modified

CBCS SCHEME

USN | | | | | | | | | | | **17EC54**

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Suppose you are planning a trip to Miami, Florida from Minneapolis in the winter time. You are receiving the following information from Miami Weather bureau:
(i) Mild and Sunny day (ii) Cold day (iii) Possible snow flurries
Explain the amount of information content in each statement. **(06 Marks)**

b. The output of an information source consists of 128 symbols, 16 of which occurs with probability of $\frac{1}{32}$ and the remaining 112 occurs with probability of $\frac{1}{224}$. The source emits 1000 symbols/sec. Assuming that the symbols are chosen independently. Find the Average Information Rate of this source. **(06 Marks)**

c. The state diagram of a stationary Mark off Source is shown in Fig.Q1(c):
(i) Find the entropy of each state
(ii) Find the entropy of the source
(iii) Find G_1 and G_2 and verify that $G_1 \geq G_2 \geq H$.
Assume $P(1) = P(2) = P(3) = \frac{1}{3}$

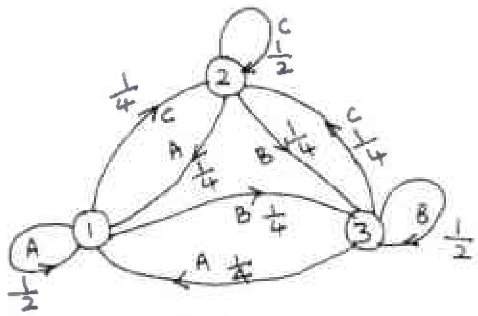

Fig.Q1(c) **(08 Marks)**

OR

2 a. What is self information? Mentions its various measuring units and also mentions the reasons for choosing logarithmic function. **(06 Marks)**

b. A binary source is emitting an independent sequence of 0's 1's with probabilities of P and 1 – P respectively. Plot the entropy of this source versus probability. **(06 Marks)**

c. For the first order Markov statistical model as shown in Fig.Q2(c).
(i) Find the probability of each state (ii) Find H(s) and $H(s^{-2})$

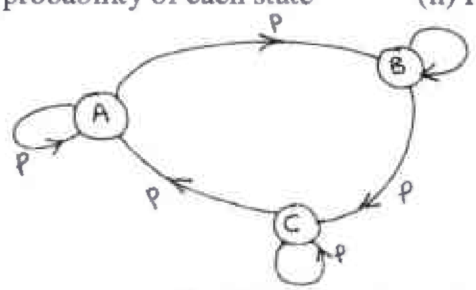

Fig.Q2(c) where A, B, and C are the states. **(08 Marks)**

Module-2

3 a. Identify whether the codes shown in Table.Q3(a) are instantaneous. Justify your answer.

Symbols	Code A	Code B	Code C
S_1	00	1	0
S_2	01	01	100
S_3	10	001	101
S_4	11	00	111

Table.Q3(a) **(06 Marks)**

b. Consider a Discrete Memory Source (DMS) with S = {X, Y, Z} with P = {0.6, 0.2, 0.2}. Find the code word for the message "YXZXY" using Arithmetic code. **(06 Marks)**

c. An information source produces a sequence of independent symbols having the following probabilities. More composite symbol as slow as possible.

Symbol	A	B	C	D	E	F	G
Probabilities	$\frac{1}{3}$	$\frac{1}{27}$	$\frac{1}{3}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{27}$	$\frac{1}{27}$

Construct Binary Huffman encoding and find its efficiency. **(08 Marks)**

OR

4 a. Write the Shannon's Encoding Algorithms. **(06 Marks)**

b. Consider the following source with probabilities:

S = {A, B, C, D, E, F} P = {0.4, 0.2, 0.2, 0.1, 0.08, 0.02}

Find the code words using Shannon-Fano algorithm and also find its efficiency. **(06 Marks)**

c. Consider the following discrete memoryless source:

