Communication Theory Homework 5

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1. Describe when and why we use raised cosine pulses, citing the necessary conditions, at least one theorem and drawing at least one figure.
2. True raised cosine pulses are not realizable – why not? What is done in practice to approximate the raised cosine?
3. Find the entropy of a geometrically distributed random variable (that is, a variable with probability mass function $f(m) = p(1-p)^{m-1}$ for positive integer m and some fixed probability p) as a function of p.
4. Suppose a source has alphabet $\{a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8\}$ with corresponding output probabilities $\{\frac{1}{16}, \frac{1}{16}, \frac{1}{4}, \frac{1}{32}, \frac{3}{32}, \frac{1}{8}, \frac{1}{16}, \frac{5}{16}\}$. Determine the entropy of the source.
5. Design a Huffman code for the above source. Validate that it satisfies the Kraft inequality, and that the average length satisfies the Huffman code entropy inequalities.
6. Find the transmission power (in Watts) necessary for an AWGN channel with $N_0 = 108$ J and transmission bandwidth $B = 1$ MHz to achieve a channel capacity of 1 Mb/s.
7. The next several questions will refer to the (n,k) linear block code with generator matrix

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

   You may use MATLAB to help with any question below, although they can all be done by hand.
   First – What are n and k?
8. Make a list of every data vector and associated codeword.
9. What is the minimum Hamming distance of the code, d_{min}? How many errors can this code correct?
10. There exists a systematic code with the same codewords as this code – how can you know that from looking at the list? It hould be straightforward to create the generator matrix of this systematic code, G_S.
11. Find the parity check matrix of G_S, H.
12. Does H work as a parity check matrix for G? To help answer this, find GH and $G_S H$.