VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur

Department of Information Technology

QUESTION BANK

Name of the Subject : IT2302-Information Theory and coding **Semester/Class:** V /IT-1 &2
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UNIT – 1

PART-A

1. State source coding theorem.
2. State channel capacity theorem.
3. State channel coding theorem for a discrete memory less channel.
4. What is prefix coding?
5. Define mutual information and its properties.
6. What is average information or entropy?
7. What is a relationship between uncertainty and information?
8. If X represents the outcome of a single roll of a fair die. What is the entropy of X?
9. A code is composed of dots and dashes. Assume that dashes three times longer than dot and has one third of probability of occurrence. Calculate average information in the dot-dash code.
10. Calculate entropy H(X) for a discrete memory less source X, which has four symbols X1,X2,X3 & X4 with probabilities P(X1)=0.4,P(x2)=0.3,P(X3)=0.2 and P(x4)=0.1.
11. Consider an additive white Gaussian noise channel with 4 KHz bandwidth and noise power spectral density $\eta/2=10^{-2}$ w/Hz. The signal power required at the receiver is 0.1 mw. Calculate capacity of this channel.
12. Give the kraft-Mc millan inequality for the instantaneous code.
13. Calculate the amount of information if $P_k=1/4$.
14. Define efficiency of the source encoder
15. Define rate of information transmission across the channel.
16. Define bandwidth efficiency.
17. Define code variance & code redundancy
18. Write the properties of information
19. List out the parameters to evaluate a encoder as efficient encoder.
20. What is shannon limit?

PART-B

1. State and prove the source coding theorem &State and prove the properties of mutual information

2. A discrete memory less source has an alphabet of seven symbols whose probabilities of occurrence are as described below Symbol: s0 s1 s2 s3 s4 s5 s6 and probabilities are 0.25 ,0.25, 0.0625, 0.0625 ,0.125, 0.125 ,0.125 Compute the Huffman code for this source moving combined symbols as high as possible
3. Encode the following messages with their respective probability using basic Huffman algorithm

M1	M2	M3	M4	M5	M6	M7	M8
1/2	1/8	1/8	1/16	1/16	1/16	1/32	1/32

Calculate the efficiency of coding and comment on the result.
4. Find the channel matrix of the resultant channel. Find P(z1) if P(x1)= 0.6 and P(x2)= 0.4
5. State the channel capacity theorem. Find Shannon limit for AWGN channel and explain its significance of it.
6. Consider that two sources S1 and S2 emit messages x1, x2, x3 and y1, y2, y3 with joint probability p(X,Y) as shown in the matrix form

$$\begin{matrix} 3/40 & 1/40 & 1/40 \\ 1/20 & 3/20 & 1/20 \\ 1/8 & 1/8 & 3/8 \end{matrix}$$

Calculate the entropies H(X), H(Y),H(X /Y) and H(Y/X).
7. An analog signal having 4 kHz bandwidth is sampled at 1.25 times the Nyquist rate, and each sample is quantized into one of 256 equally likely levels. Assume that the successive samples are statistically independent.
   (i) What is the information rate of this source? (6)
   (ii) Can the output of this source be transmitted without error over an AWGN channel with a bandwidth of 10 kHz and an S/N ratio of 20 dB? (5)
   (iii) Find the bandwidth required for an AWGN channel for error-free transmission of the output of this source if the S/N ratio is 25 dB. (5)
8. Write short notes on:
   (a) Binary Communication Channel
   (b) BEC
   (c) Binary symmetric channel
   (d) State and prove the Upper bound & lower bound of Entropy.
9. A discrete memory less source has 5 symbols x1, x2, x3, x4, x5 with probabilities 0.4, 0.19, 0.16, 0.15, 0.1 respectively attached to every symbol. Construct a Shannon fano code for the source and calculate code efficiency**. (or)**
   In a message , each letter occurs the following percentage of times

letter :	A	B	C	D	E	F
% of occurrence :		23	20	11	9	15	22

   1) calculate the entropy
   2) devise the code book using Huffman technique and find the average code word length
   3) devise a code book using shannon fano technique and find the average code word length

4) compare and comment on the result of both sequence.

10. Encode the following messages with their respective probability using basic Huffman algorithm

M1	M2	M3	M4	M5	M6	M7	M8
16/32	4/32	4/32	2/32	2/32	2/32	1/32	1/32

Calculate the efficiency of coding and comment on the result.

