

## Fourier GUI Approximation Assignment

You will need the following files to complete this assignment

- 1) FourierGUI.exe-----LabVIEW executable file
- 2) Fourer\_LabVIEW\_GUI.pdf-----Documentation file including Fourier Series

Note: When a non-integer frequency value is used for wave parameters and the approximation appears out of phase click on the STOP button on the bottom right of the GUI and then restart the GUI by selecting Operate>Run from the menu bar

### Part 1 Square Wave Approximation

Open the fourierGUI executable file. Set the wave parameters for a square wave of amplitude one (1) and frequency (2). View the time response tab to verify that the appropriate square wave has been generated. Viewing the frequency response window will show the individual frequencies generated to simulate the square wave.

- 1) Using Appendix A Fourier Coefficients calculate the first five sinusoid amplitudes and frequencies required to approximate a square wave of amplitude 1 at a frequency of 2Hz. Show your calculations for the first two sinusoids. Input these values in the fourierGUI for each of the sine waves on the left side of the GUI to approximate the square wave and verify that the time response window shows the appropriate approximation by selecting the auto approximation option.
- 2) Looking at the time response notice that the most prominent sinusoid is the largest amplitude wave with the lowest frequency. Now view the frequency response window to see the individual sinusoid frequencies overlaid in red on the first five frequencies of the square wave. Consider how frequency domain processing may be useful in determining the content of a measured signal.
- 3) Now view the low-pass filter tab in the fourierGUI. Select a value of 100 Hz for the cut-off frequency. What, if any, are the noticeable differences in the time response of the approximated square wave? What are the differences in the frequency response plot at this cut-off frequency? Now select a cut-off frequency closer to the highest frequency sinusoid. How does the time-domain plot change? How does the frequency domain plot change as the cut-off frequency is lowered?

Note: The x-axis scale on the plots can be adjusted by double-clicking the highest value to highlight the number then entering the desired value

## Part 2 Sawtooth Wave Approximation

- 1) Select the sawtooth option in the wave selector drop-down menu. Generate a sawtooth wave of amplitude 1 frequency 6Hz. Calculate the required amplitudes and frequencies using the appropriate Fourier series approximation. Once these values are inputted in the GUI go to the band-pass filter tab. Select the upper and lower cut-off frequencies such that the fourth sinusoid (24Hz) signal is isolated. What do you notice about the resulting summed time response?
- 2) Enter an amplitude and frequency of one (1) for the wave parameters. Select the frequency response tab and select auto approximate. What do you notice about the spacing of the frequency traces, (red bars), for the approximated signal. Select a frequency of 2 for the wave parameters and notice the difference in spacing. What is it about the Fourier series approximation for a sawtooth wave that causes this inconsistency with respect to the square and triangle wave?

## Part 3 Triangle Wave Approximation

- 1) Change the wave selector to triangle wave. With the auto approximation option selected choose the amplitude and set the frequency to 1 for the wave parameters. View the time and frequency response tabs. Now change the frequency to 1.5 and notice the change in the time response plot. Look at the frequency response plot and compare the frequency traces to the frequency values for each of the five sinusoids. What have you learned with respect to frequency and sampling rate that might help to explain what you are seeing when a non integer frequency is chosen.
- 2) To further understand the effects of leakage attempt to isolate the second sinusoid which should be at a frequency of 4.5. Using the band-pass filter set the lower cutoff frequency to 4.4 and the upper cutoff frequency to 4.6. Notice how the 4.5 Hz signal is not seen as an individual trace in the frequency response. Instead, the individual signal is smeared across a frequency range. What is the cause of this and how is this concept important during laboratory testing and signal processing?

## Write-up

A short write-up (memo-report) is required upon completion of the assignment. Include answers to the questions from each of the three parts in the discussion section of the report. Don't forget to reference the files and documents used for the assignment.