# EE611 Problem Set 5

1. A decision-feedback filter needs to be designed for a ISI channel defined as follows:

$$v_k = \sum_{n=0}^{2} f_n I_{k-n} + \eta_k$$

where $f_n = 0.25$ for $n = 0, 2$ and $f_n = 1$ for $n = 1$. Assume that the DFE operates on the output of the noise-whitening filter. Let the length of the feed-forward filter be 4. (a) Write down, in matrix-vector form, the linear equations to be solved to determine the feed-forward filter coefficients. (b) Write down the equations to determine the coefficients of the feedback filter in terms of the feedforward filter coefficients and the channel coefficients. (c) Assuming that the variance of $\eta_k$ is 0.1, calculate the filter coefficients.

2. Find the capacity of the discrete memoryless channels shown in Figure 1.

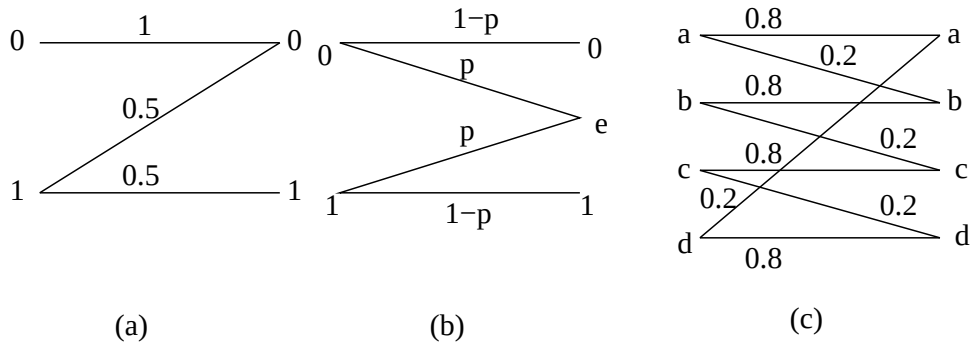


Figure 1:

3. Consider two parallel Gaussian channels with channel gains $h_1 = \sqrt{2}$ and $h_2 = 3$ and noise covariances $N_1 = 1$ and $N_2 = 2$. Assume that the transmitter knows the channel characteristics. Also assume that the noise in the two channels are independent of each other and the transmitted signals.

   (a) At "low" SNR, which of the two channels would you use?

   (b) For what value of net input power $P$ would you start using both channels?

   (c) Plot the capacity as a function of the net input power $P$ using the waterfilling power allocation. Compare this capacity with the capacity achieved using equal power allocation to the two channels.

4. Find and plot (as a function of $SNR = 1/\sigma^2$, where $\sigma^2$ is the noise variance) the capacity of a discrete-time AWGN channel when the input is restricted to be $\pm 1$. The capacity can be computed numerically.