$S = \{S_0, S_1, S_2, S_3, S_4\}$ P = {0.55, 0.15, 0.15, 0.1, 0.05}

Compute Huffman code by placing composite symbol as high as possible. Also find average code word length and variance of the code word. **(08 Marks)**

Module-3

5 a. What is Joint Probability Matrix? How it is obtained from Channel Matrix and also mention properties of JPM. **(06 Marks)**

b. For the communication channel shown in Fig.Q5(b), determine Mutual Information and Information Rate if $r_s = 1000$ symbols/sec. Assume $P(X_1) = 0.6$ and $P(X_2) = 0.4$.

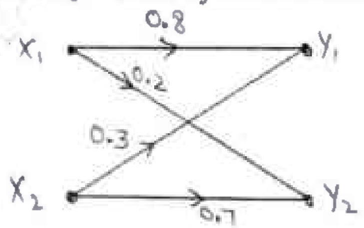

Fig.Q5(b)

(06 Marks)

c. Discuss the Binary Erasure Channel and also prove that the capacity a Binary Erasure Channel is $C = \overline{P} \cdot r_s$ bits/sec. **(08 Marks)**

OR

6 a. What is Mutual Information? Mention its properties. **(06 Marks)**

b. The noise characteristics of a channel shown in Fig.Q6(b). Find the capacity of a channel if $r_s = 2000$ symbols/sec using Muroga's method.

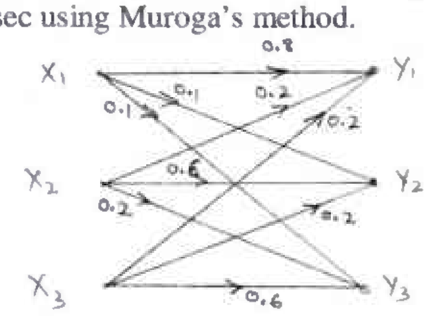

Fig.Q6(b)

(06 Marks)

c. State and prove the Shannon-Hartley Law. **(08 Marks)**

Module-4

7 a. What are the advantages and disadvantages of Error Control Coding? Discuss the methods of controlling Errors. **(06 Marks)**

b. The parity check bits of a (7, 4) Hamming code are generated by

$$C_5 = d_1 + d_3 + d_4$$

$$C_6 = d_1 + d_2 + d_3$$

$$C_7 = d_2 + d_3 + d_4$$

where d_1, d_2, d_3 and d_4 are the message bits.

(i) Find G and H for this code.

(ii) Prove that $GH^T = 0$. **(06 Marks)**

c. Design a syndrome calculating circuit for a (7, 4) cyclic code with $g(X) = 1 + X + X^3$ and also calculate the syndrome of the received vector R = 1110101. **(08 Marks)**

OR

8 a. For a systematic (6, 3) linear block code, the Parity Matrix P is given by

$$[P] = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

(i) Find all possible code words.

(ii) Find error detecting and correcting capability. **(06 Marks)**

b. A (7, 4) cyclic code has the generator polynomial $g(X) = 1 + X + X^3$. Find the code vector both in systematic and non-systematic form for the message bits (1101). **(06 Marks)**

c. Draw the Encoder circuit of a cyclic code using (n – K) bit shift Registers and explain it. **(08 Marks)**

Module-5

9 a. Consider (3, 1, 2) Convolution Encoder with $g^{(1)} = 110$, $g^{(2)} = 101$ and $g^{(3)} = 111$.

(i) Draw the encoder diagram.

(ii) Find the code word for the message sequence (11101) using generator Matrix and Transform domain approach. **(16 Marks)**

b. Discuss the BCH codes. **(04 Marks)**

OR

10 a. Consider the convolution encoder shown in Fig.Q10(a).

(i) Write the impulse response and its polynomial.

(ii) Find the output corresponding to input message (10111) using time and transform domain approach.

