Problems related to the lecture notes on OFDM in the course Digital Communication, advanced course (ETTN01). Study period 2, 2014.

X1. Consider an OFDM signal with K subcarriers.

a) Which QAM symbol is located around the reference carrier frequency f_{rc} if:
i) K=451 ii) K=900

b) Consider the equivalent complex baseband OFDM signal illustrated in Figure 1b in the lecture notes. At which baseband sub-carrier frequency will the QAM symbols a_0 and a_{K-1} appear if: i) K=451 ii) K=900

X2. a) It is given that $T_s = 105\ \mu s$ and $T_{CP} = 5\ \mu s$. Calculate an approximate bandwidth of the high-frequency OFDM signal if K=800.

b) When sampling the complex baseband OFDM signal corresponding to the case in a) is it then reasonable to use the sampling frequency $f_{samp} = 10.24$ Msamples per second?

X3. The complex baseband QAM signal $x_n(t)$ that carries a_n is given in equation (2.8) on page 8. N samples from this signal results in the discrete-time signal given in equation (2.18) on page 13. Consider now the Fourier transform of this discrete-time signal, given in equation (2.19). Show that a frequency-domain sample of this Fourier transform sampled at $\nu = \frac{g_n}{N}$ results in the value $a_n N$.

X4 Consider the case illustrated in Figure 4. Determine the frequency-domain samples (DFT) $X_0, X_1, \ldots, X_{11}$.

X5. How do we obtain the desired time-domain samples when we have found the frequency-domain samples in problem X4?

X6. Assume that K=9 and N=12.

a) Use equations (2.23) and (2.25) to determine the frequency-domain samples (DFT) $X_0, X_1, \ldots, X_{11}$.
b) Use equation (2.27), and the matrix given on page 15, to determine the frequency-domain samples (DFT) $X_0, X_1, \ldots, X_{11}$. Check that the same result as in a) is obtained.

X7. Consider the time-domain samples of the complex baseband OFDM signal $x(t)$ in equation (2.3) on page 6, which are the outputs from the IDFT. Assume that N=64, and that the CP is three samples. Specify the samples that constitute the CP, in terms of the outputs from the IDFT.

X8. Study the example on pages 28-29 so that you understand equation (6.8) and the conclusions on page 29.

X9. Note that the "complete" channel parameter $H_{eq,n}$ appearing in equations (6.15) and (6.16) on page 32, is not the same as the channel parameter $H(f_n)$ that appears in equations (5.12)-(5.13) on page 27. Explain why.

X10. Explain why the noise-less part of the frequency-domain samples obtained from the DFT in the receiver can be expressed according to equation (6.26) on page 37.