ECE 3254 Laboratory
Thevenin Equivalent
Laboratory #3 Fall 2009
PRELAB (100 points total)

Name ________________________
Date: ________________
Bench: __________

Prelab assignment (to be completed before coming to Lab 3):
Read through the entire Lab3 handout and Lab3 notes.

1. For the voltage divider of Fig 3-1, find an equation for the current through R1 (I_{R1}) in terms of R1, R2, and Vs. Show your work for full credit. (5 points)

Find an equation for Vo (V_{R1}) in terms of R1, R2, and Vs (RL is open circuited - not connected). Note: This is the "voltage divider equation" that you will use frequently for 3254 Lab. Show your work for full credit. (5 points)

For the voltage divider of Fig 3-1 with Vs = 15V, R1 = 10kΩ, and R2 = 5.6kΩ, calculate Vo and I_{R1} (no load connected). Show your work for full credit. (5 points)

Calculated Voc (V_{R1}) = _________________, Calculated I_{R1} = _________________

Model the voltage divider in Pspice (load the model from Lab 1, save it as Lab 3 something, then modify the values). Use Pspice to obtain the open circuit voltage for Vo and I_{R2} (no load connected). <u>Print the Pspice schematic with simulation V and I bias values turned on.</u> Label V_{R1} and I_{R1} on your print. [Note: You may choose to build a second circuit for Question 2 on the same page, and print the combined schematic. The resistors on the second circuit will not be numbered R1 and R2] (10 points)

Pspice Voc (V_{R1}) = _________________, Pspice I_{R1} = _________________

How do Voc and I_{R1} from Pspice compare to the calculated values? (2 points)

Enter the calculated and Pspice values for Voc and I_{R2} on the Data sheet part I-2.

2. Calculate the short circuit current (Isc) available at the output terminals (This will be I_{R2} with R1 shorted.). Show your work for full credit. (5 points)

Use pspice to obtain the short circuit current (I_{SC}) at the divider output. <u>Print the pspice schematic with simulation V and I bias values turned on.</u> Label Isc on your print. [Note: You may choose to build this as second circuit on the schematic with Question 1, and print the combined schematic.] (5 points)

Pspice Isc = ________________

How does Isc from Pspice compare to the calculated value? (2 points)

Draw the Thevenin Equivalent model circuit for the voltage divider and calculate the values for Vth and Rth. Show your work for full credit. (3 points for circuit drawing, 10 points for calculation of values)

Vth = ______________, Rth = _______________

What value of RL produces the most power in the load resistor? RL_{Pmax} = _______________ (2 points)

Enter the calculated and Pspice values for Isc, Vth, and Rth on the Data sheet part I-3.

3. For three values of RL, use the Thevenin equivalent model to calculate V_{RL}, I_{RL} , and P_{RL}. (12 points)

RL	RL (value)	V_{RL}	I_{RL}	P_{RL}
Rth / 2	____________	_____________	______________	______________
Rth	____________	_____________	______________	______________
Rth * 2	____________	_____________	______________	______________

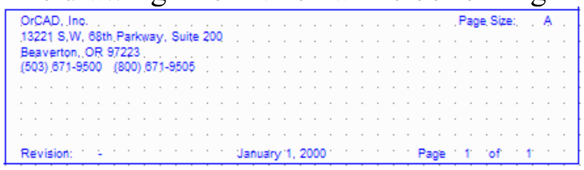
Enter these values on the Data sheet part I-4

4. Use Pspice to predict V_{RL}, I_{RL}, and P_{RL} for [Rth / 2] < RL < [Rth * 2]. See the Lab 3 Notes for details of each step. (20 points)

   a. Begin with the voltage divider from question 2. Save the model with a new name.
   b. Add a new variable resistor to use for RL.
   c. Move (or place) the Voltage and Current probes to measure V_{RL} and I_{RL}.
   d. Add a Parameter for the Variable resistor

e. Set up the analysis – we want to observe the output as RL changes value

f. In the drawing information at the bottom right corner of the schematic,



edit the text to include at least your name, the date, and “ECE Lab 3 Thevenin model”.

g. Save your file!

h. Run the Simulation

i. Add a trace for the load power (P_{RL})

j. Change I(RL) to milliAmps

k. Widen each trace for printing

l. Use the cursor to find and Label V_{RL}, I_{RL}, and P_{RL} for RL = Rth/2, Rth, and Rth*2.

m. Use the “Text Label” button on the tool bar to add “ECE3254 Lab 3 Thevenin Model” and your name to the simulation.

n. Print the schematic and simulation.