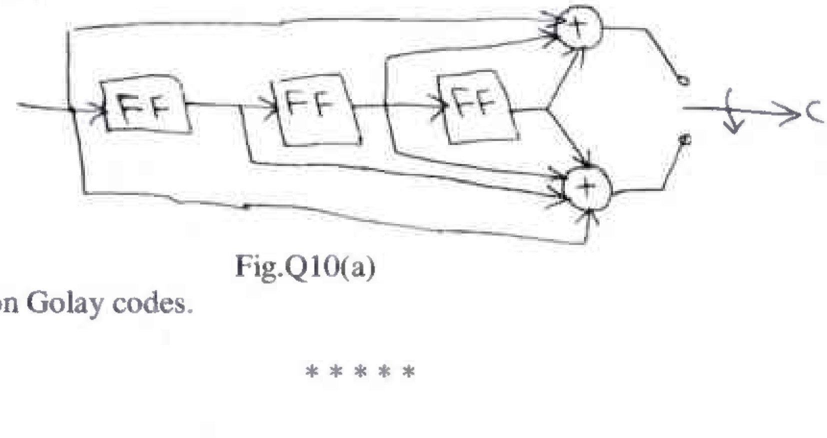

Fig.Q10(a) **(16 Marks)**

b. Write a note on Golay codes. **(04 Marks)**

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Question Number	Solution $P-1 \mid 7$	Marks Allocated
1 a)	(i) Contains very little / or no information, since the weather in Miami is mild and sunny most of the time	2M
	(ii) cold day contains more information, since it is not an event that occurs often.	2M
	(iii) snow flurries convey even more information since the occurrence of snow in Miami is a rare event	2M (6M)
b)	$H(S) = \sum_{i=1}^{n} P_i \log \frac{1}{P_i} = 16 \times \frac{1}{32} \log_2 32 + 112 \times \frac{1}{224} \log 224$	3M
	$\boxed{H(S) = 6.4036}$ bits/sym	
	$R_s = H(S)\, r_s = 6.4036 \times 1000 = 6403.67$ bits/sec	3M (6M)
c)	(i) $H_i = \sum_{j=1}^{n} P_{ij} \log \frac{1}{P_{ij}}$	
	$H_1 = H_2 = H_3 = \boxed{1.5}$ bits / message symbol	2M
	(ii) $H = P_1 H_1 + P_2 H_2 + P_3 H_3 = \left(\frac{1}{3} \times 1.5\right) \times 3 = \boxed{1.5}$ bit/ms	1M
	(iii) Construct tree for state 1, 2 & 3	2M
	Find G_1: $P(A) = \frac{1}{3}$, $P(B) = \frac{1}{3}$, $P(C) = \frac{1}{3}$	
	$G_1 \; H(\bar{S}) = 3 \times \frac{1}{3} \log_2 3 = \boxed{1.585}$ bit / ms	1M (8M)
	Find G_2:	
	$P(AA) = \frac{1}{6}$, $P(AC) = \frac{1}{12}$, $P(AB) = \frac{1}{12}$, $P(CA) = \frac{1}{12}$	
	$P(CC) = \frac{1}{6}$, $P(CB) = \frac{1}{12}$, $P(BA) = \frac{1}{12}$, $P(BC) = \frac{1}{12}$, $P(BB) = \frac{1}{6}$	2M
	$G_2 = \frac{1}{2}\left[3 \times \frac{1}{6} \log_2 6 + 6 \times \frac{1}{12} \log 12\right] = \boxed{1.5425}$ bit/ms	
	$\therefore \boxed{G_1 \geq G_2 \geq H}$	2M
2 a)	$I_K = \log \frac{1}{P_K}$	
	where P_K - probability occurrence of K^{th} symbol	2M
	$\log_2 \rightarrow$ Bits, $\log_{10} \rightarrow$ Hartley, $\log_e \rightarrow$ NATS	2M (6M)
	Reasons: (1) I_K - Non-negative	
	(2) Lowest possible I_K is zero, which occurs for sure event	2M
	(3) More information is ...	

