# EE 2101 - EXPERIMENT 7
RMS AND AVERAGE VALUES

You may need to review the equations for calculating RMS and average values of a periodic waveform. Prior to performing this lab, determine the ratio between the RMS value and the peak value for sinusoid, triangle, and square waveforms. Also, note that for DC, the DC value equals the average value which equals the RMS value. For a waveform containing an AC signal with a DC offset, the RMS value is the square root of the sum of the squares of the AC and DC component RMS values.

1. Connect the output of the function generator in parallel with an analog AC voltmeter, a digital multimeter (DMM) set to read AC volts, and the oscilloscope.

2. Set the function generator for a 2-volt peak-to-peak sinusoid at 1 kHz and record both voltmeter readings. Compare to the calculated RMS value.

3. Repeat (2) for a triangle wave. Treat waveform as bipolar (-1 V to 1 V swing) for calculations.

4. Repeat (2) for a square wave. Treat waveform as bipolar (-1 V to 1 V swing) for calculations.

You should find that neither of the meters yields the correct RMS value for all 3 waveforms. True RMS voltmeters are available at somewhat higher cost. Some of these block the DC component and read the RMS value of the AC signal only. Most AC meters respond to the average value of the rectified signal, since the average of any symmetrical AC waveform is zero. The meter output is then scaled to read the RMS value for a sinusoid. Erroneous answers result from any other waveform.

5. The following figure shows a periodic pulse waveform:
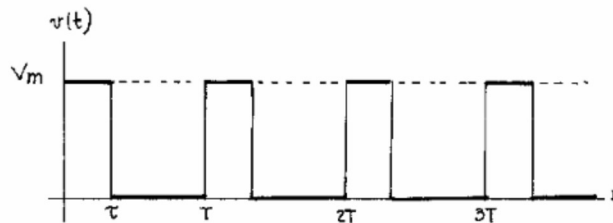
The voltage of the pulse waveform is given by

$$v(t) = \begin{cases} V_m \text{ for } 0 < t < \tau \\ 0 \text{ for } \tau < t < T \end{cases}$$

and is periodic with a period of T seconds. For a given peak value V_m the RMS value of this waveform is a function of the ratio $\frac{\tau}{T}$. Using the oscilloscope, set the signal generator to produce this waveform at a frequency of 1 kHz with $V_m = 1$ volt. Tabulate the RMS voltages obtained from the measurement menu on the oscilloscope, the DMM, and the analog meter for the following set of values

$$\frac{\tau}{T} = 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8$$

Add another column to your table showing the exact RMS voltage obtained by evaluating

$$\sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

On a common graph, plot these four values of RMS voltage versus the ratio $\frac{\tau}{T}$.

6. Set the signal generator to produce a sinusoid with no DC offset at the highest frequency available. Turn the amplitude control up until there is noticeable distortion on the waveform. Record the frequency, the peak-to- peak voltage of the waveform, and print out the waveform. Measure and record the rms voltages: using the oscilloscope's measurement menu, the DMM, and the analog meter. Store the oscilloscope trace in CSV format and then import the trace into a spreadsheet program like Microsoft Excel. Then use the spreadsheet program to calculate the rms value of this distorted sinusoid. Compare the results of this calculation with the three previous measurements.