## MULTISIM DEMO 13.2: FOURIER ANALYSIS IN MULTISIM

Just like with Filters, there are two ways to analyze circuits in the frequency domain. The first, is the Spectrum Analyzer Instrument. The other way is with the actual "Fourier Analysis" available under the Analyses menu. It allows for a little bit more control and flexibility.

Let's analyze a periodic signal of our own making generated by the PIECEWISE\_LINEAR\_ VOLTAGE source. Place it in the schematic and leave its output hanging as shown in Fig. 13.2.1.



Insert the time-voltage pair shown in Fig. 13.2.2 below. You'll notice that the overall length of the signal which we are creating is 0.05 seconds. Checkmark the "Repeat data during simulation" box at the bottom of the PWL window. This makes the PWL signal periodic. Since the overall length of our signal is 0.05 seconds, this means that the frequency of the repeating signal will be 20 Hz (1/0.05 s).

	PWL Voltage
	PWL Voltage     Label Display Value Fault Pins User Fields Analysis Setup     C Use data directly from file     File name     Browse     Edit file     Initialize from file     Image: Comparison of the state of the
-	Replace OK Cancel Info Help   Figure 13.2.2 PWL source with time-voltage pairs inserted.

👝 🖸 🛛 🕅 Grapher View File Edit View Tools 🗅 🚅 🖬 🚭 🔃 👗 🖻 🖻 의 🗰 🗏 1월 🔍 🍳 🔍 🔍 🔂 🕉 💰 🕫 🦫 , 🔝 🕅 Fourier Analysis Transient Analysis Circuit2 Transient Analysis 1.25 1.00 750 00m 500.00m 250.00m 0 -250.00m 25m 50m 75m 100m0 Time (S) Selected Diagram: Transient Analysis Figure 13.2.3 Output of Transient Analysis showing periodic waveform .

Run a Transient Analysis on the output of the PWL source from 0 to 0.1 seconds. The resultant output signal should look like that shown below in Fig. 13.2.3.

Now let's see what sinusoidal components make up the signal shown above. Exit the Grapher window, and open up the Fourier Analysis setup window which can be accessed under Simulate>Analyses>Fourier Analysis. The window will look like that in Fig. 13.2.4 found on the next page.

We know that the frequency of our signal is 20 Hz, so let's insert 20 Hz into the Frequency resolution (Fundamental Frequency) field. Set the number of harmonics to 5, and set TSTOP to 0.3 seconds.

What we've just done is told Multisim to look for the sinusoidal components which make up our signal in Fig. 13.2.3 starting with a fundamental frequency of 20 Hz and working up to the fifth harmonic by analyzing a 0.3 second sample of the signal.

When you press Simulate, a chart/graph should appear similar to the one in Fig. 13.2.5. The chart at the top lists the primary characteristics of the sinusoids which make up the signal which we are analyzing up through the fifth harmonic. The plot at the bottom is simply a graphical manifestation of the chart at the top (pretty much identical to the output of the Spectrum Analyzer Interactive Simulation tool.)

You'll notice in from Figures 13.2.5 and 13.2.6 (found on page 13.2-4) that the only significant sinusoidal signals occur at 20 Hz, 60 Hz, and 100 Hz. The signals at 40 Hz and 80 Hz are practically non-existent.

🛷 Fourier Analysis	×
Analysis Parameters Output Analysis Options Sum	mary
Sampling options	
Frequency resolution (Fundamental frequency):	20 Hz Estimate
Number of harmonics:	5
Stop time for sampling (TSTOP):	0.3 sec Estimate
Edit transient analysis	
Results	
Display phase Display	Chart and Graph 💌
☑ Display as bar graph	
Normalize graphs Vertical scale	Linear
More Options	
Degree of polynomial for interpolation:	1
Sampling frequency:	2000 Hz
Simulate OK	Cancel Help
Figure 13.2.4 Fourier Anal	lysis setup window

Multisim's Fourier Analysis allows for more in-depth exploration and analysis of periodic signals in the frequency domain than what the Spectrum Analyzer provides. For example, we could get a Fourier output directly of a current variable (or even power) with the Fourier Analysis, but we could not do that with the Spectrum Analyzer. However Fourier Analysis is not the most user-friendly analysis. The two "Estimate" buttons (visible in Fig. 13.2.4) don't always work and when they do, they often provide incorrect or just plain wrong values such as infinity. So for very complicated periodic signals, it may take a few iterations with the Fourier Analysis in order to obtain satisfactory results.

Grapher View e Edit View Tools								
			N v≠ I an Ba I ⊞a Indi	300				
		0, 0, 0, 🖬 🗞 🕅						
urier Analysis				ot 110				
				Circuit2			i i i i i i i i i i i i i i i i i i i	
Fourier analysis for V(1):								
DC component:	0.5							
No. Harmonics:	5							
THD:	11.8325 %							
Gridsize:	128							
Interpolation Degree:	1							
Harmonic	Frequency	Magnitude	Phase	Norm. Mag	Norm. Phase			
1	20	0.405366	-90	1	0			
2	40	2.89209e-016	142.293	7.13452e-016	232.293			
. 3	60	0.0451131	-90	0.11129	-4.2633e-014			
4	80	1.64934e-016	90.0424	4.06877e-016	180.042			
5	100	0.016293	-90	0.0401933	1.27898e-013			
1 3 2 4 3 5 4								
			F	ourier Analysis				
500m 7								
400m -								
300m -								
200m -								
100m -								
0 - <u>4</u>	۵ ۵	AA	<u>م م</u>	<u></u>		aa	<u>م</u>	4
100								
-100m +0		25	50		75	100		
Frequency (Hz)								
			igure 13.2.5					

8 Harmonic	Frequency	Magnitude	Phase	Norm. Mag	Norm. Phase
9 1	20	0.405366	-90	1	0
10 2	40	2.89209e-016	142.293	7.13452e-016	232.293
11 3	60	0.0451131	-90	0.11129	-4.2633e-014
12 4	80	1.64934e-016	90.0424	4.06877e-016	180.042
13 5	100	0.016293	-90	0.0401933	1.27898e-013
14	Fig	ure 13.2.6 Enlargen	nent of table from	Fig 1325	