COLLEGE OF ENGINEERING
SUNY POLYTECHNIC INSTITUTE

ECE 260

Name:____

Date:____

Laboratory 1 – Resistors and the Color Code

Purpose: The purpose of this exercise is to develop proficiency in the understanding of resistors and how their values differ.

Equipment Required

- Laptop and ELVIS II Board (optional)
- FLUKE Hand-held Multimeter or some other multimeter
- Various resistors
  - 1 1MΩ 1-W resistor
  - 1 1MΩ 2-W resistor
  - 1 1MΩ ½ -W resistor
  - 1 6.8Ω, 91Ω, 220Ω, 3.3kΩ, 10kΩ, 470kΩ, 1MΩ ¼ resistors

Learning Objectives

1. Become familiar with a multi-meter
2. Learn how to read and use the resistor color code
3. Become familiar with the impact a voltmeter and ammeter have on a circuit

Basic Theory Behind Reading Resistive Value

The code

Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Gray	White
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

The mnemonic:

Bad Boys Race Our Young Girls But Violet Generally Wins

How to read the code

- First find the tolerance band, it will typically be gold (5%) and sometimes silver (10%). If no band is given, it is assumed the tolerance is 20%
- The first two color bands (those closest to the end of the resistor or those furthest from the tolerance band, determine the first two digits of the resistor value
  - Starting from the other end, identify the first band - write down the number associated with that color; in this case Blue is 6.
  - Now 'read' the next color, here it is red so write down a '2' next to the six. (you should have '62' so far.)
- The third band determines the power of 10 multiplier. Read the third or 'multiplier' band and write down that number of zeros following the first two digits.

In this example we get '6200' or '6,200'. If the 'multiplier' band is Black (for zero) don't write any zeros down.

- If the 'multiplier' band is Gold, move the decimal point one to the left. If the 'multiplier' band is Silver, move the decimal point two places to the left. If the resistor has one more band past the tolerance band it is a quality band.

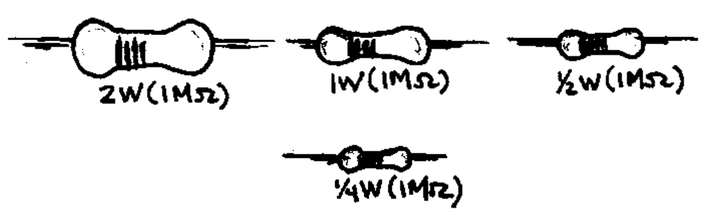
For the tolerance, read the number as the '% Failure rate per 1000 hour' This is rated assuming full wattage being applied to the resistors. (To get better failure rates, resistors are typically specified to have twice the needed wattage dissipation that the circuit produces) 1% resistors have three bands to read digits to the left of the multiplier. They have a different temperature coefficient in order to provide the 1% tolerance.

For increasing the wattage ratings the size of the film resistor will increase to provide the “body” required to dissipate the resulting heating effects.

Never measure resistance by an ohmmeter in a live circuit, due to the possibility of damaging the meter with excessively high currents and obtaining readings that have no meaning. It is best to remove the resistor from the circuit before measuring its resistive value or at a minimum, disconnect one end of the resistor from the remaining circuit.

Procedure

1. **Body Size**
   In the space below, identify, from the physical size, the ¼-W, ½-W, 1-W, and 2-W 1MΩ film resistors. Note that the resistance of each is the same, but the size increases with the wattage rating:



   How much larger is the 1-W resistor than the ½-W resistor? Is the ratio the same for the 2-W resistor as compared to the 1-W resistor?

2. Color Code

Using the procedure describe above, determine the color bands for each resistor appearing in the table below. Then for each resistor enter in the table the value of the color bands for all four bands (as shown in the example).

Table 1

Resistor Nominal Value	Color Bands - Color				Color Bands – Numerical Value			
	1	2	3	4	1	2	3	4
22Ω	Red	Red	Black	Gold	2	2	0	5%
91 Ω								
220 Ω								
3.3 kΩ								
10 kΩ								
470 kΩ								
1 MΩ								
6.8 Ω								

The percent tolerance is used to determine the range of resistance levels within which the manufacturer guarantees the resistor will fall in. It is determined by first taking the percent tolerance and multiplying it by the nominal resistance value. This value is added and subtracted from the nominal value to determine the range.

Complete Table 2 for each resistor in Table 1.

Table 2

Resistor Nominal Value	Minimum Resistance	Maximum Resistance
22Ω	20.9 Ω	23.1 Ω
91 Ω		
220 Ω		
3.3 kΩ		
10 kΩ		
470 kΩ		
1 MΩ		
6.8 Ω		

Obtain an equivalent resistor and measure the resistance value using a digital multimeter (DMM) and insert the value into Table 3. Determine the percent difference between the nominal value and the measured value using the following equation.

$$\%\,Difference = \left|\frac{Nominal - Measured}{Nominal}\right| x\ 100$$

Table 3

Resistor Nominal Value	DMM		
	Measured Value	Falls within Specified Tolerance (Yes or No)	%Difference
22Ω	22.9 Ω	Yes	4.09%
91 Ω			
220 Ω			
3.3 kΩ			
10 kΩ			
470 kΩ			
1 MΩ			
6.8 Ω			

For the DMM measurements, are all the resistors within the specified tolerance range? If not, how many resistors did not fall within the tolerance range?

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3. Body Resistance

Guess the resistance of your body between your hands and record the value in Table 4. Measure the resistance of your body between your hands with the DMM by holding one each lead firmly in each hand. Hold the leads as tight as possible and record the value. If you slightly dampen your fingers, does the resistance go up or down? Why?

Table 4

Guessed body resistance	
Measured body resistance	
Damp Fingers	

Calculation:

4. Meter Resistance

Ideally, the internal resistance of the DMM should be infinite (like an open circuit) when measuring voltage in a network (why?). Most DMM have the same internal resistance for all the DC voltage scales. An internal resistance of 10 MΩ to 20 MΩ is typical for a variety of commercially available DMMs.

Use yours and your neighbor's DMM to measure the internal resistance of each voltage scale of your DMM that appears on your meter. Record your answers in Table 5.

Table 5

DMM Voltage Range Values (V)	Specified Internal Resistance	Measured Resistance
6		
60		
600		
1000		

The ammeter is also an instrument that when inserted in a network should not adversely affect the normal current levels. However, since it is place in series with the branch in which the current is being measured, its resistance should be as small as possible.

Using the DMM as an ohmmeter, measure the resistance of each current scale of the DMM and record your answers in Table 6.

Table 6

DMM Current Range Values	Measured Resistance
Amps	
Milli-Amps	

5. Exercises

a) What are the ohmic values and tolerances of each of the commercially available carbon resistors?

Color Bands - Color					
1	2	3	4	Numerical Value	Tolerance
Brown	Black	Blue	Gold		
Yellow	Violet	Orange	Gold		
Brown	Gray	Gold	None		
Red	Yellow	Silver	Gold		
Green	Brown	Green	Silver		
Green	Blue	Black	None		

b) In your own words, review the procedure for using a DMM to read the resistance of a resistor.

c) A VOM (Volt-Ohm-Milliammeter) is similar to a DMM but has an analog display. Under what conditions would an analog display have advantages over a digital display?