Lab1: Circuit Analysis

STUDENT NAME

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1 Objectives

1. To understand how to read resistor values using the color coding system
2. To measure the true value of resistors using a handheld Digital Multimeter (DMM)
3. To build a simple resistor circuit using a standard breadboard
4. To measure voltage drops across resistors using the DMM
5. To measure current flowing in a branch
6. To understand why measuring voltages is safe, since the internal resistance of the meter in that setting is near infinite (at least $10^7\Omega$ or 10 MegaOhm)
7. To understand why measuring current can be dangerous, since the internal resistance of the meter in that setting is zero, and shortcuts can be easily made.
8. To understand and verify the three basic circuit laws being i) Ohm's Law, ii) Kirchoff's Voltage Law (KVL) and iii) Kirchoff's Current Law (KCL)

2 Equipment

1. Power supply
2. Bread board
3. Resistors, 1k, 2.7k, 4.7k, 10k
4. Handheld Digital Multimeter (DMM)

3 Procedures

Measure the exact values of the resistors using the handheld DMM, and determine the color coding of the resistors using Figure 2 and Figure 3. To determine the value of a resistor use the following equation: $R = ab * 10^c \pm d\%$. Example: If a resistor has the color coding Yellow-Violet-Red-Gold, then $a = 4$, $b = 7$, $c = 2$ and $d = 5$ %. The value of the resistor is now $47 * 10^2 = 4.7k \pm 5\%$. Fill out the following table:

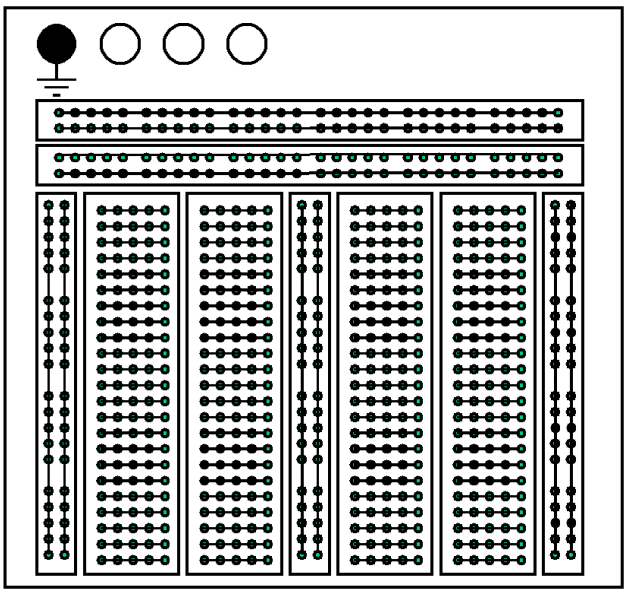


Figure 1: Typical bread board for experimental circuit construction.

Nominal value	Measured value	Color ring 1	Color ring 2	Color ring 3	Tolerance
1k					
2.7k					
4.7k					
10k					

The breadboard is organized as shown in Figure 1: There are three binding posts, on which we will connect the 10 V DC power supply (positive is red, ground is black).

4 Circuit measurements

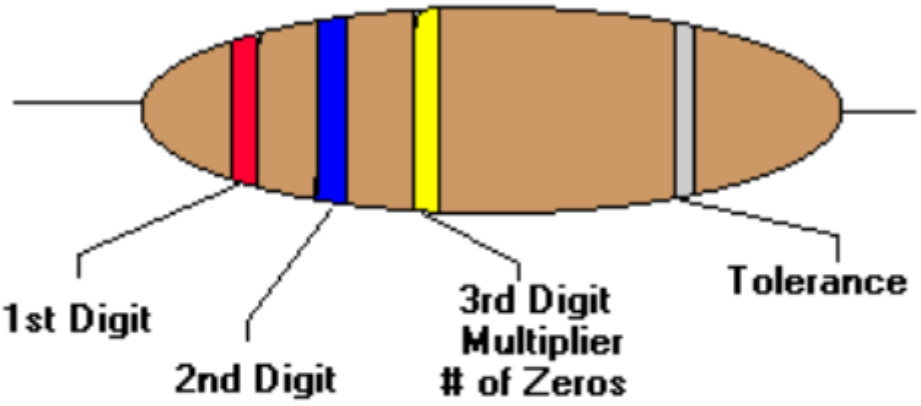
1) Hook up the circuit as shown below on the breadboard. When you are done, let the TA or instructor check your work.
2) Turn on the power supply with the input dials all the way down (CCW) and slowly adjust the power supply to 10V.

3) Measure the voltages across all resistors as shown in Figure 4; keep the red DMM wire on top. Fill out the table:

Nominal value	Voltage drop (V)
2.7k	
4.7k	
10k	

VOLTAGE MEASUREMENTS ARE SAFE, SINCE IN THIS MODE THE INTERNAL RESISTANCE OF THE METER IS NEAR INFINITE.

