a) Draw the block diagram of general type-II one step majority-logic decoder and explain it. [6M]
   (b) Determine the weight enumerator for the entenderd Hamming code of length 2^m. [6M]

5. Show that the minimum Hamming distance of a linear block code is equal to the minimum number of columns of its parity check matrix that are linearly dependent show also that the minimum Hamming distance of a Hamming code is always equal to 3. [12M]

6. The polynomial over the binary field is $g(p)= p^8+p^6+p^4+p^2+1$, [4+4+4M]
   (i) Find the lowest rate cyclic code whose generator polynomial is g(p). What is the rate of this code?
   (ii) Find the minimum distance of the code found in (a).
   (iii) What is the coding gain for the code found in (a)?

7(a) Explain applications of block codes for error control in data storage systems. [6M]
   (b) Explain encoder of (7,4) Hamming code with neat sketch. [6M]

8(a) Explain Syndrome decoding procedure for Hamming codes. [5M]
   (b) The parity check matrix of (7,4) Hamming code is expressed as,

$$[H] = \begin{pmatrix} 1 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 \end{pmatrix}$$

   Evaluate the syndrome vector for single bit errors. [7M]

9(a) Explain generalized weight emunerator with example. [7M]

(b) Write a short note on perfect codes. [5M]

10(a) Explain probability of an undetected error for linear codes over a binary symmetric channel.[6M]

(b) Explain the following: [3+3M]

i. Hamming distance

ii. Error detecting and correcting capabilities of hamming codes.

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UNIT –IV

1. Construct the decoding table for a single error (7, 4) cyclic code whose generator polynomial is

$g(x)=x^3+x^2+1$. [12M]

2. Briefly explain the following: [4+4+4M]
   (a) Structural properties of convolutional code.
   (b) Trellis diagram.
   (c) Convolutional interleaving.

3. Verify whether $g(x)= 1+x+x^2+x^3+x^4$ is a valid generator polynomial for generating a cyclic code for message [1 1 1]. [12M]

4. Consider a (3, 1, 2) convolutional code with $g^{(1)}=(011)$, $g^{(2)}=(110)$,$g^{(3)}=(101)$. [4+4+4M]
   (a) Draw the encoder block diagram.
   (b) Find the generation matrix.
   (c) Find the code-vector corresponding to the information sequence d = 10001.

5a) Draw the encoder circuit for the (7,4) cyclic code generated by $g(x)= 1+x+x^3$. [6M]

b) Explain how syndrome is computed for cyclic codes and from this how the error is detected. [6M]

6. Draw the circuit diagram for error-tapping decoder for the (15,7) cyclic code generated by $g(n)=1+x^4+x^6+x^7+x^8$ and explain it. [12M]

7a) Consider the (3, 1, 2) convolutional code with
   $g^{(1)}=(110)$,$g^{(2)}=(101)$,$g^{(3)}=(111)$
   i) Draw the encoder block diagram
   ii) Find the generator matrix.
   iii) Find code word corresponding to the information sequence u = (1 1 1 0 1) [7M]

b) Explain the decoding of convolutional codes based on maximum likelihood criteria. [5M]

8. A convolutional code is described by g_1=[I 0 I], g_2=[I I I] and g_3=[I I I]

a) Draw the encoder corresponding to this code. [4M]

b) Draw the state transition diagram for this code . [4M]

c) Draw the trellis diagram for this code. [4M]

9. A rate 1/3, K = 6 convolutional code is given by the generator polynomials.

$g(1,1)=1+x^2+x^3+x^5$

$g(1,2)=1+x+x^4+x^5$

a) Write g(1) and the matrices [Gα] and [Hα]. [4M]

b) Determine H.D and t for the code [4M]

c) Draw a possible decoder for the code, after checking if the code is majority logic decodable. [4M]

10a) Design a syndrome calculator for a (7,4) cyclic code generated by the polynomial $G(p)=p^3+p+1$.Evaluate the syndrome for Y=(1001101) [6M]

b) Write the advantages and disadvantages of i) Cyclic codes [3+3M]

ii) Convolutional codes.

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UNIT –V

1. (a) Write a stack sequential decoding algorithm for convolution codes. [6M]
   (b) Draw the code tree for (3, 1, 2) code with L = 5 and decode the sequence, r = (011,100,001,111,001, 011, 100). [6M]
2. Determine the generator polynomial of all primitive BCH codes of length 31. Use the halois field GF(2^5) generated by P(X)=1+X^2+X^5. [12M]
3. Explain in detail the Viterbi algorithm for decoding of convolutional codes with a suitable example.[12M]
4. It is directed to determine a BCH code having approximately 1000 bits in a code word with the capability of correcting errors. Find d_{min},m,r,k, the rate of the code. [12M]
5. (a) Explain error correcting procedure for BCH codes. [6M]
   (b) Explain construction of Falois Fields GF(2m). [6M]
6. Write a short note on:
   a) BCH Bounds. [6M]
   b) Iterative algorithm. [6M]
7. Construct GF(2^3) from GF(2) by using the third degree irreducible polynomial p(x)= x^3+x^2+1. [12M]
8. Consider (31,21), t ≤2 and (31, 16), t ≤ 3 BCH codes. Write the parity check matrices for the codes , and check if the codes are majority logic decodable. Find the syndrome bits in terms of error bits. [12M]
9. (a) Explain properties of Falois Fields. [6M]
   (b) Explain construction of Falois Fields GF(2m). [6M]
10. Explain the following: [4+4+4M]
    (i) Free distance and coding gain
    (ii) Metric diversion effect
    (iii) Decoding procedure for BCH codes.