Simulation Results: (12 points)

RL	RL (value)	V_{RL}	I_{RL}	P_{RL}
Rth / 2	____________	____________	____________	____________
Rth	____________	____________	____________	____________
Rth * 2	____________	____________	____________	____________

Enter these values on the Data sheet part I-4

How do the Pspice simulation results compare to the calculated values? What is responsible for the differences? (2 points)

5. Rth can still be calculated if you can not measure Isc but you can measure Voc and the voltage across a know load resistor. Find an equation for Vth and Rth in terms of a measured Voc, VL, and RL. (show work) (5 points)

Enter this equation on the Data sheet part II-2

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Last Revised: 09-14-2009 Removed P_{Rth} calculations

Record all measurements and calculations on the data sheet.
Always include the units for each measurement and calculation!

Part I: Voltage Divider

1. Build the Voltage Divider circuit of Fig 3-1 on the protoboard with Vs = 15VDC, R1 = 10kΩ, and R2 = 5.6kΩ. Before Construction, use a multimeter to measure the actual values of R1 and R2. Initially leave RL unconnected (an open circuit).

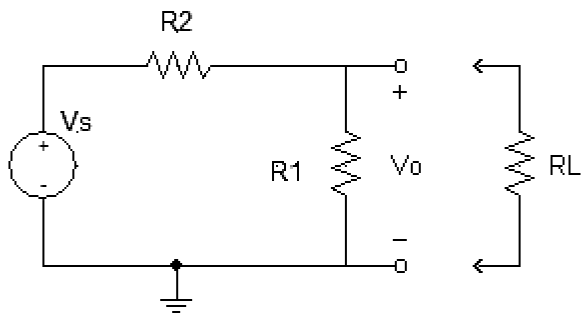

Figure 3-1

2. With no load connected, use a multimeter to measure Vo (this is the open circuit voltage Voc) and I_{R1}. Remember – you must open the circuit and insert the meter in series to measure current.

3. Measure the short circuit current (the current meter acts as a short circuit)

   Using the values you measured in Parts 2 and 3, calculate the divider's Thevenin equivalent values.

   Measure V_{RL} (don't forget to move the probes back to the Volts position on the meter) for RL ≈ Rth / 2, RL ≈ Rth, and RL ≈ Rth * 2. Round the three RL resistors to the nearest standard resistor value for these measurements. Do not series connect resistors to make RL. Using V_{RL}, calculate I_{RL}, and the power dissipated in the resistor P_{RL}.

4. Rebuild the circuit as a Thevenin equivalent source using the closest standard resistor value for Rth (one resistor ≈ Rth, Vs is adjusted to Vth).

   Measure V_{RL} (don't forget to move the probes back to the Volts position on the meter) for RL ≈ Rth / 2, RL ≈ Rth, and RL ≈ Rth * 2. Round the three RL resistors to the nearest standard value for these measurements. Using V_{RL}, calculate I_{RL} and the power dissipated in the load resistor RL (P_{RL}).

Part II: Function Generator Thevenin Source

1. Use Labview to set the function generator to produce a 10Vpp sine wave at 2 kHz with 0V DC offset and the Output set to High Z. Measure the output voltage with the oscilloscope set for maximum accuracy.

2. Connect a 100Ω resistor (RL) to the Generator and measure the output voltage with oscilloscope set for maximum accuracy.

Use your measurements to determine Vth and Rth.

3. Use Labview to change the Generator Output from “High Z” to “50 Ohms” and measure the output voltage with oscilloscope set for maximum accuracy.

   Remove the 100Ω resistor and measure Voc with RL = ∞.

   Use your measurements to determine this Vth and Rth.

4. Remove the resistor, change the Generator Output from “50 Ohms” to “High Z”, and measure the output voltage with oscilloscope set for maximum accuracy.

   Connect a load to the Generator that is as close as possible to Rth using a standard resistor value. Measure the generator output V_{RL} with the oscilloscope set for maximum accuracy.

