# EE 321: Digital Signal Processing
Python Assignment: Set - P03

1. A music equalizer can adjust the amplitude of the audio signal at different frequency bands. A music file *music.wav* is provided. You will implement a 3-band music equalizer. The audio spectrum will be divided into 3 bands: 20 Hz – 200 Hz, 200 Hz – 2 KHz, and 2 KHz – 20 KHz, each with adjustable gains. The block diagram of the 3-band equalizer is shown as follows, where $G_n \in [0,1]$ is the gain of the nth band.
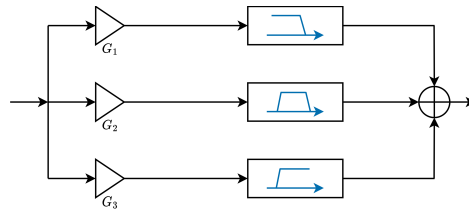
(a) First you have to design three filters (low-pass filter, band-pass filter, and high-pass filter) in Python. Use FIR filter with Kaiser window, $\beta = 0.5$, order $= 80$, $F_s = 8KHz$. Plot the magnitude and phase response of all the designed filters. (Do not use any DSP Python libraries for filter design. Build your own filter function.)

(b) Implement the designed equalizer in Python. Verify the frequency response of the equalizer by plotting the magnitude response of each band. Load the audio signal from the music file "music.wav" into a numpy array. Analyze and plot the frequency components present in the audio signal.

(c) Apply the designed equalizer to the loaded audio signal. Plot the spectrogram of the equalized audio. Adjust the gains at different bands and observe the effects. (to avoid clipping, please divide the gain of the original audio signal by 3 before passing it through the equalizer).

Submission Guidelines:

- Read all the questions carefully. If you have any doubts, discuss with the corresponding TA.

- Write all the codes in a single IPYTHON Notebook only (Jupyter Notebook or Google Colab). Submit the IPYTHON Notebook (.ipynb format) containing all your codes, plots, comments, and explanations for each task. You can create separate sections and subsections within the notebook for different parts of the questions.

- Do not use any DSP Python libraries. Build your own functions from scratch.

- Prepare a detailed assignment report explaining all the questions asked, different steps, derivations and calculations, algorithms, and generated outputs and attach all the necessary plots. Submit the report in PDF format only.