Q.6 Attempt any two:

i.	What is meant by the syndrome of linear block code? The received vector for the (7, 4) code is Y = 1001101. Find the transmitted codeword using the syndrome decoding technique. Given that- $$H = \begin{bmatrix} 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$	**5**	4	1 2 3	4	1
ii.	Design 1/2 convolutional encoder with constraint length 3. Find the encoded bits for the message 1001. The generated sequences are $g^{(1)}$= [111] and $g^{(2)}$= [101]. Also, draw the state table and state diagram.	**5**	4	1 2 3	4	1
iii.	The generator polynomial of (7,4) cyclic code is $G(p) = p^3 + p + 1$. Find code vectors in systematic form if m=0101.	**5**	4	1 2 3	4	1

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec 2024
EC3CO11 Digital Communication

Programme: B.Tech. Branch/Specialisation: EC

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c, or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

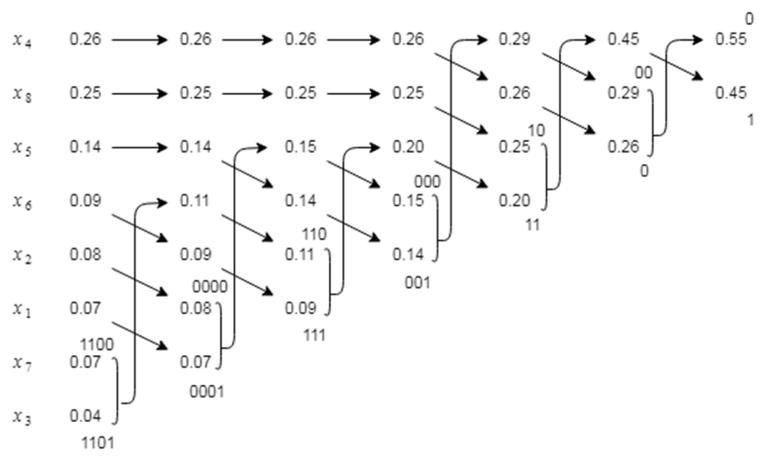
			Marks	**BL**	**PO**	**CO**	**PSO**
Q.1	i.	In a PCM system, an analog signal ranges between 0 to 4V is divided into 8 equal intervals for conversion to 3-bit digital output. The maximum quantization error (in V) is- (a) 0.5 (b) 0.3 (c) 0.25 (d) 1	**1**	2	1	2	
	ii.	In the digital communication system, which one of the following modulation techniques requires maximum bandwidth- (a) PCM (b) DM (c) ADM (d) DPCM	**1**	2	1	2	
	iii.	In which Line coding method, logic 1 is represented by half bit wide pulse and logic 0 is represented by absence of pulse- (a) RZ-AMI (b) Bipolar RZ (c) Manchester coding (d) Unipolar RZ	**1**	1	1	1	
	iv.	What are the characteristics of Matched Filter? (a) Maximizes SNR (b) Minimizes SNR (c) Minimizes Interference (d) Independent of SNR	**1**	1	1	1	

v.	Which of the following digital modulation techniques gives the maximum probability of error- (a) PSK (b) FSK (c) QAM (d) ASK	**1**	1	1	1		
vi.	Which of the following systems allows larger processing gain? (a) Direct sequence spread spectrum (b) Frequency hopping spread spectrum (c) Time hopping spread spectrum (d) Pulse code modulation	**1**	1	1	1		
vii	If there are M messages and each message has the probability with p=1/M, the entropy is- (a) 0 (b) 1 (c) M $\log_2$M (d) $\log_2$M	**1**	2	1	3		
vii	If the probability of a message is ¼, then the information in bits is- (a) 8 bits (b) 2 bits (c) 4 bits (d) 1 bit	**1**	2	1	3		
ix.	If the convolutional codes are represented by (n, k, m), what does 'm' signify? (a) Coded bits (b) Message bits (c) Memory order (d) Constraint length	**1**	1	1	1		
x.	A cyclic code can be generated using- (a) Generator matrix (b) Generator polynomial (c) Generator polynomial & matrix (d) Parity check matrix	**1**	1	1	1		
Q.2 i.	What are the significant advantages of digital communication over analog communication?	**2**	1	1	1		
ii.	Explain the process of quantization in the PCM system. What is the impact on the bandwidth requirement if the quantization levels are increased?	**3**	2	2	2		
iii.	Illustrate how the PCM system works with the output signal format for each block of PCM. Elaborate on how DPCM is different from PCM.	**5**	3	2	2		

