83050 DIGITAL TRANSMISSION (DIGITAALINEN SIIRTOTEKNIIKKA)
Exam 13.5. 2005

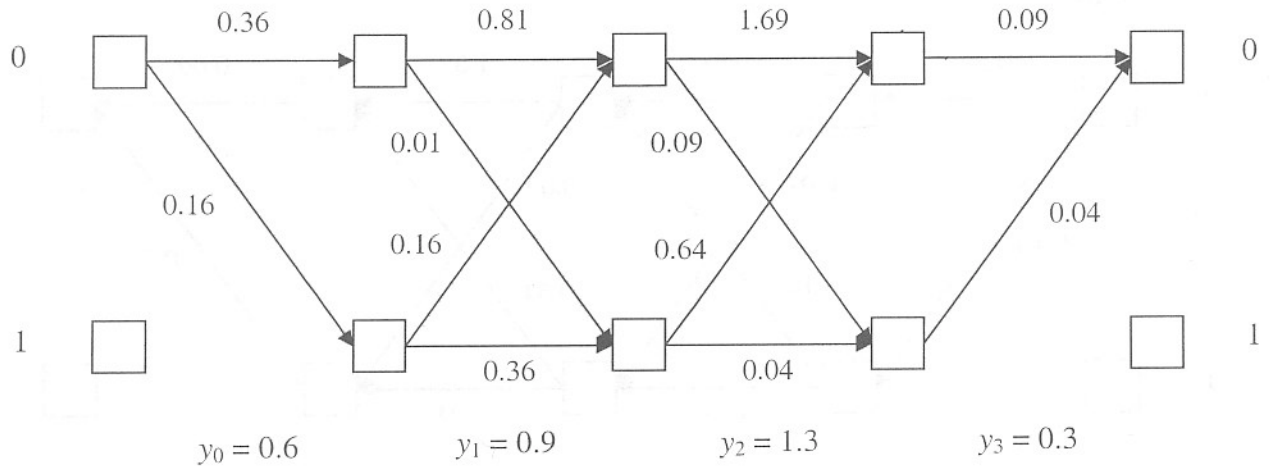
Suomenkielinen versio toisella puolella.

1. Present the model of a Binary Symmetric Channel (BSC) and explain/sketch how the capacity of such a channel depends on its properties. Discuss the capacity of a BSC also at an intuitive level. **(4 p)**

2. In a PAM system, the transfer function of the transmit filter is $G(f)$ and the channel transfer function is $B(f)$. Which criterion should the receive filter satisfy in order to achieve zero ISI? Which problems does this solution have, i.e., why it is not necessarily optimal? **(4 p)**

3. Using the Q-function, show in general form how the symbol error probability of PAM/QAM constellations in the AWGN case depends on the properties of the noise and the constellation? What is this Q-function? **(4 p)**

4. The figure shows a trellis diagram that can be used in the detection of a linearly digitally modulated signal after a multipath channel. The path metrics have been calculated in the diagram. The noise model affecting in the channel is additive white Gaussian noise. Explain how the symbol sequence detection problem can be solved in principle using this diagram. Which optimality criterion this detection principle satisfies? Give also a step-wise illustration about how the Viterbi algorithm works in this example case. What is the advantage of using Viterbi algorithm in such detection problems? **(6 p)**



5. Considering linear equalizers, describe the zero-forcing and MSE design principles. Assuming that the equivalent discrete-time channel transfer function and channel noise variance are known, what is the linear equalizer transfer function in each case? Which of these two principles results in lower mean-squared error at the equalizer output? Linear equalizers are said to have the *noise enhancement* problem. What does this mean? **(6 p)**

6. Present a (non-trivial) example block diagram of a convolutional coder. What is the code rate? Show the trellis diagram. Code the bit-sequence 0 0 1 0 1 0 (assuming that the initial state is zero). Describe briefly the techniques that are commonly used for decoding in case of convolutional code? **(6 p)**