Objective

The purposes of this laboratory project are to introduce the use of an oscilloscope, to experimentally determine the output resistance of the function generator, and to determine an equivalent current source model for the function generator.

Pre-Laboratory Work

Read this handout thoroughly. Watch the videos ‘Oscilloscope Overview’, ‘Oscilloscope Demonstration’, and ‘Oscilloscope Downloading Screenshots using Wintek32’

Information

Oscilloscope

The oscilloscope is a graph-displaying device that draws a graph of an electrical signal. In most applications the graph shows how signals change over time: the vertical (Y) axis represents voltage and the horizontal (X) axis represents time. As is the case in most situations, a picture of the signal conveys information in an easy to interpret fashion.

![Oscilloscope Diagram]

Fig. 1. The above is a representation of an oscilloscope screen. Each square is a division. The amount of time or magnitude of voltage is determined by referring to the SEC/DIV or VOLTS/DIV settings, and multiplying this value by the number of divisions traversed.

The oscilloscope familiarization section in the Circuits Laboratory Manual available at: http://www.uwplatt.edu/ee/TechDoc/manual.pdf is a good way to become familiar with the basic operation of the oscilloscope. Connect the oscilloscope to the function generator and experiment with the functions listed in the manual.

Function Generator

The function generator was introduced in the previous laboratory project. The function generator was treated as an ideal source for that project. In reality the function generator, like all voltage sources, has a series resistance associated with it.

![Function Generator Diagram]

Fig. 2. The above diagrams show models of real voltage and current sources supplying a load resistor R. In both cases the source resistance is internal to the source, and therefore must be determined indirectly.
In this laboratory project the source resistance, also referred to as the output resistance, will be determined. In order to accomplish this two pieces of information will be used, the no load voltage which gives \( V_s \) and the change in \( V_{ab} \) for different values of \( R_l \).

**Procedure**

Measure and record the actual resistance of all the resistors.

**Function Generator**

Use two BNC to micro-clip connectors to connect the MAIN output of the function generator to CH 1 of the oscilloscope. Be sure than the **black micro-clips from each are connected to each other** and the **red micro-clips are connected to each other. Do not cross the lines.** Once the function generator is connected to the oscilloscope, turn both units on. When all of the above tasks have been completed:

1. Press the button on the function generator under the menu item Freq and enter ‘1’ then press the button under the menu item kHz.
2. Press the button on the function generator under the menu item Ampl and enter ‘2’ then press the button under the menu item V_{pp}.
3. Press the Output button on the function generator.
4. Set the VOLTS/DIV for channel 1 to 500mV/div (this is just a starting point, adjustments may be necessary).
5. Set the SEC/DIV to 250μs.
6. Press the CH 2 menu button twice to turn off channel two.
7. Press the CH 1 menu button and ensure AC coupling, and Probe 1X.
8. Use the Position knob for channel 1 to center the waveform.
9. Press the MEASURE button on the oscilloscope and make sure one of the measurements being taken is CH1 Pk-Pk voltage (to change this make sure the top menu item has Type selected, then press the button next to CH1 until Pk-Pk appears).
10. Record the peak-to-peak voltage with no load resistor connected. (The measurement will be more accurate if the VOLTS/DIV knob is adjusted so that the signal fills up as much of the screen as possible without going off the screen.)
11. Clip in the 1kΩ resistor between the black and red micro-clips and record the peak-to-peak voltage measured by the oscilloscope.
12. Repeat step 11 for the remaining values of resistors in the table below:

<table>
<thead>
<tr>
<th>Table 1 is for recording the terminal voltages of the function generator for different load resistors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistor</td>
</tr>
<tr>
<td>Voltage</td>
</tr>
</tbody>
</table>

13. Turn off the oscilloscope and function generator.

**Assignment**

Submit a document following the informal laboratory report format containing the following:

1. **Report Header**

2. **Data**
   A table of the measured values and the calculated equivalent resistance for each point.

3. **Schematic**
   Determine the Thevenin and Norton equivalent circuits for the function generator (schematics with component values). *Use the no load value of voltage as the Thevenin voltage, and the measured data to determine the size of the resistance that was in series with it.* (Solve the voltage
divider equation for the unknown resistance for each measured value and determine a reasonable value.)

4. Discussion
   How could ignoring the resistance of a source affect results in the laboratory?
   Any unexpected data must be explained.

Check-off
   In order to receive credit for performing this laboratory project it is necessary to have the instructor or student assistant review your data. The data must then be submitted to the laboratory project data dropbox in D2L for this project (only files in pdf are accepted).