EE 473 HW 6 (Fall 2019)

1) Homework is due **December 10, Tuesday!**

2) Be neat and well-organized with your submission and coding. Sloppy homeworks, including hand-written ones, will be rewarded with a 25-point deduction.

3) Do NOT exceed 4 pages. Additional pages will not be graded, or even looked at.

1: *Reading.* Oppenheim and Schafer/2e, Chapter 7 is behind us. We did not cover 7.5 in class but it is a reading assignment. Next is discrete Fourier transform (DFT) of Chapter 8.

2: *Kaiser.* Design a low-pass filter (LPF) using the Kaiser window where the maximum passband and stopband tolerances are $\delta_p = 0.05$ and $\delta_s = 0.01$, respectively. The passband should end at $\omega_p = 0.4\pi$ rad, and the stopband should begin at $\omega_s = 0.6\pi$ rad. Show all steps of your design and plot the magnitude/phase responses of the filter.

3: *Parks-McClellan.* Now design an LPF using the Parks-McClellan algorithm with $K = \delta_p/\delta_s = 5$. As in **2**, the passband ends at $\omega_p = 0.4\pi$ rad and the stopband begins at $\omega_s = 0.6\pi$ rad. Set the filter order the same as what you determined for Kaiser filter in **2**. (Your initial estimate of the $L+2$ extremal frequencies can be equally spaced over the passband and stopband. See Oppenheim and Schafer/2e, Sections 7.4 and 7.5, as well as the uploaded Remez.pdf document for more detail.) Show all steps of your design and plot the magnitude/phase responses of the filter.

Computer programs are available for carrying out the minimax optimization in Parks-McClellan algorithm numerically. They are based on the so-called Remez exchange algorithm. In the Matlab signal processing toolbox, the function `remez` can be used to design minimax GLP FIR filters of Type I, II, III and IV. The function `cremez` can be used to design complex-valued FIR filters with arbitrary phase. (Note: Newer versions of Matlab use `firpm` instead of `remez`.)

4: *Conclusion.* Comment on how the two approaches (Kaiser versus Parks-McClellan) compare in their frequency responses? Which one would you prefer, why?