E 8.1

On a fading channel, the received average signal energy is measured to be 10^{-10} Ws. The fading in the channel is assumed to be Rayleigh distributed. The additive white Gaussian noise has a spectral density of $N_o/2 = 10^{-12}$ W/Hz. The receiver in use is assumed to work satisfactory if the SNR is larger than 4 dB.

a. Determine the time availability for the level 4 dB.
b. We have the possibility of using diversity with selection combining. How many branches are required in order to obtain a time availability of 99.99%?

E 8.2

Data transmission over a radio channel exposed to Rayleigh fading. The modulation method is binary coherent PSK and the mean SNR is 13 dB.

a) Determine the bit error probability for the transmission without diversity.
b) Determine the number of diversity branches required to obtain a bit error probability lower than 10^{-5}. The combining method is maximal ratio combining.
c) What is the bit error probability for a channel only disturbed by AWGN for the same SNR?

E 8.3

A radio channel exposed to slow flat Rayleigh fading is used to transmit binary data with the data rate 36 kbit/s. The modulation method is noncoherent FSK. The bit error rate is measured to be $7*10^{-3}$. The goal is to reduce the bit error rate down to 10^{-6} by using frequency diversity with selection combining. Determine the required number of branches to obtain this bit error rate.

E 8.4

In a two-branch diversity system with the modulation method noncoherent FSK, selection diversity combining is used. The radio channel is slowly flat Rayleigh fading and the signal envelope in each branch is regarded as uncorrelated with the same mean energy. Determine the reduction (expressed in dB) in mean SNR obtained for a bit error probability of 10^{-4}, if the combining method is changed to maximal ratio combining.

Homework-8 Deadline 08 April 2002 at 10.00

Homework return box is located at Otakaari 5, 2nd floor, near the E-wing. You can also return the answers to the assistant just before the class.

A multipath fading channel has a multipath spread of T_m=1 s and a Doppler spread of B_d=0.01 Hz. The total channel bandwidth at bandpass available for signal transmission is W=5 Hz. To reduce of effects of inter-symbol interference, the signal designer selects a pulse duration T=10 s.

a) Suppose that the channel is used to transmit binary data via (antipodal) coherently detected PSK in a frequency diversity mode. Explain how would you use the available channel bandwidth to obtain frequency diversity and determine how much diversity is available.
b) For the case in (a), what is the approximate SNR required per diversity to achieve an error probability of 10^{-6}?
c) Suppose that a wideband signal is used for transmission and a RAKE-type receiver is used for demodulation. How many taps would you use in the RAKE receiver?
d) If binary orthogonal signals are used for the wideband signal with square law postdetection combining in the RAKE receiver, what is the approximate SNR required to achieve an error probability of 10^{-6}? (Assume that all taps have the same SNR).