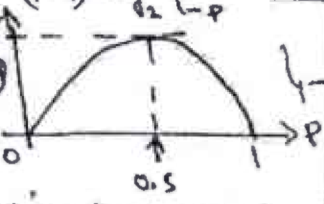
Subject Title: ITC Subject Code: 17EC54

Question Number	Solution P-2 / 7	Marks Allocated

b) $\sum_{i=1}^{q} P_i \log \frac{1}{P_i} = P \log \frac{1}{P} + (1-P)\log_2 \frac{1}{1-P}$ — 2M

P	0	0.2	0.4	0.5	0.6	0.8	1
H	0	0.721	0.97	1	0.97	0.721	0

— 2M



— 2M (6M)

c) (i) $P(A) = P\,P(A) + P\,P(C)$ —(1)
$P(B) = P\,P(B) + P\,P(A)$ —(2)
$P(C) = P\,P(C) + P\,P(B)$ —(3)
using (3) & solving $\boxed{P = \frac{1}{2}}$ — 2M

$\therefore \boxed{P(A) = P(B) = P(C) = \frac{1}{3}}$ — 2M

(ii) $H(A) = H(B) = H(C) = $ bits/m.s

$H(S) = P(A)H(A) + P(B)H(B) + P(C)H(B) = 1$ bit/m.s — 4M

$H(S^2) = 2H(S) = 2$ bits/m.s

(8M)

3 a) Code A: Is instantaneous

$\therefore \sum_{i=1}^{4} r^{-l_i} = 2^{-2} + 2^{-2} + 2^{-2} + 2^{-2} \le 1 \Rightarrow$ Satisfy Kraft McMillan inequality — 2M

Code B: Not instantaneous

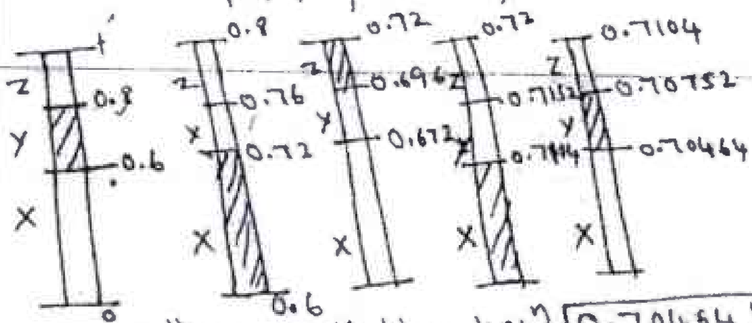
$\therefore \sum_{i=1}^{q} r^{-l_i} = 2^{-1} + 2^{-2} + 2^{-3} + 2^{-2} > 1 \Rightarrow$ Not Satisfy KMI — 2M

Code C: Instantaneous

$\therefore \sum_{i=1}^{q} r^{-l_i} = 2^{-1} + 2^{-3} + 2^{-3} + 2^{-3} < 1 \Rightarrow$ Satisfy the KMI — 2M

(6M)

b) Given $S = \{X, Y, Z\}$ & $P = \{0.6, 0.2, 0.2\}$



— 6M

Code for "YXZXY" lie betn $\boxed{0.70464 \text{ to } 0.70752}$

c)

Code	Sym	Prob					
1	A	1/3	1/3	1/3	1/3	1/3	2/3 0
00	C	1/3	1/3	1/3	1/3	1/3 00	1/3 1
011	D	1/9	1/9	1/9	2/9 010	1/3 01	
0100	E	1/9	1/9	1/9 0100	1/9 011		
01011	B	1/27	2/27 01010	1/9 0101			
010100	F	1/27 010100	1/27 01011				
010101	G	1/27 010101					

— 5M

$L = 2.4074$ bits/sym
$H(S) = 2.289$ bits/sym — 2M

$\eta_c = \frac{H(S)}{L} \times 100 = 95.09\%$ — 1M

(8M)