UNIT –2

PART-A

1. Give the principle behind DPCM.
2. Define statistical encoding and differential encoding
3. What is temporal masking and frequency masking?
4. What is perceptual coding? Give the advantages of perceptual coding.
5. State the advantages of coding speech at low bit rates.
6. What is dolBy AC-1? List the advantages of dolby AC-1.
7. Why subband coding is preferred for speech coding?
8. List the three features which determine the perception of a signal by the ear.
9. What is the major advantage of the adaptive Huffman coding over static Huffman coding?
10. Mention two basic properties of linear prediction.
11. What is quantization noise and on which parameter it depends?
12. Differentiate vocoder and waveform coder?
13. How dynamic Huffman coding is different than basic Huffman coding?
14. How CELP provides better quality than LPC in speech coding?
15. Why is dynamic Huffman coding employed?
16. What is the basic concept of linear coding?
17. What is the principle of adaptive Huffman coding?
18. What is the need for compression techniques?
19. Define processing delay and algorithm delay in speech coders.
20. Explain Run-length encoding.

PART-B

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1. Write short notes on: (I)Dolby AC – 1 audio coders. (II) Dolby AC – 2 audio coders (III)MPEG audio coders (IV) vocoders
2. Explain the linear predictive coding (LPC) model of analysis and synthesis of speech signal.
3. Explain in details about perceptual coding. Inconnection with perceptual coding, briefly describe the following concepts (I) frequency masking. (II) temporal masking
4. With suitable example briefly explain static Huffman coding and dynamic Huffman coding. Also compare them.

5. Explain the principles of LPC .Draw the schematic of an encoder and decoder, and identify and explain the perception parameters and associated vocal tract excitation parameters.
6. Briefly describe the procedures followed in dynamic Huffman coding.
7. List the different types of lossless and lossy data compression techniques Why lossy compression techniques are used for speech, audio, and video .justify your answer with numeric calculations.
8. Explain the basic idea of DCT- based ITU-T H.261 video coding standard with suitable encoder block diagram
9. Explain the main components of CELP coder with suitable encoder and decoder block diagram.
10. Explain dynamic Huffman coding and generate the code tree for the string 'information'.

UNIT – III

PART-A

1. Write the formula for quantization which is used in JPEG compression.
2. Define the terms 'group of pictures' and 'prediction span' with respect to video compression.
3. List the three tokens available at the output of the entropy encoder in JPEG algorithm.
4. Distinguish between global color table and local color table in GIF.
5. State the intended application of MPEG-1, MPEG-2 and MPEG-3.
6. What is Graphics Interchange Format (GIF)? Mention its main application.
7. What is the need for compression techniques? What do you mean by negative compression?
8. Write two features of TIFF format.
9. Compare JPEG and JPEG 2000 standards.
10. What is known as black-based motion compensation and motion estimation?
11. What do you understand by "GIF Interlaced mode"?
12. What is the significance of D-frames in video coding?
13. State the main application of GIF.
14. Why differential coding is carried out only for DC coefficient in JPEG?
15. Why graphical interchange format is extensively used in the internet?*
16. What is makeup code and Termination code in digitization of documents?
17. Compare MPEG1, MPEG 2, MPEG 3 and H.261.
18. Define I,P,B frames in video
19. Which mathematically algorithm used in GIF,TIFF and digitized documents formats
20. Define DCT and Quantization.

PART-B

1. Explain the encoding procedure of I,P and B frames in video coding with suitable diagrams.*
2. A) Write short notes on: (i) GIF (ii)Digitized documents(iii) CIF (iv) TIFF .

B) With the aid of a diagram, describe the interlaced mode of operation mode of operation of GIF and also describe the principles of TIFF.*

3. State and explain the encoding procedure used with the motion vector. Draw the necessary sketches.
4. With suitable block diagram, briefly explain JPEG encoder and JPEG decoder.* Investigate on the 'block preparation' and' quantization 'phases of JPEG compression process with diagrams whenever necessary.
5. With suitable block diagram ,briefly explain the implementation schematic of H.261.Also,briefly explain macro-block and frame/picture encoding formats of H.261.*(or) Explain the basic idea of DCT- based ITU-T H.261 video coding standard with suitable encoder block diagram
6. List the different types of lossless and lossy data compression techniques. (or)Why lossy compression techniques are used for speech, audio and video .justify your answer with numeric calculations.*
7. A) Explain the encoding procedure of MPEG-1 video compression with the help of block diagram.
   B) What are the special features of MPEG-4 standard?*
   C) Compare H.261 and MPEG-1 standard.*
8. (A) discuss in brief the principles of compression. (B) In the context of compression for text, image, audio and video, which of the compression techniques discussed above are suitable and why?*
9. How are the predictive coded (P) frames and bi directionally predictive coded (B) frames are used to improve compression efficiency in MPEG-1 algorithms.
10. Write short notes on: video compression principles and technique.* With the help of block diagrams explain the working MPEG algorithm for video coding and its application.*