4) Measure the current flowing into the 2.7k resistor as shown in Figure 5



$$R = ab \times 10^{c} \pm d\%$$

Figure 2: Resistor Color Coding Chart.

Left three bands (a, b, c) indicate nominal resistance value, and right one (d) indicates tolerance.

Color	Value	Multiplier	Tolerance
Black	0	0	
Brown	1	1	
Red	2	2	
Orange	3	3	
Yellow	4	4	
Green	5	5	
Blue	6	6	
Violet	7	7	
Gray	8	8	
White	9	9	
Gold		0.1	5%
Silver		0.01	10%
None			20%

Figure 3: Resistor Color Coding Table.

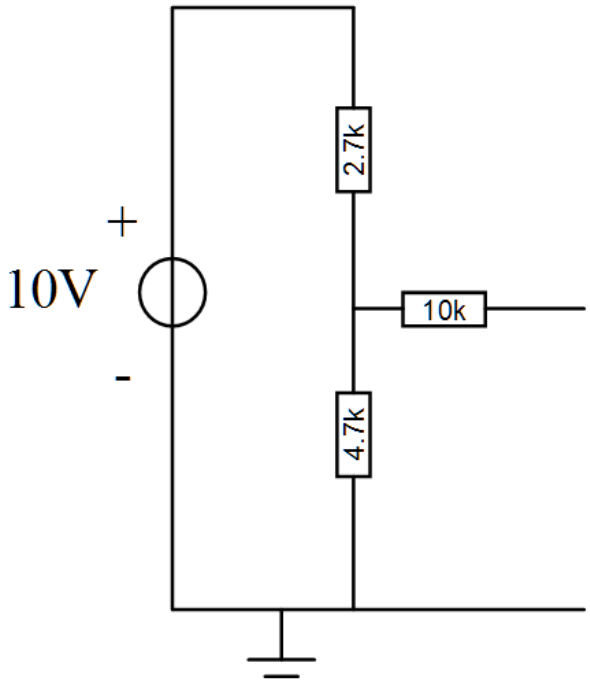


Figure 4: Circuit1. Ask yourself how much current is flowing in the 10k branch.

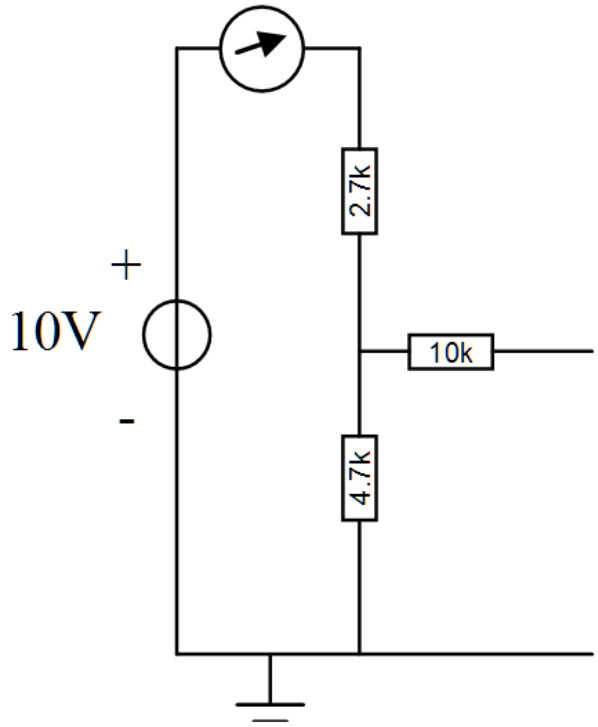


Figure 5: Circuit2. Measure the current into the 2.7k resistor, after the measurement set your DVM back to Voltage measurement.

CURRENT MEASUREMENTS ARE POTENTIALLY DANGEROUS BECAUSE IN THIS MODE THE INTERNAL RESISTANCE OF THE METER IS ZERO, SO PAY CLOSE ATTENTION.

4a) Remove the top wire of the 2.7k resistor
4b) Turn your DMM to Current measurement and move the red wire to Current Measurement
4c) Connect your meter between the positive binding post and the loose end of the resistor
4d) Measure the current and fill out the table:

Nominal value	Current (A)
2.7k	

4e) **Immediately move the red wire of the DMM back to Voltage measurement and turn the dial to DC Voltage measurement.** Measure the voltage drops across the following resistors and fill out the table.

