ENGR 110: Introduction to Circuits

This is a lab designed to get you acquainted with circuits, and particularly power and energy in circuits. It will help prepare you with background information related to the Solar Tracking project.

SAFETY NOTES:

(1) Even low voltage power sources can be dangerous. Under normal circumstances a few volts is unlikely to give you a shock. But there are circumstances where low voltages can be dangerous.
(2) Even low voltage power supplies often have high voltage components. They certainly do if they are connected to the mains. Never use a power supply that is damaged, and never get water near one.
(3) Note also resistors can get very hot if they carry too much current. They can smoke and burn, and start fires. Note that a few volts can be enough to heat many items to very high temperatures. It depends on their resistance and the resulting current.

As usual, the easiest way to submit work such as algebra and diagrams is to write on paper, take photos, and insert them into this document. In any case you will need to submit a pdf.

Working in Groups

Students will work in small groups of 2-4 to complete this lab. It is absolutely required that ALL members of the group get to have fun connecting the circuits and making measurements. It is not acceptable for one member of the group to do all the hands-on work while others watch. To make sure everyone gets a chance, complete the following table while you are working on the lab. Specify what circuit construction and/or measurements each member of the group completed. Identical tables should appear in the lab scripts for each group member.

Work Summary: (10 marks)

Group member 1 name David Nangoi

Circuit construction and measurements done by this group member:

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Measurements

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Group member 2 name Lekesh

Circuit construction and measurements done by this group member:

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Made diagrams

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Group member 3 name Tom

Circuit construction and measurements done by this group member:

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All circuits and most calculations

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Group member 4 name ___________________________

Circuit construction and measurements done by this group member:

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Circuits

Note: Include units in your answers!

Note about the meters: The yellow Fluke is the better ammeter, but you need to remember to push the yellow button in the upper right corner to set the meter to measure DC.

CORE 1: (5 marks)

Connect a 1kΩ resistor to a power supply set to 5 V. Sketch the circuit. Show in your diagram where you would put a voltmeter and an ammeter to measure the voltage across the resistor and current through the resistor. **Check with a tutor before you continue.**

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V = IR   5 = I * 1000 therefor it should be 0.005 amps

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CORE 2: (5 marks)

What is the resistance of an ideal voltmeter? An ideal ammeter? How is this related to the way they are connected in a circuit? What are resistances of real meters?

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The Ideal resistance of a volt meter would be should have an infinity high resistance to not allow any current to by pass the circuit being measure because it is in parallel.

Where as because Amp meters are run in series it need an infinity low/ zero , to not impeded the cercuit

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CORE 3: (5 marks)

Turn off the power supply and connect the meters. Check with your tutor if you are not confident, then turn on the power supply and measure the voltage across the resistor and the current through the resistor.

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Volts across the resistor where measure at 5v

Amps measured at 5 mA

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CORE 4: (10 marks)

Calculate the power delivered to the load using three different formulas. Verify the answers are all the same.

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P = IV , P=I^2 R , P = V^2 /r

P = 0.005 * 5 = 0.025 w , P 0.005^2 * 1000 = 0.025 W , P = 5^2 / 1000 = 0.025 W

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COMPLETION 1: (5 marks)

Make a diagram of a 1 kΩ resistor and a 470 Ω resistor connected in series to a 5 V power supply. Predict the current through each and the voltage across each.

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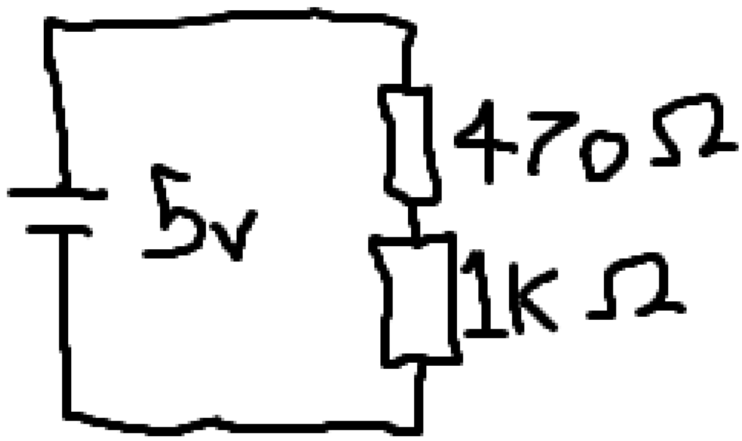

Total R = 1470 ohm's

Total I = V/R = 5/1470 = 0.0034 amps , = 3.4 mA

V= IR , V1 (for 1k ohms) = 0.0034 * 1000 = 3.4 V && V2(for 470 ohms) = 0.0034 * 470 = 1.60 V (rounded)

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COMPLETION 2: (5 marks)

Connect the circuit you sketched in Completion 1 and test your predictions. Explain any discrepancies.

