Answers to Problems related to the lecture notes on OFDM in the course Digital Communication, advanced course (ETTN01). Study period 2, 2015.

X1. a) -----

b) i) $f_{rc} = f_c = f_{450/2} = f_{225}$, so a_{225}

ii) $f_{rc} = f_c - f_\Delta/2 = f_{898/2} = f_{449}$, so a_{449}

c) i) a_0 at the frequency $g_0 f_\Delta = -\frac{450}{2} f_\Delta = -225 f_\Delta$ Hz.

a_{450} at the frequency $g_{450} f_\Delta = \frac{450}{2} f_\Delta = 225 f_\Delta$ Hz.

ii)) a_0 at the frequency $g_0 f_\Delta = -\frac{498}{2} f_\Delta = -449 f_\Delta$ Hz.

a_{899} at the frequency $g_{899} f_\Delta = \frac{900}{2} f_\Delta = 450 f_\Delta$ Hz.

X2. a) Since K is quite large we use that the bandwidth approximately is $K f_\Delta = 8$ MHz.

b) Yes, since $f_{samp} = 10.24$ Msamples per second, i.e., $f_{samp} = 1024 f_\Delta$, and $N = 1024$ is larger than K and N is also a power of 2.

X3. The easiest way is to evaluate the left hand side of Equation (2.23).

X4 a) See the lecture notes.

b) See page 16 in the lecture notes.

c) ----

d) The desired sequence $X_0, X_1, \ldots, X_{11}$ equals:

$Na_3, Na_4, Na_5, Na_6, Na_7, 0,0,0,0, Na_0, Na_1, Na_2$, where N=12.

X5. By using the size-N IDFT, in Equation (2.26) or in Equation (2.18)! Note that you do not need to calculate the time-domain samples that the IDFT produce.

X6. a) The desired sequence $X_0, X_1, \ldots, X_{11}$ equals:

$Na_4, Na_5, Na_6, Na_7, Na_8, 0,0,0, Na_0, Na_1, Na_2, Na_3$, where N=12.

b) -----

X7. The time-domain samples that constitute the CP in this case are: x_{61}, x_{62}, x_{63} . x_n is defined in Equation (2.13) on page 13.

X8. -----

X9. The channel parameter $H_{eq,k}$ also includes the effects on the OFDM signal from the different steps in the receiver, while the channel parameter $H(f_k)$ only describes consequences due to the physical multi-path (filter) channel. Please see page 39 for additional information.

X10. If we ignore the additive noise, then the only difference between the received OFDM signal and the transmitted OFDM signal is the equivalent channel parameters $H_{eq,k}$. See, e.g., the comment on page 42. So, at the receiver side the distorted signal points

$$(\boldsymbol{\mathcal{H}a})^{tr} = (a_0 H_{eq,0} \;\; a_1 H_{eq,1} \ldots . a_{K-1} H_{eq,K-1}) \qquad (6.25)$$

are carried by the received OFDM signal. We learned on page 19 that the corresponding DFT output sequence is a "rotated" version of the carried sequence of signal points. Hence, Equation (2.31) on page 20, which is valid at the transmitter side, needs to be modified at the receiver side. The modification means that $\boldsymbol{a}$ in Equation (2.31) should be replaced with $\boldsymbol{\mathcal{H}a}$ and then Equation (6.26) on page 44 is obtained.

X11. The K distorted and noisy signal points are given in Equations (6.28) – (6.29) on p. 44.