NAME _____

EET 150 Lab 4
Series Circuits

OBJECTIVES:

- Measure resistance, currents, and voltages in series circuits, and verify that the measured values agree with theoretical predictions.
- Verify that Kirchhoff's Voltage Law correctly predicts voltage drops in series circuits.
- Investigate the operation of potentiometers.

PROCEDURE:

1. Select the resistors shown in Table A. Use the multimeter to measure their resistances, and record the values in the table. **Throughout this lab, round all predicted values, measured values, and percentage errors to three significant digits.**

TABLE A: **Resistor Values**

Resistor I.D.	Nominal Value	Actual Value
R_1	4.7 kΩ	
R_2	1 kΩ	
R_3	620 Ω	
R_4	75 Ω	

2. For each of the series combinations shown below, predict the total resistance. Record your predictions in Table B. Then build each combination on the breadboard and measure its total resistance. Record in Table B, along with percentage errors.

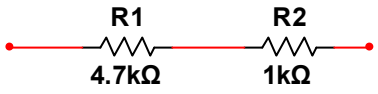


Fig.1

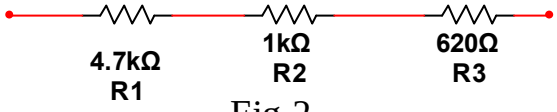


Fig.2

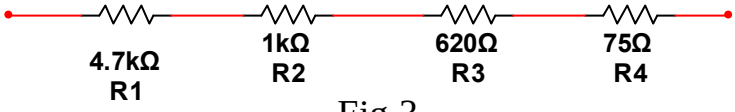
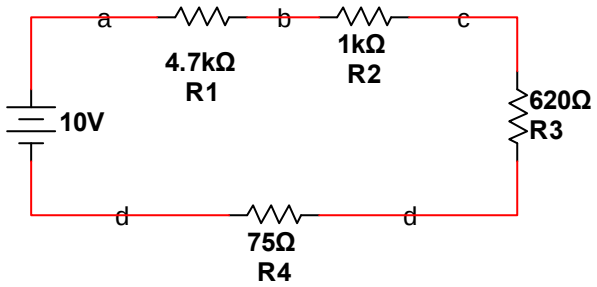


Fig.3

TABLE B: Total Series Resistance

Figure	Predicted R_T	Measured R_T	DMM Range Used	% Error
Figure 1				
Figure 2				
Figure 3				

3. Consider Circuit 1, shown in the schematic diagram below. Use your knowledge of series circuits to predict the quantities listed in Table C. (Note: I_a means current at point *a* in the schematic, in other words, the current between the power supply's positive terminal and R_1. Similarly for I_b, I_c, and so on.) Record your predictions in the table. Then build the circuit and measure these quantities. Record your measured values, along with percentage errors.



Circuit 1

TABLE C: Currents and Voltages in Circuit 1

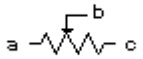
Quantity	Predicted Value	Measured Value	DMM Range Used	% Error
I_a				
I_b				
I_c				
I_d				
V_1				
V_2				
V_3				
V_4				

4. Now that you know the voltage drop across each resistor, use Kirchhoff's Voltage Law to predict the voltages listed in Table D. Then measure each voltage by placing the multimeter's red (positive) lead at the first point listed and the black (negative) lead at the second point listed. For example, to measure V_{ac}, place the meter's red lead at point *a* and the meter's black lead at point *c*. Pay attention to the sign (negative or positive) of the voltage reading that you get, and record that sign in the table. Then compute and record percentage errors.

TABLE D: Voltages in Circuit 1 by KVL

Quantity	Predicted Value	Measured Value	DMM Range Used	% Error
V_{ac}				
V_{eb}				
V_{ad}				
V_{ca}				
V_{db}				
V_{ae}				
V_{ea}				

5. Shown below is the symbol for a potentiometer.



A potentiometer is a type of variable resistor that has three terminals. The resistance between the two end terminals, labeled *a* and *c* in the diagram, is fixed: it does not change as the potentiometer's knob is rotated. The middle terminal, labeled *b* in the diagram, is called the "wiper". As the potentiometer's knob is rotated, the resistance between terminals *a* and *b* does vary. Also, the resistance between terminals *b* and *c* varies. In fact, when the knob is turned all the way in one direction, R_{ab} will be a **minimum** and R_{bc} will be a **maximum**; and when the knob is turned all the way in the other direction, R_{ab} will be a maximum and R_{bc} will be a minimum. (Hopefully the meaning of the notation that I am using here is obvious: for instance, R_{bc} means the resistance between terminals *b* and *c*.)

Let's see how this works. Locate a 1 kΩ potentiometer and turn its knob all the way to the left (counter-clockwise). Measure R_{ab}, R_{ac}, and R_{bc}; record measured values in Table E. Then turn the knob all the way to the right (clockwise). Measure and record the three resistances again. Then do the same with the knob turned to the midpoint of its range, halfway between the two extremes. Measure and record the three resistances again.

TABLE E: 1 **kΩ** Potentiometer Resistances

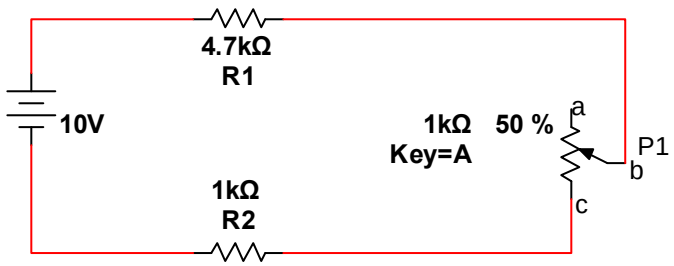
Knob Position	R_{ab}	R_{ac}	R_{bc}
Fully counter-clockwise			
Fully clockwise			
Midpoint			

6. Now locate a 100 kΩ potentiometer and repeat the activity above, recording your results in Table F.

TABLE F: 100 **kΩ** Potentiometer Resistances

Knob Position	R_{ab}	R_{ac}	R_{bc}
Fully counter-clockwise			
Fully clockwise			
Midpoint			

7. A common use of a potentiometer is to provide a variable voltage between the middle terminal and one end terminal. The series circuit shown below contains a 1 kΩ potentiometer and two resistors. (Ignore the "50%" in the potentiometer's label.)



Circuit 2

As the potentiometer is adjusted through its entire range, the voltage V_{bc} will vary. Based on what you've learned from your resistance measurements above, predict the maximum and minimum values of V_{bc}, and record in Table G. Also predict the value of V_{bc} when the potentiometer's knob is at its midpoint. Then build the circuit and measure these quantities by connecting the meter to the appropriate points in the circuit and adjusting the potentiometer through its range.

TABLE G: Range of V_{bc} in Circuit 2

Quantity	Predicted Value	Measured Value	DMM Range Used	% Error
V_{bc}(min.)				
V_{bc}(max.)				
V_{bc}(midpt.)				

TECHNICAL CONCLUSION: Re-read the objectives at the beginning of this lab. For each objective, briefly state what you've learned from the lab. Include some discussion of how far off (percentage errors) your measured values were from your predicted values.