UNIT –4

PART-A

1. What is error control code?
2. Differentiate random error and burst error.
3. What is the use of linear block code?
4. What is meant by systematic and non systematic codes?
5. Show that c={000,001,101} is not a linear code.
6. Define code efficiency.
7. What is Hamming code?
8. Check LBC (6,3) for hamming when dmin is 4.
9. Define Hamming weight and Hamming distance. Find the hamming weight of 10110 and the hamming distance between 1111 and 0000.
10. Give the error correcting capability of a linear block code.
11. Define syndrome. [Define syndrome in error correcting coding?]

12. State two properties of syndrome (used in linear block codes).
13. What is the significance of a syndrome vector in the context of error control coding?
14. List the properties and advantage of cyclic codes.
15. List the properties of Syndrome polynomial of cyclic codes.
16. Why cyclic codes are extremely well suited for the error detection?
17. How syndrome is calculated in Hamming codes and cyclic codes?
18. Why syndrome decoder is called maximum likelihood decoder?
19. Consider G= [100111; 010110; 001101], find out parity check matrix.
20. Drive the sub matrix for LBC of the given, $C_5=d_1+d_2+d_4$, $C_5=d_1+d_2+d_3$, $C_5=d_1+d_3+d_4$, $C_5=d_2+d_3+d_4$.

PART-B

1. Using suitable equations explain coding and decoding procedure in linear block codes.[Discuss in detail about linear block codes and the relation between message block, code word block and parity bit block.] [Explain the generation of a (7,4) linear block code using an example. Explain a method of decoding a linear block coded message using an example.]
2. For a (6,3) systematic linear block code, the three parity-check bits c4,c5 and c6 are formed from the following equations: c4=d1+d3, c5=d1+d2+d3, c6=d1+d2
   (i) Write down the generator matrix.
   (ii) Construct all possible generator matrix.
   (iii) Suppose that the received word is 01011. Decode this received word by finding the location of the error and the transmitted data bits.
3. A.The generator matrix for a(6,3) block code is given below. Find all the code word of this code

$$G=\begin{matrix}0&0&1&1&1&0\\0&1&0&1&0&1\\0&0&1&0&1&1\end{matrix}$$

B. Consider a (6,3) linear code whose generator matrix is

$$G=\begin{matrix}1&0&0&1&0&1\\0&1&0&1&1&0\\0&0&1&0&1&1\end{matrix}$$

(i) Find all the code vectors.
(ii) Find all hamming weights and distances.
(iii)Find minimum weight parity check matrix.
(iv)Draw the encoder circuit.

4. The SEC (7,4) Hamming code can be converted into a double error detecting and single error correcting (8,4) code by using an extra parity check .Construct the generator matrix for the code and also construct encoder and decoder for the code.
5. Consider the (7,4) Hamming code defined by the generator polynomial $g(x)=1+x+x^3$.The code word 1000101 is sent over a noisy channel, producing the received word 0000101 that has a single error. Determine the syndrome polynomial s(x) for this received word. Find its corresponding message vector m and express m in polynomial m(x).
6. Consider the (7,4) Hamming code with P =110 .Determine the code word for

   011

   111

   101

   the message 0010.Suppose the code word 1100010 is received. Determine if the code word is correct. If it is in error correct the error
7. With relevant block diagram, describe the encoder for cyclic code. Discuss the various steps involved in the procedure. What is syndrome? How does it relate to the presence/absence of error in the received code word? [Explain the encoder and syndrome calculator for an (n,k) cyclic code using block diagram.] [Explain cyclic codes with its generator polynomial and parity check polynomial.]
8. A. Let g(x) be the generator polynomial of a cyclic code C. Find a scheme for encoding the data sequence {d0,d1,……..dk-1} into an (n, k) systematic code C.

   B. Verify whether g(x)=1+x+x2+x4 is a valid generator polynomial for generating a cyclic for message (111).
9. Consider the generator of a (7,4) cyclic code by generator polynomial $g(x)=1+x+x^3$

(i) Calculate the code word for the message sequence 1001 and construct systematic generator matrix G.

