EECE208 Intro to Electrical Engineering Lab   Dr. Charles Kim

3. DC Circuit I

Objectives:
   This experiment lays emphasis on series circuit connection and a mathematical rule pertaining to series circuits. In this experiment we will use ohms law to find current and voltages in a series circuit and apply *KVL* to the series circuit. In addition, this experiment will demonstrate how the voltage is distributed amongst resistors in a series connection, the *voltage divider*.
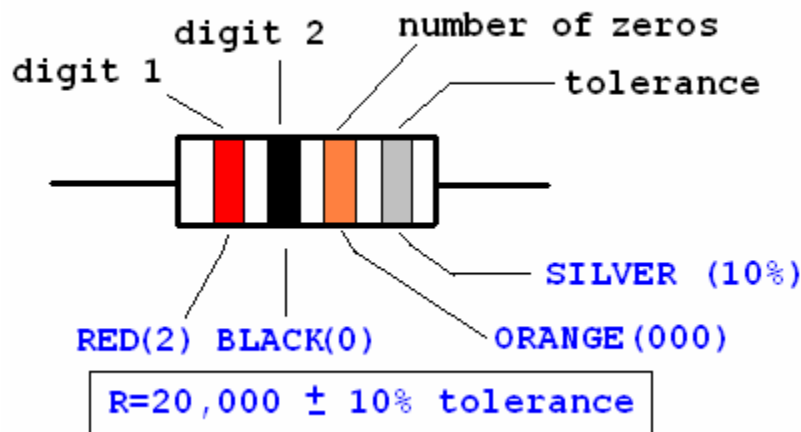
Resistors:
   Resistors limit current and in the process produce or dissipate heat. Resistors are either fixed or variable in nature. Fixed resistors are usually color coded with a four-band code that indicates the specific resistance and tolerance. The table and the figure below illustrate the color-coding technique for fixed resistors.

Values for the first three bands:

Color	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Gray	White	Gold	Silver
Value	0	1	2	3	4	5	6	7	8	9	-1	-2

Tolerance values for the fourth band:

Color	Gold	Silver	No Band
Tolerance	5%	10%	20%

For an interactive resistance calculation,
visit http://www.electrician.com/resist_calc/resist_calc.htm

The color-coding of resistor is an estimate of the resistance value of fixed resistors, therefore, the actual value can be experimentally measured using a Digital Multi-Meter (DMM). When measuring the resistance of a fixed resistor the DMM has to be brought into the **ohm mode**. It is normal practice not to measure the resistor value while it is connected in a circuit since the other resistors connected in that circuit might affect the value being measured and it might lead to an erroneous reading.

Voltage Divider:

  For a simple circuit with a voltage source and two resistors (R1 and R2) in series, the currents through the resistors are the same by the law of KCL. The current is determined by the voltage divided by the total (or equivalent) resistance. That is, $I = \dfrac{V_s}{R_T}$ (1).

Then, the voltage drop across each resistor can be obtained by applying Ohm's Law:
$V_1 = I \cdot R_1$ and $V_2 = I \cdot R_2$

If we focus on the voltage V_2, the current can be expressed as $I = \dfrac{V_2}{R_2}$ (2).

If we equate equations (1) and (2), we then get an equation for V_2 in terms of the source voltage, total resistance, and R_2: $V_2 = V_s \cdot \dfrac{R_2}{R_T}$ (3).

Similarly, we get the equation for V_1: $V_1 = V_s \cdot \dfrac{R_1}{R_T}$ (4).

As equations (3) and (4) show, the source voltage is divided between two resistors and the voltage division is proportional to the value of the resistance. Or, *the voltage across a resistor is equal to input voltage multiplied by the ratio of the resistance to the total resistance.*

PRE-LAB -3:   **Name:** _____   **ID#:** _____

1. **Randomly** select any five resistors from the supply room, and record the following for each resistor and find the resistance value and tolerance.

