EE283 Lab 3
KVL and KCL Measurements
And
Node Analysis

Objective: The object of this exercise is to

- Verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).
- Calculate and simulate the voltages and currents in the circuit used for KVL and KCL.

Equipment Operation:

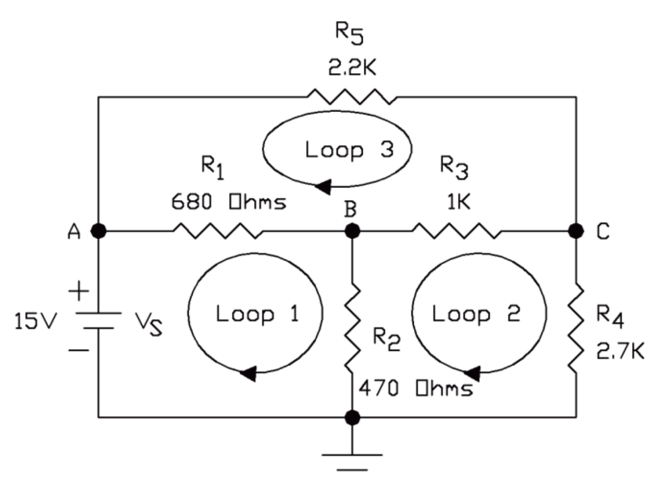
- Digital Multimeter (DMM Keysight 34461A see appendix C)
- Resistor Color Codes (see appendix A)
- Power Supply (see appendix B)
- Breadboard (see appendix D)

Procedure:

- Use the DMM to measure the voltage across each component and the current through each component to verify KVL and KCL.

1. Using the resistors supplied, measure the resistance values using the DMM and record the values and tolerances in the table below and in your report. Then construct the circuit below on your breadboard.

Reference Designation	Nominal Resistance value – Ohms	Actual Resistance Value – Ohms	Resistor Tolerance %
R_1	680		
R_2	470		
R_3	1K		
R_4	2.7K		
R_5	2.2K		



Setup Figure

2. Using the DMM set to measure V_{DC} measure the voltage at nodes A, B and C. Also measure the voltage across R_1, R_3 and R_5. Record these voltages in the table below being very careful to observe the correct polarity for the resistor voltages (i.e. for resistor R_1 measure V_{A-B} with the positive (red terminal on DMM) DMM lead connected at node A and the COM (black terminal on DMM) DMM lead connected at node B)

   Record these values in the table below and in your report.

V_A V_{DC}	V_B V_{DC}	V_C V_{DC}	V_{A-B} V_{DC}	V_{B-C} V_{DC}	V_{A-C} V_{DC}

   Using the voltages measured in the table above add all of the voltages in each of the three loops shown. Show your work here and in your report.

   ΣLoop 1 voltages:____________________________________V_{DC}

   ΣLoop 2 voltages:____________________________________V_{DC}

   ΣLoop 3 voltages:____________________________________V_{DC}

   Is the KVL satisfied for these loops?

3. Using the DMM set to measure A_{DC} measure the current through each of the resistors and the power supply. Record these currents in the table below and in your report being very careful to observe the correct polarity for the currents (i.e. for resistor R_1 if voltage V_{A-B} is positive lift the resistor lead at node A and insert the DMM with the positive lead connected to node A and the COM DMM lead connected to R_1).

$I_{Power\ Supply}$ A_{DC}	I_{R1} A_{DC}	I_{R2} A_{DC}	I_{R3} A_{DC}	I_{R4} A_{DC}	I_{R5} A_{DC}

Using the currents measured in the table above add all of the currents at each of the nodes shown. Show your work here and in your report.

ΣNode A currents:____A_{DC}

ΣNode B currents:____A_{DC}

ΣNode C currents:____A_{DC}

Is the KCL satisfied for these nodes?

