S J P N Trust's

Hirasugar Institute of Technology, Nidasoshi.

Inculcating Values, Promoting Prosperity

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E&C Engg. Dept.
Exam.
Internal Assessment
Odd Sem(2017-18)

THIRD INTERNAL ASSESSMENT

Sem :V
Date:19/11/2017

Sub: Information Theory and Coding
Time:3:00pm-4:0pm

Sub. Code: 15EC54
Max. Marks: 25

Note: Answer two full questions, draw sketches wherever necessary.

Q. No		Discription of Question	Marks	CO
1	a	Explain the need of parity or redundant bits in the data communication. Explain types of error detection and correction methods.	4	CO304. 4
	b	Consider a (6, 3) LBC with generator matrix : Find (i) All codewords (ii) All Hamming weights (iii) d_{min} & w_{min} (iv) PCM and (v) Draw encoder circuit diagram $G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$	8	CO304. 4
OR				
2	a	Explain the syndrome calculator and error detection with the help of neat circuit diagram	4	CO304. 4
	b	What is standard array? Explain the construction of standard array. Construct the standard array for (6, 3) LBC with parity matrix $P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ and decoder circuit.	8	CO304. 4
3	a	Discuss the properties of PTM, JPM, and I(X, Y)	6	CO304. 3
	b	For the joint probability matrix: Find (i) H(X) (ii) H(Y) (iii) H(X, Y) (iv) H(X/Y), and (v) H(Y/X). $JPM = P(X,Y) = \begin{bmatrix} 0.15 & 0 & 0 & 0.10 \\ 0.05 & 0.10 & 0.10 & 0.05 \\ 0 & 0 & 0.10 & 0.05 \\ 0.10 & 0.10 & 0 & 0.10 \end{bmatrix}$	7	CO304. 3
OR				
4	a	Explain important communication Channels with suitable channel diagram and their channel capacities.	5	CO304. 3
	b	Find the capacity of channel using Muroga's theorem: $P(\frac{Y}{X}) = \begin{bmatrix} 0.2 & 0.5 & 0.3 \\ 0.2 & 0.6 & 0.2 \\ 0.1 & 0.1 & 0.8 \end{bmatrix}$	8	CO304. 3

Course Coordinator　　　　Module Coordinator　　　　HOD

- IA SCHEME OF EVALUATION

Sem : V	Subject : Information Theory & Coding	Sub Code : 15EC54	Date : 14/11/17

Q. No.	Bit	Description	Marks	Mapped CO's
2	a)	Syndrome calculator (for LBC)	04	CO304.5, 6.

Consider a received vector

$r = (r_0, r_1 \ldots r_{n-1})$ and Syndrome $S = (S_0, S_1 \ldots S_{n-k-1})$ $\quad n-k-1 = q-1$

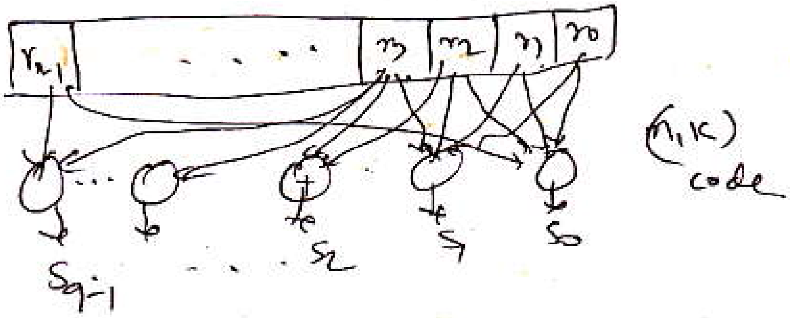
$$S = rH^T = [r_0 \; r_1 \; r_2 \ldots r_{n-1}] \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1n-k} \\ P_{21} & P_{22} & \cdots & P_{2n-k} \\ P_{k1} & P_{k2} & \cdots & P_{kn-k} \\ 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & & & \\ 0 & \cdots & \cdots & 1 \end{bmatrix}$$

