

# **IME-100**

## **Interdisciplinary Design and Manufacturing**

### **Introduction to Circuits**

After completing this Tutorial, you will be able to:

- Identify circuit components (resistors & their value, LEDs, switches, breadboard)
- Build LED circuit on breadboard
- Build a switch circuit on breadboard

## Introduction to Electrical Circuits

There is plenty of resources available online to learn the basic concepts of electricity and electrical circuits. Here is one useful resource:

<http://www.youtube.com/watch?v=fDvZOp9Ogro>

For more information about voltage, current, resistance and the Ohm's law, watch the following video:

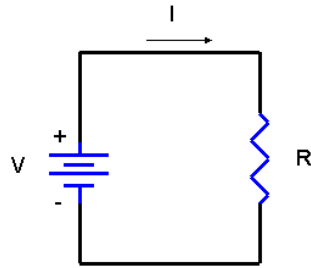
<http://www.youtube.com/watch?v=J4Vq-xHqUo8>

Come prepared for discussions, answer questions, and ask questions when you don't understand some concepts.

Key terminologies to focus on:

- Static electricity
- Electrons
- Electric current
- Electric Voltage
- Sources of Electric Voltage
- Wire or conductor
- Resistor
- Resistance
- Potentiometer (variable resistance)
- Switch
- Light source (lamp, LED)
- Electrical symbols (voltage source, wire, resistor, switch, light source)
- Measuring electricity (Volt, Amp, Ohm, Watt)
- Ohm's Law ( $V = IR$ )
- Series circuit
- Parallel circuit

Example: In a simple circuit made up of a 12 V battery connected directly to a 5Ω resistor, calculate the amount of current flowing through the circuit.



### Power Supply

- Circuits need power supplies to drive electrons (current)

Spec: Voltage, Current, Amp-Hr

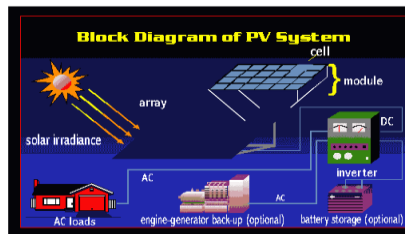
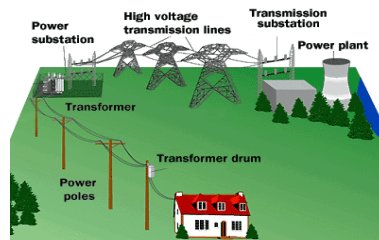
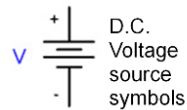
- Sources of power:

Battery

Electrical outlet

Green sources:

Solar, wind



Note:  
 D.C. – direct current  
 A.C. – alternating current

## Resistance values & color codes

- Resistor – electrical component that limits or ‘resists’ the flow of electrons (current) in a circuit

All resistors are not created equal

They come in different values, shapes, colors and types

- Types: Carbon composition, carbon film, metal film, thick film, thin film, wirewound, *potentiometers* (variable resistance), photoresistor, thermistor
- Resistor values are determined from *color codes*

Color	Value	Multiplier	Tolerance
Black	0	$\times 10^0$	$\pm 20\%$
Brown	1	$\times 10^1$	$\pm 1\%$
Red	2	$\times 10^2$	$\pm 2\%$
Orange	3	$\times 10^3$	$\pm 3\%$
Yellow	4	$\times 10^4$	- 0, + 100%
Green	5	$\times 10^5$	$\pm 0.5\%$
Blue	6	$\times 10^6$	$\pm 0.25\%$
Violet	7	$\times 10^7$	$\pm 0.10\%$
Gray	8	$\times 10^8$	$\pm 0.05\%$
White	9	$\times 10^9$	$\pm 10\%$
Gold	–	$\times 10^{-1}$	$\pm 5\%$
Silver	–	$\times 10^{-2}$	$\pm 10\%$
None	–	–	$\pm 20\%$

Example:

Green = 5, Blue = 6, Red = 2  
 Resistance =  $56 \times 10^2 = 5600 \Omega = 5.6 \text{ K}\Omega$   
 Last band of Gold => Tolerance =  $\pm 5\%$