OR	iv. Explain delta modulation with a block diagram. What are the significant problems associated with delta modulated signal?	**5**	2	2	2		
Q.3	i. What are the desirable properties of a line coding scheme?	**3**	2	1	2		
	ii. State the principle of maximum likelihood detector. Derive the error performance of the ML detector in a white Gaussian noise channel.	**7**	3	1 2	2		
OR	iii. Discuss the principle of obtaining eye patterns. Explain how eye pattern is helpful in obtaining the performance of the system with a neat sketch.	**7**	3	1 2	2		
Q.4	i. Define chip duration and chip rate.	**2**	1	1	1		
	ii. Describe the generation and detection of coherent binary PSK signals. Draw the signal space diagram of a coherent QPSK modulation scheme and find the probability of error.	**8**	3	1	2	1	
OR	iii. Describe the spread spectrum modulation system with a block diagram. How is the PN sequence generated in the DS-SS system, and what are its properties?	**8**	3	1	3	1	
Q.5	i. Define entropy. Find the entropy of a discrete memoryless source with probability s1=1/2, s2=1/4, and s3=1/4.	**3**	3	1 2	4		
	ii. Construct the huffman code with minimum code variance for the following probabilities and determine the average code length and code efficiency: P(x)= {0.26, 0.25. 0.14, 0.09, 0.08, 0.07, 0.07, 0.04} .	**7**	4	1 2	4	1	
OR	iii. State and explain the Shannon's capacity theorem. Explain the trade-off between bandwidth and signal-to-noise ratio by taking a suitable example.	**7**	4	1 2 3	4	1	

Marking Scheme

EC3CO11 (T) Digital Communication (T)

Q.1	i)	(c) 0.25		**1**
	ii)	(a) PCM		**1**
	iii)	(d) Unipolar RZ		**1**
	iv)	(a) Maximizes SNR		**1**
	v)	(d) ASK		**1**
	vi)	(a) DSSS		**1**
	vii)	(d) $\log_2 M$		**1**
	viii)	(b) 2 bits		**1**
	ix)	(c) Memory order		**1**
	x)	(b) Generator Polynomial		**1**
Q.2	i.	The significant advantages of digital communication over analog communication systems are: at least TWO merits of digital communication systems. (1 mark each)		**2**
	ii.	Quantization		**3**
		-Definition.	-1 mark	
		-Example with Quantization level	-1 mark	
		-As the number of quantization levels increases, the bandwidth requirement of the PCM system increases because more levels are needed to represent the analog signal accurately.	-1 mark	
	iii.	PCM system works with the output signal format		**5**
		Diagram, signal format, the task of each block	-3 marks	
		Two differences between DPCM and PCM.	-2 marks	
OR	iv.	Delta Modulation		**5**
		-detail with block diagram	-3 marks	
		-the drawbacks of DM	-2 marks	
Q.3	i.	No DC Component, Self-synchronization, Noise immunity (Any three properties)		**3**
	ii.	Principle of ML detector	-2 marks	**7**
		Error performance	-5 marks	
OR	iii.	The principle of eye patterns.	-3 marks	**7**
		Eye pattern for evaluating the performance of the system	-4 marks	
Q.4	i.	Chip duration	-1 mark	**2**
		Chip rate	-1 mark	
	ii.	Generation of Coherent binary PSK Signals	-2 marks	**8**
		Detection of Coherent binary PSK Signals	-2 marks	
		Signal space diagram	- 2 marks	
		Probability of error	-2 marks	
OR	iii.	Spread spectrum modulation system	-2 marks	**8**
		Block diagram of SS	-2 marks	
		PN sequence generated in the DS-SS system	-2 marks	
		Properties of PN sequence	-2 marks	
		Define chip duration and chip rate.		
Q.5	i.	Define Entropy	-1 mark	**3**
		It is given by the expression:	-2 marks	
		$H(X)= P(xi) \log_2(1/P(xi))$ bits/sample.		
		H= 3/2 bit		
	ii.			**7**
			-3 marks	
		Average Code length= L=2.75 bits/symbol	-2 marks	
		H(x)=0.81 bits/message		
		Efficiency=H(x)/L=0.81/2.75=0.29=29%	-2 marks	
OR	iii.	Shannon's capacity theorem	- 4 marks	**7**
		Trade-off between bandwidth and SNR	- 3 marks	
Q.6				
	i.	Syndrome	-1.5 marks	**5**