Subject Title : ITC **Subject Code :** 17EC54

Question Number	Solution	Marks Allocated
4 a)	- List the source symbol in the decreasing order of prob - Compute the sequence α_i - Determine the smallest integer value l_i i.e. $2^{l_i} \geq \frac{1}{p_i}$ - Expand α_i in binary form upto l_i places - Remove the binary point to get the desired code	6M
b)	Sym, P, stages, Code: A: $\boxed{0.4}$ 0, $\boxed{0.4}$ 0 — 00 B: $\boxed{0.2}$ 0, $\boxed{0.2}$ 1 — 01 C: $\boxed{0.2}$ 1, $\boxed{0.2}$ 0 — 10 D: $\boxed{0.1}$ 1, $\boxed{0.1}$ 1, $\boxed{0.1}$ 0 — 110 E: $\boxed{0.08}$ 1, $\boxed{0.08}$ 1, $\boxed{0.08}$ 1, $\boxed{0.08}$ 0 — 1110 F: $\boxed{0.02}$ 1, $\boxed{0.02}$ 1, $\boxed{0.02}$ 1, $\boxed{0.02}$ 1 — 1111	3M 1M
	$L = 2.3$ bits/m.s, $H(S) = 2.194$ bits/m.s $\eta_c = \frac{H(S)}{L} \times 100 = 95.39\%$	2M
c)	code, sym, prob: 0, S_0, 0.55 — 0.55 — 0.55 — 0.55 0 100, S_1, 0.15 → 0.15 (11) → 0.3 (10) → 0.45 1 101, S_2, 0.15 → 0.15 (100) → 0.15 (11) 110, S_3, 0.1 (110) → 0.15 (101) 111, S_4, 0.05 (111)	5M
	$L = 1.9$ bits/m.s & $Var(l_i) = \sum_{i=1}^{q} (l_i - L)^2 = 0.99$	3M
5 a)	$P(X_i, Y_j) = P(Y_j \mid X_i)\, P(X_i) = P(X_i \mid Y_j)\, P(Y_j)$	2M
	Which is obtained by multiply all the elements of 1^{st} row of channel matrix by $P(X_1)$, 2^{nd} row by $P(X_2)$ ---- and n^{th} row by $P(X_n)$ i.e. $P(Y_j \mid X_i) = \begin{bmatrix} P(Y_1\mid X_1) & P(Y_2\mid X_1) & \cdots & P(Y_m\mid X_1) \\ P(Y_1\mid X_2) & P(Y_2\mid X_2) & \cdots & P(Y_m\mid X_2) \\ \vdots & \vdots & & \vdots \\ P(Y_1\mid X_n) & P(Y_2\mid X_n) & \cdots & P(Y_m\mid X_n) \end{bmatrix}$	

Subject Title : ITC Subject Code : 17EC54

Question Number	Solution $P-4/7$	Marks Allocated

1

$$P(y_j|x_i)\,P(x_i) = \begin{bmatrix} P(y_1|x_1)P(x_1) & P(y_2|x_1)P(x_1) & \cdots & P(y_m|x_1)P(x_1) \\ P(y_1|x_2)P(x_2) & P(y_2|x_2)P(x_2) & \cdots & P(y_m|x_2)P(x_2) \\ \vdots & \vdots & & \\ P(y_1|x_n)P(x_n) & P(y_2|x_n)P(x_n) & \cdots & P(y_m|x_n)P(x_n) \end{bmatrix}$$ — 2M

Property ① Add column wise of JPM to get the probability of o/p symbols
② Add row wise of JPM to get the prob. of $P(x_i)$
③ Sum of all elements of JPM = 1 — 2M

b) $P(Y|X) = \begin{bmatrix} 0.8 & 0.2 \\ 0.3 & 0.7 \end{bmatrix} \Rightarrow P(X,Y) = \begin{bmatrix} 0.48 & 0.12 \\ 0.12 & 0.28 \end{bmatrix}$ — 1M

