**First miniproject: Audio processing with digital filters**

**Objectives:** Implement digital FIR filters with Matlab to enhance or attenuate different frequency bands of an audio signal. Please refer to the powerpoint notes “sig2\_4.pptx” for details.

1. Basic outcome (must be achieved to attain a PASS grade)

Implement 4 variations of a low-pass filter, based on 4 different window functions, namely, Rectangular, Hanning, Hamming, and Blackman. Major steps for building each variation of the digital filter are outlined as follows. A sample Matlab code for implementing a FIR filter based on a rectangular window “Rectangular\_Window\_FIR.m” is provided.

1. Generate a low-pass transfer function with certain cut-off frequency in the frequency domain.
2. Convert the transfer function to a unit impulse response in the time domain.
3. Apply one of the 4 window functions, determine the length *N* of the unit impulse response, and find the maximum magnitude of the side-lobes in the frequency domain.
4. Construct a FIR digital filter based on the unit impulse response.
5. Input an audio clip, and input it into the FIR filter (a sample audio clip “octave.wav” is provided).
6. Evaluate the output audio signal manually (through listening), and analyzing the gain/attenuation at different frequencies.
7. Advanced outcomes (optional, marks will be added if high quality works on advanced outcome are shown).

Four suggested advanced outcome topics:

* Repeat 1 (tasks of the Basic outcome) with different cutoff frequencies and audio clip(s).
* Convert the digital filters implemented in 1 to high-pass filters, and repeat steps 1d) to 1f).
* Develop a user friendly GUI for loading and saving the audio clips, selecting digital filters, controlling various functions (e.g. play, stop, etc.), and showing important results.
* Implement a 3-band equalizer for controlling the gain/attenuation of the bass, midrange, and treble frequency range.

1. Deliverables
   1. **1st assignment**: The Matlab source codes of this miniproject, with instructions on operations (e.g. which file to run), to be submitted via Canvas within one week (i.e. before the end of Week 6).
   2. **2nd assignment**: Demonstration and presentation on Week 7 (details to be announced). Softcopy of the presentation to be submitted via Canvas before the end of Week 7. In the demonstration, each group may be asked to run the source codes it submitted previously.