

## 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 picture, 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  $\mu$ s of RMS jitter. It is fed with a 7.04 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?