ME-5700 Assignment #3 – Fall 2015
Due: October 2, 2015 at 5:00pm.
INDIVIDUAL WORK ONLY!

The goal of this assignment is to learn about how to use and implement the FFT in Matlab and understand leakage.

Laboratory: Windows and the FFT.

Use the function generator/amplifier/speaker/microphone/NI Compact DAQ 9234 card to perform the following tasks.

1. Generate a sinusoidal signal that will have no leakage with respect to your sampling parameters and produce an amplitude spectrum using the proper window for this data. Pick a frequency that is near the center of your spectrum, where your sampling frequency is determined by taking 51,200 and dividing it by the 5^{th} digit of your M-number. Round this sampling frequency to the nearest available sample frequency on the 9234 as given by Equation 1 below.

2. Generate a sinusoidal signal that exhibits the greatest leakage error with respect to the sampling parameters used above. Produce an amplitude spectrum using the window that will produce the largest leakage error. Pick a frequency that is near the center of your spectrum.

3. Generate a sinusoidal signal that exhibits the greatest leakage error with respect to your sampling parameters and produce an amplitude spectrum(s) using the window that produces the smallest frequency error and the smallest amplitude error, this may require more than one window to be used. Pick a frequency that is near the center of your spectrum.

Homework

4. Repeat steps 1-3 of Lab portion above in MATLAB. Generate a signal with the same amplitude and frequency of that in steps 1-3, quantize it with 24 bits, and the same range used on the NI CompactDAQ. FFT this signal using the same window used in the NI CompactDAQ and compare your results to those achieved using the NI CompactDAQ. Include any plots needed to support your comparison.

5. Determine appropriate signal processing parameters to acquire a sinusoidal signal of 250 Hz with an amplitude of 500 millivolts rms. This is very typical of a microphone calibration signal. You should be able to estimate the amplitude in both the time and frequency domains which may require different acquisition settings. You may only use sampling frequencies and blocksizes that are available on the NI 9234 card. Use the minimum sampling rate(s) possible to clearly accomplish this task. Include appropriate plots to show your results in Matlab.

6. Implement the Uniform, Hanning, and Flattop windows in your Matlab code with both Amplitude and Energy Correction Factors.

7. Implement block averaging in your Matlab code for arbitrary blocksizes. Average the FFT results from blocks when given a long time history that is to be processed in smaller blocks, each of length N points.

8. Using the signal generator create a square wave whose frequency falls on a delta_f with an amplitude of 2.3 volts-peak and capture enough time data on the NI9234 for 50 averages with a blocksize of 1024. Process this time history using the MATLAB code developed in steps 6 and 7 using both the Flattop and Hanning windows. Overlay the two spectrums to show the differences in the windows.

Note: The following equation provides the available data rates of the NI 9234

$$f_s = \frac{(f_M) \div 256}{n}$$

where n is any integer from 1 to 31
and the internal master timebase, f_M = 13.1072MHz

Deliverables:

Submit a report that describes the work you have completed along with answers to the questions. The text of your write-up should be **no more than two pages.** You **do not need to include all plots** which you generated in the report, only include plots necessary to support your discussion and conclusions. ***Please use the grammar and spell checker in your word processing program.***

Reports must be submitted digitally through CANVAS by the due date given.