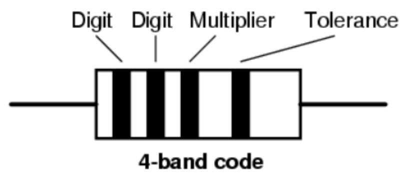
- Calculate the node voltages and component currents using either MatLab, Excel or by hand calculation. Use the actual resistance values and V_S voltage for your calculations. Record these values in the table below and in your report. All of your equations and calculations must be shown in your report.
- Simulate the circuit using LTspice or PSpice and record the node voltages and component currents in the table below and in your report. Use the actual resistance values and V_S voltage for your simulation. Show your simulation circuit in the report (it should have a white background) and the reference designations should agree with those shown in the setup figure in this exercise.

	V_A V_{DC}	V_B V_{DC}	V_C V_{DC}	I_{R1} A_{DC}	I_{R2} A_{DC}	I_{R3} A_{DC}	I_{R4} A_{DC}	I_{R5} A_{DC}	$I_{PWR\ SUP}$ A_{DC}
Calculated Values									
Simulated Values									
Measured Values									

- Conclusion: In your report compare the measured, calculated and simulated values of all of the voltages and currents. Were KVL and KCL satisfied? If not why not?

Remember that your report must be legible. If I can’t read it you won’t get credit for it!

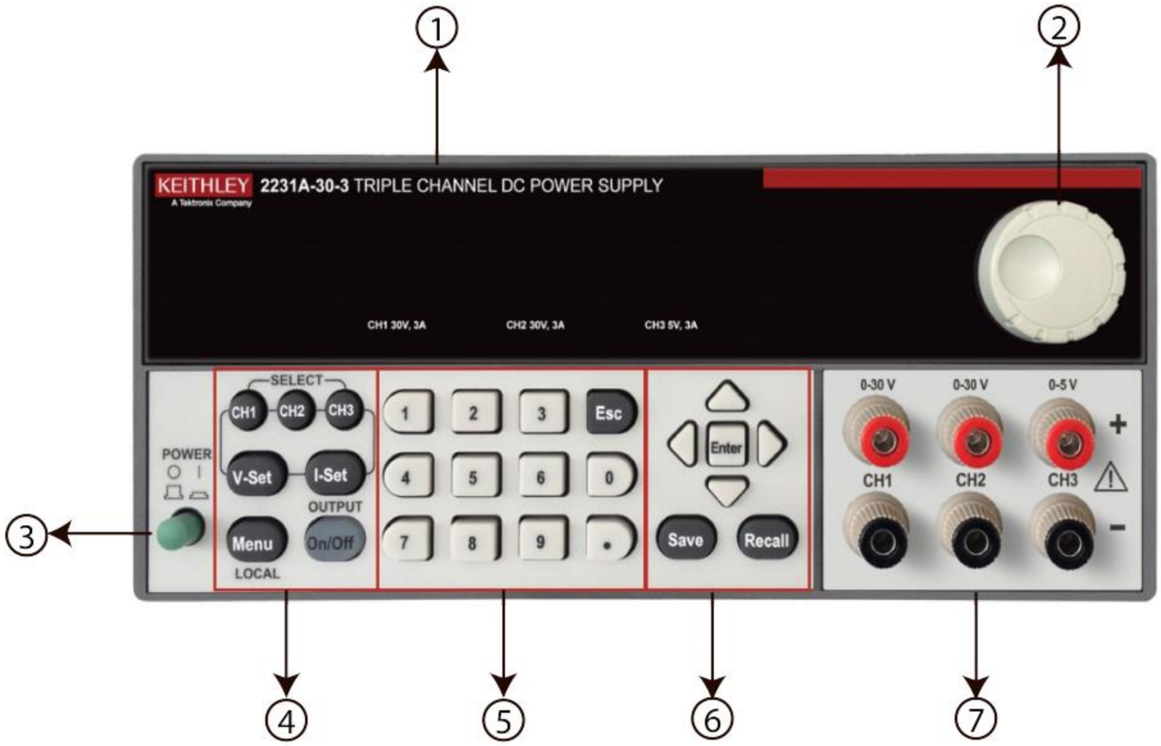
Appendix A



Color	Digit	Multiplier	Tolerance (%)
Black	0	10^0 (1)	
Brown	1	10^1	1
Red	2	10^2	2
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	0.5
Blue	6	10^6	0.25
Violet	7	10^7	0.1
Grey	8	10^8	
White	9	10^9	
Gold		10^{-1}	5
Silver		10^{-2}	10
(none)			20