$P(X) = [0.6, 0.4]$ $P(Y) = [0.6, 0.4]$

$H(Y) = 0.6 \log_2 \frac{1}{0.6} + 0.4 \log_2 \frac{1}{0.4} = 0.9709$ bits/sym

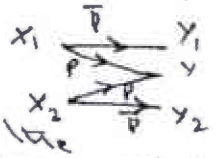
$H(Y/X) = \sum\sum P(x_i, y_j) \log \frac{1}{P(y_j/x_i)} = 0.7855$ bits/sym — 1M

$I(X,Y) = H(Y) - H(Y/X) = 0.1854$ bits/sym — 2M

$R_t = \{I(X,Y)\} r_s = 0.1854 \times 1000 = 185.4$ bits/sec — 2M

(6M)

c) Whenever error occurs, sym y will be received and no decision will be made about the information, but an immediate request will be made (ie ARQ) through a reverse channel for retransmission of the transmitted signal till a correct signal is received. This ensure 100% correct data recovery. — 2M



$P(Y/X) = \begin{bmatrix} \bar{p} & p & 0 \\ 0 & p & \bar{p} \end{bmatrix} \Rightarrow P(X,Y) = \begin{bmatrix} \bar{p}w & pw & 0 \\ 0 & p\bar{w} & \bar{p}\bar{w} \end{bmatrix}$

$P(x_1 = 0) = w$ & $P(x_2 = 1) = \bar{w}$, but $w + \bar{w} = 1$ & $p + \bar{p} = 1$

$P(Y) = [\bar{p}w \quad p \quad \bar{p}\bar{w}]$

$P(X|Y) = \begin{bmatrix} 1 & w & 0 \\ 0 & \bar{w} & 1 \end{bmatrix}$

$H(X|Y) = \sum\sum P(x_i, y_j) \log \frac{1}{P(x_i|y_j)}$

$\boxed{H(X|Y) = p\, H(X)}$

$I(X,Y) = H(X) - H(X|Y) = (1-p)H(X) = \bar{p}\,H(X)$

$C = \mathrm{Max}\{I(X,Y)\} r_s = \{\bar{p}\, H(X)_{max}\} r_s = \bar{p} \log_2 2 \cdot r_s$

$\boxed{C = \bar{p}\, r_s}$ bits/sec — 6M

(8M)

