SUB. - CS430 INFORMATION & CODING THEORY LAB.



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING,

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QUESTIONS FOR ICT - LAB PRACTICE

1. Implement a random number generator.

Solution

2. Given a source that emits a sequence of symbols following a specific probability distribution from some finite set of alphabets, WAP that computes the self information of each symbol and the entropy of the source.

Solution

3. Write code to calculate entropy of each symbol from an input file.

Solution

- 4. WAP to check if a given code is
 - a. uniquely decodable or not
 - **b.** instantaneous or not

Solution

5. WAP to check if a given code satisfies Kraft's inequality.

Solution

- 6. WAP to implement Run length coding.
- 7. WAP to implement Huffman coding. Also compute the average code length and the efficiency of the code generated using Huffman algorithm. <u>Solution</u>
- 8. WAP to implement Arithmetic Coding.
 Solution
- **9.** WAP to implement Shannon Fano coding. Solution

10. WAP to implement Lempel Ziv Welch encoding.

Solution

11. Implement Lempel-Ziv Decoder and combine Huffman and Lempel-Ziv encoders to form a combined encoder.

Solution

12. Implement Linear Block Code Generator. Read the Generator Matrix from a file.

Solution

13. WAP to implement a syndrome-decoding scheme for (n, k) binary linear code.

Solution

14. WAP to find generator matrix G over GF(2) if the parity check matrix is given.

Solution

15. WAP to find the minimum distance of a binary linear block code for a given generator matrix for that code.

Solution

16. WAP to implement Cyclic Redundancy Check (CRC) codes.

Solution

17. WAP to implement Hamming Codes.

Solution

18. WAP to find the minimum distance of a cyclic code over GF(2) for a given generator polynomial for that code.

Solution

19. Given symbols and their probabilities, Huffman source coding was done on those symbols and code efficiency was found to be 0.977195454. Now apply Shannon-Fano source encoding and find the code-efficiency of this algorithm on the same given example. Observe the differences between the both source encoding schemes.

0.4 0.19 0.16	0.15	
	0.15	0.1

Solution

- 20. Huffman coding. Consider the random variable X = x1 x2 x3 x4 x5 x6 x7 [0.50 0.26 0.11 0.04 0.04 0.03 0.02]
 - (a) Find a binary Huffman code for X.
 - (b) Find the expected code length for this encoding.
 - (c) Extend the Binary Huffman method to Ter-nary (Alphabet of 3) and apply it for X.

Solution

- 21. WAP to calculate the minimum hamming distance, and validate that minimum hamming distance is equal to minimum hamming weight.

 (Solution same as Q15. Validation part left for the reader)
- 22. Implement randomized Shannon Fano and compare it with normal Shannon Fano.

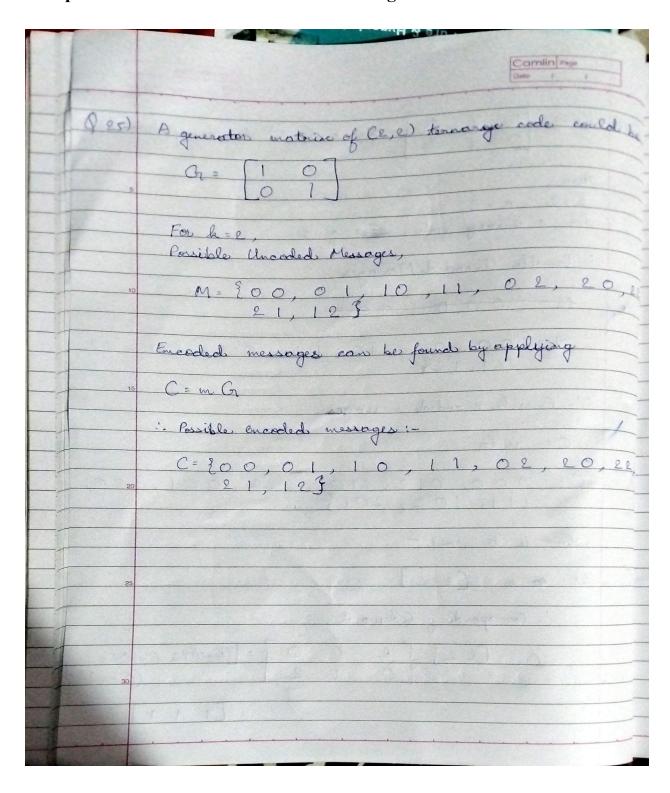
(In randomized shannon-fano, we randomize the splitting point of the probability array at each step. Rest is the same as in normal shannon-fano. The comparison part is left for the reader.)