Appendix B

Keithley 2231A-30-3 Power Supply



Item	Description
1	Vacuum fluorescent display (VFD)
2	Rotary knob
3	POWER button
4	Function buttons: Channel select buttons, V-Set (voltage setting), I-Set (current setting), Menu and Output On/OFF
5	Numeric buttons and ESC button
6	Up/Down/Left/Right arrow buttons, Enter button and Save/Recall function buttons
7	Output terminals

This unit has three independent and isolated power supplies CH1, CH2 and CH3. The output voltages for each supply are obtained at the terminals in item 7. The red terminal is positive with respect to the black terminal.

The CH1 and CH2 output voltages each has an adjustable voltage range of 0 to 30 volts and can supply up to 3 amperes of current. The CH3 output voltage has an adjustable voltage range of 0 to 5 volts and can supply up to 3 amperes of current. Each power supply channel can operate in either a constant voltage or constant current mode. For all of the lab exercises we will operate the power supplies in constant voltage mode and with the current limit set to $0.5A_{DC}$.

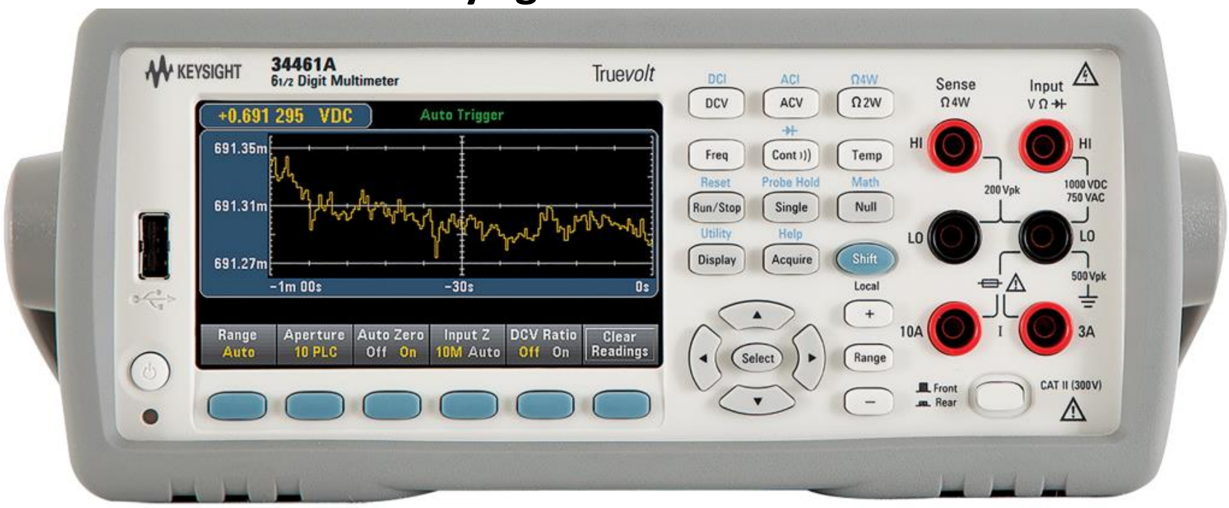
To set the CH1 output voltage:

- Turn this power supply on by pushing in the power switch at item 3.
- Set the maximum output current to 0.5 A_{DC} by pushing the CH1 button at item 4. Then push the I-Set button at item 4 and enter 0.5 on the numeric keypad at item 5. Then push the Enter button at item 6.
- Push the CH1 button at item 4 then push the V-Set button at item 4 and enter the desired output voltage on the numeric keypad at item 5. Then push the Enter button at item 6.
- Pushing the Output ON/OFF button at item 4 outputs the desired voltage at the CH1 output terminals at item 7. At this point the CH 1 display shows the desired output voltage and the actual supply current (not the current limit). It should also display CV which means the power supply is operating in the constant voltage mode. If the display reads CC it means the power supply is supplying $0.5A_{DC}$ which means there is probably a short circuit someplace. Pushing the Output ON/OFF button a second time will turn off the voltage at the output terminals.

