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Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

ECE1022A Labwork

Basics of Electrical and Electronics Engineering

List of Laboratory Exercises / Practical:

1. Introduction to instruments and electronic components, Build and test Light Emitting diode Circuit on Bread Board
2. Design of rectifier using PN junction diode.
3. Design of voltage regulator using Zener diode.
4. Measurement of transistor amplifier gain in CE configuration.
5. Design and implementation of Full Adder using basic and universal gates.
6. Design of inverting and non-inverting amplifier using OPAMP.
7. Verification of KVL, KCL
8. Finding Resonant Frequency of series R-L-C circuit
9. Finding efficiency and regulation of Single-phase Transformer using Direct Loading method.

Project –PBL Activity

021-22) FY Div 9 Basic Electr

classroom.google.com/c/NDM3NjI5Mzc0NjMy

(2021-22) FY Div 9
sic Electrical and Electronics Engg.(ECE1022A)

Stream | Classwork | People | Grades

Class code
mpa4752

Upcoming
No work due soon
View all

Announce something to your class

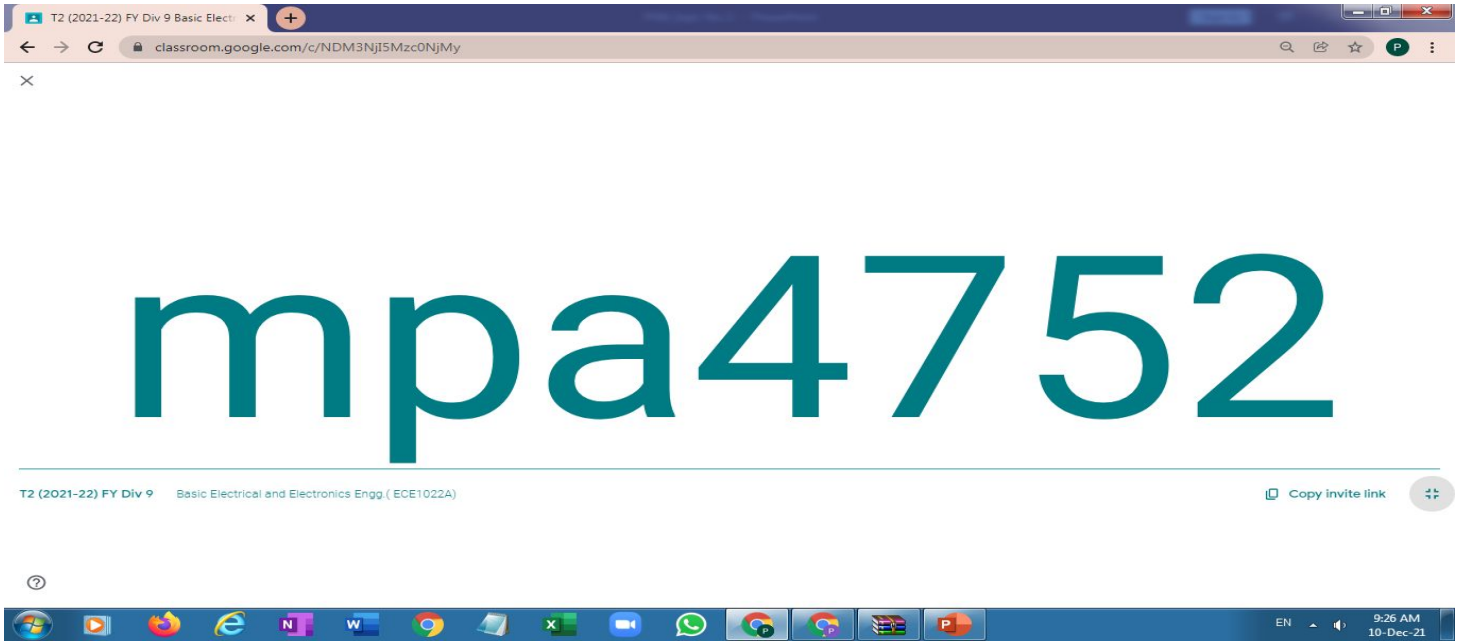
Priyamwada Mahajani posted a new assignment: BEEE Expt 1- Study of Electronic Componen...
9:16 AM (Edited 9:20 AM)

Priyamwada Mahajani posted a new material: Books
Dec 7

Priyamwada Mahajani
Dec 7 (Edited Dec 7)

Hello students,

EN



Google Classroom Link:

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BEEE Lab- Electronics section(Expt no. 1-6)

EXPT No. 1

Introduction to Instruments and Electronic Components, Build and Test Light Emitting Diode Circuit on Bread Board

Electronic Components

Electronic Components are of two types

- Passive Components: Passive electronic components are not able to amplify or process an electrical signal by themselves.

  Examples: Resistor, Capacitor, Inductor, Switch, Cables.

- Active Components: Active electronic components are able to amplify or process an electrical signal.

  Examples: Diodes and transistors

Passive Components

- Resistor
- Capacitor
- Inductor

Resistor

- An opposition to the flow of charge (i.e. current) through any material called resistance of the material.
- The function of a valve is to control the amount of fluid that flows through a pipe

- In an electronic circuit, the resistor is used to control the amount of current that flows through a conductor.

Resistor

- It is measured in ohms (Ω)
- Resistance of a metallic wire is given by

$$\mathbf{R = \rho l / A}$$

Where, ρ = specific resistivity = constant,

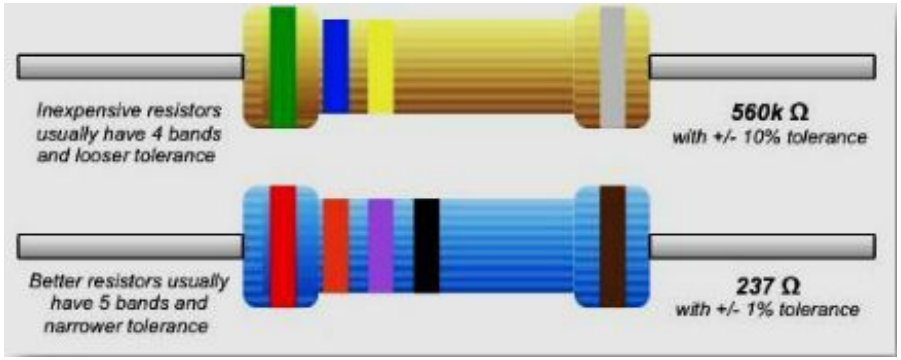
l = length of a wire and

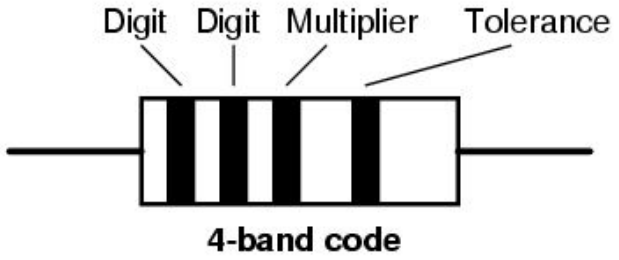
A = area of cross-section of wire.

- In some parts of electronic circuits, resistance is deliberately introduced. The device or component to do this is called a resistor.

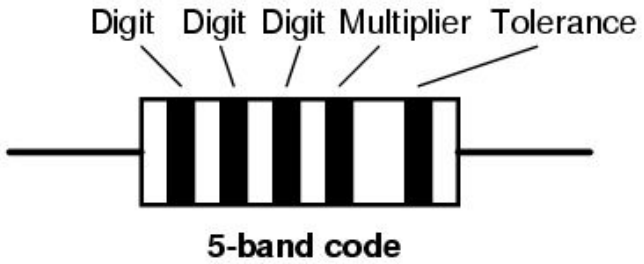
Symbol of Resistor

Reading a Value of Fixed Resistor





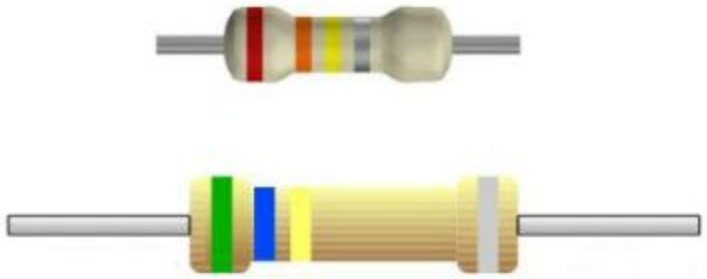
4-band code



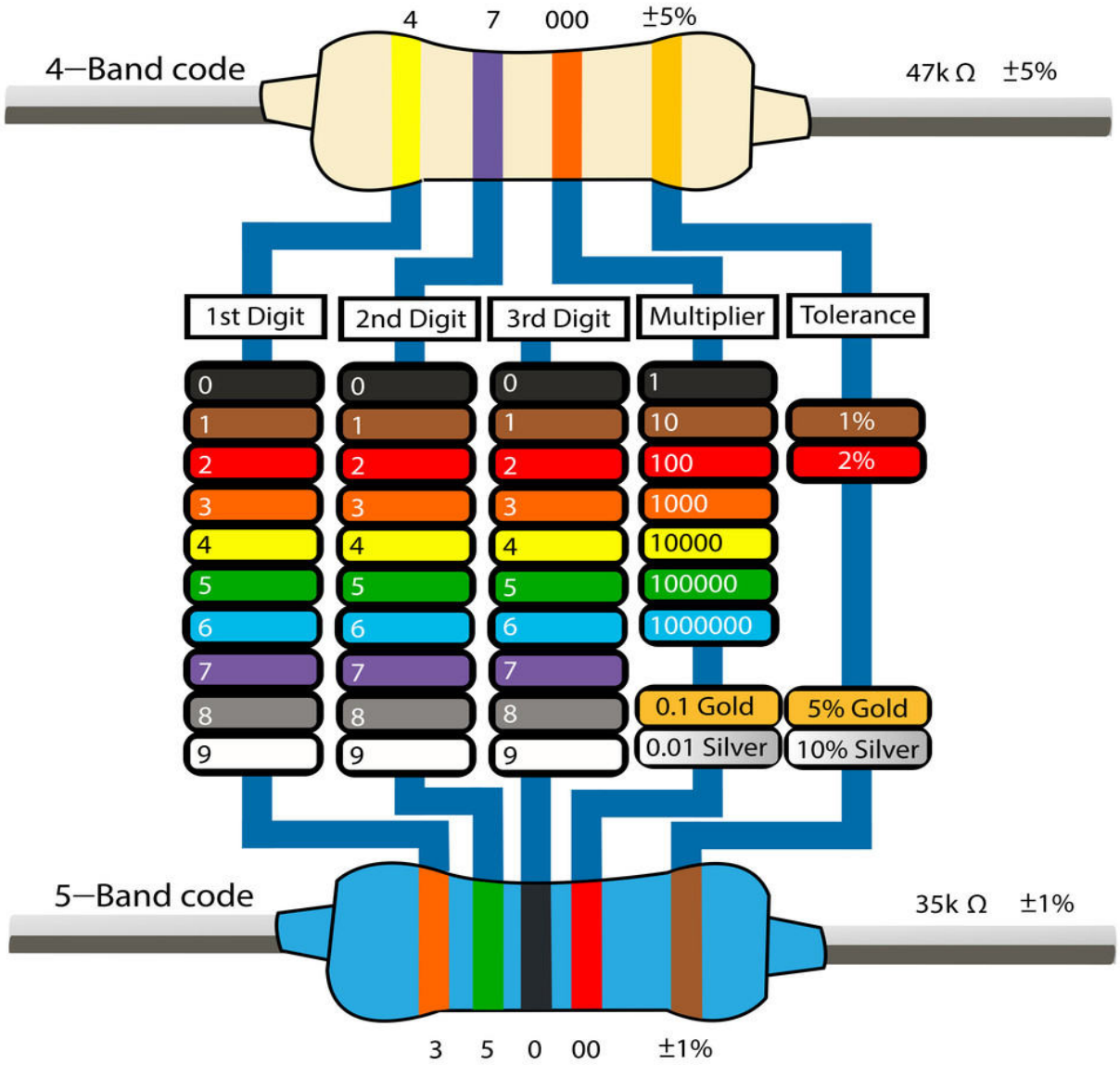
5-band code

Reading Value

- If your resistor has four color bands ,turn the resistor so that the gold or silver band is on right hand side or the end with more bands should point left.



Reading Value



Tolerance decides range

- Tolerance of a Resistor is also an important property to consider
- A 100 ohm resistor with a 10% tolerance can mean its value can be any fixed value between 90 to 110 Ohms.
- A 120 Ohm resistor with a 10% tolerance can mean its value can be any fixed value between 108 and 132 Ohms.
- So there is some overlap between 100 Ohm and 120 Ohm resistance in terms of its limits.

Mnemonic to Remember

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

"B B ROY of Great Britain had a Very Good Wife"

Standard Values in market

1	10	100	1K	10K	100K	1M	10M
1.2	1.2	1.2	1.2	1.2	1.2	1.2	
1.5	**15**	**150**	**1.5K**	**15K**	**150K**	**1.5M**	
1.8	18	180	1.8K	18K	180K	1.8M	
2.2	**22**	**220**	**2.2K**	**22K**	**220K**	**2.2M**	
2.7	27	270	2.7K	27K	270K	2.7M	
3.3	**33**	**330**	**3.3K**	**33K**	**330K**	**3.3M**	
3.9	39	390	3.9K	39K	390K	3.9M	
4.7	**47**	**470**	**4.7K**	**47K**	**470K**	**4.7M**	
5.6	56	560	5.6K	56K	560K	5.6M	
6.8	**68**	**680**	**6.8K**	**68K**	**680K**	**6.8M**	
8.2	82	820	8.2K	82K	820K	8.2M	