$$H = \begin{bmatrix} 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

S = [YH^T]

Y = 1001101

S=[1 0 0]

For syndrome (100), the error pattern is: 0000 100

The corrected transmitted word is 1001001 -3.5 marks

ii. Encoded bits -1 mark **5**

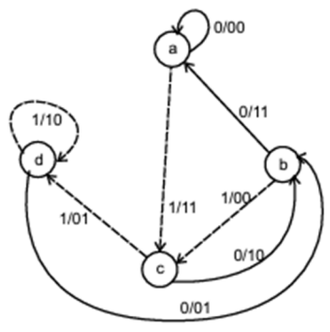
State table

State table, in which present state and next state of all possible inputs are calculated. The code word can be calculated from all possible input.

Msgbits m	presentstate m_1 m_2			Nextstate			C_1 $m \oplus m_2$	C_2 $m \oplus m_1$	State diagram
0	0	0	a	0	0	a	0	0	a: 0 a(00), 1 c(11)
1	0	0	a	1	0	c	1	1	
0	0	1	b	0	0	a	1	1	b: 0 a(11), 1 c(00)
1	0	1	b	1	0	c	0	0	
0	1	0	c	0	1	b	1	0	c: 0 a(10), 1 c(01)
1	1	0	c	1	1	d	0	1	
0	1	1	d	0	1	b	0	1	d: 0 a(01), 1 c(10)
1	1	1	d	1	1	d	1	0	

-2 marks

State diagram



-2 marks

iii. Here n =7, k =4 , Number of check bits q= n-k = 7- 4 = 3 and Block length n= 7. **5**

Consider any message vector M = (m3, m2, m1, m0) = (0 1 0 1).

Then, the message polynomial will be

$M(p) = m_{k-1}p^{k-1} + m_{k-2}\,p^{k-2} + \ldots\ldots\ldots + m_1 p + m_0$

$M(p) = m_3 p^3 + m_2\,p^2 + m_1 p + m_0 = p^2 + 1$

Given generator polynomial is $G(p) = p3 + p + 1$

-2 marks

To obtain systematic code vectors

$$C(p) = rem\left[\frac{p^q M(p)}{G(p)}\right]$$

To obtain $p^q M(p)$ Since q =3

$p^q M(p) = p^3(p^2 + 1) = p^5 + 0\,p^4 + p^3 + 0p^2 + 0p + 0$

$$\left[\frac{p^q M(p)}{G(p)}\right] = \frac{p^5 + 0\,p^4 + p^3 + 0p^2 + 0p + 0}{p^3 + p + 1}$$

$p^2 + 0 + 0$ ← Quotient

$p^3 + 0p^2 + p + 1 \;\overline{)\; p^5 + 0p^4 + p^3 + 0p^2 + 0p + 0}$

Mod-2 addition →

$p^5 + 0p^4 + p^3 + p^2$

$\oplus \quad \oplus \quad \oplus \quad \oplus$

$0 \quad +0 \quad +0 \quad +p^2 + 0p + 0$

Remainder

$Therefore\ C(p) = p^2 + 0p + 0$

-3 marks

Answer: = $(m3,m2,m1,m0 : c2,c1,c0) = (0101 : 100)$

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