23. Given the values of k, n and generator matrix for binary code. A bit stream input is given to the program as channel encoded data. Decode this data and obtain uncoded data.

(Same as Q13)

	Camlin Page Date 1
()-24)	G = [2 1 0] for a (2,3) ternarry coole
	Here, $k = 9$, $n = 3$ For a ternay code, $q = 3$
10	· Possible Uncoded Messages,
	$M = \{000, 01, 10, 11, 02, 20, 22, 21, 12\}$
15	Possible encoded messages, C= m Gr
	C={000,012,210,222,021,120,111,102,201}
	How is it done-
25	Let a m = [e 2]
30	:. Corresponding Codeword, C= [22] [2 1 0] = [(4+0)7.3 (2+2)7.9 0 1 2 (0+4)7.5]
	= [1 1 1]

25. Derive a generator matrix for (2, 2) ternary code, and then find all possible uncoded and the encoded messages.

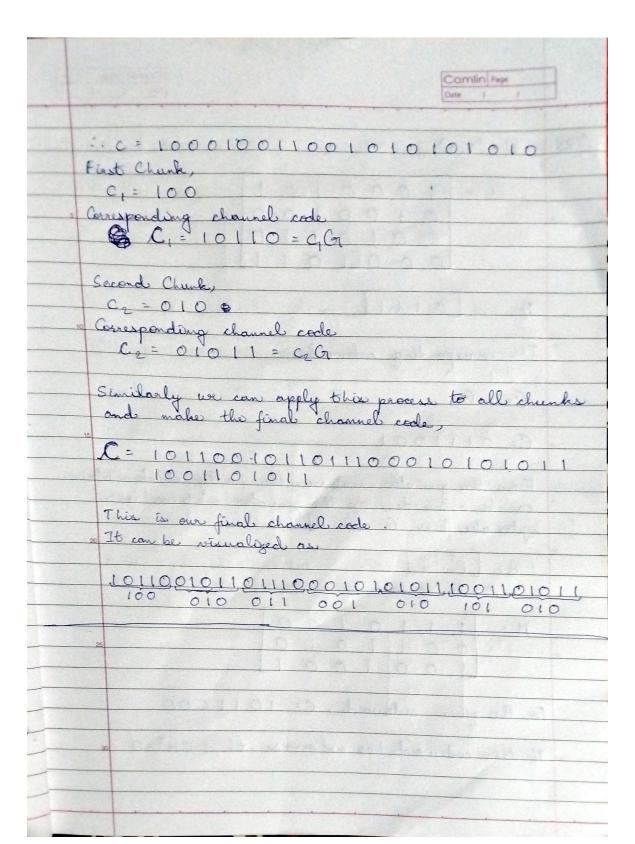


26. Let C=(2,2) be a cyclic code over F(2). Try to detect and correct single-bit errors for this code structure.

		Camlin Page Date 1 1
26)	C = (2, 2) syclic code over $F(2)For C = (2, 2), m = 2, k = 2$)
	so, the modulo polynomial is:	
	f(n) = (n2-1) = (1+nc) (1+nc).	
,	: . We have 3 choixes for g(nc),	
	grand = 1 grand = 1 grand = 1+10 grand = (1+10) ² 15 ble know, degree of grand = n-h = 2-2=0 :- ble can only choose grand = 1 20 blith grand = 1, no coding is a sign we cannot detect or correct	done.
	25	
	30	