Test/Exercise

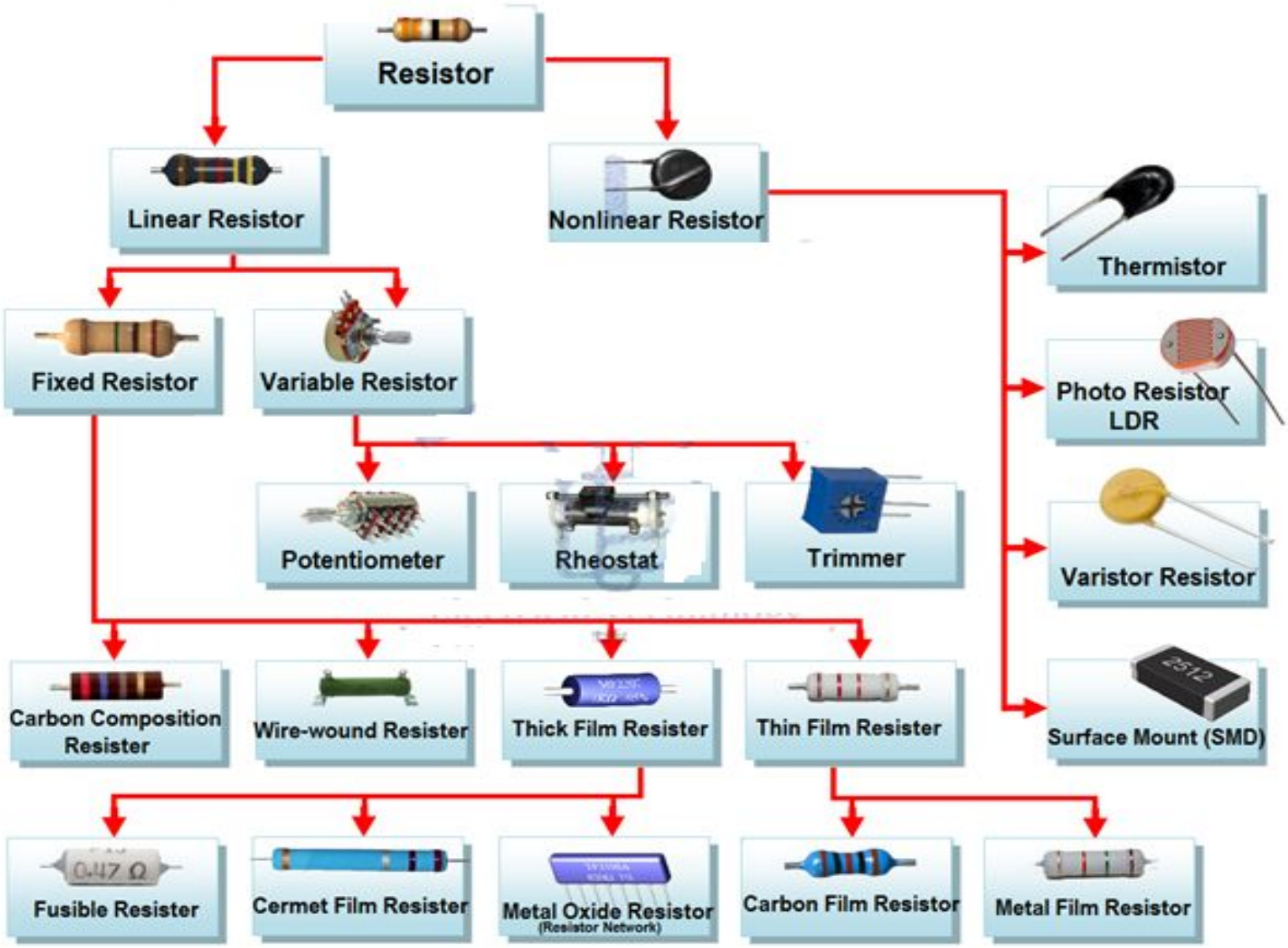
Find values of following resistances with its tolerance

- R1- Brown, Black, Red, Silver
- R2-Orange, Orange, Red, Gold
- R3-Yellow, Violet, Orange, Gold
- R4-Green, Blue, Brown, Silver
- R5-Red, Red, Yellow, Gold

Find R value- Answers

- Brown, Black, Red, Gold 1K
- Orange, Orange, Red, Gold 3.3K
- Yellow, Violet, Orange, Gold 47K
- Green, Blue, Brown, Gold 560
- Red, Red, Yellow, Gold 220K

Classification of resistors



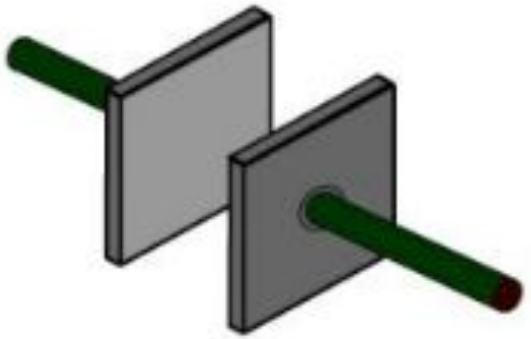
Capacitor

- A capacitor (originally known as a condenser) is used to store energy (charge) in an electric field between a pair of conductors called ‘plates’.
- The ability of a capacitor to store charge is measured by its capacitance. Unit of capacitance is Farad.
- A capacitor offers low impedance to ac but very high impedance to dc.
- So it is used to couple alternating voltage from one circuit to another while at the same time blocking the dc.
- It is also used as a bypass capacitor where it does not allow ac to go through the circuit by providing alternate path to it.
- Capacitor is also used in tuning circuits along with an inductor.

Construction of a Capacitor

The basic construction of all capacitors is of two parallel metal plates separated by an insulating material (the dielectric).

Real capacitors are made by taking thin strips of metal foil and the appropriate dielectric material and sandwiching them together.



Capacitance

- Capacitance is the capacity to store charge
- Capacitors are marked with a value which indicates their capacitance
- It is measured in Farads.

$$C = \frac{\varepsilon A}{d}$$

Where,

C = Capacitance in Farads

ε = Permittivity of dielectric (absolute, not relative)

A = Area of plate overlap in square meters

d = Distance between plates in meters

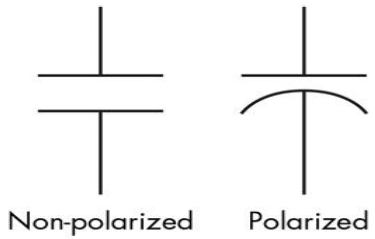
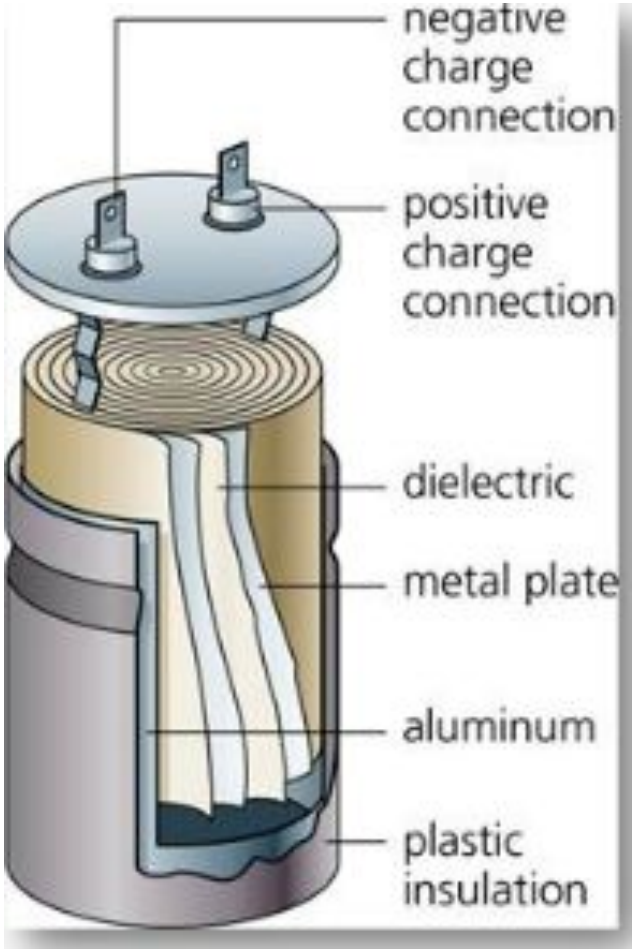


Fig. 1.3: Symbol of capacitor

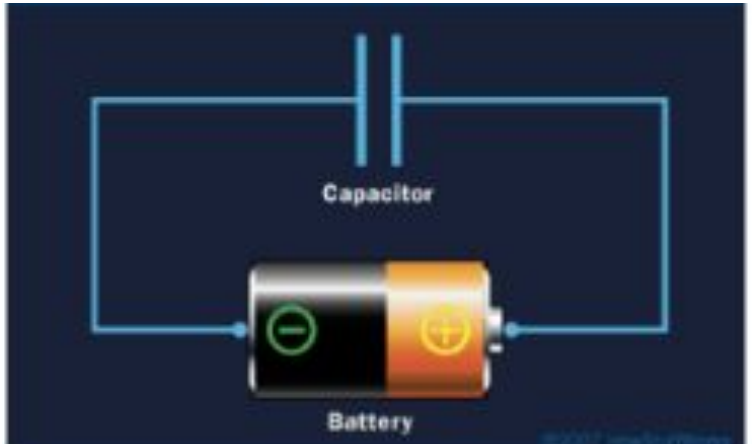
Construction of a Capacitor



Capacitor achieve large area (thus large capacitance) by doing something tricky, such as putting a dielectric between 2 layers of metal foil and rolling it up like in this figure.

Charging and Discharging

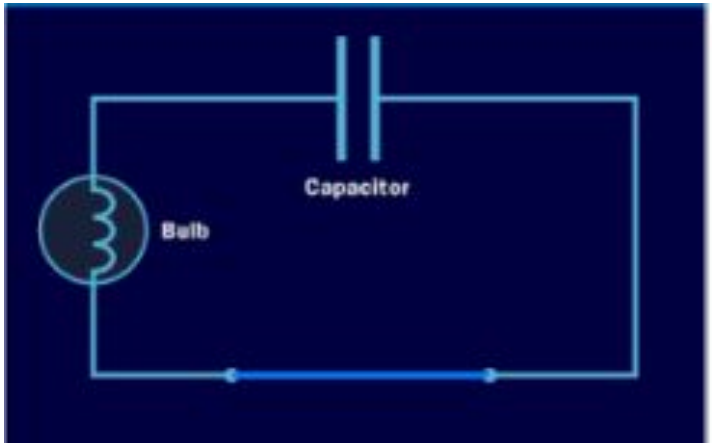
Charging:



- The plate on the capacitor that is connected to the negative terminal of the battery accepts electrons that the battery is producing .
- The plate on the capacitor that is connected to the positive terminal of the battery loses electrons to the battery.
- Once it’s charged, the capacitor has the same voltage as the battery.

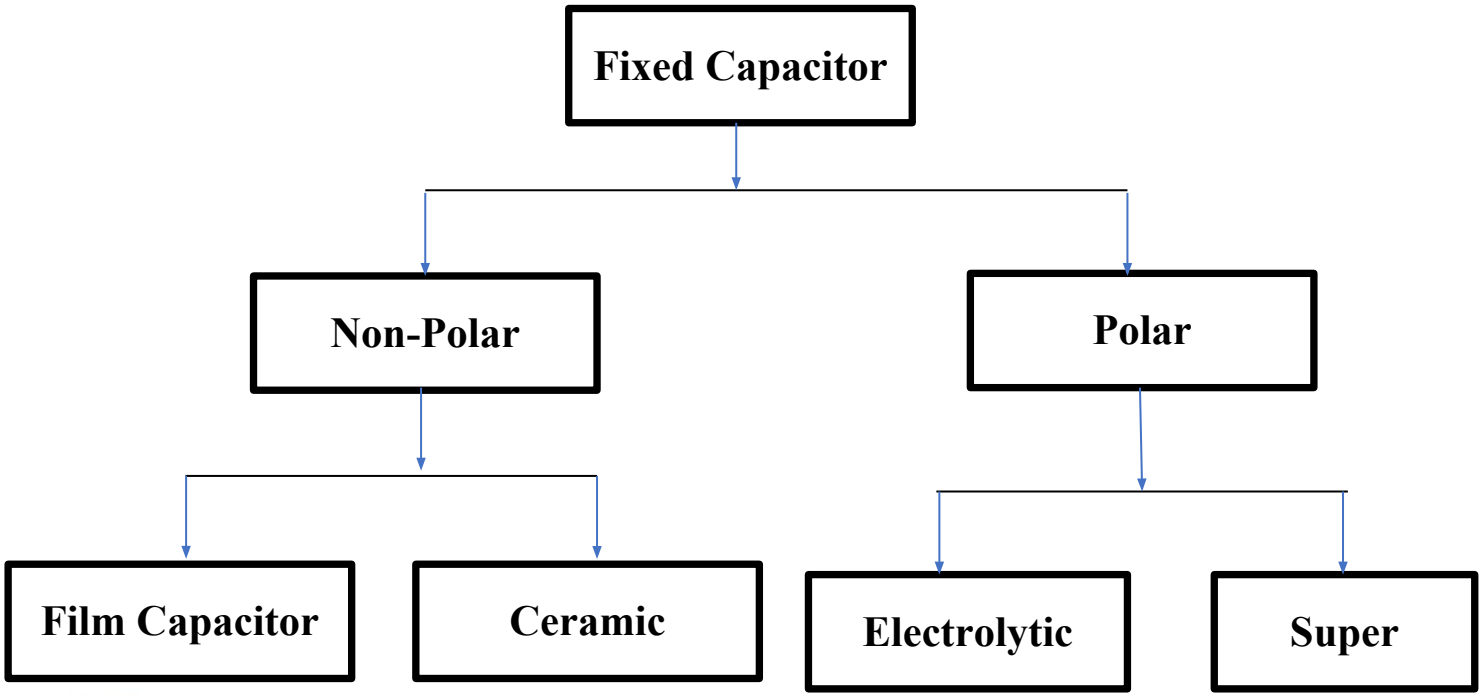
Charging and Discharging

Discharging:



- If the battery is replaced with a wire, current will flow from one plate of the capacitor to the other.
- The bulb will light initially and then dim as the capacitor discharges, until it is completely drained out.

Classification of capacitors



Film (Polyester)

Ceramic

Electrolytic

Super

Inductors

- Device that controls the current is the inductor
- However unlike the resistor that affects the current uniformly at all times, the inductor only affects currents when they are changing in value.
- It consists of a wire wound as a coil around a core. The core may consist of a air filled hollow tube or solid material

Inductors

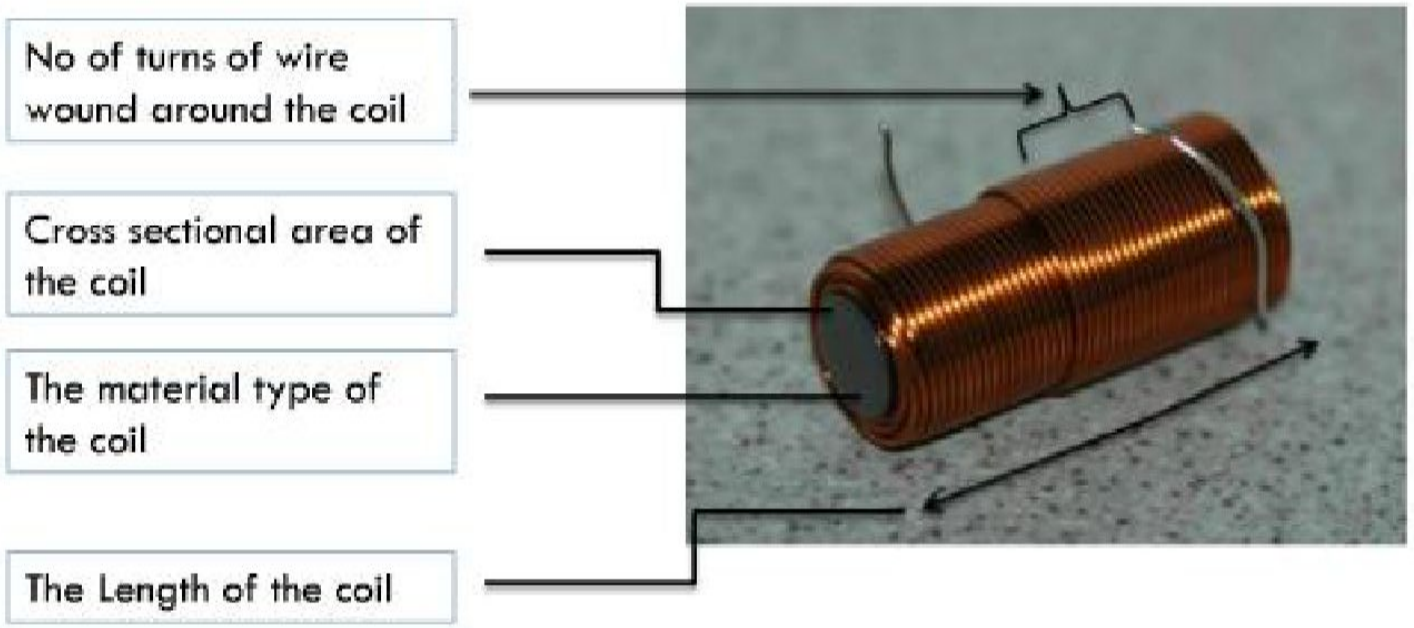
- When current flows through a coil, it generates a magnetic field.
- This magnetic field reacts so as to oppose any changes in current.
- This reaction of the magnetic field of trying to keep current flow at steady rate is known as inductance and the force it develops is called induced emf.
- Inductance is measured in Henry (H).