Subject Title: ITC **Subject Code:** 17EC54

Question Number	Solution P-5/7	Marks Allocated
6 a)	$I(X,Y) = H(X) - H(X\|Y)$ with Expn	3M } 6M
	Properties: $- I(X,Y) = I(Y,X)$ $- I(X,Y) \geq 0$ $I(X,Y) = H(Y) - H(Y/X)$ $I(X,Y) = H(X) + H(Y) - H(X,Y)$	3M
b)	$P(Y\|X) = \begin{bmatrix} 0.8 & 0.1 & 0.1 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix}$	
	$\begin{bmatrix} 0.8 & 0.1 & 0.1 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix} \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \end{bmatrix} = \begin{bmatrix} 0.8\log 0.8 + 0.1\log 0.1 + 0.1\log 0.1 \\ 0.2\log 0.2 + 0.6\log 0.6 + 0.2\log 0.2 \\ 0.2\log 0.2 + 0.2\log 0.2 + 0.6\log 0.6 \end{bmatrix}$	2M } 6M
	$= \begin{bmatrix} -0.922 \\ -1.371 \\ -1.371 \end{bmatrix}$ Solving above Matrix, we get $Q_1 = -0.7723,\ Q_2 = -1.5207,\ Q_3 = -1.5207$	2M
	$C = \log_2 [2^{Q_1} + 2^{Q_2} + 2^{Q_3}] \times r_s = 718$ bits/sec	2M
c)	$C = B\log(1 + \frac{S}{N})$ bits/sec B = Channel BW (Hz), N = Noise power (W) $= \eta B$. S = Signal power (W)	2M } 8M
	Proof of $C = B\log(1 + S/N)$	6M
7 a)	Adv: Improves Data Quality, Reduction in E_b/N, Reduction in Transmitted power Disadv: Increased BW, System becomes more Complex	3M } 6M
	Methods of controlling Errors: — forward acting error correction } with Expn — Error detection Method	3M
b)	$C = [d_1, d_2, d_3, d_4,\ c_5, c_6, c_7]$	
	$C = DG = [d_1\ d_2\ d_3\ d_4] \left[\begin{array}{cccc\|ccc} 1&0&0&0&1&1&0 \\ 0&1&0&0&0&1&1 \\ 0&0&1&0&1&1&1 \\ 0&0&0&1&1&0&1 \end{array}\right] \to G$	2M } 6M
	$H = [P^T \vdots I_{n-k}] = \left[\begin{array}{cccc\|ccc} 1&0&1&1&1&0&0 \\ 1&1&1&0&0&1&0 \\ 0&1&1&1&0&0&1 \end{array}\right]$	2M
	$GH^T = \begin{bmatrix} 1000 & 110 \\ 0100 & 011 \\ 0010 & 111 \\ 0001 & 101 \end{bmatrix} \begin{bmatrix} 1&1&0 \\ 0&1&1 \\ 1&1&1 \\ 1&0&1 \\ 1&0&0 \\ 0&1&0 \\ 0&0&1 \end{bmatrix} = 0$	2M

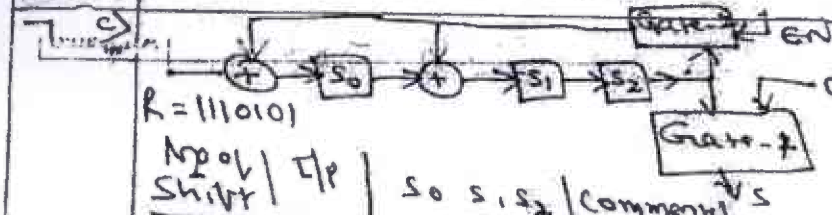
Subject Title : ITC

Subject Code : 17EC54

P-6/7

Question Number	Solution	Marks Allocated

7 c)



$R = 1110101$ — 3M

No of Shift	I/P	S_0 S_1 S_2	Comment
Initialization G_2-ON & G_1-OFF		0 0 0	← Clear the content of Register
1	1	1 0 0	
2	0	0 1 0	
3	1	1 0 1	
4	0	1 0 0	
5	1	1 1 0	
6	1	1 1 1	
7	1	0 0 1	← Indicate the error

5M — 8M

$S = 001 \Rightarrow S(X) = X^2$

8 a) $C = DG = [d_1 d_2 d_3]\begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$ — 2M

	code	wt
0	000 000	0
1	001 110	3
2	010 011	3
3	011 101	4
4	100 101	3
5	101 011	4
6	110 110	4
7	111 000	3

3M

$d_{min} = 3$

Error detection $= d_{min} - 1 = 2$ — 1M

Error Correction $= \frac{d_{min} - 1}{2} = 1$ — 1M

6M

b) $D = 1101 \Rightarrow D(x) = 1 + x + x^3$

Non-systematic:

$V(x) = D(x)\,g(x)$

$\boxed{V(x) = 1 + x^2 + x^6 \quad \text{OR} \quad V = 1010001}$ 2M

Systematic

$$\frac{x^{n-k} D(x)}{g(x)} = \frac{x^3 + x^4 + x^6}{1 + x + x^3}$$

$$x^3 + x + 1 \overline{)\, x^6 + x^4 + x^3} \quad x^3$$
$$x^6 + x^4 + x^3$$
$$0$$

