USN | | | | | | | | | | 10EC55

Fifth Semester B.E. Degree Examination, June/July 2019
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

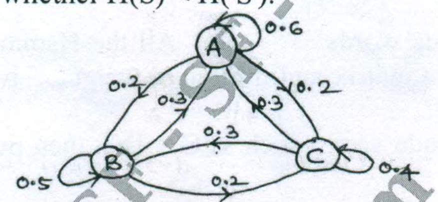
PART - A

1 a. Define the following with respect to information theory : i) Self Information ii) Entropy iii) Rate of Information iv) Mutual Information. **(04 Marks)**

b. Find the inter relationships between Hartley's nats and bits. **(06 Marks)**

c. For the first order Markov source shown in the fig.Q1(c), i) Find the stationary distribution ii) Entropy of each state and hence the entropy of source iii) Entropy of adjacent source and verify whether $H(S) < H(\overline{S})$. **(10 Marks)**

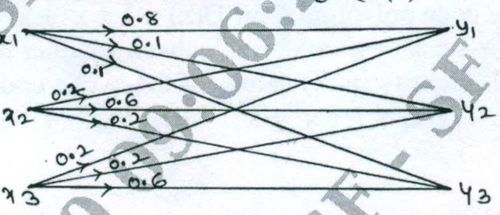
Fig.Q1(c)



2 a. Using Shannon's binary encoding procedure, construct a code for the following discrete source $S = \{S_1, S_2, S_3, S_4, S_5\}$ with $P = \{0.4, 0.25, 0.15, 0.12, 0.08\}$. **(10 Marks)**

b. Find the capacity of the discrete channel shown in fig. Q2(b). **(05 Marks)**

Fig.Q2(b)



c. Explain Rate of information transmission over a discrete memoryless channel. Justify that this is given $Di = [H(X) - H(X/Y)]r_s$ bits/sec. **(05 Marks)**

3 a. Given an eight symbol source with probabilities $P = \{0.25, 0.20, 0.15, 0.15, 0.10, 0.05, 0.05, 0.05\}$ construct binary and ternary codes for the same using Huffman's encoding algorithm. Determine code efficiency in each case. **(12 Marks)**

b. Noise matrix of a symmetric channel is illustrated below which has the following source symbol probabilities $P(x_1) = 2/3$; $P(x_2) = 1/3$.

$$P(Y/X) = \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}$$

i) Determine H(X) , H(Y) , H(X, Y) , H(X/Y), H(Y/X) and I(X, Y).

ii) Determine channel capacity. **(08 Marks)**

4 a. An analog signal is band limited as 4KHz. It is sampled at 2.5times an Nyquist rate and each sample is quantized to 256 levels. These levels are equally likely to occur. The samples are assumed to be statistically independent. Find i) Information rate of the sampled signal ii) Can you Transmit the signal without errors on a Gaussian channel with 50KHz bandwidth and S/N ratio of 23 dB?

iii) What bandwidth is needed to transmit the signal without errors. if S/N ratio is 10dB? **(08 Marks)**

b. State Shannon – Hartley law. Derive an expression for the upper limit on the channel capacity as the band width tends to infinity. **(06 Marks)**

c. A friend of yours says that he can design a system for transmitting the output of a micro computer to a line printer operating at a speed of 30lines/minute over a voice grade telephone line with a bandwidth of 4KHz and (S/N) = 20dB. Assume that line printer needs eight bits of data per character and prints out 80 character per line. Would you believe him? **(06 Marks)**

PART - B

5 a. Consider a (6, 3) linear code whose generator matrix is given below :

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

Find i) All code words ii) All the Hamming weights and distances iii) Find minimum weight matrix and minimum weight iv) Parity check matrix v) Draw the encoder circuit. **(14 Marks)**

b. If C is a valid code vector such as C = DG, then prove that $CH^T = 0$, where H is the parity check matrix. **(06 Marks)**

6 a. A (15, 5) linear cyclic code has a generator polynomial **(12 Marks)**
$g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$.

i) Draw the block diagram of an encoder and syndrome calculator of this code.
ii) Find the code polynomial for $D(x) = 1 + x^2 + x^4$ in systematic form.
iii) If $V(x) = 1 + x^4 + x^6 + x^8 + x^{14}$, check whether it is a valid code polynomial or not.

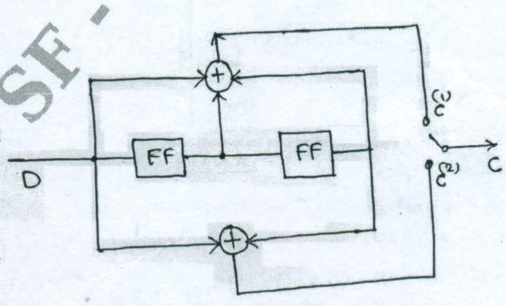
b. Given $n \leq 7$, identify (n, k) values of the cyclic codes generated by the following generator polynomial. i) $g(x) = 1 + x^2 + x^3$ ii) $g(x) = 1 + x + x^2 + x^4$ iii) $g(x) = 1 + x^2 + x^3 + x^4$. **(08 Marks)**

7 Write short notes on :
a. RS codes.
b. Shortened cyclic codes.
c. Golay codes.
d. Burst error correcting codes. **(20 Marks)**

8 a. Consider (3, 1, 2) convolution code with $g^{(1)} = (110)$, $g^{(2)} = (101)$ and $g^{(3)} = (111)$. Draw the encoder block diagram and also find the generator matrix. **(08 Marks)**

b. For the convolution encoder shown in fig. Q8(b), if information sequence D = 10011, find the output sequence using i) Time domain approach ii) Transform domain approach. **(12 Marks)**

Fig.Q8(b)



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