Fig. 1.5: Symbol of Inductor

Inductance

The amount of inductance in henries a coil has, is determined by the following factors -

- No of turns of wire wound around the coil
- Cross sectional area of the coil
- The material type of the coil
- The Length of the coil



Inductance

$$L = \frac{\mu N^2 A}{l}$$

Where:

$L = Inductance\ in\ henries\ (H)$

$\mu = permeability\ (Wb/A \cdot m)$

$N = number\ of\ turns\ in\ coil$

$A = area\ encircled\ by\ coil\ (m^2)$

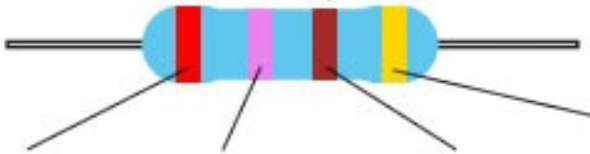
$l = lenth\ of\ coil\ (m)$

Inductor value

TOKEN INDUCTOR COLOR CODE

Result is in µH

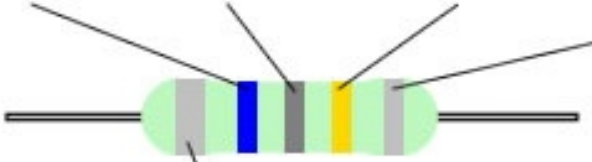
4-BAND-CODE



270µH ± 5%

COLOR	1st BAND	2nd BAND	MULTIPLIER	TOLERANCE
Black	0	0	1	± 20%
Brown	1	1	10	Military ± 1%
Red	2	2	100	Military ± 2%
Orange	3	3	1,000	Military ± 3%
Yellow	4	4	10,000	Military ± 4%
Green	5	5		
Blue	6	6		
Violet	7	7		
Grey	8	8		
White	9	9		
None				Military ± 20%
Gold			0.1 / Mil. Dec. Pt.	Both ± 5%
Silver			0.01	Both ± 10%

MILITARY-CODE

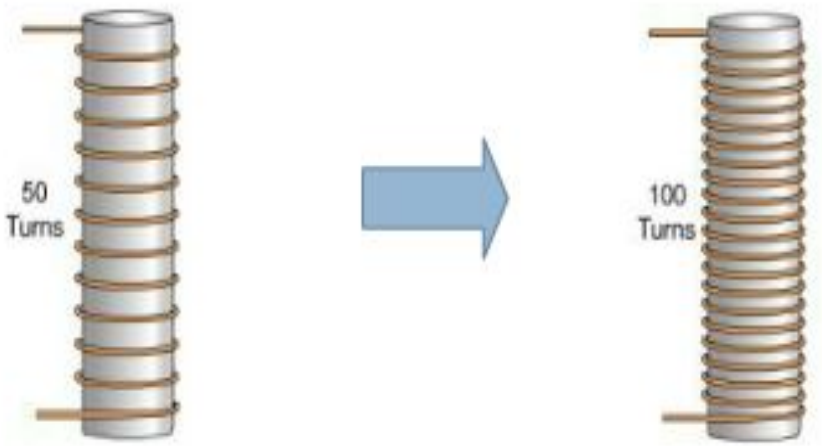


6.8µH ± 10%

Military Identifier (Silver)

Test

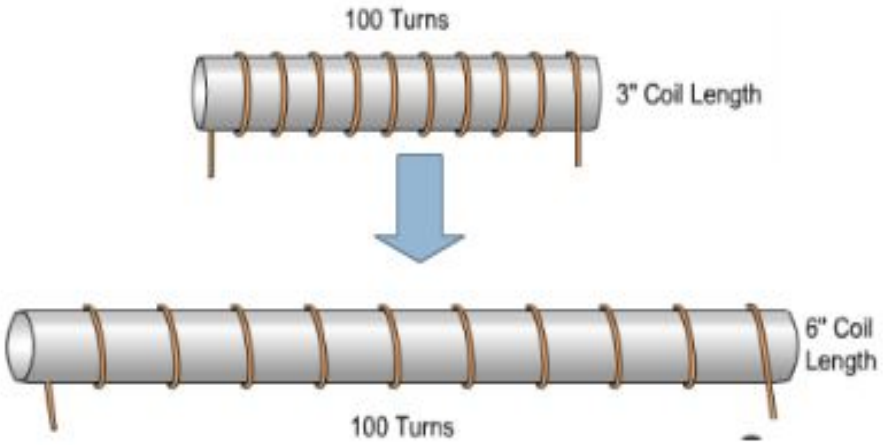
If the number of turns of coil around an inductor is increased (doubles), how will the inductance change ?



- Increase
- Decrease
- Will Not Change

Test

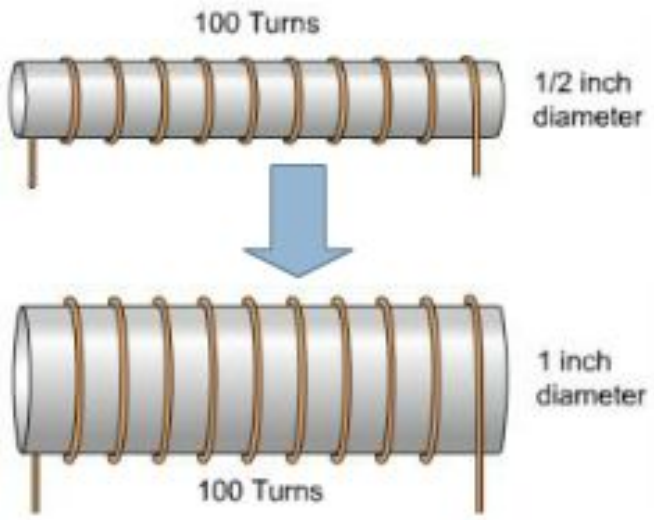
If the distance between the turns of coil around an inductor is increased (doubles), how will the inductance change ?



- Increase
- Decrease
- Will Not Change

Test

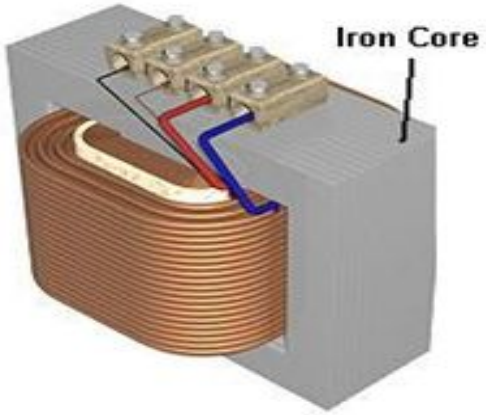
IF the diameter of the coil around an inductor is increased(doubles),how will the inductance change?



- Increase
- Decrease
- Will Not Change

Classification of inductors

Air-core



variable

Active Components

- Diode
- Transistor

Diode

- If a piece of P-type semiconductor material is joined to a piece of N-type semiconductor material such that crystal structure remains continuous at the boundary, then a P-N junction is formed.
- Such a P-N junction forms a very useful device called a semiconductor diode.
- The most important characteristic of a diode is that it allows unidirectional flow of current.
- It conducts well in forward direction and poorly in reverse direction.

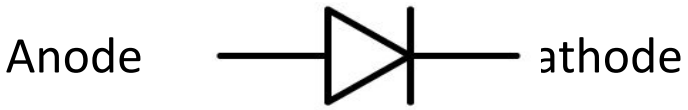
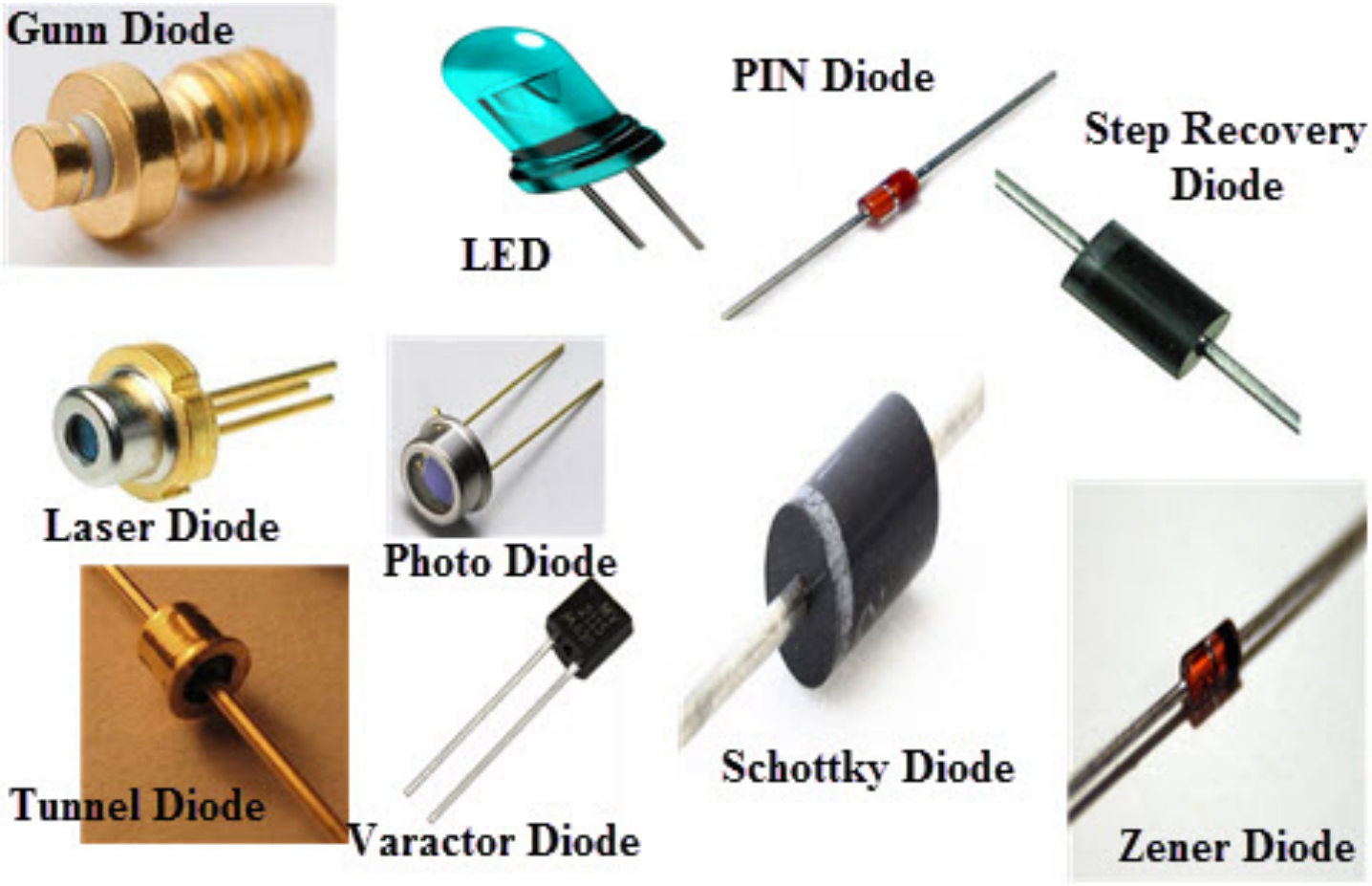


Fig. 1.7: Symbol of diode

Various types of diodes



Transistors

- A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power.
- It is composed of semiconductor material usually with at least three terminals for connection to an external circuit.
- The output power can be higher than the input power, means, transistor can amplify a signal

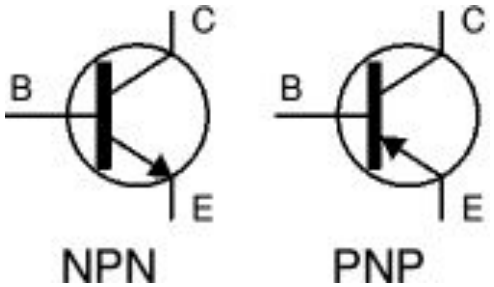
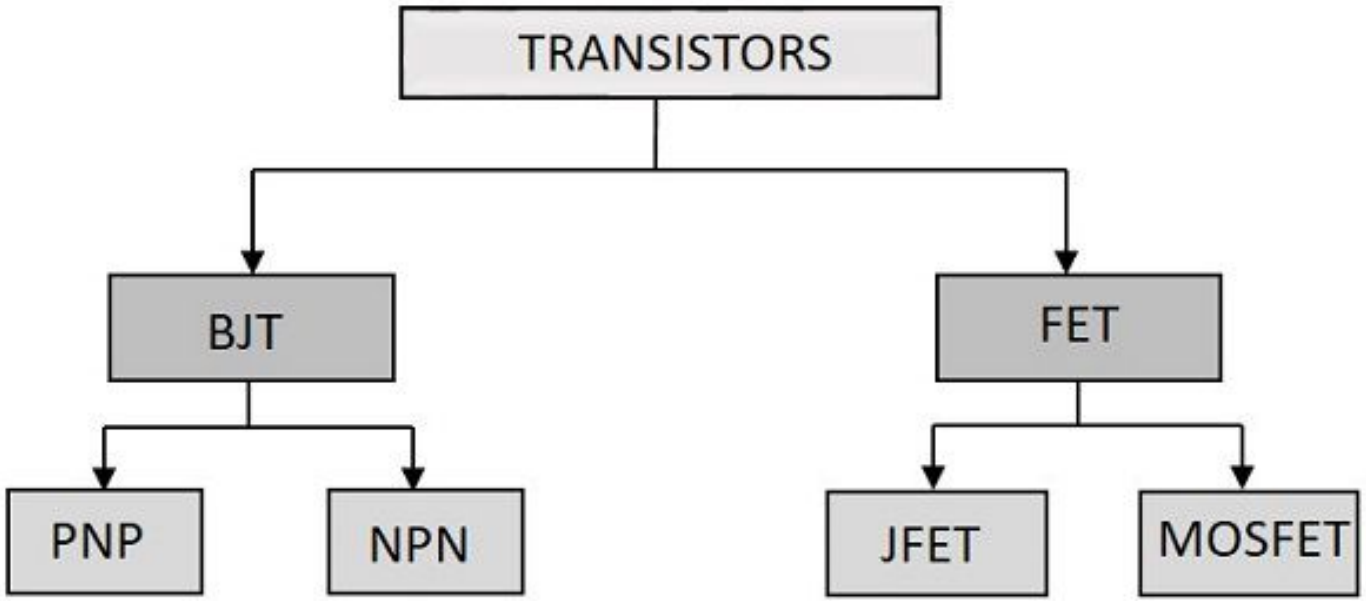


