Fourier Series MATLAB GUI Assignment

This assignment can be used with the Fourier Series MATLAB GUI. It helps to illustrate some of the main concepts of the frequency domain and the Fourier series.

1. Using the frequency slider bar for the first sine wave, adjust the frequency to any value and update the plot to see the result. Look at the FRF plot at the bottom left of the window. Notice that, when the frequency is an integer number, the FRF plot is a single line. When the frequency is not an integer, however, the energy of the signal appears to be "smeared" over several frequencies. This effect is worst when the sine wave is exactly halfway between two frequencies (e.g., 12.5 Hz). This "smearing" occurs due to something called leakage. Leakage is commonly seen in real laboratory measurements, and in this case it is an effect of the FFT calculation used to produce the plot. It is not a real characteristic of the signal. Consider this when looking at the FRF plots of other signals.

2. Plot two sine waves together, with the following properties:
   Sine wave 1: Frequency: 10 Hz
               Amplitude: 10
   Sine wave 2: Frequency: 30 Hz
               Amplitude 0.3
   Examine the plot. Can you see the high-frequency signal on the time-domain plot? Now look at the FRF. Is the high-frequency signal easier to see in the frequency domain?

3. Again, plot two sine waves together, with the following properties:
   Sine wave 1: Frequency: 3 Hz
               Amplitude: 0.2
   Sine wave 2: Frequency: 45 Hz
               Amplitude: 9
   Can you clearly see the low-amplitude signal in the time domain? The frequency domain? Consider how frequency domain processing might be useful in the laboratory to determine the content of a measured signal.

4. Experiment with adding multiple sine waves together, and examine what the resulting signal looks like.

5. Add the "Square wave" sample signal to the plot. Try adjusting the properties of the five sine waves to replicate the square wave (hint: try adjusting the phase, in addition to the frequency and amplitude). Comparing the frequency content of your signal with that of the sample signal can help you do this.

6. To view the correct values for the first five terms of the Fourier series of a square wave, press the "Set" button on the right side of the window. Compare the FRF of the summed signal to that of the actual square wave, how do they differ? Try removing the higher-order terms from the summed signal, one at a time. How many terms are needed to give a fairly good approximation of the square wave?