

## CECS 211 - LAB 4

### Prototyping Series and Parallel Resistors

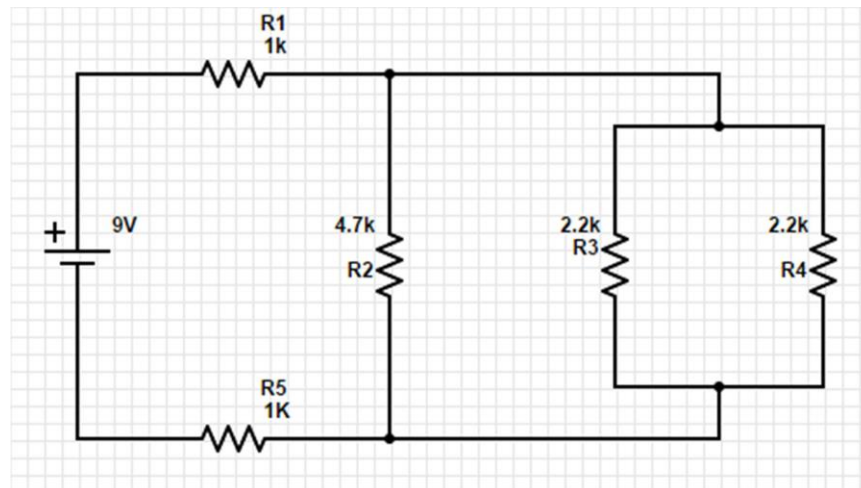
NAME:

POSSIBLE POINTS: 10

NAME:

#### DIRECTIONS:

We are going to step through the entire process from conceptual to a physical prototype for the following resistor circuit.



#### STEP 1 - CALCULATIONS:

Calculate the following for the above circuit and label the above schematic with the symbols from the table and the arrows for the current directions:

$I_T$	
$I_1$	
$I_2$	
$I_3$	
$I_4$	
$V_{R1}$	
$V_{R2}$	
$V_{R3}$	
$V_{R4}$	
$V_{R5}$	

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#### STEP 2 - MODELING:

Create a Multisim Simulation for the circuit and include a screen capture of the circuit with multimeters to validate all the previous calculations. We refer to this as verification by modeling the circuit. You'll find that in practice when designing a product that if the model doesn't work then there is no chance that the physical implementation will work.

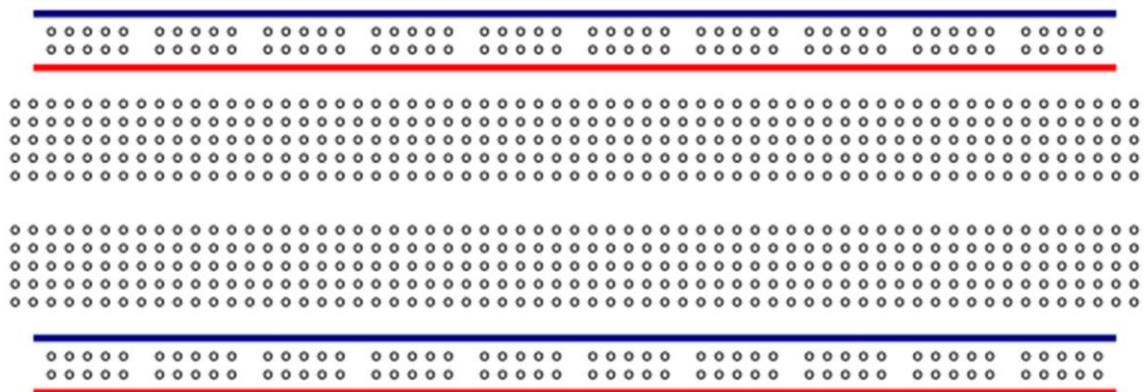
#### STEP 3 - PROTOTYPING:

Create a prototype of the above circuit on your breadboard using your resistor kit and and "hookup" wire to connect the power supply.

#### BREADBOARDS:

The best method of experimenting and building simple circuits with leaded components such as resistors is to use a "breadboard" to build circuits. Breadboards, more formally known as solderless modular sockets, get their name from the early days of radio, when it was common to build vacuum tube circuit prototypes on a wooden breadboard.