Fig. 1.8: Symbol of Transisor

Transistors



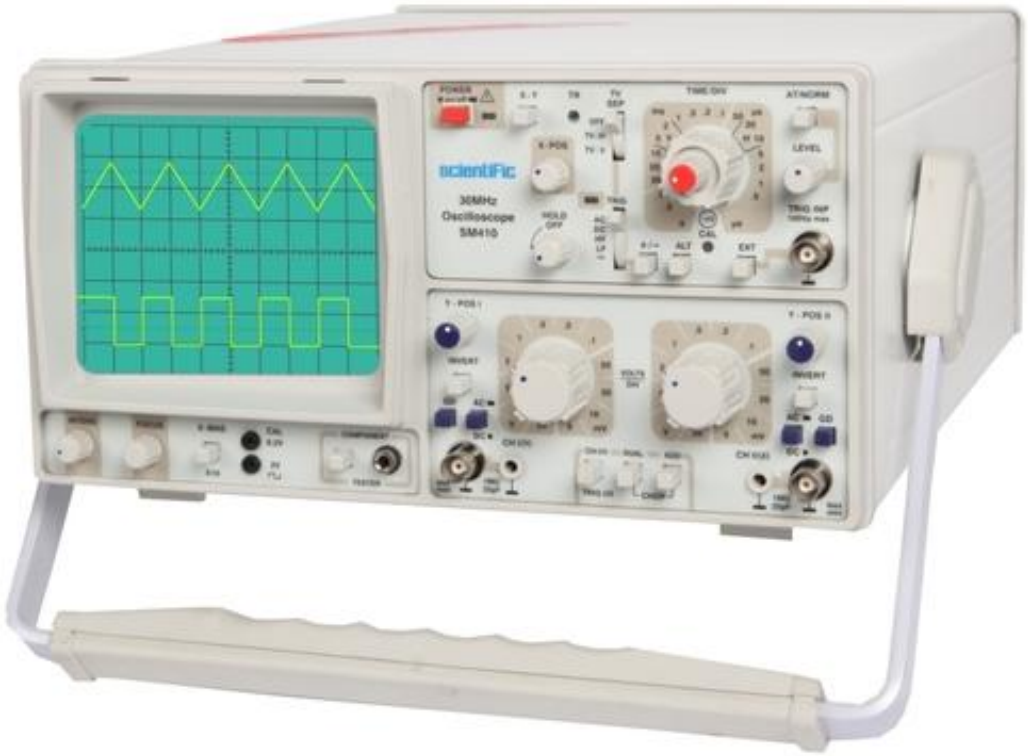
Electronic Instruments

- Cathode Ray Oscilloscope
- Function Generator
- Multi-meter

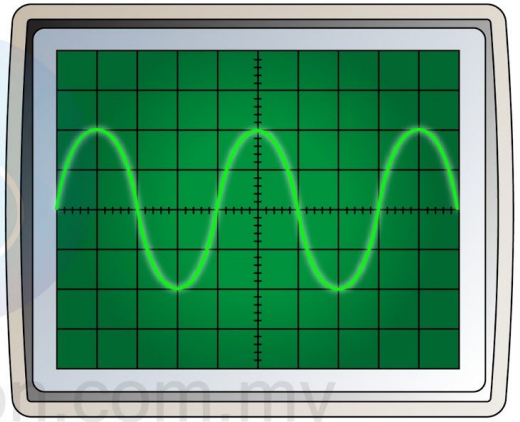
Cathode Ray Oscilloscope

- The cathode-ray oscilloscope (CRO) is a common laboratory instrument that provides accurate time and amplitude measurements of voltage signals over a wide range of frequencies.
- Its reliability, stability and ease of operation make it suitable as a general purpose laboratory instrument.
- CRO is used for voltage measurement, current measurement, examination of waveform, measurement of phase and frequency, component testing etc.

Cathode Ray Oscilloscope



Cathode Ray Oscilloscope



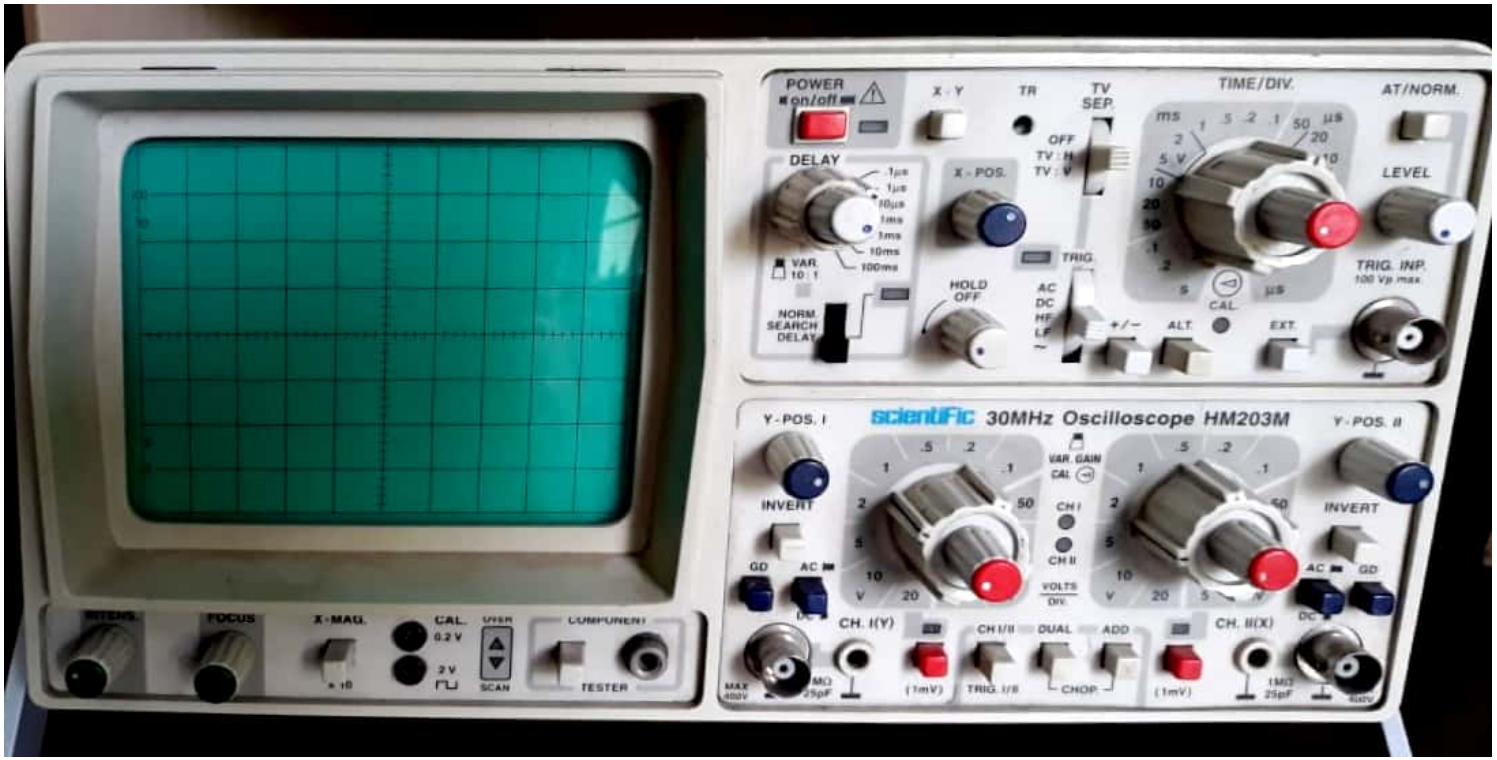
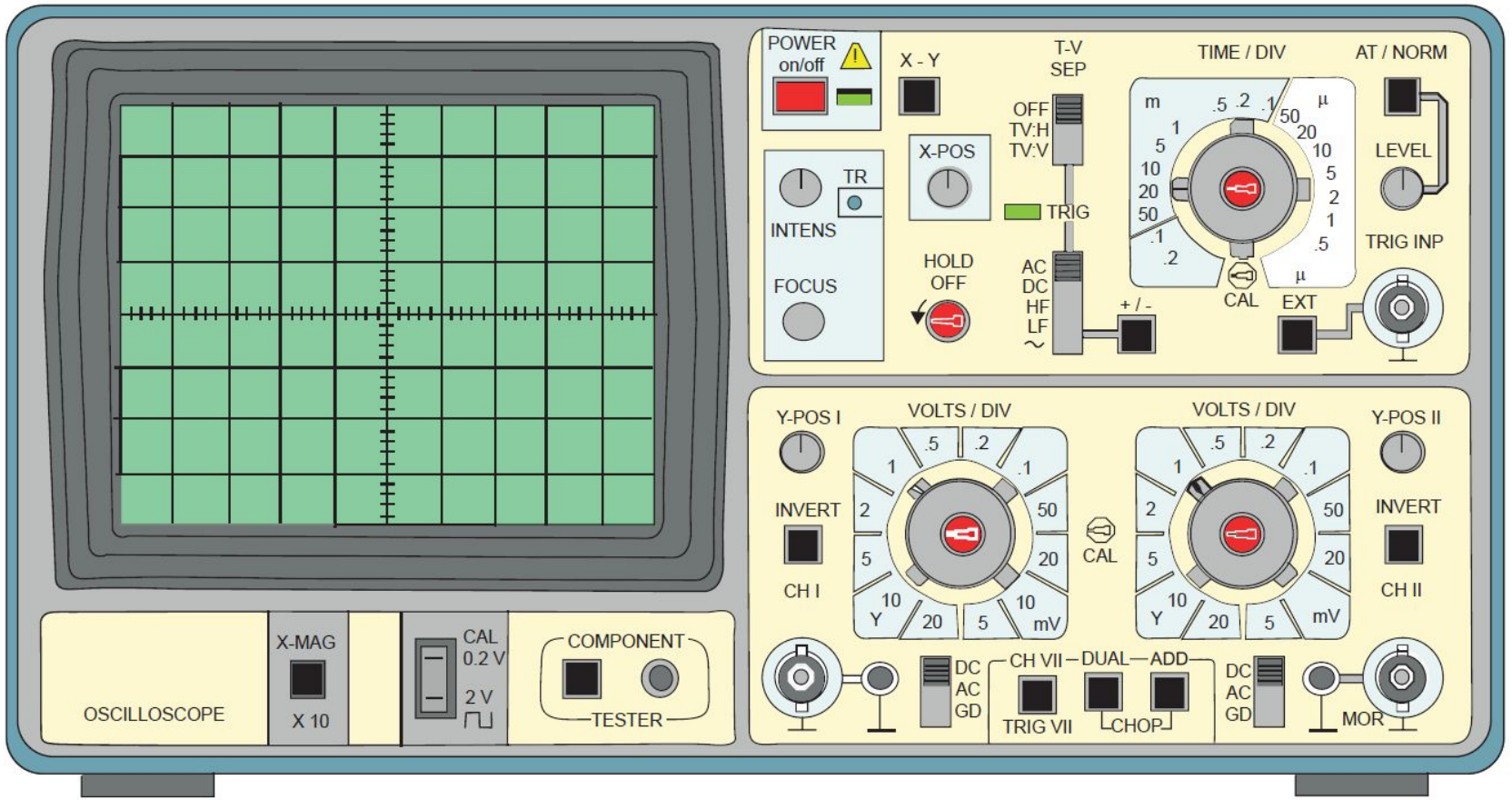


Fig. 1.9: Front panel of CRO

Cathode Ray Oscilloscope



Oscilloscope Display Grid

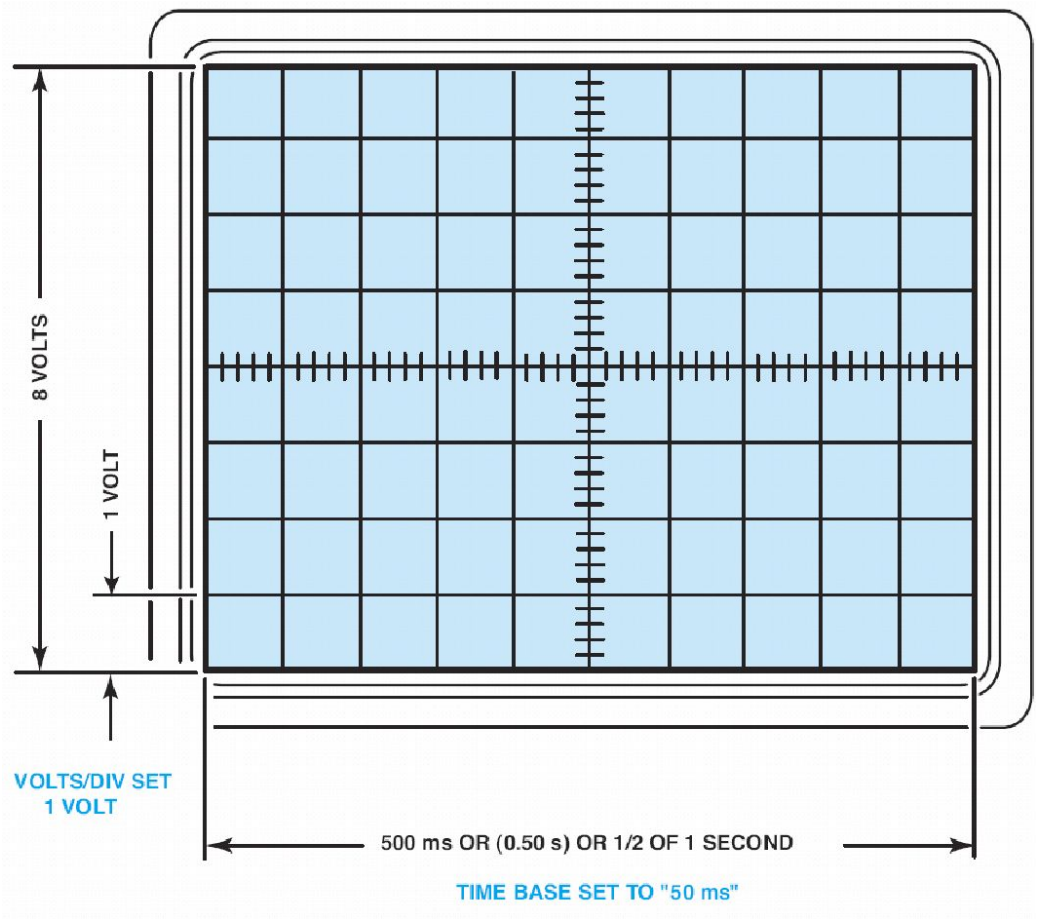


FIGURE 9–1 A scope display allows technicians to take measurements of voltage patterns. In this example, each vertical division is 1 volt and each horizontal division is set to represent 50 milliseconds.