$\therefore V(x) = x^{n-k} D(x) + R(x)$

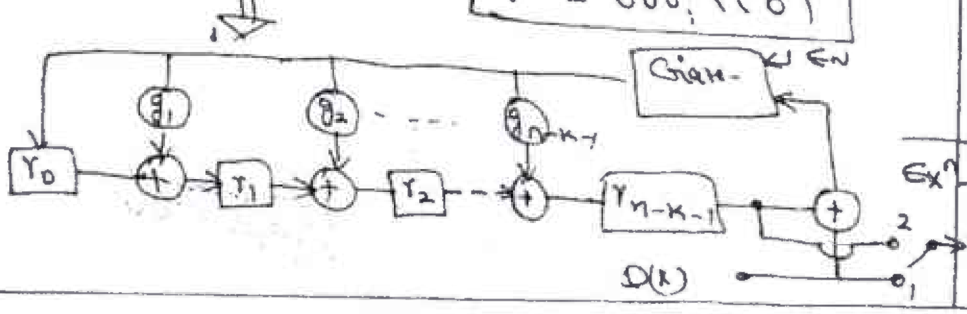
$\boxed{V(x) = x^3 + x^4 + x^6 \quad \text{OR} \quad V = 000\,1101}$

4M

2+4 = 6M

c) $R(x) = \frac{x^{n-k} D(x)}{g(x)} + Q(x)$

$\Downarrow$



— 3M
Ex^n — 5M

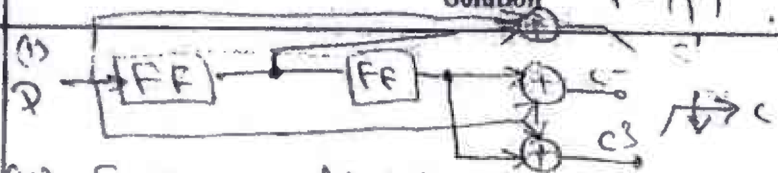
8M

Subject Code:

Question Number	Solution	Marks Allocated

P-7/7

9 a) (i)



— 2M

(ii) Generator Matrix

$$G = \begin{bmatrix} 111 & 101 & 011 & 000 & 000 & 000 & 000 \\ 000 & 111 & 101 & 011 & 000 & 000 & 000 \\ 000 & 000 & 111 & 101 & 011 & 000 & 000 \\ 000 & 000 & 000 & 111 & 101 & 011 & 000 \\ 000 & 000 & 000 & 000 & 111 & 101 & 011 \end{bmatrix}$$

$C = DG = [11101][G]$

$= [111, 010, 001, 110, 100, 101, 011]$ — 7M

Transform domain:

$c^1(x) = 1 + x^3 + x^4 + x^5 \Rightarrow 1001110$

$c^2(x) = 1 + x + x^3 + x^6 \Rightarrow 1101001$

$c^3(x) = 1 + x^2 + x^5 + x^6 \Rightarrow 1010011$ — 7M.

$\therefore C = [111, 010, 001, 110, 100, 101, 011]$

b) BCH codes — 4M

10 a) (i) $g^{(1)} = 1011 \quad g^{(2)} = 1111$

$g^1(x) = 1 + x^2 + x^3, \quad g^2(x) = 1 + x + x^2 + x^3$ — 2M

(ii) Time domain: $L = 5, \ l = 8,$

Using $c_i^d = \sum_{i=0} d_{l-i}\, g_{i+1}^d$

$c^1 = 10000001, \quad c^2 = 11011101$ — 7M

$C = [11, 01, 00, 01, 01, 01, 00, 11]$

Transform domain.

$c^1(x) = D(x)\, g^1(x)$

$c^1(x) = 1 + x^7 \Rightarrow 10000001$

$c^2(x) = D(x)\, g^2(x) = 11011101$ — 7M

$C = [11, 01, 00, 01, 01, 01, 00, 11]$

b) Golay code — 4M