Concordia University
Department of Electrical and Computer Engineering
ELEC 6831: Digital Transmission Systems I
Final Exam, Summer 2002

Q1 (25%)

An (n,k) = (8,5) linear block code with a generator polynomial of $g(x) = 1 + x + x^2 + x^3$ is considered.

a) Prove that this code is cyclic and non-perfect.
b) Evaluate the error correction and detection capability of the code.
c) Calculate the probability of undetected error if the uncoded bit error probability is 10^{-2}.

Q2 (25%)

Consider the rate 1/3, constraint length K=3, convolutional code given by
$g_1(x) = 1 + x^2, g_2(x) = 1 + x, g_3(x) = 1 + x + x^2$.

a) Draw the encoder implementation and the trellis diagram of the encoder. Is this code systematic? Why?
b) Evaluate the minimum free distance of the code by evaluating the transfer function T(D).
c) Assume that all zero sequence is transmitted and the 5^{th} received bit is in error. Show the steps of Viterbi decoding algorithm by decoding the received bits.

Q3 (25%)

A stream of digital data with data rate of 10 Mb/s is to be transmitted using a gray coded 4-ary modulation scheme. The received signal power, P_r is 0.02 watts and the noise power spectral density, N_0 is 2×10^{-10} Watts/Hz

a) Consider 4PAM modulation scheme is used. Draw signal constellation diagram of the system and calculate bit error probability. Draw the block diagram of the transmitter and the receiver.
b) Repeat part "a" for 4PSK modulation.
c) Compare two modulation schemes of parts "a" and "b".

Q4 (25%)

A stream of digital data with data rate of 4 Mb/s is to be transmitted using non-coherent orthogonal 4-level FSK system. The received signal power to noise density ratio P_r / N_0 is 76 dB-Hz. The required performance of the system is a bit error rate of 10^{-9}.

a) Evaluate the bit error rate of the system without coding and calculate the required coding gain to achieve the system performance.
b) Use BCH(127, 106) code which has capability of correcting 3 errors in a block of 127 bits. Evaluate the bit error rate of the system.
c) Using the BCH code of part b, can we achieve the required system performance? If not what should be done? If we can achieve the performance, do you think this code is an overkill? Do you have a suggestion?

Available Time: 3 Hours