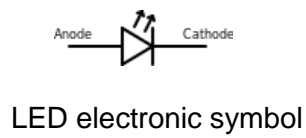
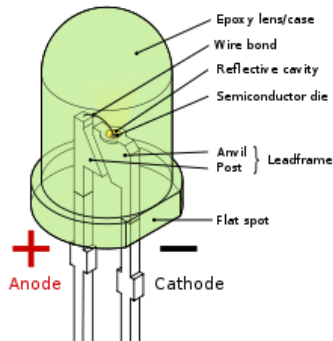
Exercise: Determine the nominal resistance values of these resistors, given their band colors:

1) Red, Org, Blu, Gld =

2) Blu, Blk, Brn, Red =

## Light Emitting Diode (LED)

- LED is a light source manufactured from semiconductor material.
- They are used as indicator lamps in many devices and are gaining interest for automotive, household and industrial lighting applications



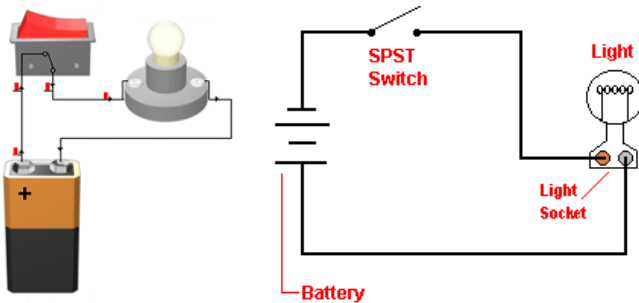
Red, Green, and Blue (RGB) LEDs

### **LED based energy efficient lighting:**

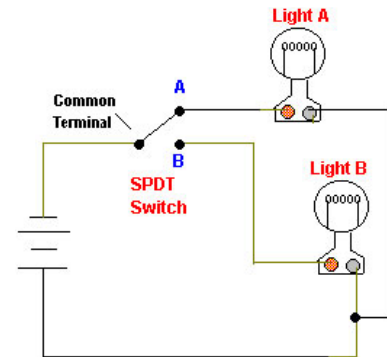


## Switches

- Circuits need: power supply and other useful devices such as resistors, switches, lights, sensors, buzzers, etc.
- Example: Controlling light (s) with switch



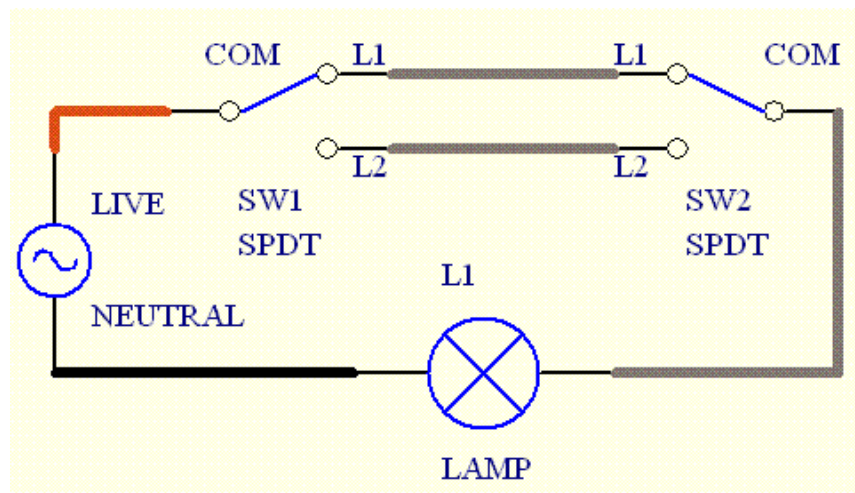
Controlling single light with SPST switch



Controlling two lights with SPDT switch

[http://catalog.miniscience.com/catalog/electricity/Knife\\_Switch\\_Diagrams.html](http://catalog.miniscience.com/catalog/electricity/Knife_Switch_Diagrams.html)

