Exercises for topics discussed in Lecture 11:

(FIR filter design by method of windows, notch filters)

Matlab – voluntary homework (+1 point):

1)

Design a band-stop filter using the method of windows (do not use *fir1* function or *FilterDesigner*). Let the filter satisfies the following specifications: $\omega_{p1} = 0.3\pi$, $\omega_{s1} = 0.4\pi$, $\omega_{s2} = 0.6\pi$, $\omega_{p2} = 0.7\pi$, $\delta_s = 0.00001$, $\delta_{p1} = \delta_{p2} = 0.0002$. (Porat 301/9.13)
Visualize the magnitude response of the resulting filter.

(Conventional windows do not satisfy the desired ripple level. This requirement is satisfied only by Kaiser window with suitably chosen free parameter β).
(To find the suitable β use the formulas (9.2)/361-362 in Schaum or help to Matalb function *kaiserord()*).
(Select even filter order *N*, i.e., odd coefficient number *L*).

2)

Dependency of the transition-band width on the filter length (method of windows). Design a low-pass filter with cut-off frequency $\omega_c = 0.25\pi$. Select several different filter lengths (10,20,40,80,160,320) and compute for each length corresponding magnitude response. Visualize the the results within single graph. Observe, if the dependency of the filter length and transitional band width ($\Delta\omega = 4\pi/L$) holds.

Detailed procedure of filter design using windows is described in Schaum, chapter 9.3.1 / 359 or Lecture notes for Topic 11. The cut-off frequency ω_c is selected in the middle of the transitional band, i.e., $(\omega_p + \omega_s)/2$. The filter order is selected as *N=L-1*, where *L* is the number of coefficients of the impulse response. To design a high-pass, *N* must be selected as even.

- Evaluation criteria
  - Functionality/runable + correctness of solution
  - Comments in code
  - Originality
  - Effective code (fast)