Today's breadboards are a grid of insulating plastic atop a pattern of conducting metal strips. Here is a top view of a typical breadboard:

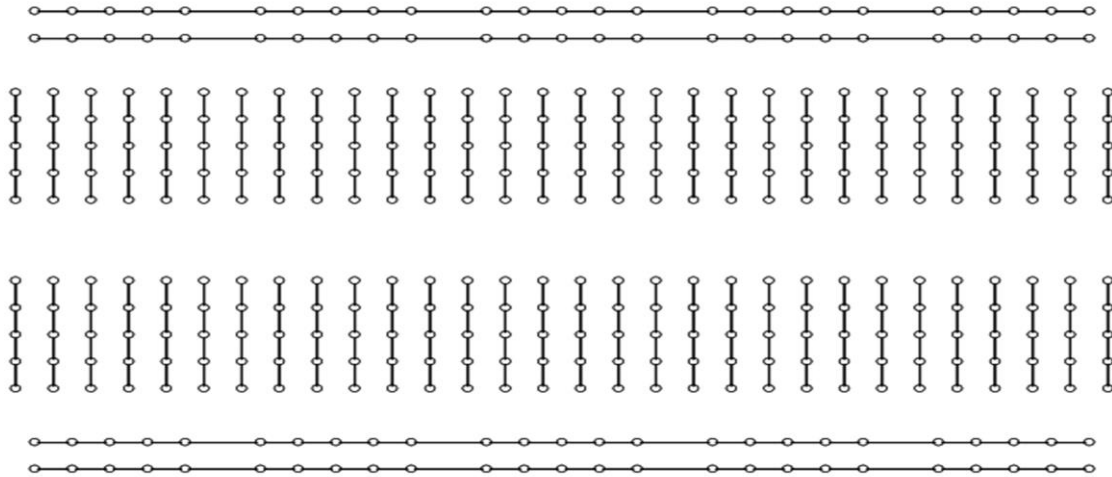


Component leads and wires are inserted into the holes and make contact with the conducting metal strips underneath, thus "connecting" them together.

The pattern of conducting strips underneath the insulating plastic is shown below. Notice there are two horizontal strips along both sides of the breadboard and a series of shorter vertical strips. The two horizontal strips are normally used for power supply connections, with one strip being the supply voltage and the other being the ground connection. The horizontal strips are often known as rails.

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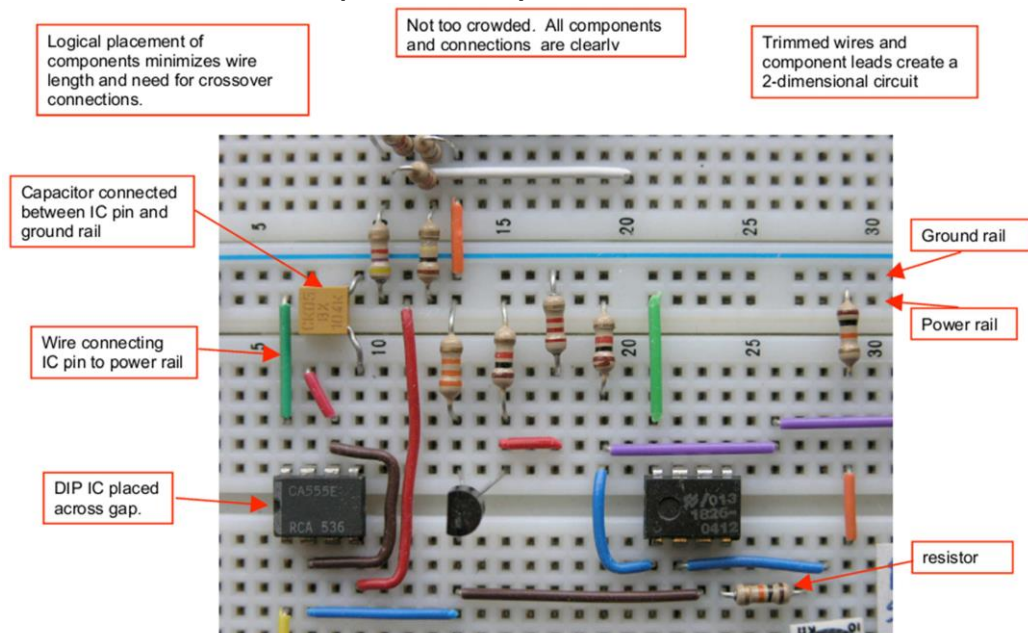


Note the gap separating the vertical strips. The dual in-line package (DIP) IC is normally placed across this gap. One row of pins is one side of the gap, and the other row of pins is on the opposite side.

