Information Theory & Coding

QUESTION BANK

1. Relate the amount of information provided and probability of occurrence of events.
2. What is the channel capacity of a binary symmetric channel with error probability 0.01?
3. Define the terms coding efficiency and redundancy.
4. What is source coding? Define code length & code efficiency. Give the relation between it.
5. What is meant by stop-and-wait ARQ? Explain.
6. A discrete source emits one of five symbols once every milliseconds with probabilities 1/2, 1/4, 1/8, 1/16 and 1/16. Find the source entropy and information rate.
7. State and explain Shannon Hartley theorem.
8. Define G and H matrix and show that $G \cdot H^T = 0$.
9. Name anyone coding method used for burst error correction. Explain.
10. What is interleaving? Explain about block interleaving.

11. Consider that two sources emit messages x_1, x_2, x_3 and y_1, y_2, y_3 with the joint probabilities *p (X, Y)* as shown in the matrix form:

$$p(X,Y) = \begin{bmatrix} 3/40 & 1/40 & 1/40 \\ 1/20 & 3/20 & 1/20 \\ 1/8 & 1/8 & 3/8 \end{bmatrix}$$

(i) Calculate the entropies of X and Y.

(ii) Calculate the joint and conditional entropies, H (X,Y), H (X/Y), H(Y/X) between X and Y

(iii) Calculate the average mutual information I(X;Y).

Or

12. (a) Define (i) Discrete entropy H (X) and joint entropy H (X,Y) and
(ii) Mutual information I(X;Y).

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

13. Derive an expression for the capacity of a band-limited AWGN channel

Or

14. A BSC has the error probability p = 0.2 and the input to the channel consists of 4 equiprobable messages $x_1 = 000$; $x_2 = 001$; $x_3 = 011$; $x_4 = 111$. Calculate

    (a) p(0) and p (1) at the input;

    (b) Efficiency of the code;

    (c) Channel capacity.

15. A Memory less source emits six messages with probabilities {0.4, 0.2, 0.2, 0.1, 0.1}. Find the Shannon - Fano code and determine its efficiency.

Or

16. Construct the Huffman code with minimum code variance for the following probabilities and also determine the code variance and code efficiency:

    {0.25, 0.25. 0.125, 0.125, 0.125, 0.0625, 0.0625}

17. 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.

Or

18. A (7, 4) cyclic code has a generator polynomial: $g(X) = X^3 + X + 1$.

    (i) Draw the block diagram of encoder and syndrome calculator.

    (ii) Find generator and parity check matrices in systematic form.

19. (a) Explain the working of (2,1,3) convolutional encoder using transform domain approach.

    (b) Explain Sequential decoding.

Or

20. (a) Explain the maximum likelihood decoding and viterbi decoding algorithms of a

convolution encoder.

(b) Describe about block and Convolutional interleaving.

1. Define (i) Joint entropy; and (ii) Conditional entropy.
2. Sketch the transition diagram of a binary erasure channel and explain.
3. What are instantaneous codes?
4. Find the generator and parity check matrices of a (7, 4) cyclic code with generator polynomial $g(X) = 1 + X + X^3$.
5. What is meant by constraint length and free distance of a convolution code?
6. Define Mutual Information. Explain how it is related to entropy for a lossless channel, prove that $H(X/Y) = 0$.
7. Give the relation between channel capacity C, bandwidth W and signal to noise ratio S/N of a AWGN channel. Explain the trade-off between them.
8. Define BCH code and brief about Reed-Solomon code.
9. Explain briefly the syndrome calculation circuit for (n,k) cyclic code.
10. Briefly describe the steps of Viterbi algorithm.
11. (a) Prove that the entropy for a discrete source is maximum when the output symbols are equally probable.

    (b) Find the discrete entropy for the source with symbol probabilities

    {0.3, 0.25, 0.2, 0.15, 0.1}

Or

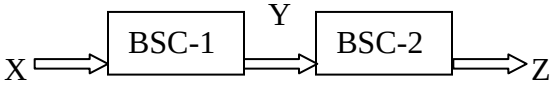
12. (a) Define mutual information I (X ; Y) and show that I (X ; Y) $\geq$ 0.

    (b) Derive the relationship between entropy and mutual information.

13. (a) From channel capacity theorem, find the capacity of a channel with infinite bandwidth and explain. (6 marks)

    (b) Two binary symmetric channel with error probability 0.1, are cascaded as shown below and P (0) = 0.25.Calculate I (X,Y)and I (X,Z).

    (6 marks)



Or

14. (a) State Shannon-Hartley theorem and from that derive Shannon's theoretical limit. (7 marks)

(b) What is meant by optimum modulation system? Explain. (5 marks)

15. (a) State and prove Kraft's inequality. (7 marks)

(b) Explain about arithmetic coding. (5 marks)

Or

16. (a)Given $x_i=\{x_1, x_2, x_3, x_4, x_5, x_6\}$with probabilities $p(x_i)= \{0.3, 0.25, 0.2, 0.12, 0.08, 0.05\}$. Make Huffman code. Find efficiency of this code. (8 marks)

(b) What is ZIP coding? Explain. (4 marks)

17. (a) Explain the encoding method of a (7, 4) linear block code.

(b) Define generator and parity check matrices of a (7, 4) linear block code. Explain how to generate a linear block code using G-matrix. Explain with an example.

Or

18. Construct a symmetric (7,4) cyclic code using the generator polynomial $g(x)= x^3+x+1$. What are the error correcting capabilities of this code? For the received word 1101100, determine the transmitted codeword.

19. Consider (3,1,2) convolutional code with g(1) = (110), g(2) = (101) and g(3) = (111):

(i) Draw the encoder block diagram.

(ii) Find the generator matrix.

(iii) Find the code word corresponding to the information sequence (11101) using time domain approach.

Or

20. Explain ARQ in detail.