Department of Electronics & Communication Engineering

Faculty of Engineering, Integral University, Lucknow

Assignment Sheet 1

Information Theory & Coding (EC-031)

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Problems : 10

1. One of five possible messages Q_1 to Q_5 having their probabilities $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}$, respectively, is transmitted. Calculate the average entropy.
2. Let messages $Q_1, \ldots\ldots\ldots\ldots, Q_M$ have probabilities $p_1, \ldots\ldots\ldots\ldots\ldots, p_M$ of occurring.
   (a). Write final mathematical expression for Entropy.
   (b). If M = 3, write H in terms of $p_1 \& p_2$, by using the result that $p_1 + p_2 + p_3 = 1$
   (c). Find $p_1 \& p_2$ for $H = H_{max}$, by setting $\frac{\partial H}{\partial p_1} = 0$ & $\frac{\partial H}{\partial p_2} = 0$.
3. A code is composed of dots and dashes. Let assume that the dash is 3 times as long as dot and has one third the probability of occurrence.
   (a). Calculate the information in dot and dash.
   (b). Calculate the average information in the dot-dash code.
   (c). Assume that a dot last for 10 millisecond and that this same time interval is allowed between the symbols. Calculate the average rate of information transmission.
4. Consider the binary symmetric channel where $P(X_0) = \alpha$ & $P(X_1) = (1 - \alpha)$. Value of P_{01} is (1-p) & P_{11} is p.
   (a). Average mutual information between the channel input and output.
   (b). Channel Capacity
5. Verify that $0 \leq H(X) \leq log_2 m$
6. Develop Shannon Fanon Code for the first problem.
7. Develop Huffman Code for the first problem and compare the result with above problem.
8. A voice graded channel of telephone network has a bandwidth of 3.4 KHz.
   (a). Calculate the information capacity of the telephone channel for a signal to noise ration of 30 dB.

(b). Calculate the minimum signal to noise ration required to support information transmission through the telephone channel at the rate of 9600 b/s.

9. A discrete memory less source has as alphabet of seven symbol whose probabilities of occurrence are as described here :

Symbol	s_0	s_1	s_2	s_3	s_4	s_5	s_6
Probability	0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Compute the Huffman code for this source, moving a "combined" symbol as high as possible. Explain why the computed source code has an efficiency of 100 percent.

10. Consider a AWGN channel with 5 KHz bandwidth and with the noise power spectral density $\eta/_2 = 10^{-12}$ Watt/Hz. The signal power required at the receiver is 0.1 mill watt. Calculate the capacity of this channel.