Resistor No.	COLOR				Resistance and Tolerance
	First Band	Second Band	Third Band	Fourth Band	
1					
2					
3					
4					
5					

2. Calculate the voltages across the resistors in the circuit below. Choose freely any resistive values of the four resistors, in the range of [100Ω, 10kΩ], in your calculation.
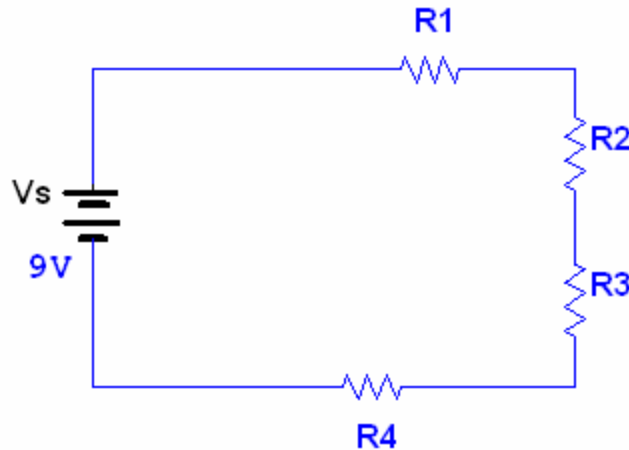
3. Describe the way you would use TEK DM2510G Digital Multi-Meter (DMM) if you want to measure the voltage across R1.

4. Describe the way you would use DMM if you want to measure the current flowing through R1. (Before answering the question, read the operating manual of TEK CDM250 DMM, which is the closest DMM manual I could get from Tektronix. The manual of DM2510G DMM is not available. But the operating method is still the same. The CDM250 manual is available from web site.)

LAB PROCEDURE

Equipment:

1. Breadboard.
2. Resistors
3. DMM for voltage and current measurements.
4. Power supply

Procedures:
1.Select any four resistors from the supply box whose values are in the range of [100Ω, 10kΩ].
2. Measure each resistor using DMM the actual (or measured) resistive value.
3. Construct the following circuit using the four resistors selected on your breadboard.
4. Now, using DMM, measure the total resistance of the circuit.
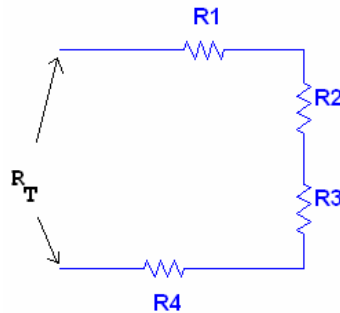
5. Record your findings in the Table below.

Resistors	Resistance	
	By Color Code	By Measurement
R1		
R2		
R3		
R4		
R$_T$		

6. Now apply a DC voltage source of 9V to the circuit as shown below.
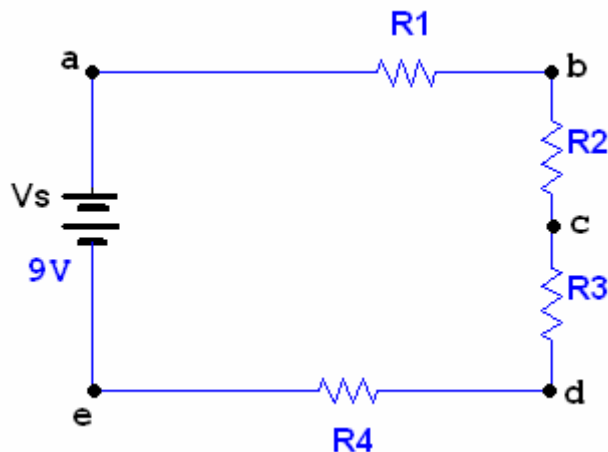
7. Using DMM measure the voltages of V_{ab}, V_{bc}, V_{cd}, and V_{de}, and compare them with calculated values. Fill the following Table.

Voltage	Calculated Value	Measured Value
V_{ab}		
V_{bc}		
V_{cd}		
V_{de}		

8. Using the calculated R_T and the source voltage, calculated the current through the resistors.

$I_{calc} = $ _____

9. Using the DMM as Ammeter (or current meter), measure the current through the resistors.
(follow your answer of #4 of the Pre-Lab problem.)

$I_{meas.} = $_____

DISCUSSION POINTS
  *Again, this is just suggestion. I honor more of your own discussion idea.
  (a) Instrument has reading errors and resistor has tolerance, then, what is certain or uncertain in circuit analysis?
  (b) If you measured current is far away from your calculated current, where would be the problem?
  (c) When your DMM reading is like 0.01[A], what would be the range of the correct value of the reading?
     Is it safe to interpret 0.01[A] and 10 [mA]?
    (Could 0.01[A] be actually 6.89[mA] or 5.12[mA] or 9.99[mA]?)
  (d) Can you think of a home appliance which applies voltage division rule?