Digital Communication Systems Exam

December 19, 2016

Note: Use of calculator is allowed, the necessary equations and q-table are given in the last three pages.

1. Explain the following:
   a) Discuss the three diversity techniques (1p)
   b) Encryption and its advantages (1p)
   c) TDMA and FDMA multiple access techniques (1p)
   d) Intersymbol interference and the three approaches to tackle the effect of intersymbol interference (1p)
   e) Orthogonal frequency division multiplexing (1p)
   f) Structure of a digital communication system and the purpose and tasks of each component (2p)
   g) Advantages of spread spectrum communication (1p)

2. Suppose that QPSK is used for transmitting information over an AWGN with a power spectral density of $0.5N_0 = 10^{-10}$W/Hz. The transmitted signal energy is $E_b = 0.5A^2T$, where T is the bit interval and A is the signal amplitude. Determine the signal amplitude required to achieve an error probability of 10^{-6} when the data rate is 100kbits/s and 300kbits/s. (4p)

3. A satellite relay based communications link has a round trip delay of 0.25seconds. The error detection code rate is 8/10 with a code block length of 1500 symbols. The system has a BPSK modulator with an output symbol rate of 10,000 symbols per second. The channel imposes errors on the transmission with a probability of 10^{-4}. An automatic repeat request system will be used. Find out the maximum supportable transfer rate in bits per second assuming that only detectable error patterns occur, when the used ARQ system is

   a) Stop-and-wait ARQ (2p)

   b) Go-back-N ARQ (2p)

4. A CDMA system consists of 16 equal-power users that transmit information at a rate of 20 kbits/s, each using a DS spread spectrum signal operating at a chip rate of 2MHz. The modulation is binary PSK.
   a) Determine the E_b/J_0, where J_o is the spectral density of the combined interference. (2p)
   b) What is the processing gain? (1p)
   c) How much the processing gain should be increased to allow for doubling the number of users without affecting the output SNR. (2p)

5. The generator matrix of a (7, 4) systematic linear block code is given as follows

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

a) What is the code rate and parity-check matrix for this code? (1p)
b) Determine the minimum hamming distance. (1p)
c) Determine which of the following vectors are codewords in the code {0011000, 1010001, 1110100, 0101011}? (2p)
d) How many bits error within a given codeword can be corrected in this coding? (1p)

6. A discrete memoryless source outputs letters from the alphabet R, S, T, U, and V with respective probabilities 0.1, 0.15, 0.2, 0.25, 0.3.
   a) What is the average information content of the source output? (1p)
   b) If this source outputs 500 alphabets per second, what is the bit rate of the source output? (1p)
   c) Use Huffman encoding procedure to determine binary code for the source output alphabets? (2p)