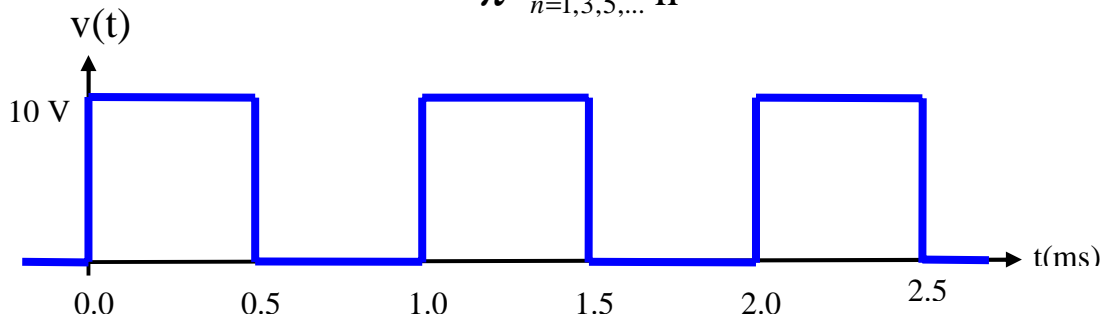


Fourier Analysis of a Pulse Waveform using PSPICE

A Fourier Analysis can be performed in PSPICE as part of a Transient Analysis. The pulse waveform shown below was placed in parallel with a resistor and a Transient Analysis and Fourier Analysis was performed for three periods of the waveform. PSPICE generated the Fourier series coefficients for each harmonic and they were compared to those calculated using the Fourier series shown below.

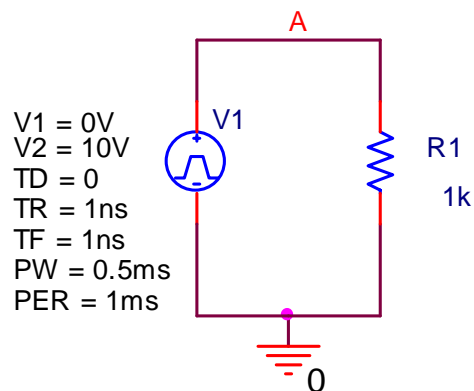
$$v(t) = 5 + \frac{20}{\pi} \sum_{n=1,3,5,\dots}^{\infty} \frac{1}{n} \sin(2000n\pi t)$$



PSPICE Schematic:

EGR 261
 Signals and Systems
 File: FourierPulse.opj

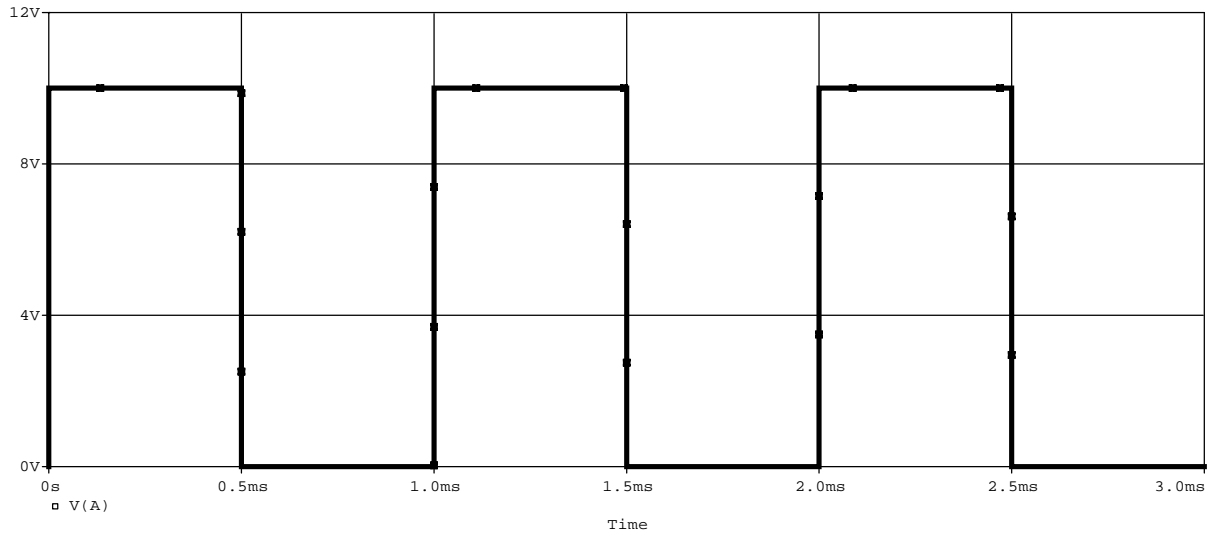
Fourier Analysis of a Pulse Waveform using PSPICE