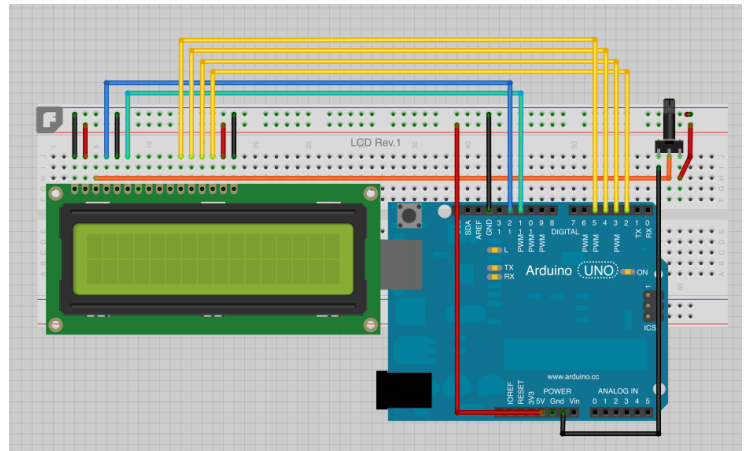
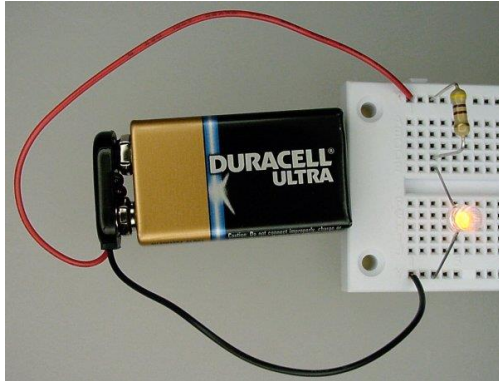
## Example: two-way switch control of light



<http://www.electronics-project-design.com/LightSwitchWiring.html>

## Prototyping

- A **prototype** is an early sample or model built to test a concept or process or to act as a thing to be replicated or learned from.
- Solderless **breadboards** are the fastest way to hook up a circuit for quick setup & testing.

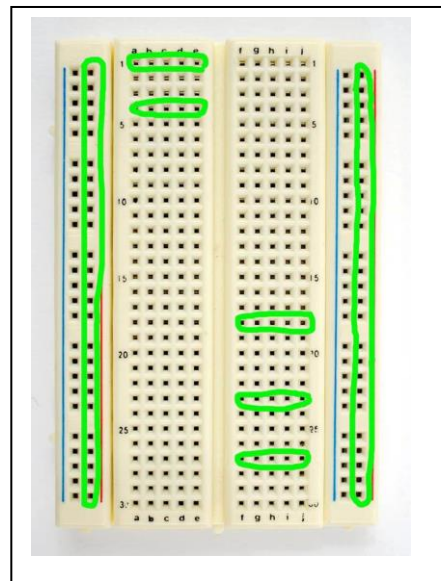


## Breadboard

- A construction base for prototyping electronics.
- Soldering is not required.
- Sockets are already connected

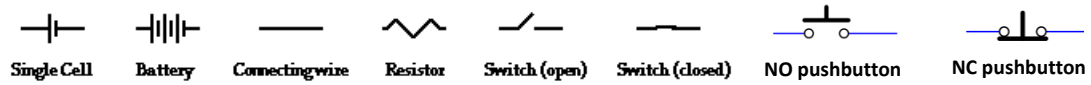
Both sides: vertically

Inside: horizontally.

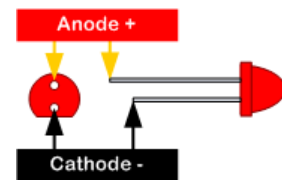
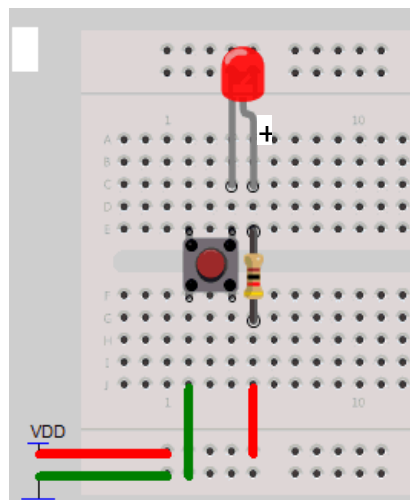
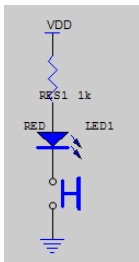


## Schematic Diagram to Actual Wiring on Breadboard

Schematic diagram symbols:



Example: Build this pushbutton controlled LED circuit on your breadboard and demonstrate to your instructor



Identifying LED polarity