ECE 153A - Homework 5

1. A sampler of sampling frequency 1 kHz is taking samples of a sine-wave input signal at different frequencies.

   Consider input signal frequencies of 250 Hz, 333 Hz, 667 Hz, 750 Hz, 1250 Hz and 1333 Hz. For each input frequency:

   (a) Plot 50 samples of the sampled signal.

   (b) From that plot, find the frequency of the reconstructed signal.

   Hint: You may use whatever plotting package to draw this picutre, e.g. Excel/Libreoffice, Python, Matlab.

2. An audio ADC has a sampling frequency of 44.1 kHz. It is clocked by a clock source with 1 μs of RMS jitter. It is fed with a 15 kHz sine wave at 1 V amplitude, which exactly fills its dynamic range.

   (a) What is the period of each sample?

   (b) What is the magnitude of the RMS voltage noise that results from that jitter?

   (c) What is the effective number of bits of the converter, assuming this is the dominant noise source?

3. An audio signal, sampled at 50 kHz is processed using a 128-point FFT for frequency identification.

   (a) What is the frequency spacing between FFT bins?

   (b) What is the highest frequency this system can identify?

   (c) If the sampling frequency is increased, and the number of FFT bins remains constant, what happens to the bin spacing?

   Applying a peak-fitting algorithm to the results allows the FFT algorithm to identify frequency differences as small as 1/5th the bin spacing.

   (d) What is the largest sampling frequency that can be used with a 128-point FFT that would allow 440 Hz and 461 Hz to be clearly distinguished?