Types of Oscilloscopes

- An **oscilloscope** (usually called a **scope**) is a visual voltmeter with a timer that shows when a voltage changes.
- Following are several types of oscilloscopes.
  - An *analog scope*
  - A *digital scope*

Scope Setup and Adjustments

- **SETTING THE TIME BASE**
- **VOLTS PER DIVISION**

MILLISECONDS PER DIVISION (MS/DIV)	TOTAL TIME DISPLAYED
1 ms	10 ms (0.010 sec.)
10 ms	100 ms (0.100 sec.)
50 ms	500 ms (0.500 sec.)
100 ms	1 sec. (1.000 sec.)
500 ms	5 sec. (5.0 sec.)
1,000 ms	10 sec. (10.0 sec.)

CHART 9–1

The time base is milliseconds (ms) and total time of an event that can be displayed.

Cathode Ray Oscilloscope

- Information given by oscilloscopes
  - Time and voltage
  - Frequency and phase
  - DC and AC components
  - Spectral analysis
  - Rise and fall time
  - Mathematical analysis

Cathode Ray Oscilloscope

Various controls of CRO are as follows:

i. Intensity: to adjust the brightness of the trace

ii. Focus: to adjust the sharpness of the trace

iii. X-position: moves the trace horizontally

iv. Vertical position: moves the trace vertically

v. Volt/div: to control the overall vertical "height" of the trace

vi. AC/GND/DC: GND is used to check the ground level of the trace. AC/ DC provides coupling of the signal without or with dc voltage.

vii. LEVEL: to be adjusted slightly to obtain a stable trace

viii. TIME/DIV : to control the sweep speed of the electron beam

ix. MONO/DUAL: for dual trace operation

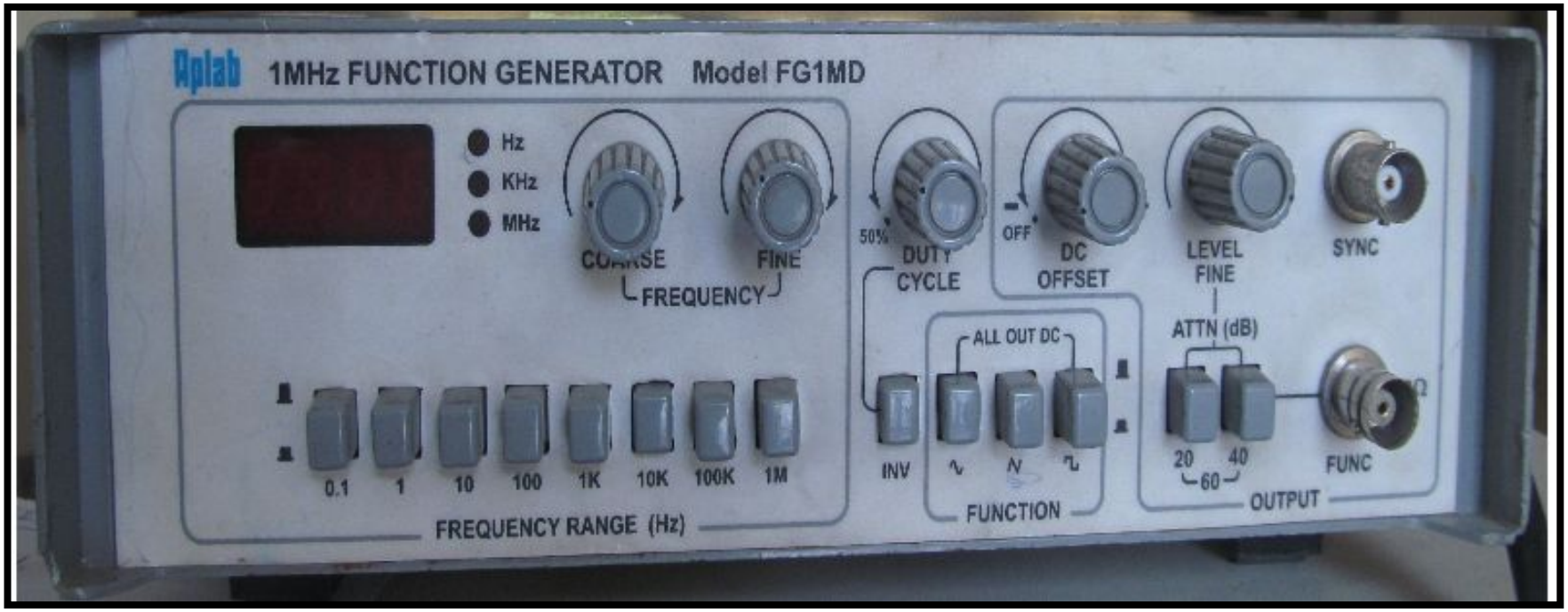
Function Generator

- Function generator is the equipment which supplies ac voltage.
- This voltage is used as a signal to test working of different electronic circuits such as amplifier.
- Frequency of ac signal supplied by function generator can be varied.
- In addition to producing sine waves, function generators may typically produce other repetitive waveforms including saw-tooth and triangular waveforms, square waves, and pulses.

Function Generator/ Signal Generator

Aplab Make 3 MHz Multiwaveform signal generator

Function Generator

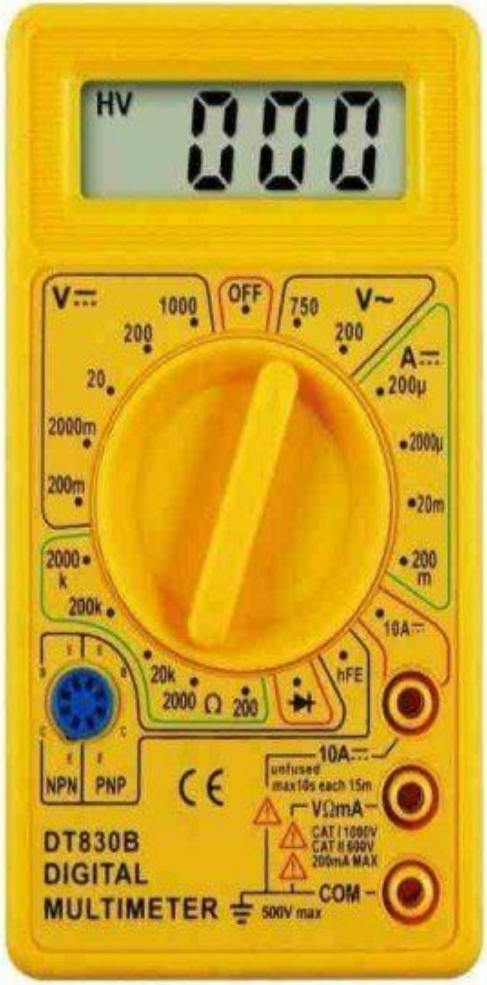


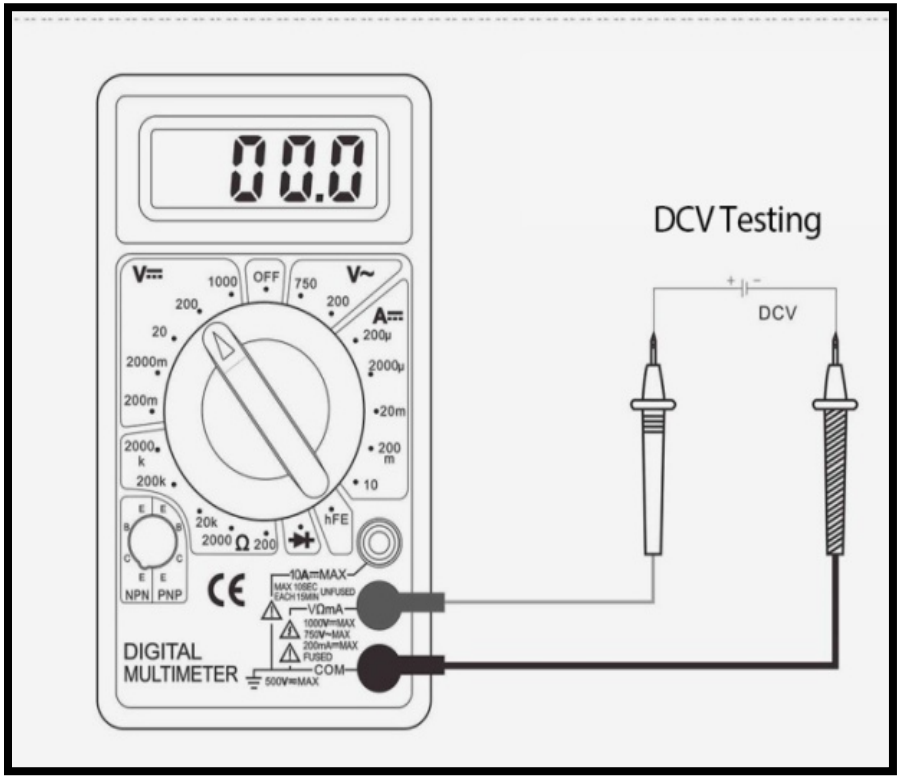
Front panel of function generator

Multi-meter

- A digital multi-meter (DMM) is a test tool used to measure different types of electrical quantities.
- This is a hand-held device which is very useful to detect faults or to provide field measurements at a high degree of accuracy.
- It is capable of providing several measurements like alternating voltage, direct voltage, alternating current, direct current, resistance (Ohms) etc.
- Continuity testing can also be done using multi-meter.
- There are two types of multimeters- Analog & Digital
  - Analog has a needle style gauge
  - Digital has a LCD display (Referenced during this PPT)

Multi-meter

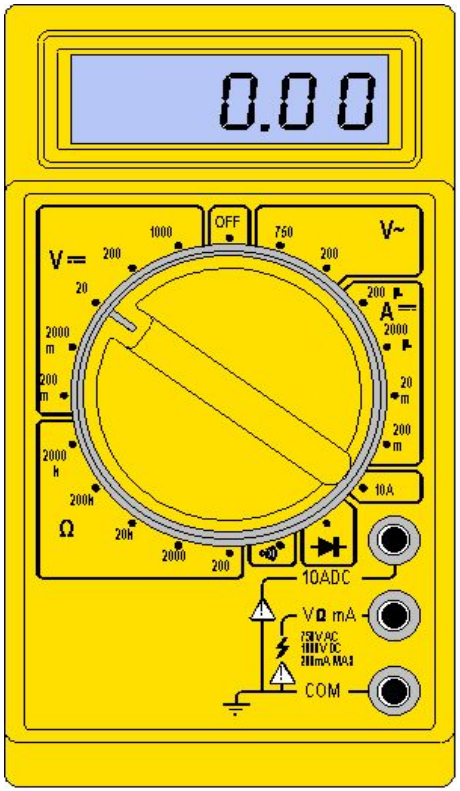




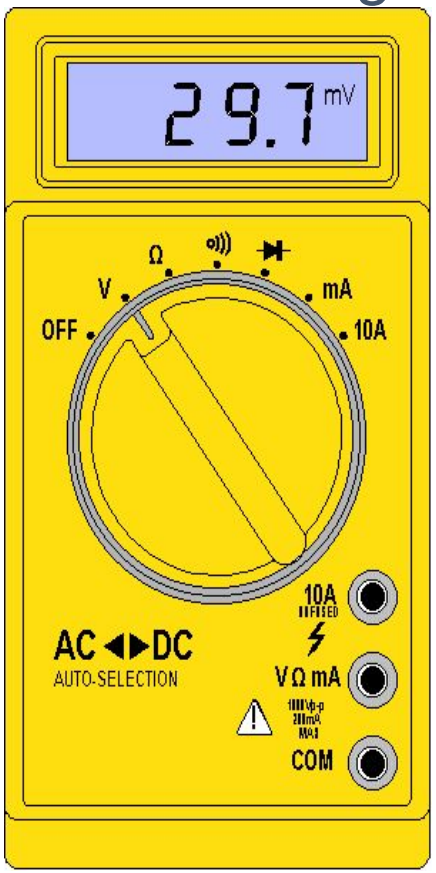
anel of digital multi-meter

There are 2 styles of multimeters

Switched
Manually switch between ranges to get most accurate reading.



Auto Range
Switches between ranges automatically for best reading.



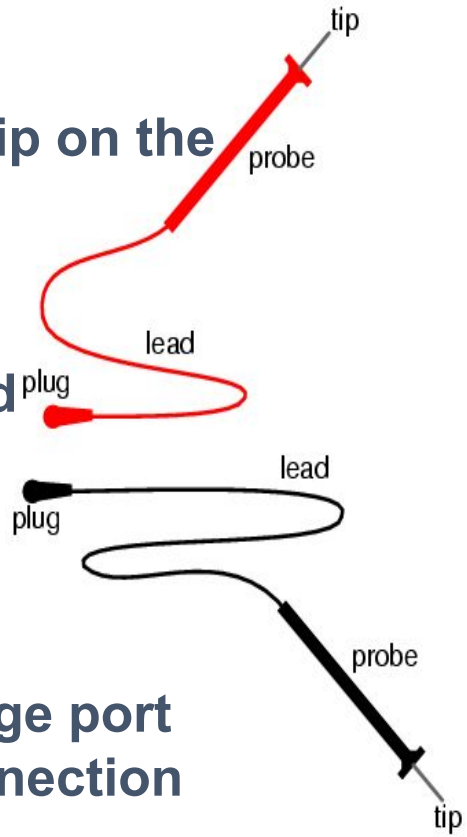
MultiMeter leads

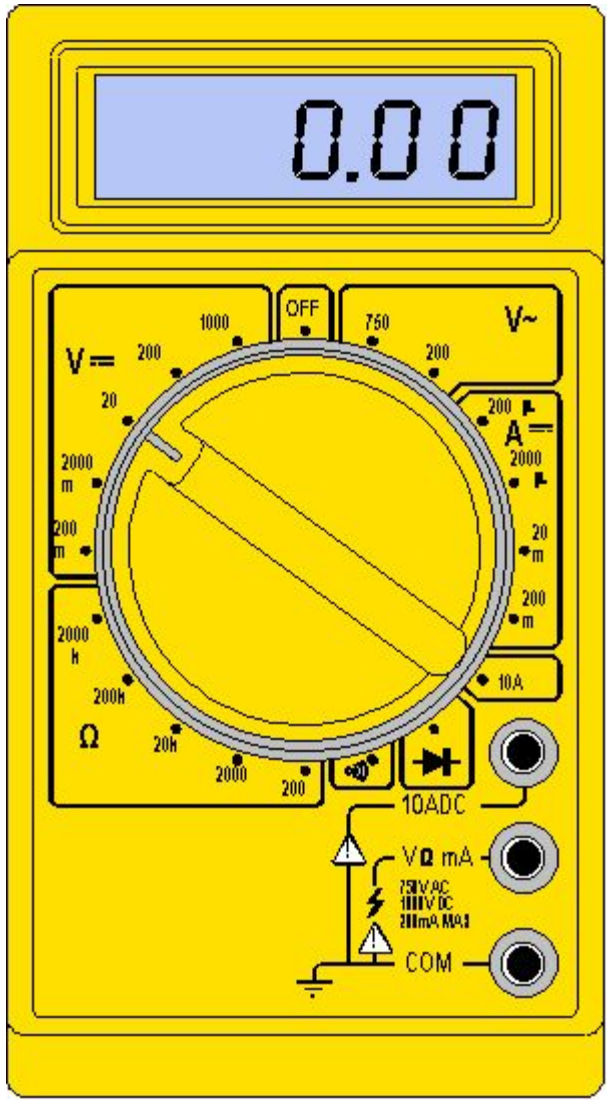
Probes
Are the handles used to hold tip on the tested connection

