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APR-MAY 2022

B. E. (Sixth Semester) Examination, ~~2020~~

(New Scheme)

(IT Engg. Branch)

INFORMATION THEORY & CODING

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Part (a) of each question is compulsory and carry 2 marks. Attempt any two parts from part (b), (c) and (d) and carry 7 marks each. Only write correct option is part (a).

1. (a) Logarithmic measure of information is defined by where I_K is information and P_K is probability of events. 2

(i) $I_K = P_K \log_2 P_K$

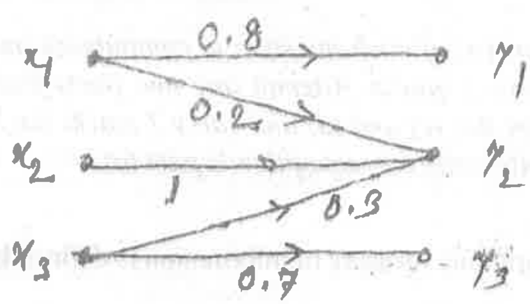
(ii) $I_K = -P_K \log_2 P_K$

(iii) $I_K = -\log_2 P_K$

(iv) $I_K = \log_2 P_K$

(b) Explain all components of communication system with proper block diagram. 7

(c) A communication channel where, source transmits message x_1, x_2 and x_3 with the probabilities 0·3, 0·4 and 0·3. The source is connected according to following given figure :



Calculate all the entropies. 7

(d) What is mutual information? Prove that mutual information.

$$I(x;y) = H(x) - H(x/y) \text{ bits/symbol.}$$

where $H(x)$ is marginal entropy and $H(x/y)$ is conditional entropy. 7

2. (a) Efficiency of code is defined by : 2

(i) $\eta = \dfrac{H(x)}{\bar{L}\log_2 M}$

(ii) $\eta = \dfrac{\bar{L}H(x)}{\log_2 M}$

(iii) $\eta = \bar{L}\dfrac{\log_2 M}{H(x)}$

(iv) $\eta = \dfrac{H(x)\log_2 M}{\bar{L}}$

(b) Apply the Huffman coding for the following message ensemble :

$[X] = [x_1, x_2, x_3, x_4, x_5, x_6, x_7]$

$[P] = [0 \cdot 4, 0 \cdot 2, 0 \cdot 12, 0 \cdot 08, 0 \cdot 08, 0 \cdot 08, 0 \cdot 04]$

For $M = 3$ and also find coding efficiency. 7

(c) Apply the Shannon Fano coding procedure for the following message ensemble. 7

$[X] = [x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8]$

$[P] = [0{\cdot}25, 0{\cdot}25, 0{\cdot}125, 0{\cdot}125, 0{\cdot}0625, 0{\cdot}0625, 0{\cdot}0625, 0{\cdot}0625]$

Take $m = 2$ and find coding efficiency.

(d) Find mutual information for the channel shown by : 7

$$P(X,Y) = \begin{matrix} & y_1 & y_2 \\ x_1 & 0 \cdot 25 & 0 \cdot 25 \\ x_2 & 0 \cdot 15 & 0 \cdot 15 \\ x_3 & 0 \cdot 1 & 0 \cdot 1 \end{matrix}$$

3. (a) The channel capacity of an ideal AWGN channel with infinite bandwidth is given by : 2

(i) $C_\infty = 1 \cdot 34\ S/\eta\ \ b/s$

(ii) $C_\infty = 1 \cdot 44\ S/\eta\ \ b/s$

(iii) $C_\infty = 1 \cdot 34\ \eta/S\ \ b/s$

(iv) $C_\infty = 1 \cdot 44\ \eta/S\ \ b/s$

(b) Prove that the channel capacity of white band limited Gaussian channel is

$$C = w \log(1 + S/N)\ \text{bit/sec}$$

Where :

W is channel bandwidth

S is signal power

N is noise power 7

(c) An analog signal having 4 kHz bandwidth is sampled at 1·25 times the Nyquist rate and each sample is quantized into one of 256 equally likely levels. Assume that the successive samples are statistically independent. 7

(i) Find information rate of source.

(ii) Can the output of this source can be transmitted without error over as AWGN channel with a bandwidth of 10 kHz and as S/N ratio of 20 dB.

(iii) Find the S/N ratio required for error free transmission of part (ii).

(iv) Find the bandwidth required for an AWGN channel for error free transmission of the output of this source if the S/N ratio is 20 dB.

(d) Find the channel capacity of binary symmetric channel for : 7

(i) $P = 0 \cdot 9$

(ii) $P = 0 \cdot 06$

4. (a) If minimum hamming distance of a linear block code is d min. Then total no. of error can be detected and corrected are :

(i) $(S+1) \leq d \min, (2t+1) \geq d \min$

(ii) $(S+1) \geq d \min, (2t+1) \leq d \min$

(iii) $(S+1) \geq d \min, (2t+1) \geq d \min$

(iv) $(S+1) \leq d \min, (2t+1) \leq d \min$

where S detected error, t corrected error. 2

(b) Explain error syndrome in linear block code. How it will help you to detect and correct a single bit error? Explain with example. 7

(c) The parity check matrix of a particular (7, 4) linear block code is given by : 7

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

(i) Find the generator matrix G.

(ii) List the entire code vector.

(iii) What is minimum hamming distance between code vector.

(iv) How many error can be detected and how many errors can be corrected?

(d) The generator polynomial of a (7, 4) cyclic code is $g(x)=1+x+x^2$? Find all the code words of this code. 7

5. (a) Convolution code is defined by : 2

(i) (n, K)

(ii) (n, L)

(iii) (k, L)

(iv) (n, k, L)

Where n no. of encoded bits, k no. of message bits and L is encoders memory.

(b) A convolutional code is described by $g_1=(101)$, $g_2=(111)$ and $g_3=(111)$. Draw the encoder corresponding to this code and also draw transition diagram and trellis diagram. 7

(c) Explain puncturing in convolution encoding. 7

(d) Explain turbo encoder and decoder process. 7