- Zip all your files and label the zip file as **[Roll number in lower case]_hw8.zip**
- The scripts will be executed and compared against the submitted PDF file.
- Submit a single zip file containing `.tex, .m, .pdf` and image files only.
- Generic instructions from previous homeworks stand.
- **This assignment is to be done entirely in Python**

Identify the Frequencies

Given a time signal, $g(t)$, the forward Fourier transform can help evaluate the signal in the frequency domain, $\widehat{g}(f)$. The transformation is given by

$$\widehat{g}(f) = \int_{-\infty}^{\infty} g(t) \exp(-2\pi i f t) dt \tag{1}$$

Use the above information and the time signal given in the file `signal.inp`, to identify the key frequencies present. A snippet of this signal is shown in Fig. 1.

1. Plot the amplitude of each frequency f.
2. Identify the magnitudes of the different frequencies.
3. What do you understand by Nyquist's sampling theorem?
4. For the more musically inclined, can you identify the notes (or chord) that is represented by the given signal? Refer to a chart of frequency vs key-chart.

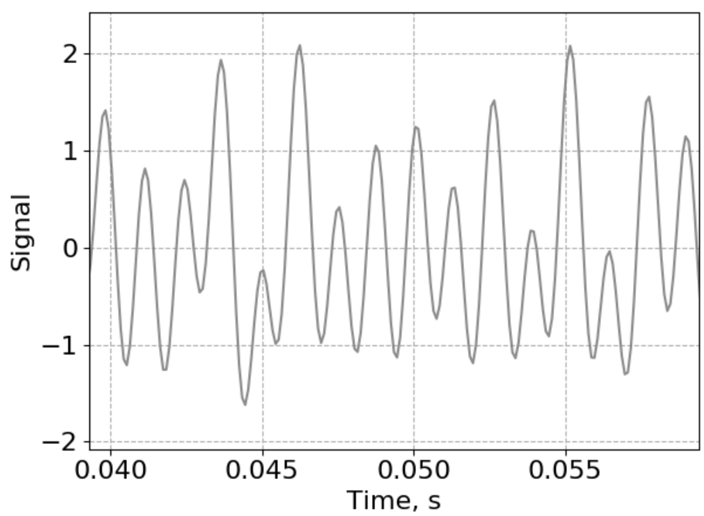

Figure 1: A snippet of the signal given in `signal.inp`.

Remove the Noise

Consider a snippet of a signal shown in Fig. 2. This signal has "broadband noise", i.e., noise that may exist in a large frequency range. However, in the present scenario, we know that the noise is of a small amplitude (always less than 0.01). Perform the following,

1. Perform an FFT of this signal, and plot the frequency-amplitude diagram.
2. Identify the “true frequencies” in the signal.
3. In the frequency domain, eliminate these frequencies, and replot the time-signal overlaid with the original signal. Zoom in the region for $t \in [0.04, 0.06]$ seconds.
4. Perform a five point median average of the time-signal, and then plot the FFT of the average time-signal. Is the noise eliminated? What about the amplitude of the “true signal”?

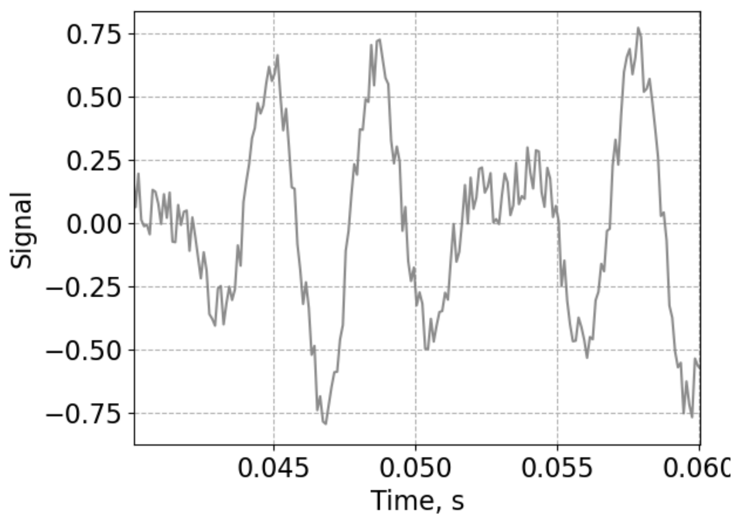

Figure 2: A snippet of the signal given in `noise.inp`.