Tips
Are at the end of the probe and provides a connection point

Red
meter lead Is connected to Voltage/Resistance or amperage port Is considered the positive connection

Black
Meter lead Is always connected to the common port Is considered the negative connection





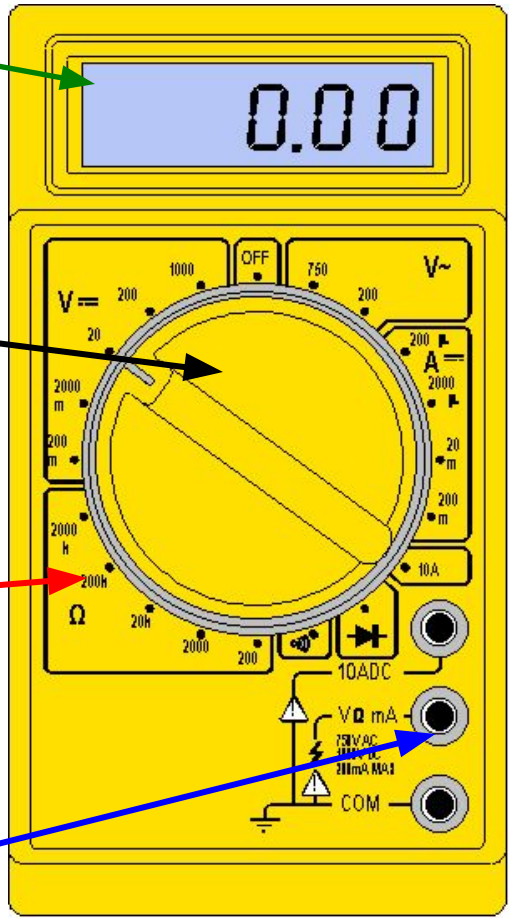
Display & Dial Settings

Digital Display
Shows measured value.

Meter Dial
Turn dial to change functions.
Turn dial to OFF position after use.

Panel Indicator
Shows each function and setting range to turn dial to.

Probe Connections
Specific for each function.



Common DMM Symbols

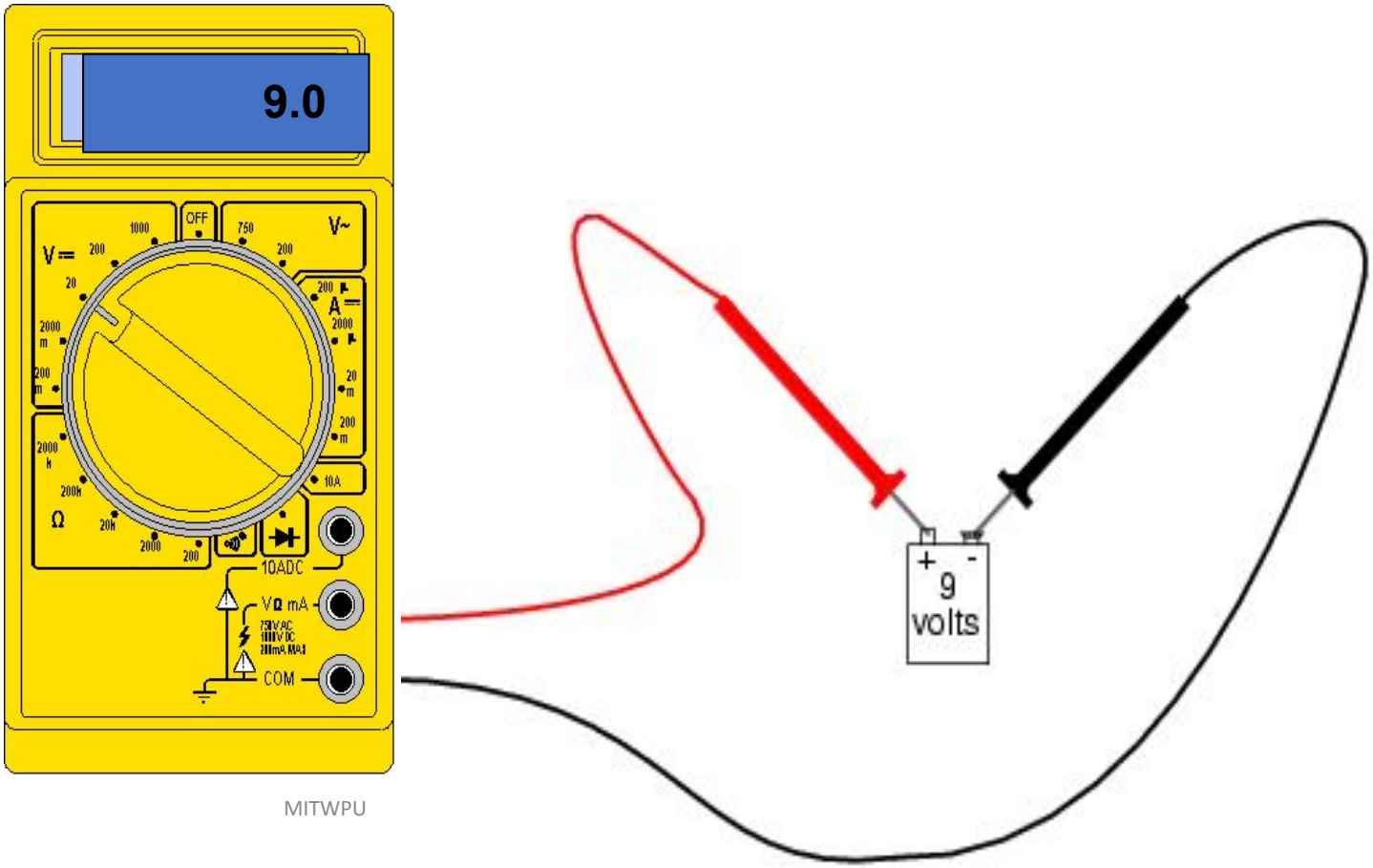
~	AC Voltage	⏚	Ground
⎓	DC Voltage	)))	Audible Continuity
Hz	Hertz	OL	Overload
+	Positive	μ	Micro
−	Negative	m	Milli
Ω	Ohms	M	Mega
	Diode	K	Kilo

Measuring Voltage

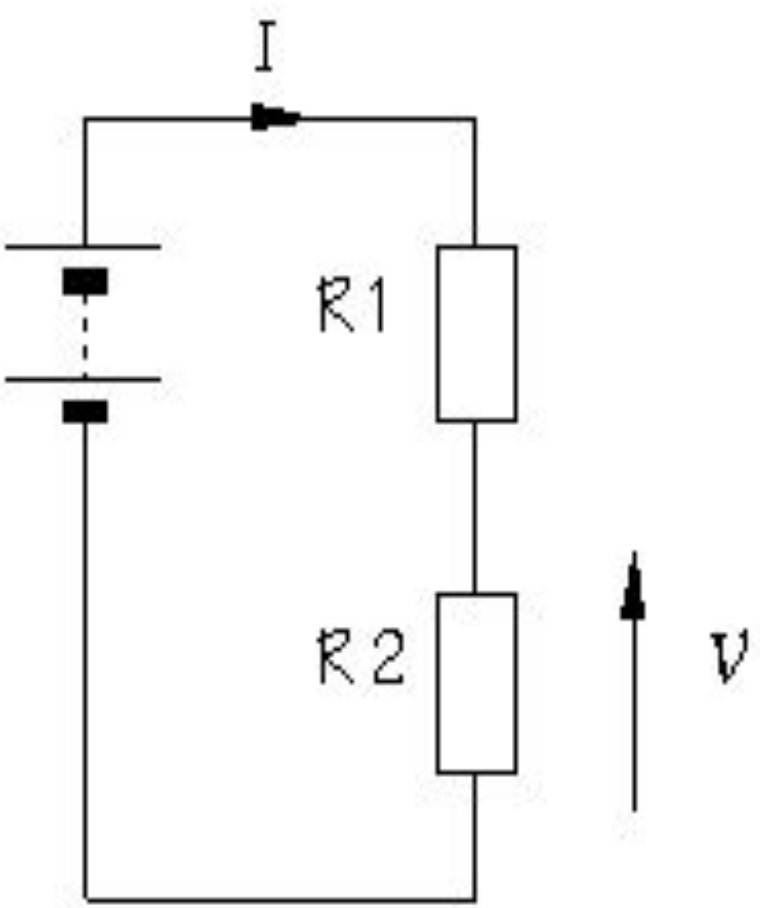
- Voltage can be measured using 2 sections AC & DC on the dial

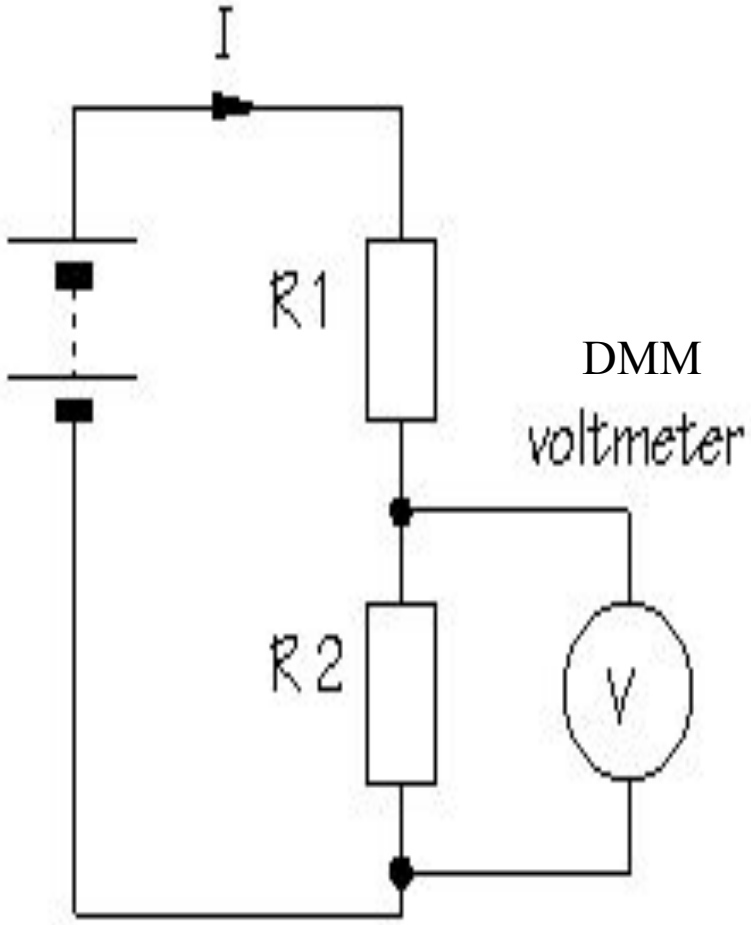
  Alternating Current (AC) is power line voltage (230 V AC)

  Direct Current (DC) is battery voltage (12V dc)



Measuring Voltage

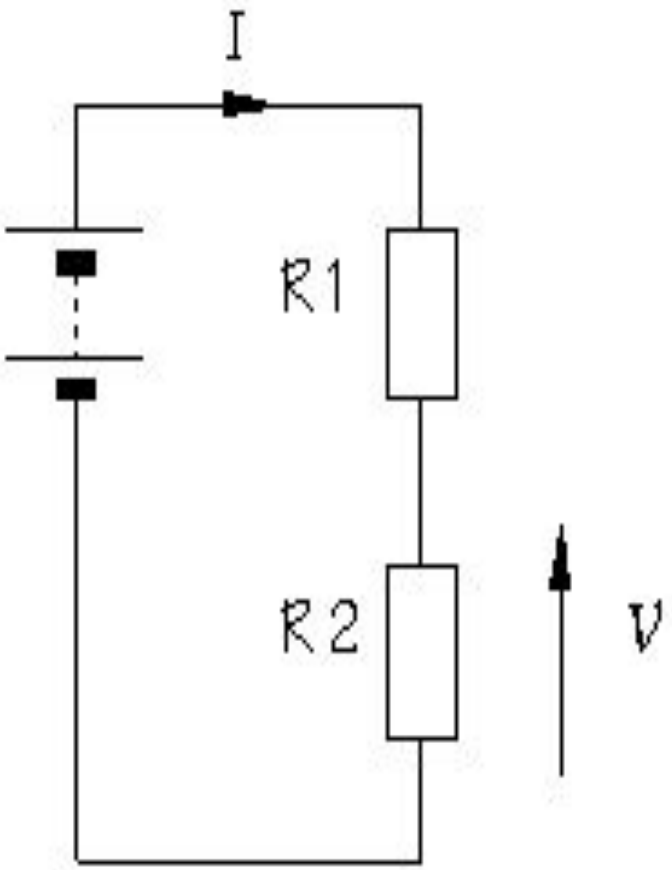


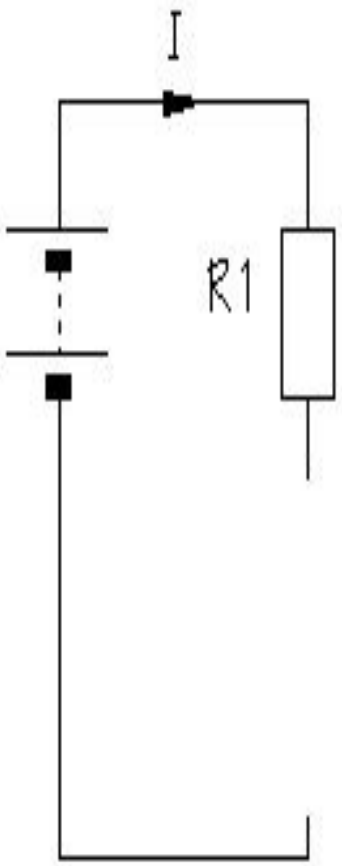


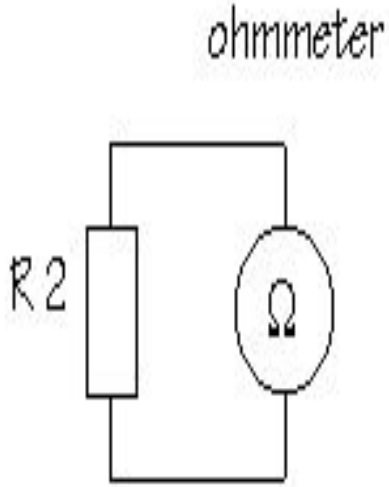
Measuring Resistance and Continuity

- Resistance is the opposition to current
- Resistance is measured in Ohm's
- Disconnect power source in the circuit before testing
- Remove component or part from system before testing
- Measure using lowest value, if OL(overload) move to next higher level
- Testing for continuity is used to verify if a circuit, wire or fuse is complete with no open/break
- Audible continuity allows an alarm/ buzzer if circuit is complete
- If there is no audible alarm resistance of 1ohm to 0.1ohm should be present

