You can answer in English or Finnish.
*No calculator allowed – no need.*
You can keep the exam paper

1. Considering discrete-time channels, sketch a chart showing the following plots:
    (a) Continuous-valued AWGN channel capacity (bits/symbol) as a function of SNR
    (b) Maximal conveyed information as a function of SNR for the following alphabets: 2-PSK, 4-PSK, 16-QAM, 64-QAM
    The characteristic shapes of the curves, asymptotic behavior, and realistic numerical values are essential.

2. (a) Sketch the spectrum of a QPSK modulated signal with channel symbol rate of 1 Msymbols/s and using 20 % roll-off according to the Nyquist pulse shaping principle. Show the essential characteristics of the spectrum in baseband form and also in bandpass form with 2 MHz carrier frequency.
    (b) Assume that an error control code with code rate of 2/3 is used. What is the avaible user bit rate? Repeat the same exercise for 16-QAM modulation.

3. Explain the following terms/concepts:
    * MMSE criterion
    * Minimum shift keying (MSK)
    * Soft decision decoding
    * Systematic code

4. Explain the structure and principle of linear channel equalizer, including an expression for the transfer function of the equalizer. Explain also the position of the channel equalizer in the optimal communication receiver. Which other modules are needed between the antenna and the equalizer? Explain also the noise enhancement problem in this context.

5. Consider the following (binary) <u>convolutional coder</u>. What is the rate of the code?
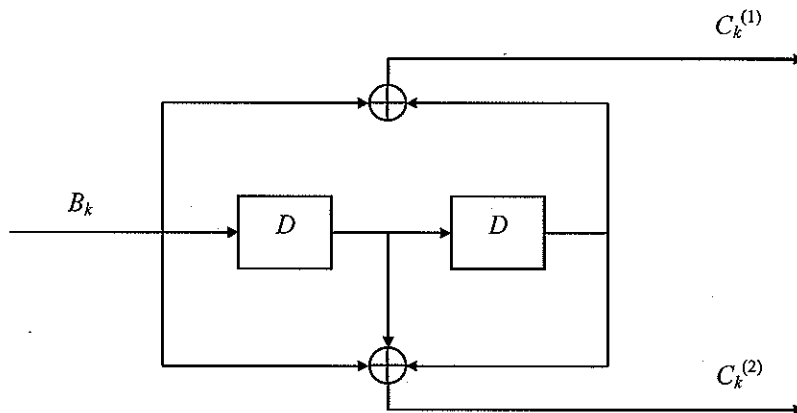
Suppose that $B_k = 0$ for $k < 0$ and $k > 3$. Represent the coder by a proper state-diagram. Draw also the corresponding trellis-diagram, label the transition weights properly, and carry out (hard) <u>Viterbi decoding</u> for the received bit sequence of [10 01 11 01 00 01].

Please remember to give feedback about course in Kaiku!