DSPIRA GnuRadio Lessons: Introduction and Simple Spectrometer
Lesson 3: Fourier Methods

In this activity you will learn a little about Fourier analysis theory and how the FFT (fast Fourier analysis) block works. This is an important component of a spectrometer program.

Building a Square Wave

- Open your 6 function signal generator from Lesson 2.
- **Save as . . .** using a new file name.
- Set the frequencies and amplitudes of sources 1-6 according to the following chart. These can be set as the Default Value in each QT GUI Range frequency block, or they can be set after starting the program using the sliders. (You can double-click on the value in the block next to the slider and type the value.)

Signal Source number	Frequency (Hz)	Amplitude
1	100	1.000
2	300	0.333
3	500	0.200
4	700	0.143
5	900	0.111
6	1100	0.091

- Run the program, and observe the Time Domain Display. You should notice a square wave pattern in time.

Building a Triangle Wave

- In each of the amplitude **QT GUI Range** blocks, change the ***Start*** value from 0 to -1.
- Now set the frequencies and amplitudes of sources 1-6 according to the following chart.

Signal Source number	Frequency (Hz)	Amplitude
1	100	-1.000
2	300	0.111
3	500	-0.040
4	700	0.020
5	900	-0.012
6	1100	0.008

- Run the program, and observe the Time Domain Display. You should notice a triangular wave pattern in time.

Discussion

- The above two activities illustrate an extremely useful principle that any function can be represented as a sum of sine and cosine functions, called a **Fourier series**.
- The Fourier series has many such applications in science and engineering.
- In the first example above, notice that the six terms summed result in a pattern that is mostly a repeated rectangular pattern, but it is not an exact rectangle. Including more terms would result in a more rectangular pattern. If enough sine and cosine terms are included in the sum, many functions can be accurately represented by a Fourier series.
- In DSP we are interested in determining which sine and cosine functions are included in a signal. To do this, we need to do what was done in the activities above **in reverse**. That is, given a signal pattern, we want to apply a procedure that will tell us what sine and cosine functions make up the Fourier series of that signal, and what their amplitudes are. This is accomplished using a **Fast Fourier Transform** (FFT). In Lesson 4 we will investigate the function of an FFT using our 6 function signal generator from Lesson 2.