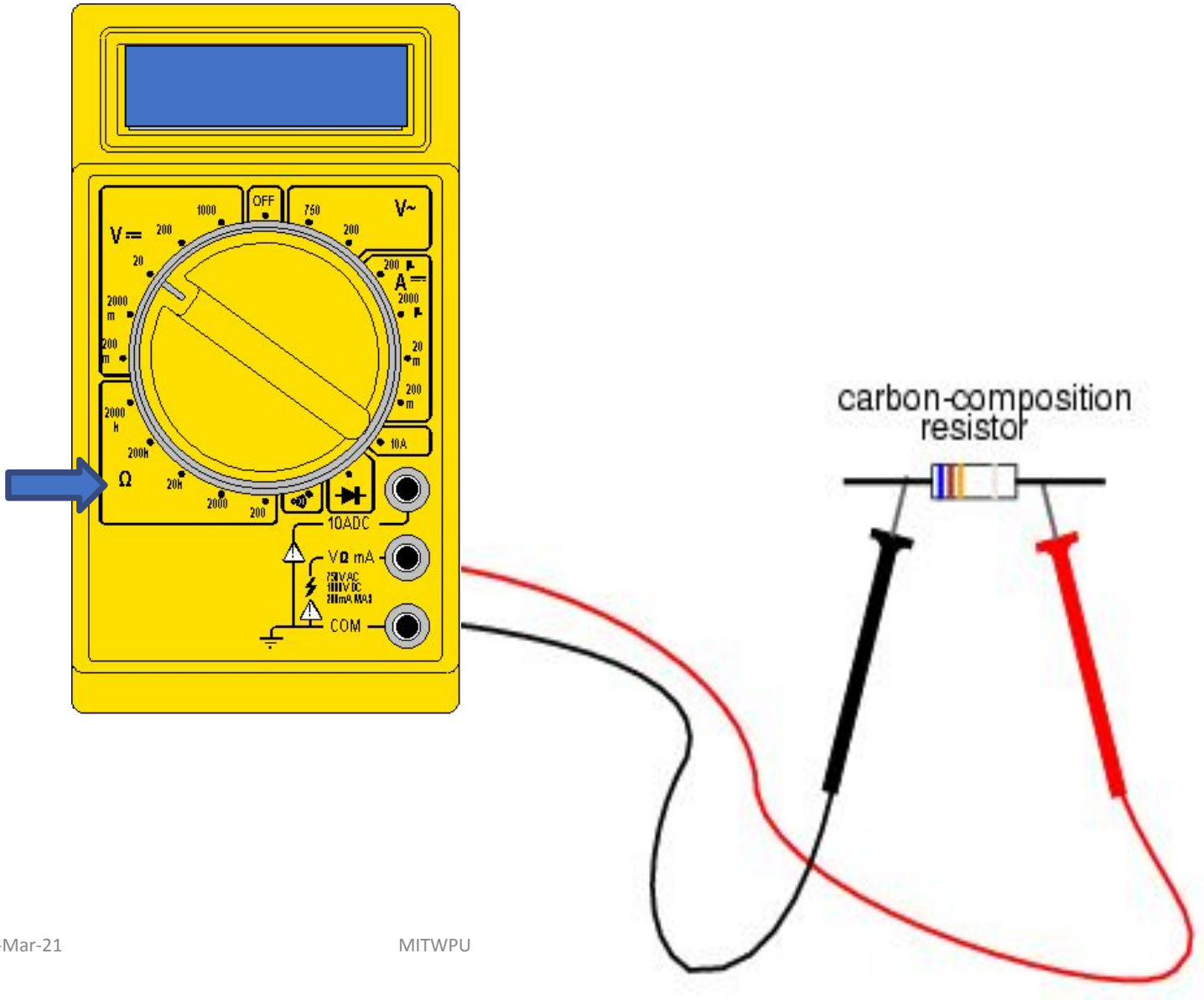
Measuring Resistance



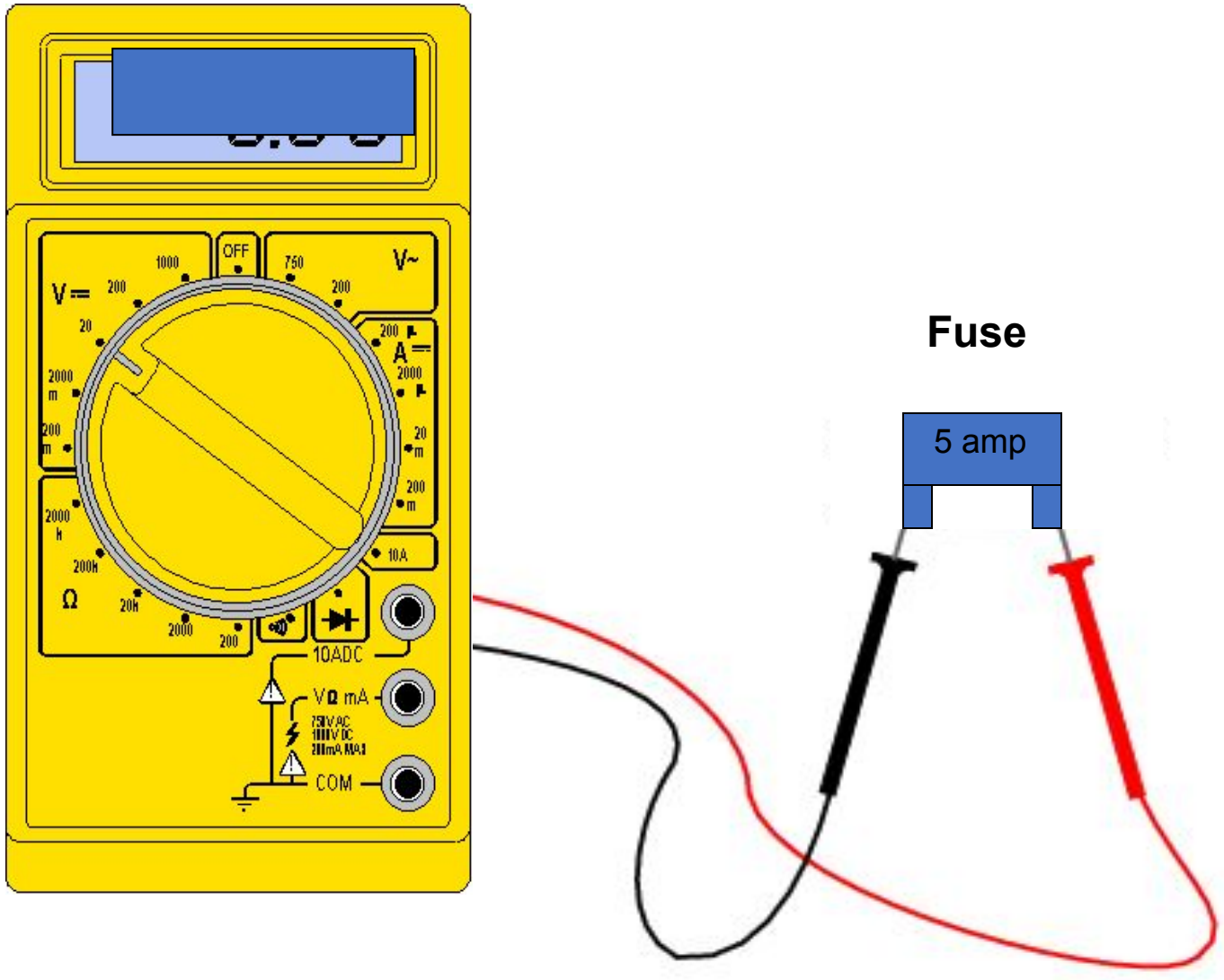




Measuring Resistance



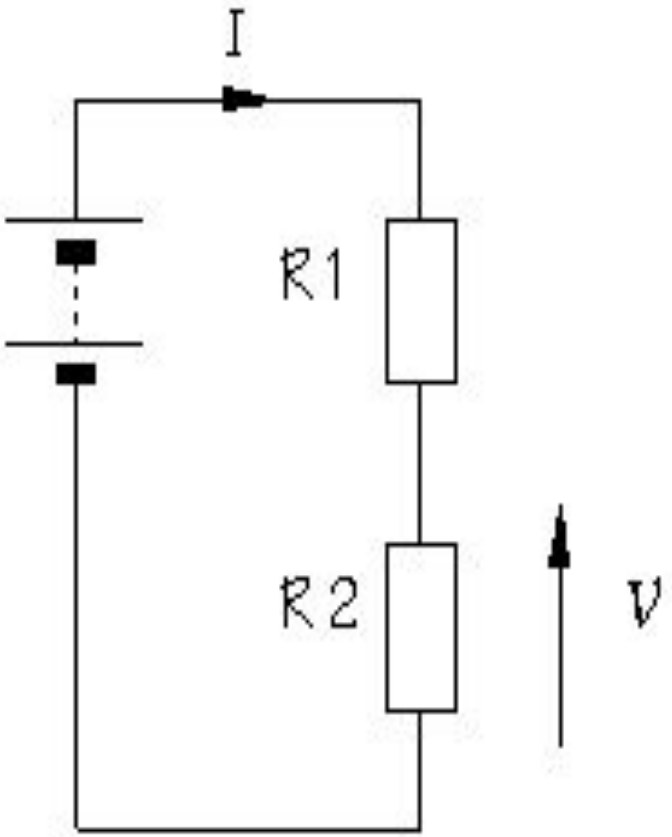
Measuring Continuity

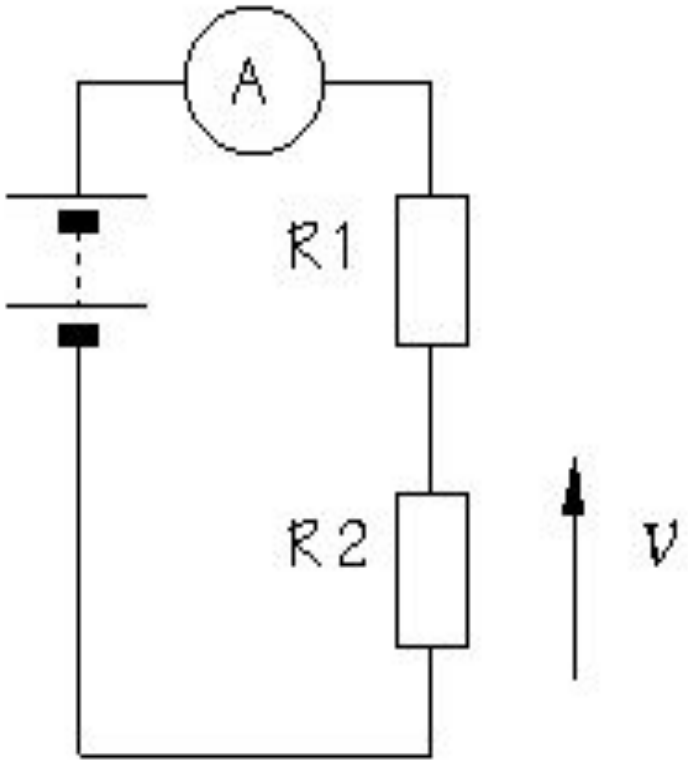


Measuring Current

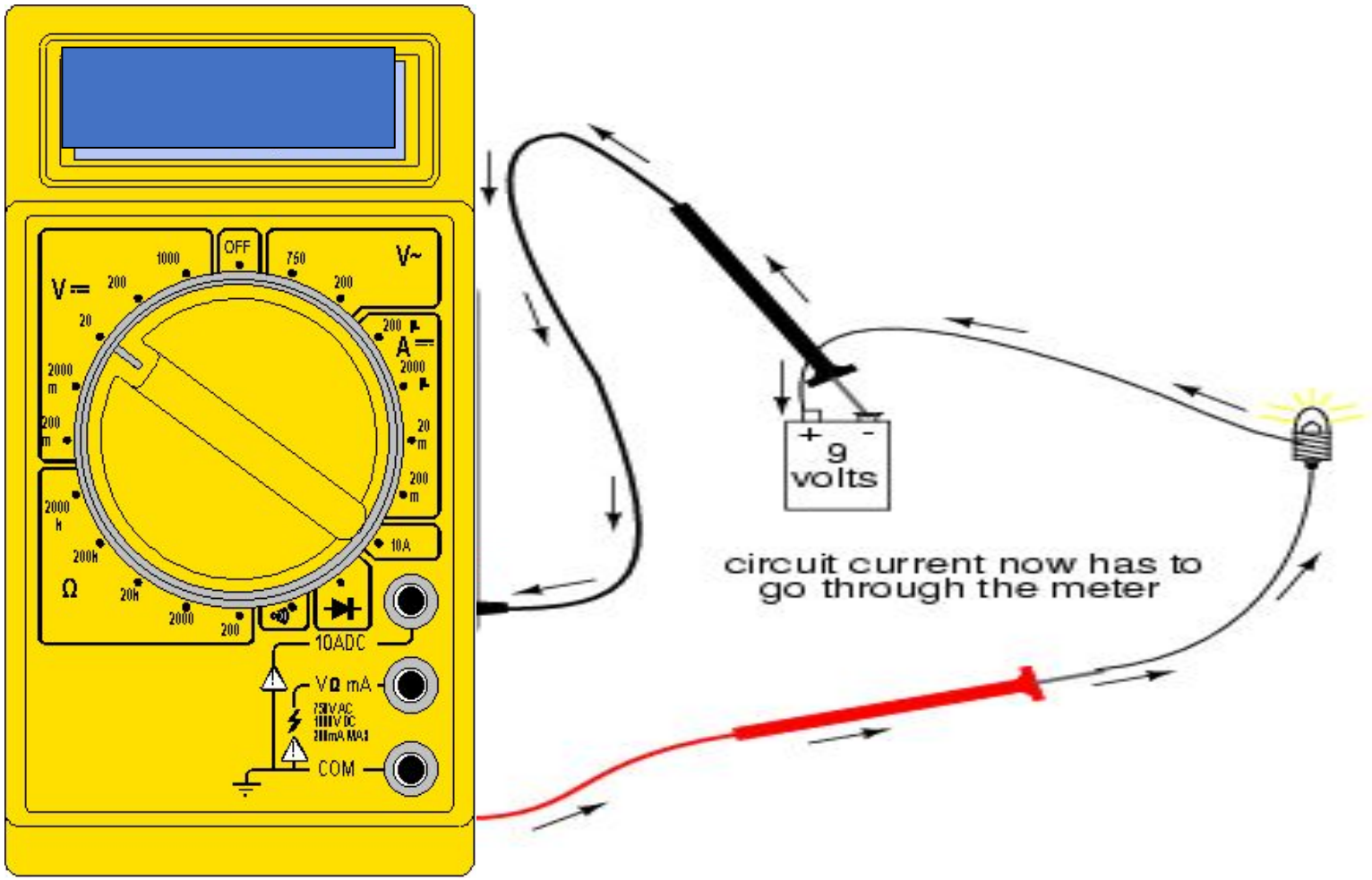
- Current (amps) is the flow of electrical charge though a component or conductor
- Current is measured in amps or amperes
- Disconnect power source before testing
- Disconnect completed circuit at end of circuit
- Place multimeter in series with circuit
- Reconnect power source and turn ON
- Select highest current setting

