Signal Analysis, Design of Experiments and System Identification
WiSe 2023/2024
5^{th} Computer Exercise
Signal Processing 01

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1. **Discrete Fourier Transform** - Introduction
   (a) Create three signals on your own, e.g., a sum of sine or cosine functions with different frequencies and different lengths. Plot the signals.
   (b) Perform a discrete and a Fast Fourier Transform. What do you observe? Are the results reasonable? (Hint: For DFT, see the file `DFT.m`, and `DFT_cosine`. For FFT, see Matlab documentation `Doc fft`). At least compare the computing time for one of the signals (use commands: `tic` / `toc`) for both the FFT and the DFT. What is the difference in computing times?
   (c) Perform the FFT now on your signals. Plot the spectra (both amplitudes and phases). (Hint: see the file `myFFT.m`).
   (d) At least to one of the signals, you should add some random noise. Implement FFT again, what do you observe? Increase the noise level; how does the result change?
   (e) For the case of the noisy signal, try *signal averaging*, what seems more appropriate averaging in time domain or frequency domain? (This requires a repeated generation of a noise corrupted signal, e.g., 10 times and then averaging either in time or frequency domain). Does that improve the quality of the results?
2. **Equation of Motion**
   (a) Please perform an FFT on the solution of the equation of motion, and plot the spectrum.
   (b) Study the effect of changing the damping on the results of FFT (try no-damping and different values of damping). Compare the spectrum of different cases? What do you observe?
   (c) What happens to the spectrum if you change the parameters for stiffness and mass?
   (d) Write down your observations. Please be careful with the annotation on the axes of your plots.
3. Document observations, findings and conclusions carefully.