Eksempler på, hvordan 5 forskellige spørgsmål vedrørende sidste del af kurset Signal Processing kan se ud.

Problem 1

A 5 kHz sinusoidal signal is sampled at 40 kHz and 128 samples are collected and used to compute the 128-point Discrete Fourier Transform (DFT) of the signal.

a) What is the time duration in seconds of the collected samples?
b) At what DFT indices do we expect to see any peaks in the spectrum?

Problem 3

Without performing any DFT or FFT computations, determine the 8-point DFT of the signal

$$x[n] = 1 + 2\sin(\frac{\pi n}{2})\, 2\cos\left(\frac{3\pi n}{4}\right) + \cos(\pi n), \qquad n = 0, 1, \cdots, 7$$

Problem 4

A signal $x_a(t)$ that is bandlimited to 10 kHz is sampled with a sampling frequency of 20 kHz. The DFT of N =1000 samples of $x(n)$ is then computed, that is

$$X[n] = \sum_{n=0}^{N-1} x[n]^{-j\frac{2\pi}{N}nk}$$

with $N = 1000$.

a) To what analog frequency does the index k =150 correspond? What about 800?
b) What is the spacing between the spectral samples?

Problem 5

Sampling a continuous-time signal $x_a(t)$ for 1 second (s) generates a sequence of 4096 samples.

a) What is the highest frequency in $x_a(t)$ if it is sampled without aliasing?
b) If a 4096-point DFT of the sampled signal is computed, what is the frequency spacing in hertz between the DFT coefficients?

Problem 6

Because some of the $\frac{1}{2}N\, log_2 N$ multiplications in the decimation-in-time and decimation-in-frequency FFT algorithms are multiplications by ± 1, it is possible to more effectively implement these algorithms by writing programs that specifically excluded these multiplications.

a) How many multiplications are there in an 8-point decimation-in-frequency if we exclude the multiplications by ± 1?