$S_0 = r_0 P_{11} + r_1 P_{21} + \cdots + r_{k-1} P_{k1} + r_k$

$S_1 = r_0 P_{12} + r_1 P_{22} + \cdots + r_{k-1} P_{k2} + r_{k+1}$

$\vdots$

$S_{n-k-1} = r_0 P_{k1} + r_1 P_{k2} + \cdots + r_{k-1} P_{kn-k} + r_{n-1}$



(b) Formation of cosets & standard array

A set of 2^n received vectors will be grouped into 2^k distinct sets with a valid codeword heading each set. First the set in which the received vector r resides has to be identified and the decoded vector will simply heading the set.

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Q. No.	Bit	Description	Marks	Mapped CO's
1	(a)	→ parity bits are required for error detection and correction → These bits are inserted at Tx-end & reused for calculation at Rx end. Types of error detection & correction: → FEC: Correcting at Rx itself → Backward correction or ARQ code: Requesting txr for retransmission	04	Co 304.5, 304.6
	(b)	$G = \begin{bmatrix} 1&0&0&1&1&0 \\ 0&1&0&1&1&1 \\ 0&0&1&1&0&1 \end{bmatrix} \Rightarrow P = \begin{bmatrix} 1&1&0 \\ 1&1&1 \\ 1&0&1 \end{bmatrix}$ All code words: $C = M \cdot P$ $m = [m_3\ m_2\ m_1]$ $\Rightarrow c_3 = m_1 + m_2 + m_3$ $c_2 = m_3 + m_2$ $c_1 = m_2 + m_1$	08	CO304.6

m_3	m_2	m_1	c_3	c_2	c_1		HW
0	0	0	0	0	0	→	0
0	0	1	1	0	1	→	3
0	1	0	1	1	1	→	4
0	1	1	0	1	0	→	3
1	0	0	1	1	0	→	3
1	0	1	0	1	1	→	4
1	1	0	0	0	1	→	3
1	1	1	1	0	0	→	4

$W_{min} = 3$

$\therefore d_{min} = 3$

$H = [P^T\ I_q] = \begin{bmatrix} 1&1&1&1&0&0 \\ 1&1&0&0&1&0 \\ 0&1&1&0&0&1 \end{bmatrix}$

- IA SCHEME OF EVALUATION

Sem :		Subject :	Sub Code :	Date :	
Q. No.	Bit	Description		Marks	Mapped CO's
		$I(X,Y)$ $\rightarrow I(X,Y) = I(Y,X)$ $\rightarrow I(X,Y) \geq 0$ $\rightarrow I(X,Y) = H(X) + H(Y) - H(X,Y)$ $\rightarrow I(X,Y) = H(Y) - H(Y/X) = H(X) - H(X/Y)$ $\rightarrow I(X,Y) = H(X) + H(Y) - H(X,Y)$			
8	(b)	$P(X) = (0.25, 0.3, 0.15, 0.3)$ $P(Y) = (0.3, 0.2, 0.2, 0.3)$ $H(Y) = ~~1.743~~ \; 1.971$ $H(X) = 0.25 \log_2 \frac{1}{0.25} + (0.3 \log \frac{1}{0.3}) \times 2 + 0.15 \log_2 \frac{1}{0.15}$ $0.5 + 1.042 + 0.41 = 1.952$ $H(X,Y) = 0.15 \log \frac{1}{0.15} + 0.1 \log \frac{1}{0.1} \times 7 + 0.05 \log \frac{1}{0.05} \times 3$ $= 0.41 + 2.325 + 0.648$ $= 3.383$ $H(Y/X) = 3.383 - 1.952 = 1.431$ $H(X/Y) = 3.383 - 1.971 = 1.412$			

- IA SCHEME OF EVALUATION

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Q. No.	Bit	Description		Marks	Mapped CO's

