CS240 Laboratory 1 Notes
Electrical and Digital Laboratory Concepts

Basic Concepts of Electricity

Electricity is the form of energy used to power computers.

Electricity is important to us in Machine Organization because it is the lowest level of computer operation which we will study (we leave the topic of Quantum Mechanics to your Physics instructors).

Electricity is the movement of electrons in a material. Materials tend to have a net negative or positive charge, depending on the balance of protons (+) and electrons (-) in the material. Electrons flow from areas of negative charge to areas of positive charge. A difference of charge between two points is known as a potential difference, and is measured in units of volts (V).

The rate at which electrons flow through a material is known as current, and is measured in units of amperes (A). By convention, current in a circuit is considered to flow from a more positive point to a more negative point, even though the actual electron flow is in the opposite direction.

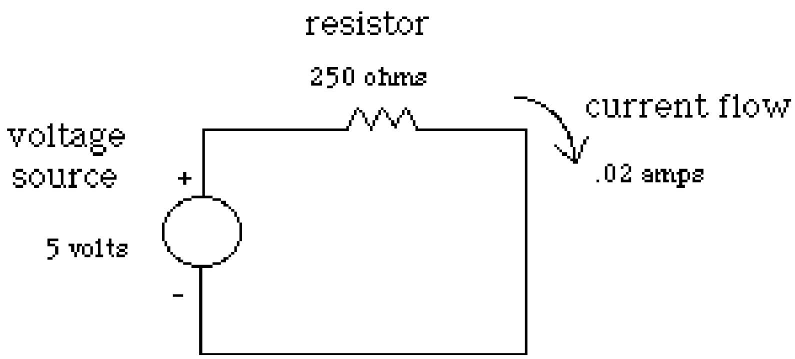
Current can be either alternating or direct. With alternating current, the terminals of the voltage source repeatedly change from positive to negative, causing the current to vary with time.

With direct current, the terminals of the voltage source are constant values, causing the current to flow in one direction, and maintain a constant value.

In this Lab, we always use direct current.

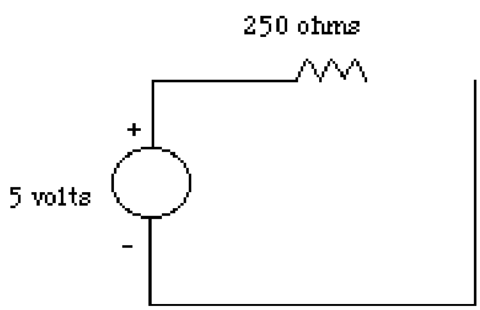
The ease of conduction, or current flow, through different materials varies, and is known as resistance. Resistance is measured in units of ohms (Ω).

An electric circuit normally contains a source of electricity, usually a battery or generator (the voltage source). The voltage source drives electrons (current) through a wire to the working part of the circuit. The working part of the circuit has a resistance, and power is released in the circuit depending on the nature of the work being performed. The electrons then return along a wire to the source, and complete the circuit. The following figure shows the symbols used for electric circuits:

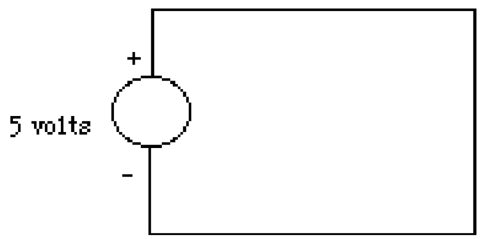


In general, the current through a circuit is directly proportional to the voltage across the circuit, and inversely proportional to the resistance of the circuit. These relationships are expressed in Ohm's Law, as V = IR.