$T = 1\text{ms}$, so $\omega_0 = 2\pi/T = 2000\pi =$ fundamental frequency (in rad/s)
 $f_0 = 1/T = 1000 =$ fundamental frequency (in Hz)

The Fourier Series for the waveform shown is $v(t) = Av + 4Vm/\pi * \text{Sum}[(1/n)\sin(n\omega_0 t)]$
 or $v(t) = 5 + 6.366 * \text{Sum}[(1/n)\sin(2000n\pi t)]$ (odd harmonics only)
 or $v(t) = 5 + 6.3662\sin(2000\pi t) + 2.1221\sin(6000\pi t) + 1.2732\sin(10000\pi t) + 0.9095\sin(14000\pi t) + 0.7074\sin(18000\pi t) + 0.5787\sin(22000\pi t) + \dots$

PSPICE Output Waveform:



PSPICE Simulation Settings:

Simulation Settings - FourierPulse

General | **Analysis** | Include Files | Libraries | Stimulus | Options | Data Collection | Probe Window

Analysis type: Time Domain (Transient) ▼

Run to time: 3ms seconds (TSTOP)

Start saving data after: 0 seconds

Options:

- General Settings
- Monte Carlo/Worst Case
- Parametric Sweep
- Temperature (Sweep)
- Save Bias Point
- Load Bias Point

Transient options

Maximum step size: _____ seconds

Skip the initial transient bias point calculation (SKIPBP)

Output File Options...

Transient Output File Options

Print values in the output file every: _____ seconds

Perform Fourier Analysis

Center Frequency: 1000 hz

Number of Harmonics: 11

Output Variables: V(A)

Include detailed bias point information for nonlinear controlled sources and semiconductors (/DP)

OK

Cancel

Help

PSPICE Output File:

```

**** 03/28/ 15:06:44 ***** PSpice Lite (Mar 2000) *****
** Profile: "SCHEMATIC1-FourierPulse" [ C:\Program
Files\OrCAD\Lite\Capture\Library\fourierpulse-SCHEMATIC1-FourierPulse.sim ]
****   CIRCUIT DESCRIPTION
*****
*Analysis directives:
.TRAN 0 3ms 0
.FOUR 1000 11 V([A])
.PROBE V(*) I(*) W(*) D(*) NOISE(*)
* source FOURIERPULSE
V_V1      A 0
+PULSE 0V 10V 0 1ns 1ns 0.5ms 1ms
R_R1      0 A 1k
**** RESUMING fourierpulse-SCHEMATIC1-FourierPulse.sim.cir ****
.END
*****
FOURIER COMPONENTS OF TRANSIENT RESPONSE V(A)
DC COMPONENT = 4.960396E+00
HARMONIC FREQUENCY FOURIER NORMALIZED PHASE NORMALIZED
NO (HZ) COMPONENT COMPONENT (DEG) PHASE (DEG)
 1  1.000E+03  6.366E+00  1.000E+00 -7.129E-01  0.000E+00
 2  2.000E+03  7.927E-02  1.245E-02 -9.223E+01 -9.080E+01
 3  3.000E+03  2.122E+00  3.333E-01 -2.139E+00 -4.967E-04
 4  4.000E+03  7.945E-02  1.248E-02 -9.445E+01 -9.160E+01
 5  5.000E+03  1.273E+00  2.000E-01 -3.567E+00 -2.484E-03
 6  6.000E+03  7.975E-02  1.253E-02 -9.667E+01 -9.240E+01
 7  7.000E+03  9.093E-01  1.428E-01 -4.997E+00 -6.955E-03
 8  8.000E+03  8.017E-02  1.259E-02 -9.889E+01 -9.318E+01
 9  9.000E+03  7.072E-01  1.111E-01 -6.431E+00 -1.491E-02
10  1.000E+04  8.071E-02  1.268E-02 -1.011E+02 -9.396E+01+
11  1.100E+04  5.785E-01  9.088E-02 -7.869E+00 -2.733E-02

TOTAL HARMONIC DISTORTION = 4.391884E+01 PERCENT

```

Comments:

The Fourier Analysis above includes all harmonics (both even and odd). The pulse waveform should only have odd harmonics, so note that the magnitudes of the even harmonics are very small. The magnitudes for the odd harmonics approximately match those calculated for the Fourier Series by hand. One reason for error might be that the pulse waveform in PSPICE is not perfect (includes non-zero rise times and fall times).

	DC	1 st	3 rd	5 th	7 th	9 th	11 th
Hand	5	6.3662	2.1221	1.2732	0.9095	0.7074	0.5787
PSPICE	4.960	6.366	2.122	1.273	0.9093	0.7072	0.5785