2 (b)

contd:

1) First row entries of the array will be the subgroup C
2) remaining will be calculated as follow

Coset leader

$v_1 \quad v_2 \quad v_3 \quad \ldots \quad v_{2^k}$

$e_2 \quad v_2+e_2 \quad v_3+e_2 \quad \ldots \quad v_{2^k}+e_2$

⋮

$e_{2^{n-k}} \quad v_2+e_{2^{n-k}} \quad v_3+e_{2^{n-k}} \quad \ldots \quad v_{2^k}+e_{2^{n-k}}$

Syndrome coset leader

Syndrome	Coset leader							
000	000000	001111	010011	011100	100101	101010	110110	111001
101	100000	101111	110011	111100	000101	001010	010110	011001
011	010000							
111	001000							
100	000100							
010	000010							
001	000001							
110	110000							

3 a

Properties of PTM
→ row total gives p(x), col total p(y)
→ row total is unity

JPM: Total probs (all elements 1) p(x) & p(y)

- IA SCHEME OF EVALUATION

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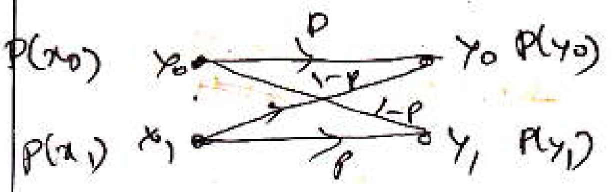
Q. No.	Bit	Description	Marks	Mapped CO's

4 (a) Important communication channels:

1) BSC

2) BEC

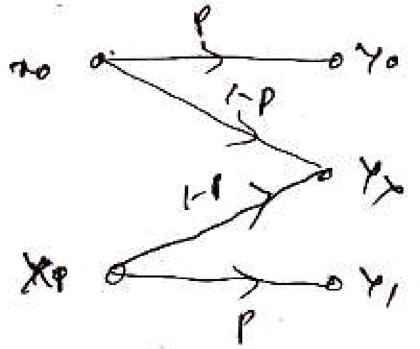
Binary Symmetric channel



⇒ straight paths when no error

⇒ cross paths when error occur

BEC: Binary erasure channel



? when there is error, no decision

b)

$$p(Y/X) = \begin{bmatrix} 0.2 & 0.5 & 0.3 \\ 0.2 & 0.6 & 0.2 \\ 0.1 & 0.1 & 0.8 \end{bmatrix}$$

$$\begin{bmatrix} 0.2 & 0.5 & 0.3 \\ 0.2 & 0.6 & 0.2 \\ 0.1 & 0.1 & 0.8 \end{bmatrix} \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \end{bmatrix} = \begin{bmatrix} 0.2\log_2 0.2 + 0.5\log_2 0.5 + 0.3\log_2 0.3 \\ 0.2\log_2 0.2 + 0.6\log_2 0.6 + 0.2\log_2 0.2 \\ 0.1\log 0.1 + 0.1\log 0.1 + 0.8\log 0.8 \end{bmatrix}$$

$-0.464 \quad -0.5 \quad -0.521$

-0.442

$-0.332 \quad -0.332 \quad -0.252$

P. T. O

- IA SCHEME OF EVALUATION

Sem : V	Subject : Info theory & coding		Sub Code : 15EC54	Date : 17/4/17
Q. No.	Bit	Description	Marks	Mapped CO's
4	(b)	Contd $0.2Q_1 + 0.5Q_2 + 0.3Q_3 = -1.685$ $0.2Q_1 + 0.6Q_2 + 0.2Q_3 = -1.771$ $0.1Q_1 + 0.1Q_2 + 0.8Q_3 = -0.521$ $Q_1 = -10.215$, $Q_2 = 1.125$, $Q_3 = -0.015$, $C = 3.03$ $-0.1Q_2 + 0.1Q_3 = -0.114$ $(Q_2 - Q_3) = 1.14$		