Signal Analysis
Lab 3: Spectra

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Due: Sept 25, Group A - 9:00am, Group B - 1.00pm

1) Write a function in the programming language of your choice (preferably Matlab or Python) that plots the two-sided amplitude or phase spectrum given a set of one-sided f_k and X_k for all positive f_k. The inputs to the function should be two 1D arrays, one each for f_k and X_k, and a flag that asks the function to plot the amplitude or the phase spectrum.
2) Using the above function, plot the amplitude and phase spectra for $\{f_k, X_k\} = \{(0, 5), (5, 1.5e^{i\pi/4}), (-5, 1.5e^{-i\pi/4}), (20, 2e^{i\pi/2}), (-20, 2e^{-i\pi/2})\}$.
3) Plot the time signal $x(t)$ that corresponds to the above spectrum in question 2.
4) Perform the Fourier Transform of the above signal $x(t)$ using Matlab's fft or Python's $numpy.fft.fft$ function. Plot the amplitude and phase spectra. Do these spectra match with the spectra in question 2?
5) Plot the time-series in the file $Lab3\_t\_xt.dat$.
   a) Visually guess the time period T_0 of the signal.
   b) Find the spectrum $\{f_k, X_k\}$.
   c) Plot the two-sided amplitude and phase spectra.
   d) What is the fundamental frequency f_0?
   e) What harmonics of f_0 are present in $x(t)$?