ETT_3005 DIGITAALISET TIETOLIIKENNEJÄRJESTELMÄT

October 29, 2018

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

1. Explain the following:
   a) Encryption and its advantages **(1p)**
   b) FDMA and CDMA multiple access techniques **(1p)**
   c) The purpose and tasks of digital communication system components. Draw the overall structure and name the components. **(2p)**
   d) Discrete memoryless channel and source. **(1p)**
   e) Intersymbol interference and the three techniques to tackle the effect of intersymbol interference **(1p)**
   f) Three digital binary modulation techniques and their features. **(1p)**
   g) Spread spectrum communication and its advantages **(1p)**

2. Suppose that QPSK is used for transmitting information over an AWGN with a power spectral density of $0.5N0 = 10^{-10}$W/Hz. The transmitted signal energy is $Eb= 0.5A^2T$, where T is the bit interval and A is the signal amplitude.
   a) Determine the signal amplitude required to achieve an error probability of 10^{-6} when the data rate is 100kbits/s. **(2p)**
   b) Determine the channel capacity for a communication system with channel bandwidth of 20kHz and signal to noise ratio based calculated in (a). **(2p)**

3. A discrete memoryless source outputs letters from the alphabet W, X, Y, and Z with respective probabilities 0.15, 0.25, 0.4, 0.2.
   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 and encode the source output alphabets? **(2p)**

4. The generator matrix of a (6, 3) systematic linear block code is given as follows

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

   a) What is the code rate and parity-check matrix for this code? **(1p)**
   b) Determine which of the following vectors are codewords in the code { 111110, 000111, 011011, 110101}? **(2p)**
   c) How many bits error within a given codeword can be corrected in this coding? **(1p)**