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Amps = 3.44 mA

V1(across 1k ohms) = 3.422 V

V2(across 470 ohms)= 1.61 V

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COMPLETION 3: (5 marks)

Calculate the power delivered to each resistor using one of the power formulas.

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P=I^2 R

P1(1k ohms) = 0.0034^2 * 1000 = 0.01156 W = 11.6mW

P2(470 ohms)= 0.0034^2 * 470 = 0.0054332 W = 5.4mW

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COMPLETION 4: (5 marks)

Make a diagram of a 1 kΩ resistor and a 470 Ω resistor connected in parallel to a 5 V power supply. Predict the current through each and the voltage across each. Test your predictions.

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R1 = 1000 ohms

R2 = 470 ohms

1/Rt = 1/R1 + 1/R2 + 1/R3

1/Rt = 1/ 1000 + 1/470 = 0.001 + 0.002127 = 0.003127 = 320 Ω i think 🙂

It = Vt / Rt = 5/320 = 0.0156 amps = 15.6mA

It = I1+I2

I1 = V/R = 5/1000 = 5mA

I2 = 5/470 =11mA

V1=V2=V3=Vs

Vs = 5v

V1 = 5v

V2 = 5v

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COMPLETION 5: (5 marks)

Calculate the power delivered to each resistor using one of the power formulas.

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P = IV'

P1 = 0.005*5 = 25mW

P2 = 0.011*5 = 55mW

Pt = 25+55 = 80mW

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COMPLETION 6: (5 marks)

Explain why the total power is larger when the resistors are connected in parallel than in series.

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Add resistors in parallel decreases the total resistance of the circuit increasing the current

Causing I in P=IV to increase increase P

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CHALLENGE 1: (5 marks)

Consider two heaters connected to a constant amplitude voltage supply (such as the mains). One has a high power heater and the other is a low power heater. Which has a lower resistance filament? Explain this in terms of all three of these formulas for power: $P = I^2R, P = IV, P = \frac{V^2}{R}$. Hint: start with the last one.

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Given that the voltage supply is constant, the high power heater will have a lower resistance filament. This is because a higher power output is achieved when the resistance (R) is lower. Using the three formulas:

(4) P = V^2/R: A higher power output requires a lower resistance (R).
(5) P = IV: A higher power output requires more current (I), which is achieved with a lower resistance (R) according to Ohm's law.
(6) P = I^2R: A higher power output requires more current (I), which is achieved with a lower resistance (R) according to Ohm's law.

So, in conclusion, the heater with the lower power output will have a higher resistance filament, while the heater with the higher power output will have a lower resistance filament.

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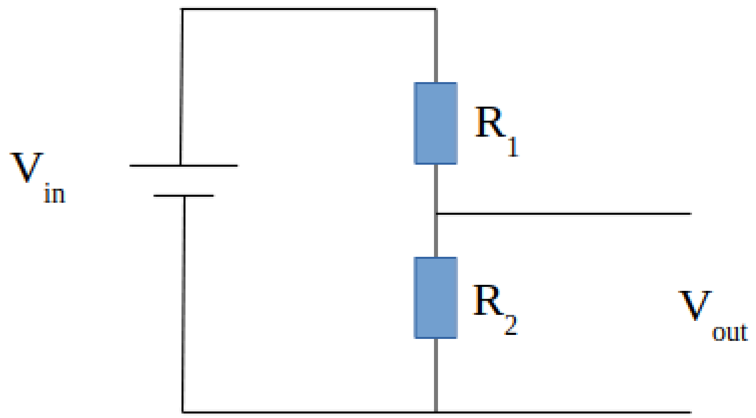
CHALLENGE 2: (10 marks)

Consider the circuit below. Find an expression for the output voltage as a function of the input voltage and resistances. This circuit is called a *voltage divider*.



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CHALLENGE 3: (10 marks)

Suppose the input voltage is 20 volts. We want the output voltage to be 5 volts, and we want the total resistance to be 18,800 Ohms. What resistors should we use?

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CHALLENGE 4: (5 marks)

Suppose a 3300 Ohm load was connected to the output. Would the circuit function as intended? Explain.

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CHALLENGE 5: (5 marks)

Predict the output voltage for the circuit in Challenge 4 and test your prediction.

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