The CH2 and CH3 power supplies operate in the same manner as the CH1 power supply.

Appendix C

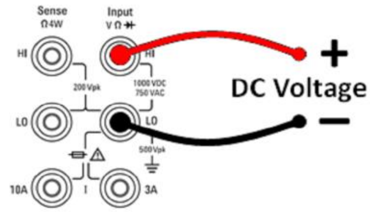
Keysight 34461A DMM



When measuring voltages the screen will look like this.

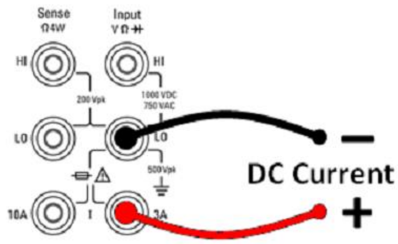
To measure DC voltages:

- Turn the DMM on by pushing the white power button in the lower left hand corner.
- Push the DCV button.
- Connect the test leads as shown below



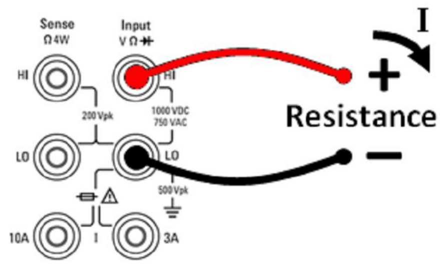
To measure DC currents:

- Turn the DMM on by pushing the white power button in the lower left hand corner.
- Push the blue Shift button and then the DCV button (this gets you DCI).
- Connect the test leads as shown below



To measure resistance:

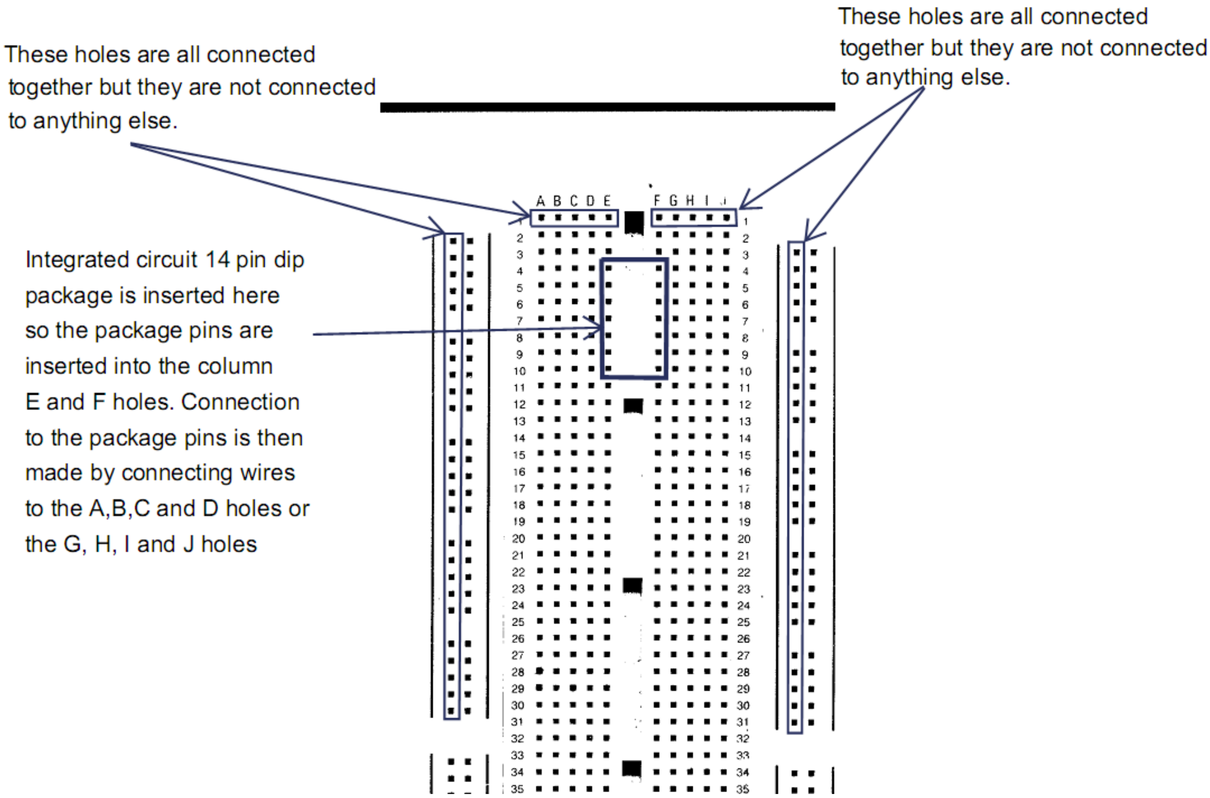
- Turn the DMM on by pushing the white power button in the lower left hand corner.
- Push the Ω2W button.
- Connect the test leads as shown below