Let C be the (5,3) linear code with generating matrix $\mathbf{G} = \begin{pmatrix} 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 \end{pmatrix}.$ Assign letters to the words in K^3 as follows: $000 \quad 100 \quad 010 \quad 001 \quad 110 \quad 101 \quad 011 \quad 111 \\ \mathbf{A} \quad \mathbf{B} \quad \mathbf{E} \quad \mathbf{H} \quad \mathbf{M} \quad \mathbf{R} \quad \mathbf{T} \quad \mathbf{W}$ Using the generating matrix \mathbf{G} , encode the message BETHERE.

1	Carriin page
027)	
	C (5,3)
0	G- (10110)
-	0 0 0 1
	n= (00101)
	n=5, k=3, q=2
10	Also, we have source encoding as:
	A > 000
	$\stackrel{R}{\longrightarrow} 100$
15	2010
	$\begin{array}{c} R \longrightarrow 001 \\ M \longrightarrow 110 \end{array}$
	R -> 101
	T -> 011
20	$W \longrightarrow 111$
	We how
+	We how, message, m = BETHERE
	So, the corresponding source code for this message
	1 de sour jon one mersage
25	C = 100010011001010101010
	For all I I I I
	For channel coded data, we have
	So, we will break this weren
30	So, we will break this message in chunks of and encode them to get the shound coded message
	y Land messo

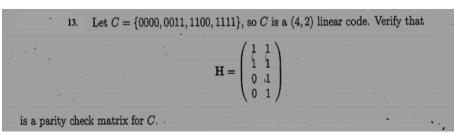


Suppose C is a (7,4) linear code with generating matrix

$$\mathbf{G} = \left(\begin{array}{cccccccc} 1 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{array}\right)$$

Calculate the codeword corresponding to the message word 0111. Which message word corresponds to the codeword 1011000?

		Camlin Page
Q	28. C= (7,4)	32032
	Gr = 1000101 0100100 0010110	
	For m = [0	6610
	The corresponding codeword,	
	Cama	23 1 1 1 2 1 1 2 1 1 2 1 1 2 1 1 2 1 1 2 1
	15 C= 0111001	
3 3	From the generation notaine, the can be obtained, as the generat systematic form, $G_1 = [I]/P]$: $H = [P^T \mid I]$	parity check in
a	H= [1 1 1 0 1 0 0] 0 0 1 1 0 1 0 1 0 0 1 0 0 1]	
	For the given codeword, C= 10	212.50
	The state of the s	211000



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Q eq)	C=20000,0011,1100,11113
	It is a (4, 2) linear code
,	Given, & H= 1100
10	If H is the correct parity check motains of C,
	CHT = O A CIEC
15	Let's check,
	CHT = 00000 11
	00011
<u> </u>	
20	Cture, we are sond considering all codewords at on instead of multiplying one by one).
- 25	CHT = [0 0] 20
	0 0 0 0 0
30	Hence, H is a correct parity check matrix for

14. Find a parity check matrix for the code $C = \{000000, 101010, 010101, 1111111\}$.

Camlin Page Date 1 1
Given,
C= 2000000, 101010, 010101, 1111111
for finding a parity check matrix, we must find a systematic generator matrix for C.
Here, nCC) = 4 = Condinality of C : k = logq(nCC))
2) k = log2 4 = 2
Also, length of each codeword in C, n=6
:. The dimensions of generator materiac are: kx n= 2x6
So, we must find 2 linearly independent codewords
Let's choose, C1=101010, C2=010101 This choice is made because its makes our generators matrix les systematic
G= 10:10 10 L0 1 0 1 0 1 I P
10, corresponding parity cheek materiae is: H= [P ^T I]= 0 1 0 0 0 0 1 0 0 0 10 D 1 0 0 0 1