A circuit which has been disconnected at some point is know as an open circuit, and no current will flow in such as a circuit, since there is no potential difference between any two connected points in the circuit:



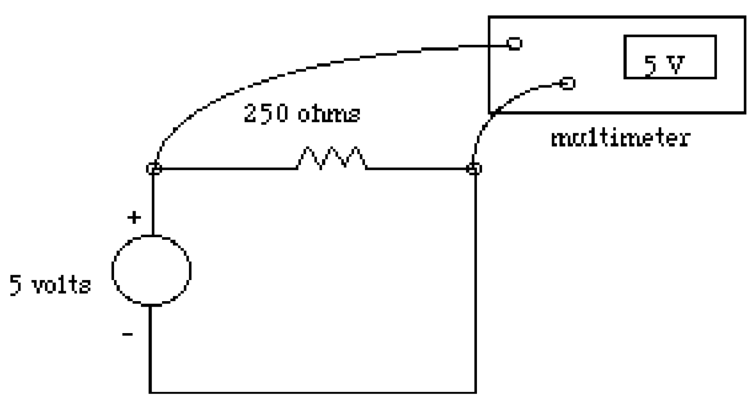
A circuit which does not have resistance to dissipate power is known as a short circuit, and results in an infinite amount of current in the circuit, since V/R = I, so that V/0 = infinite current:



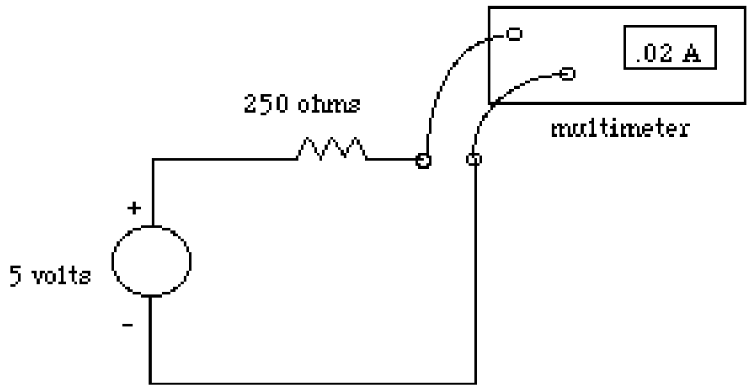
Infinite current swiftly results in the destruction of the circuit!

A **multimeter** can be used to perform voltage, current, and resistance measurements.

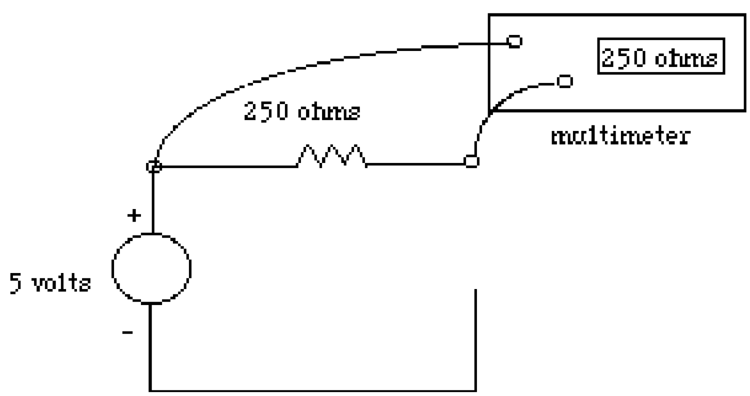
Voltage may be measured between any two points:



Current is present as a steady flow throughout the path of the circuit, and may be measured at any point. To do so, break the circuit and insert the multimeter into the circuit so that the current runs through the instrument:



Resistance may be measured with the circuit open and the power off, since the resistance is a physical property independent of voltage or current:



How to read Resistor Color Codes

A real resistor looks something like this. The bands are colored, and indicate the value of the resistor:

Resistor Color Code

color	digit	multiplier
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1000 (1K)
Yellow	4	10000 (10K)
Green	5	100000 (100K)
Blue	6	1000000 (1M)
Violet	7	10000000 (10M)
Gray	8	
White	9	

Commonly Used Prefixes for Multipliers

value	name	symbol
10^6	mega	M
10^3	kilo	K
10^{-3}	milli	m
10^{-6}	micro	u
10^{-9}	nano	n

Determining Resistor Value

Assume the band colors of a particular resistor are **blue, red, red, gold**.

Use the following strategy to determine the resistor value:

1. Find the tolerance band, it will typically be gold (5%) and sometimes silver (10%).

2. Starting from the other end, identify the 1st digit band - write down the number associated with that color; in this case blue is ‘6’.

3. The next, 2nd digit band, is red, so write down a '2' next to the six. (you should have '62' so far.)

4. Multiply the value you have written so far by the third, multiplier, band. In this example, the multiplier band is red (1K), so it is a 62 KΩ resistor.