GURU NANAK INSTITUTE OF TECHNOLOGY

An Autonomous Institute under MAKAUT

2020-2021

INFORMATION THEORY AND CODING

EC504A

TIME ALLOTTED: 3 Hours **FULL MARKS: 70**

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable

GROUP – A

(Multiple Choice Type Questions)

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

		Marks	CO No
1(i)	In modulo-8 arithmetic, we use only the integers in the range of a) 1 to 8 b) 0 to 7 c) 0 to 8 d) None of these	1	CO1
1(ii)	Entropy means a) amount of information b) rate of information c) measure of uncertainty d) probability of message	1	CO1
1(iii)	Relation between message rate (r) and information rate (R) is a) $C = B (\ln_2 (S/N))$ b) $C = B (\ln_2 (1 + S/N))$ c) $C = B/N$ d) $C = B^2N$	1	CO1
1(iv)	In Viterbi algorithm, the selected paths are regarded as a) Survivors b) Defenders c) Carriers d) Destroyers	1	CO2
1(v)	For a noiseless channel I(X;Y) is a) $H (X) – H (Y)$ b) $H (Y) – H (X)$ c) $H (X)$ d) $H (X) – H (Y/X)$.	1	CO1
1(vi)	The hamming distance between 100 and 001 is a) 0 b) 1 c) 2 d) -1	1	CO1

1(vii)	A code is with minimum distance d_{min} = 5. How many errors can it correct? a) 3 b) 2 c) 4 d) 1	1	CO5
1(viii)	The number of undetectable errors for a (n,k) linear code is a) 2^{n-k} b) 2^n c) 2^n-2^k d) 2^k	1	CO4
1(ix)	On which factor/s do/does the channel capacity depend/s in the communication system? a) Bandwidth b) Signal to Noise Ratio c) both bandwidth and SNR d) None of these	1	CO1
1(x)	The code rate for (15,5) code is a) 3 b) 1/3 c) 5 d) 10	1	CO4
1(xi)	Relation between syndrome vector (S) and error vector (E) is a) $S=H^TE$ b) $S=EH^T$ c) none of these d) both a and b	1	CO4
1(xii)	Code rate r, k information bits and n as total bits, is defined as a) r = k/n b) k = n/r c) r = k * n d) n = r * k	1	CO2

GROUP – B
(Short Answer Type Questions)

(Answer any *three* of the following) **3 × 5 = 15**

		Marks	**CO No**
2.	Define entropy and prove that entropy has maximum value when both the messages are equally likely.	5	CO1
3.	Calculate the channel capacity of an AWGN channel with a bandwidth of 1 MHz and S/N ratio of 40 dB.	5	CO4
4.	Define the term syndrome related to linear block code. For a (6,3) linear block code the generator matrix is given below. Find the possible code words. Decode the received code 100011.	5	CO4

$$[G]=\begin{bmatrix}100101\\010011\\001110\end{bmatrix}$$

5.	Determine the conjugates of α^7 and α^9 in GF (2^4).	5	CO3
6.	The convolution encoder of ½ code rate has polynomial representation as $g_1(x)=1+x^2$ and $g_2(x) = 1+x+x^2$. Draw the encoder circuit. Find the output code for the d= (1011).	5	CO4

GROUP – C
(Long Answer Type Questions)

(Answer any *three* of the following) **3 × 15 = 45**

		Marks	**CO No**
7. a)	Find the entropy of a source generating n number of messages having different probabilities of occurrence.	5	CO1
7. b)	State and explain source encoding theorem.	5	CO2
7. c)	Show that the channel capacity for a continuous channel is given by C = B log 2 [1 + S/N] bit/sec.	5	CO1
8. a)	Determine the Shanon Fano code for the following messages with the given probabilities: X_1 =0.15, X_2=0.20, X_3 =0.10, X_4 =0.05, X_5 =0.25, X_6 =0.12, X_7 =0.13 and find out the Coding efficiency.	8	CO1
8. b)	What is Hamming distance? Give relation between minimum distance and error detecting and correcting capability. Describe a Hamming code.	7	CO2
9. a)	Calculate generator polynomial for GF (2^3) [double error]	11	CO2
9. b)	Prove that α^4 is a root of x^3+x+1 in GF (2^3)	4	CO2
10. a)	For a systematic (7, 4) cyclic code determine the generator matrix and parity check matrix if $g(x) = 1 + x + x^3$.	8	CO5
10. b)	The parity check bits of a (7,3) block code are generated by C5=d2⊕ d3 C6=d1⊕ d2 C7=d1⊕ d3 Find the generator matrix for this code and Find the parity check matrix for this code.	7	CO2
11	Write short notes on any three of the following:	3 × 5	CO4
11. a)	Viterbi algorithm	5	CO2
11. b)	BCH codes	5	CO5
11.c)	Standard array decoding	5	CO2
11. d)	Turbo codes	5	CO5
11.e)	Channel capacity theorem	5	CO2