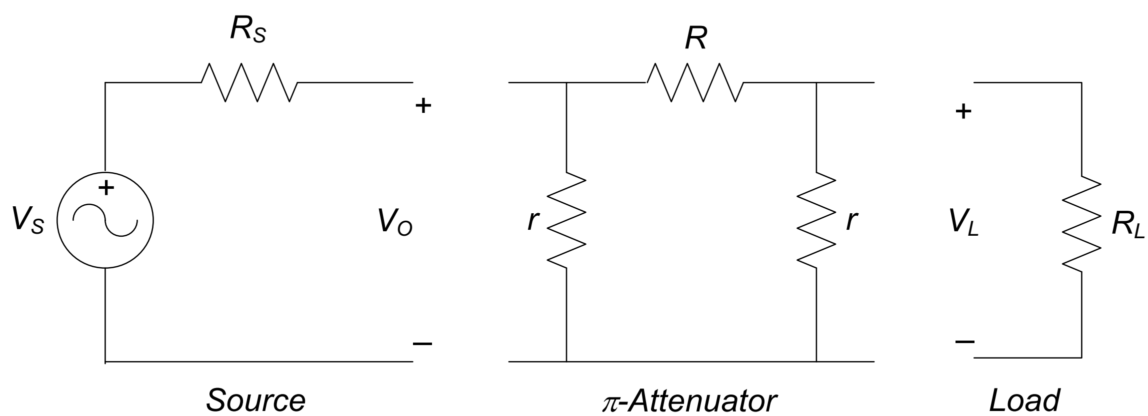
Engr228 **Lab #4** **Spring, 2020**

DC Attenuator Design and Measurement

Name ______________________________

Introduction

Attenuators are circuits that are commonly used in radio frequency applications to both reduce the level of the signal and to match the resistance of the source (R_S) to that of the load (R_L). One of the reasons that you want to match the source and load resistance is to eliminate standing waves on the transmission lines, thereby reducing distortion. Another reason is to transfer maximum power to the load. Shown below is a circuit called a π-attenuator whose name is derived from its visual architecture.



Lab Objectives

- Develop proficiency with two new pieces of laboratory equipment:
  - The function generator;
  - The oscilloscope.
- Understand resistance matching.

Equipment

- Digilent Analog Discovery 2 Module;
- Breadboard;
- Assorted resistors;
- Assorted wires.

References

- Zybooks text book;
- Course web site;
- Resistor color-code chart.

Procedure

You are going to learn two new functions of your Analog Discovery 2 module in this lab:

- Oscilloscope – visually display and measure any type of waveform.
- Function generator – generate various waveforms including sine, square, triangle, etc.

Here are YouTube tutorials for learning these two functions of your AD2 module. They may be worth watching, but they are like taking a drink from a fire hydrant. You may wish to Google on your own and try and find some better tutorials.

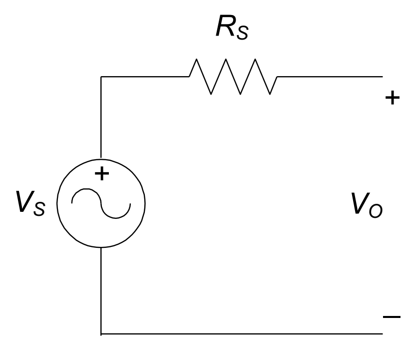
- Oscilloscope
- Function Generator

1) On the AD2 Waveforms software, open the **Wavegen** tool and setup your function generator to output a sine wave with a frequency of 1kHz and a peak-to-peak amplitude of 5V. Click the **Run** button to activate the output on the Wavegen 1 wire.

2) Next, click the plus (+) button near the top of the window and select **Scope** to open the oscilloscope window. From the Flywire bundle, connect the scope 1 positive wire (1+) to the Wavegen 1 positive lead (W1). Connect the Scope 1 (1-) negative lead to ground.

3) Using the **Measurements** tab in the scope tool, add the following measurements to the display:
    a. Peak2Peak voltage
    b. AC RMS voltage
    c. Frequency

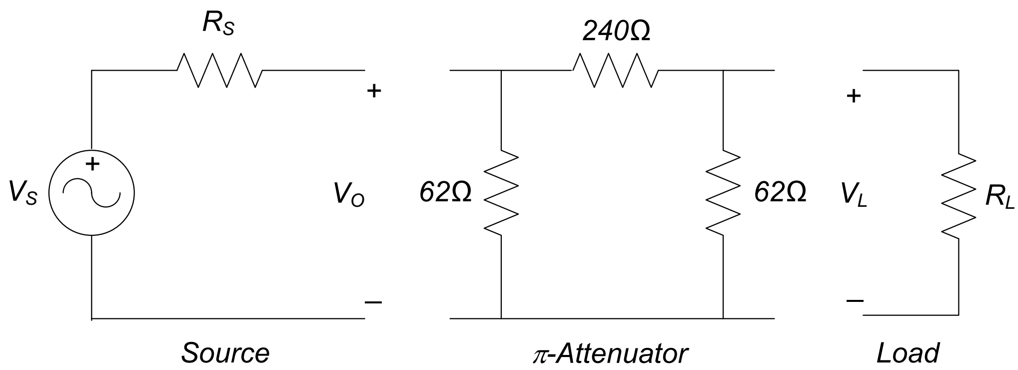
4) On your breadboard, wire up the circuit at the right, where V_S is the output from Waveform generator found on the W1 wire. Use your 51 Ω resistor for R_S. Place a load resistor R_L between the + and – terminals. Calculate and measure V_O for the load resistor values shown in the table below. Do it for both peak-to-peak and rms values. Note that this circuit behaves like a voltage divider for the AC source, just like it does for a DC source. The formula for rms calculations is:



Source

$$X_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2 dt}$$

R_L Nominal Ω	100	330	470	560	1000	2000
R_L Measured Ω						
$V_{O(calc)}$ V_{pp}						
$V_{O(meas)}$ V_{pp}						
$V_{O(calc)}$ V_{rms}						
$V_{O(meas)}$ V_{rms}						



5) Using the values for the π-attenuator circuit shown above, calculate the equivalent resistance that the source sees (the resistance seen to the right of R_S) for load values of $R_L = 0\ \Omega$, $R_L = 50\ \Omega$, and $R_L = \infty\ \Omega$. You may draw your circuits on the right and below to aid your computations. Note – you do not need to construct the circuit.

For $R_L = 0\ \Omega$

$R_{in,\ calculated}$ = ______________ Ω

For $R_L = 50\ \Omega$

$R_{in,\ calculated}$ = ______________ Ω

For $R_L = \infty\ \Omega$

$R_{in,\ calculated}$ = ______________ Ω

To Turn In

Do your work on either the .pdf or .docx version of the lab and place in the **lab4** drop box by 11:30pm on Sunday, May 3.