Nominal value	Voltage drop (V)
2.7k	
4.7k	
10k	

5) Repeat the voltage measurements with the 1k resistor placed in series with the 10k resistor as shown in Figure 6. Fill out the table:

Nominal Value	Voltage drop (V)
2.7k	
4.7k	
10k	
1k	

6) Measure the current flowing into the 1k resistor, the 4.7k resistor and into the 10k+1k branch as shown in Figure 7. Fill out the table:

Nominal value	Current (A)
2.7k	
4.7k	
10k+1k	

5 Questions

Q1: Using Ohm's law $\Delta U = iR$ verify the measured values of the voltages across all resistors

$$\Delta U = iR \tag{1}$$

A1:

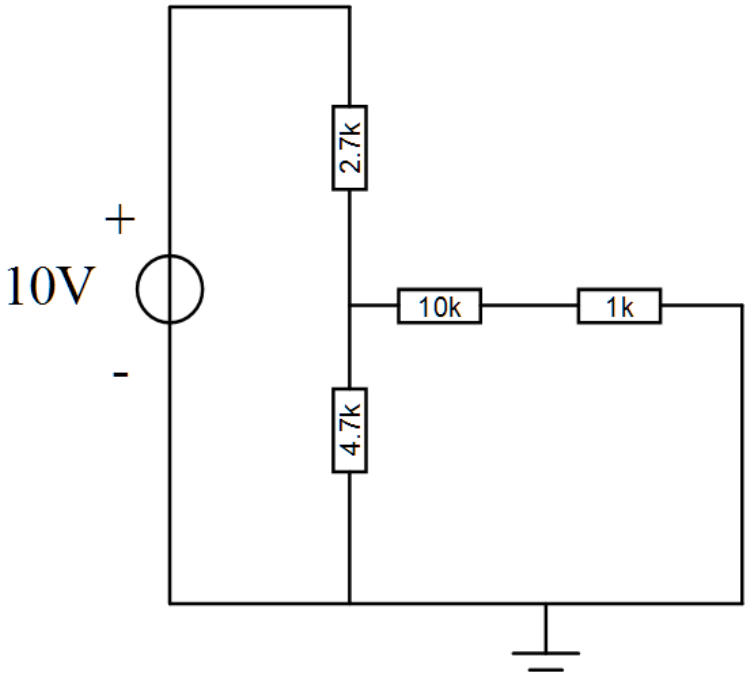


Figure 6: Circuit3. Connect a 1k resistor in series with the 10k resistor. Measure the voltages across all resistors.

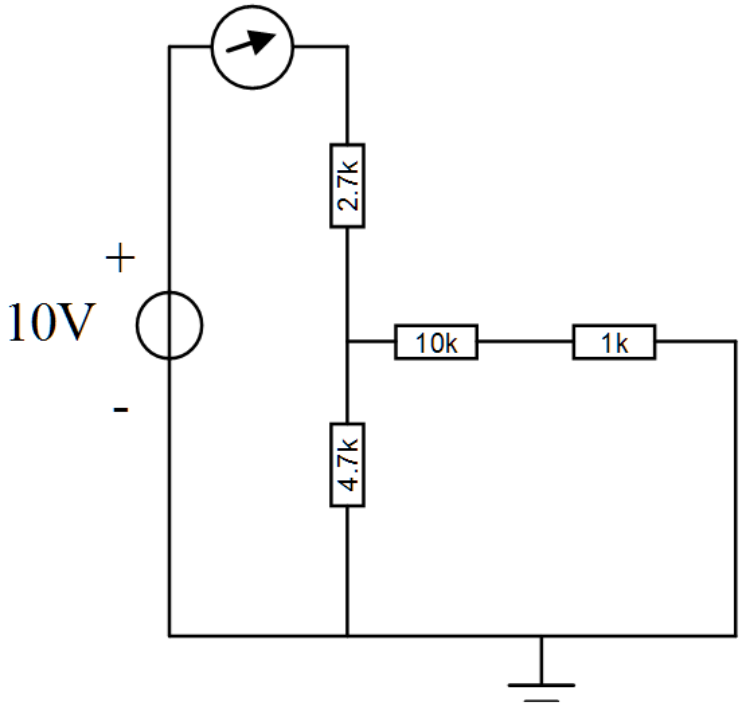


Figure 7: Circuit4. Measure the current into the 2.7k resistor, the 4.7k resistor and the branch containing the 10k and 1k resistor. After the measurement set your DVM back to Voltage measurement.

Q2: Show the validity of Kirchhoff's voltage law which reads: In a closed loop, the algebraic sum of the voltages must be zero. To do this, in the closed loop 4.7k – 10k – 1k measure all voltages keeping the order of polarity the same (always measure high-low or red wire/black wire) and add them up.

A2:

Q3: Show the validity of Kirchoff's current law which reads: In a node, the algebraic sum of the currents must be zero. Verify this using the current measurements from section 6).

A3:

6 Links

Ohm's Law
Kirchoff's Laws