

# Filter Design by Pole and Zero Placement

## Lab 11, DSP

### Objective

Students should understand how the pole-zero diagram influences the frequency response of a filter, and be able to design basic digital filters using the built-in tools of Matlab.

### Exercises

1. Open the Filter Design tool in Matlab (call `fdatool` in command line). Draw two zeros and two poles and place them such as to obtain:
  - a Low-Pass filter
  - a High-Pass filter
  - a Band-Pass filter
  - a Band-Stop filter

Visualize the frequency response, the impulse response and the filter coefficients in each case.

2. Using the controls available in the Filter Design window, design
  - a Low-Pass filter of order 3, IIR, with cutoff frequency 0.1
  - a High-Pass filter of order 3, IIR, with cutoff frequency 0.4
  - a Band-Pass filter of order 4, IIR, with frequency pass-band [0.22 0.28]
  - a Band-Stop filter of order 4, IIR, with frequency stop-band [0.22 0.28]
  - a linear-phase FIR filter of order

Experiment with the various options available. What happens in case of:

- a larger filter order?
- different filter types (Butterworth / Chebyshev 1 / Chebyshev 2 / Elliptic)?

2. Generate a 300-long periodic square signal, composed of 30 values of 1 followed by 30 values of 0, repeated for 5 times. Filter the signal with every filter from the previous exercise (use `filter()`). Plot a figure with 5x1 subfigures showing the original signal and the outputs of all filters.
3. Apply these filters on the sample signals `mtlb`, `chirp` and `train` (call `load mtlb`, `load chirp` and `load train`). Play the outputs at the speakers (`soundsc()`).

## Final questions

1. TBD