(ii) Draw the diagram of encoder and syndrome calculator generated by polynomial g(x).

10. A. Consider a (7,4) cyclic code with generator polynomial $g(x)=1+x+x^3$.Let data d=(1010).Find the corresponding systematic code word.

B. Find a (7,4) systematic cyclic code for the message 1101 using a generator polynomial $1+x^2+x^3$.

C. Find the message vector corresponding to the cyclic coded vector 1101010 using a generator polynomial 1+x2+x3 .

11. Consider the (7,4) Hamming code defined by the generator polynomial g(x)=1+x2+x3.The code word 0111001 is sent over a noisy channel, producing the received word 0101001 that has a single error. Determine the syndrome polynomial s(x) for this received word, and show it is identical to the error polynomial e(x).

UNIT –5

PART-A

1. What are the differences between block and convolution codes?

2. What is a convolutional code?
3. What is meant by constraint length of a convolutional code?
4. What do you mean by code rate and constraint length in convolution code?
5. How is a convolution code different from a block code?
6. Draw a (n,k) convolution coder of constraint length 6 and rate efficiency ½.
7. Mention the graphical representation of convolutional encoder.
8. What is meant by metric and path metric?
9. What is meant by survival path?
10. What is State diagram and Trellis diagram?
11. Define Free Distance. What is relationship between coding gain and free distance?
12. What are advantages and disadvantage of convolutional Codes?
13. Draw the encoder for a rate 1/3 convolutional coder with K = 3 and the output of modulo 2 adders
14. are x1 = m+m1+m3, x2 = m+m3
15. List the advantages of Turbo codes.
16. What is Viterbi decoding?
17. Define Concatenation.
18. Define Turbo product code.
19. What is interleaver in a turbocode?
20. What is the significance of turbo coding?

PART-B

1. For a convolution encoder with constraint length 3 and code rate of 1/2, encode the message sequence (10011) and also prepare the code tree for this encoder.
2. Construct a convolution encoder for the following specification: Rate efficiency=1/2, constraint length=4.The connection from the shift registers to modulo-2 adders are described by the following equations: $g_1(x)=1+x$, $g_2(x)=x$. Determine the output codeword for the input message 1110.
3. A convolution encoder has a single shift register with 2 stages,3 modulo-2 adders and an output multiplexer. The generator sequences of the encoder are as follows $g_1(x)=(101)$and $g_2(x)=(110)$ and $g_3(x)=(111)$.Draw (i)the block diagram of the encoder,(ii) state diagram and also explain the working principle of the encoder.
4. Assume a convolution coder. Draw its tree, state and trellis diagrams. Explain viterbi algorithm taking a suitable example.
5. A convolution encoder has a single-shift register with two stages (K=3) three modulo-2 adders and an output multiplexer. The generator sequences of the encoder are as follows. $g^{(1)}=(101)$,$g^{(2)}=(110)$,$g^{(3)}=(111)$ draw the block diagram of the encoder. Find the encoder output produced by the message sequence 10111 if r=1/2.
6. A convolution encoder is defined by the following generator polynomial:

$g(x)=1+x+x^2+x^3+x^4$. $g(x)=1+x+x^3+x^4$. $g(x)=1+x^2+x^4$.

(i) What is the constraint length of this code?

(ii) How many states are in the trellis diagram of this code?
(iii)What is the code rate of this code?

7. A rate 1/3 convolution coder with constraint length of 3 uses the generating vectors g_1=(100), g_2=(101), g_3=(111).

(i) Draw the encoder configuration and give the logic table.
(ii) Draw the state diagram for the coder.
(iii)Determine the d_{new} distance of coder.

8. Consider a convolution encoder which has two paths numbered 1 and 2. The impulse response of path 1(upper path) is(111) and the impulse response of path 2(lower path) is(101).Draw the block diagram of the encoder. Compute the codeword for the message sequence 10011.Also draw the code tree, trellis diagram for the encoder.
9. Explain the principle of Turbo coding with suitable diagram.
10. Explain various methods involved in convolution decoding procedure.[For the convolution encoder arrangement shown in the following figure. Draw the state diagram and trellis diagram. Determine output digit sequence for the data digits 1 1 0 1 0 1 0 0. What are the dimension of the code (n,k) and constraint length? Use viterbi algorithm to decode the sequence 111 100 110 001 001 101 001 111

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