# Problem Set 7 – Due November 1st, 2018

In this problem set, you have been provided with recordings of three separate waveforms. To view the waveforms and analyze their shapes, you can use a program such as Wavesurfer.

1. For each of the waveforms please answer:
   1. What are the lay terms used to describe the shape of these waveforms?
   2. What is the periodicity of each waveform?
   3. Discuss why these waveforms are different. Refer to harmonics.
2. What is the smallest number of bits required to represent each waveform?
3. Now consider the third waveform. Let's downsample this by taking every other sample from the waveform. In Matlab this would be y(1:2:end) or Python y[::2]. Now one can save this as a 4 KHz file.
   1. Will the spectrum between 0 and 2 KHz be different from the spectrum in that range before downsampling? If yes, how? If not, why not?
   2. Try the same procedure by taking every 10th sample. Does the spectrum between 0 to 400Hz look any different? If yes, how? If not, why not?
4. List two applications each that would call for narrowband and wideband analysis. Explain the situation and why the alternate analysis would not provide the details needed.
5. How do spectral and cepstral representations vary with respect to representations of source and filter components of a speech waveform? Discuss with respect to the Fourier transform operation.
6. Linear predictive coding
   1. Why is the residual of an LPC spectrum reflective of the source?
   2. Would you be able to compute an LPC on longer streams of data (an audiobook reading for example) or is it better to compute on smaller samples to build up an envelope? Please explain.
7. Cepstral representations
   1. What does the cepstral peak prominence (CPP) measure reflect when applied to a stationary signal? Why would voice clinicians care?
   2. Why have MFCCs generally been used as features for speech recognition as compared to LPC coefficients?
8. Watch this video: <https://youtu.be/w56RxaX9THY>. Why is it that researchers were able to hear the sounds once the recordings were sped up? Explain how this changes the signal that is played back.