   Change the Generator Output from “High Z” to “50 Ohms”, and measure the output voltage with oscilloscope set for maximum accuracy.

   Remove the resistor and measure the output voltage with oscilloscope set for maximum accuracy.

Before you leave: Shut down Windows, return cables to racks, return parts to correct drawer bins, return adapters to container, turn off bench power, clear bench, and place seat under bench.

ECE 3254 Lab 1 Data Sheet **Date______________** **Bench_________**
(100 points total)
Names: ________________________ ______________________ ______________________
by first name: 2nd alphabetically – wiring 3rd alphabetically – Labview 1st alphabetically – data sheet

Part I: Pspice Simulation of a Resistor and a DC Voltage Source

1. Measured values: R1 = ______________, R2 = ______________, Meter used ________________

2. *From the Prelab calculations* Voc = ________________, I_{R1} = _________________

   From the Pspice simulation Voc = ________________, I_{R1} = _________________,

   Measured Voc = _________________, I_{R1} = _________________, Meter used _______________

   How do your measurements for Voc and I_{R1} compare to the calculations and simulation?

3. *From the Prelab calculations* Isc = _______________

   *From the Pspice simulation Isc =*________________

   Measured Isc = __________________, Meter used _________________

   How does the measured Isc compare to the Prelab calculation and Pspice simulation?

   From the Prelab: Vth = _____________*,* Rth = _____________

   From Voc and Isc measured above, the calculated Vth = _____________, Rth = _____________

   How do your calculated values for Vth and Rth compare to the Prelab calculations for Vth and Rth?

   Measured values using standard value resistors for Rth and RL

RL	RL (value)	V_{RL}	I_{RL}	P_{RL}
Rth / 2	____________	_____________	______________	______________
Rth	____________	_____________	______________	______________
Rth * 2	____________	_____________	______________	______________

4. *From the Prelab calculations:*

RL	RL (value)	V_{RL}	I_{RL}	P_{RL}
Rth / 2	___________	___________	___________	___________
Rth	___________	___________	___________	___________
Rth * 2	___________	___________	___________	___________

From the Prelab Pspice Simulation:

RL	RL (value)	V_{RL}	I_{RL}	P_{RL}
Rth / 2	___________	___________	___________	___________
Rth	___________	___________	___________	___________
Rth * 2	___________	___________	___________	___________

Measured values using standard value resistors with the Thevenin Equivalent source:

RL	RL used	V_{RL}	I_{RL}	P_{RL}
Rth / 2	___________	___________	___________	___________
Rth	___________	___________	___________	___________
Rth * 2	___________	___________	___________	___________

Meter used _______________

How do the measured / calculated values in Part 3 and 4 compare to each other? How should they compare?

How do the measured and calculated values in Part 3 and 4 compare to the expected values from the Prelab and the Pspice Thevenin equivalent model circuit simulation?

What is responsible for the differences you see?

Part II: Function Generator Thevenin Source

1. RL = ∞, Measured V_{gen} = ________________ (output set to High Z)
2. RL = 100Ω, Measured V_{RL} = ________________ (output set to High Z)

   From the Prelab: in terms of Voc, RL, and V_{RL}, Rth = ______________________________

   From your measurements, Vth = ________________, Rth = _________________
3. RL = 100Ω, Measured V_{RL} = ________________ (output set to 50 Ohms)

   RL = ∞, Measured Voc = __________________ (output set to 50 Ohms)

   From your measurements, Vth = ________________, Rth = _________________
4. RL removed, Measured Voc = __________________ (output set to High Z)

   RL = _____________, Measured V_{RL} = __________________ (output set to High Z)

   RL = _____________, Measured V_{RL} = __________________ (output set to 50 Ohms)

   RL removed, Measured Voc = __________________ (output set to 50 Ohms)

   When the generator is set to 10Vpp with the output set to “50 Ohm”, what is Vth? What is Rth?

   When the generator is set to 10Vpp with the output set to “High Z”, what is Vth? What is Rth?

   Why do you need to set the Output to High Z if you are measuring circuit voltages with the scope or multimeters?
5. Before you leave: Shut down Windows, return cables to racks, return parts to correct drawer bins, return adapters to container, turn off bench power, clear bench, and place seat under bench. (Counts as 5 points of the Lab grade)