- To measure the value of a resistor it must be removed from the circuit. If the resistor is not removed from the circuit other circuit components will cause an error in the reading.

Appendix D

Breadboard Connections



EE283 Laboratory Exercise 3 Form Report

Name:______________________ Section:_____ Station:_____ Date:___________

Reference Designation	Nominal Resistance value – Ohms	Actual Resistance Value – Ohms	Resistor Tolerance %
R_1	680		
R_2	470		
R_3	1K		
R_4	2.7K		
R_5	2.2K		

Measured Resistance Values

Setup Figure Here

V_A V_{DC}	V_B V_{DC}	V_C V_{DC}	V_{A-B} V_{DC}	V_{B-C} V_{DC}	V_{A-C} V_{DC}

Voltage measurements from step 2 of the procedure

ΣLoop 1 voltages:____________________________________V_{DC}

ΣLoop 2 voltages:____________________________________V_{DC}

ΣLoop 3 voltages:____________________________________V_{DC}

Must show all work for the above summations.

Is the KVL satisfied for these loops? Yes/No If No explain why not.

$I_{Power\ Supply}$ A_{DC}	I_{R1} A_{DC}	I_{R2} A_{DC}	I_{R3} A_{DC}	I_{R4} A_{DC}	I_{R5} A_{DC}

Current measurements from step 3 of the procedure

ΣNode A currents:____A_{DC}

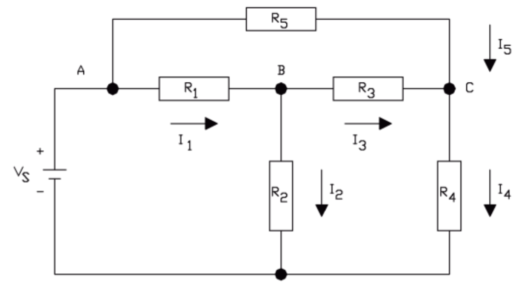
ΣNode B currents:____A_{DC}

ΣNode C currents:____A_{DC}

Must show all work for the above summations.

Is the KCL satisfied for these nodes? Yes/No If No explain why not.

Node Voltage Calculations



Show all equations for calculated node voltages on this page. Equations must be shown regardless of which type of analysis you use to calculate circuit voltages and currents.

Use extra pages if necessary.

Show MatLab or Excel equations and solutions on this page if used.

Show LTspice or PSpice simulation circuit here

Show LTspice or PSpice Simulation voltages and currents here

	V_A V_{DC}	V_B V_{DC}	V_C V_{DC}	I_{R1} A_{DC}	I_{R2} A_{DC}	I_{R3} A_{DC}	I_{R4} A_{DC}	I_{R5} A_{DC}	$I_{PWR\ SUP}$ A_{DC}
Calculated Values									
Simulated Values									
Measured Values									

Fill in this table with your data

Conclusion: In your report compare the measured, calculated and simulated values of all of the voltages and currents. Were KVL and KCL satisfied? Yes/No If No explain why not.

Write Conclusion Here