Leaded components such as resistors, capacitors and transistors are connected between vertical strips or between a strip and the power or ground rail. Wires can also be used as jumpers to interconnect vertical strips.

Breadboards come in a variety of sizes, and are usually measured in terms of the number of connection or "tie points" provided. Some breadboards come with binding posts for connecting a power supply; deluxe models have power supplies built in and with additional supports for potentiometers, LEDs, and meters.

#### Example of Neat Layout and Construction



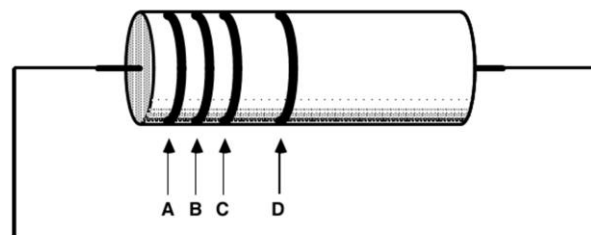
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#### RESISTORS:

Resistors are commonly used in electronic circuits, along with other components such as capacitors, inductors, and active devices such as transistors and integrated circuits (commonly called ICs). Resistors may be connected in series and/or parallel for many reasons, such as to reduce a voltage to a convenient value (as in a voltage divider) or to provide a value different from one that is commercially available. You therefore need to be able to find the equivalent resistance of various combinations of individual elements.

Resistors have a nominal value indicated by colored bands or other labeling. Refer to a color-code chart to interpret the nominal value indicated by the colored bands. The actual (measured) resistance will vary from the nominal value due to subtle mechanical and chemical differences that occur during manufacturing. The manufacturer specifies the maximum deviation from the nominal value as a  $\pm$ percentage. This range of deviation is called the tolerance of the resistor family. Typical tolerance values are  $\pm 1\%$ ,  $\pm 5\%$ , or  $\pm 10\%$ . Some resistors in your lab kit are 5%, which is indicated by a fourth band that is gold in color.



$$\text{Resistance} = AB \times 10^C \pm \text{tolerance (D)}$$

0 : Black  
1 : Brown  
2 : Red  
3 : Orange  
4 : Yellow

5 : Green  
6 : Blue  
7 : Violet  
8 : Gray  
9 : White  
-1: Gold

Tolerance:  
20% : No band  
10% : Silver  
5% : Gold

For example:

- a  $1 \text{ k}\Omega \pm 5\%$  resistor [ $10 \times 10^2$ ] is labeled BROWN:BLACK:RED:GOLD
- a  $220\Omega \pm 10\%$  resistor is labeled RED:RED:BROWN:SILVER, and
- a  $1\Omega \pm 5\%$  resistor must be represented as [ $10 \times 10^{-1}$ ], or BROWN:BLACK:GOLD:GOLD.

Note that some resistors have a 1% tolerance rating, and this requires an extra digit of precision. One percent tolerance resistors usually have a light blue colored body, and five stripes (ABCDE) interpreted as  $ABC \times 10^D \pm \text{tolerance (E)}$ , where the E band is brown in color for a 1% resistor.

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**PROTOTYPE VERIFICATION:**

Use your physical Digital Multimeter (DMM) to find the value of the following: (We will discuss how to properly use a DMM in lab.)

Measure with ohmmeter of DMM	
$R_1$	
$R_2$	
$R_3$	
$R_4$	
$R_5$	
$R_t$	
Measure with currentmeter of DMM	
$I_T$	
$I_1$	
$I_2$	
$I_3$	
$I_4$	
Measure with voltmeter of DMM	
$V_{R1}$	
$V_{R2}$	
$V_{R3}$	
$V_{R4}$	
$V_{R5}$	

**Lab Report:** Submit a lab report with the following contents where each section begins at the top of a new page:

- **Title Page:**
  - Name
  - Lab title
  - Class
  - Date
- **Section 1:** The completed table from Step 1 of this Lab with all calculations
- **Section 2:** A screenshot of your Multisim circuit from Step 2 with multimeters displaying correct measurements
- **Section 3:** A snapshot of the circuit built on your breadboard
- **Section 4:** The completed table of measurements from Prototype Verification

*Combine the contents listed above into a single PDF and upload to the beachboard dropbox and have a nice day!*