Measuring Current





Measuring Current



Review

- **A meter capable of checking for voltage, current, and resistance is called a *multimeter*,**
- **When measuring Voltage the multimeter must be connected to two points in a circuit in order to obtain a good reading. Be careful not to touch the bare probe tips together while measuring voltage, as this will create a short-circuit!**
- **Never read Resistance or test for Continuity with a multimeter on a circuit that is energized.**
- **When measuring Current the multimeter must be connected in a circuit so the electrons have to flow *through* the meter**
- **Multimeters have practically no resistance between their leads. This is intended to allow electrons to flow through the meter with the least possible difficulty. If this were not the case, the meter would add extra resistance in the circuit, thereby affecting the current**

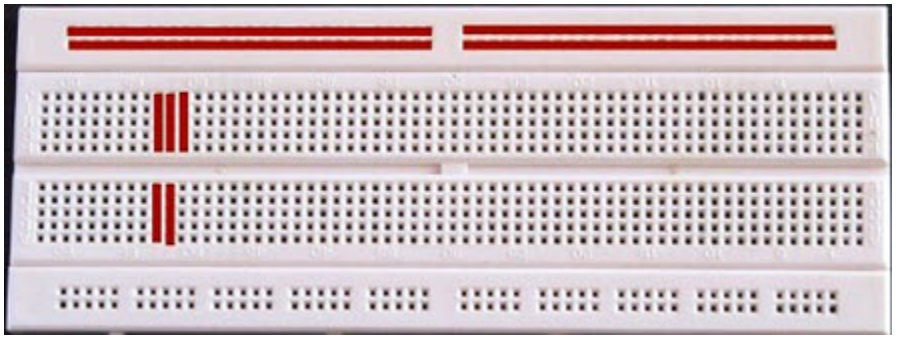
DMM : Range and resolution

Range	Resolution
2.000 V	.001 V (=1 mV)
20.00 V	.01 V (=10 mV)
200.0 V	0.1 V (=100 mV)
1000 V	1 V (=1000 mV)
200.0 mV	.1 mV (=1/10 mV)

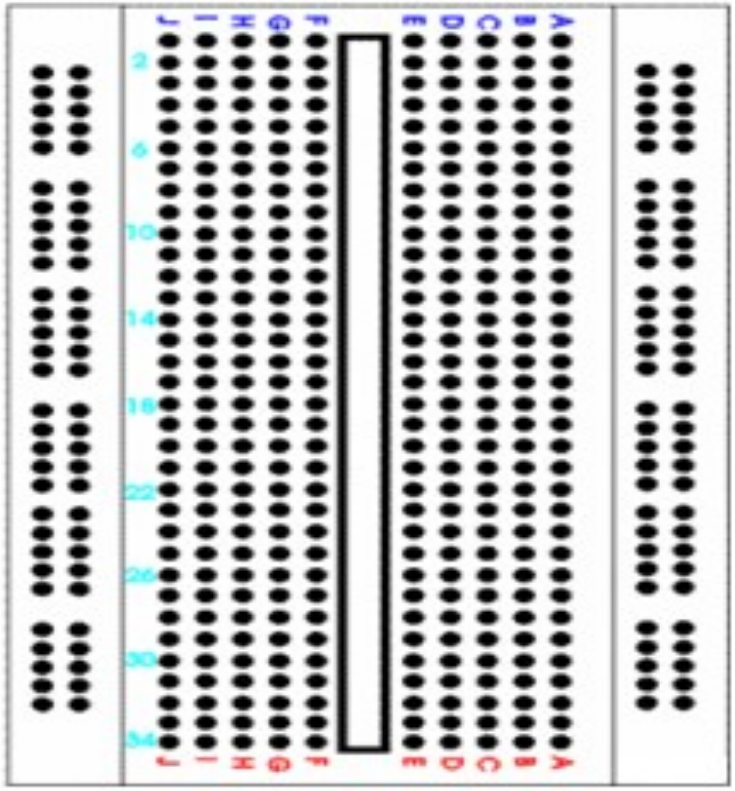
- For maximum resolution, choose the lowest possible range

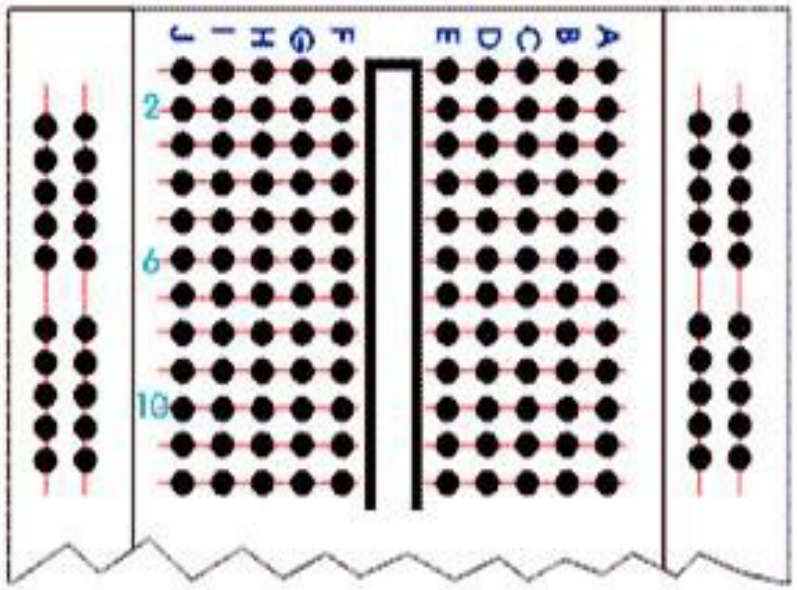
Breadboard

- A breadboard is a circuit board that is used to make temporary circuits
- The connections of the breadboard are mostly temporary and the elements can further be reassembled and reused without any damage.



Breadboard

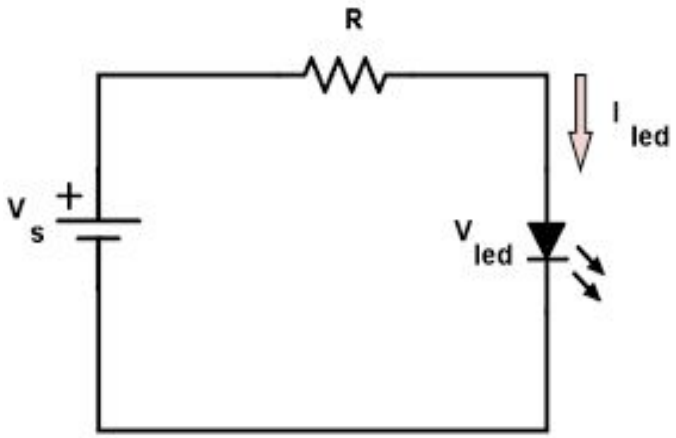


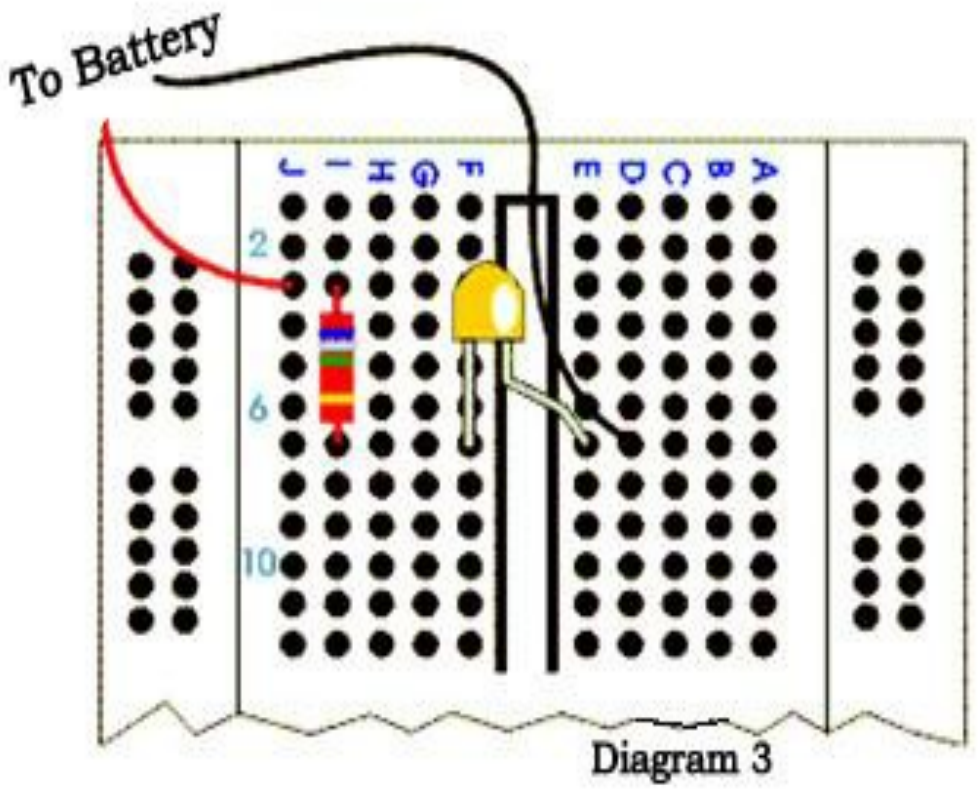


Breadboard Diagram 2

Fig.1.11 Basics of Breadboard

Building LED circuit on Breadboard





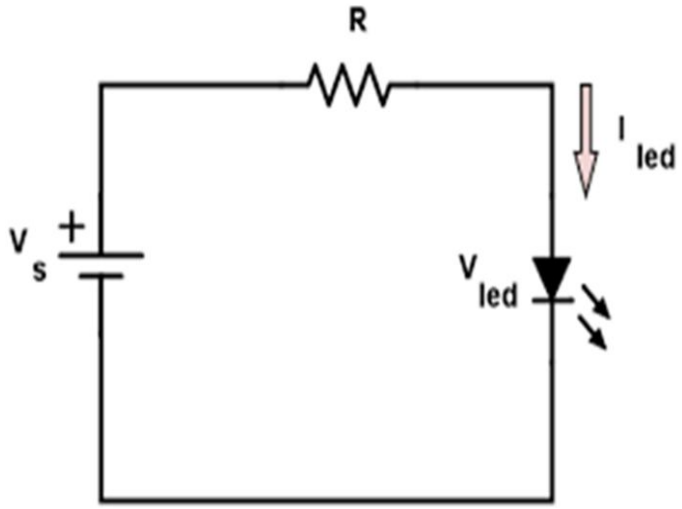
Breadboard Connections

Find a value of resistor in LED circuit

Given: Current thru LED = I= 20mA

Voltage across LED =V_{led} = 2V

Source voltage= V_S = 5V



$$V_S - V_R - V_{LED} = 0$$

$$V_R = I * R$$

$$R = (V_S - V_{LED}) / I \quad \Omega$$

$$R = 150\ \Omega$$

BEEE lab in simulation software Tinkercad

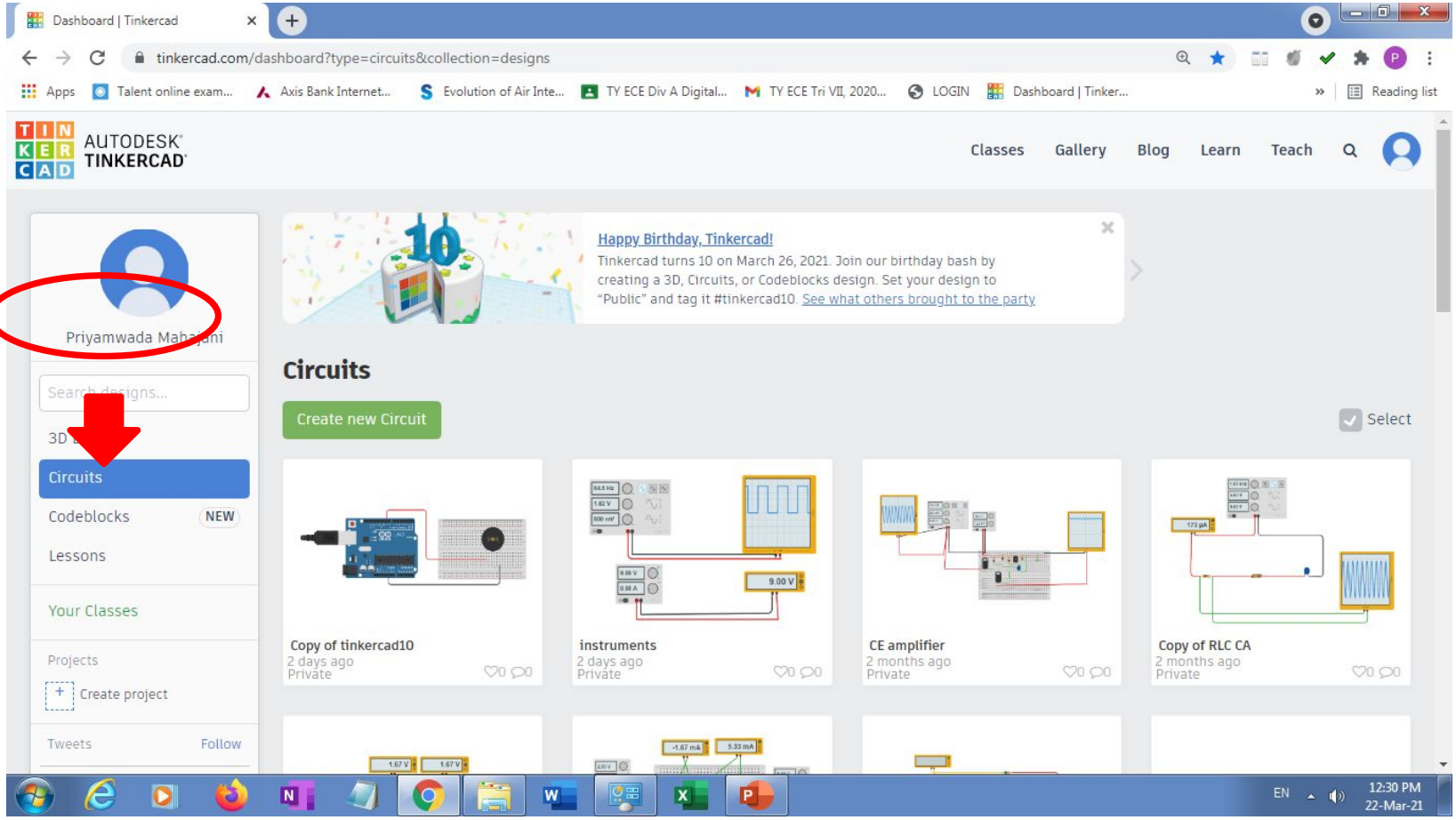
- Each expt will be simulated in a free Tinkercad software.
- All students need to register in tinkercad software by visiting the following link-

  https://www.tinkercad.com/dashboard
- Go in Circuits tab ->

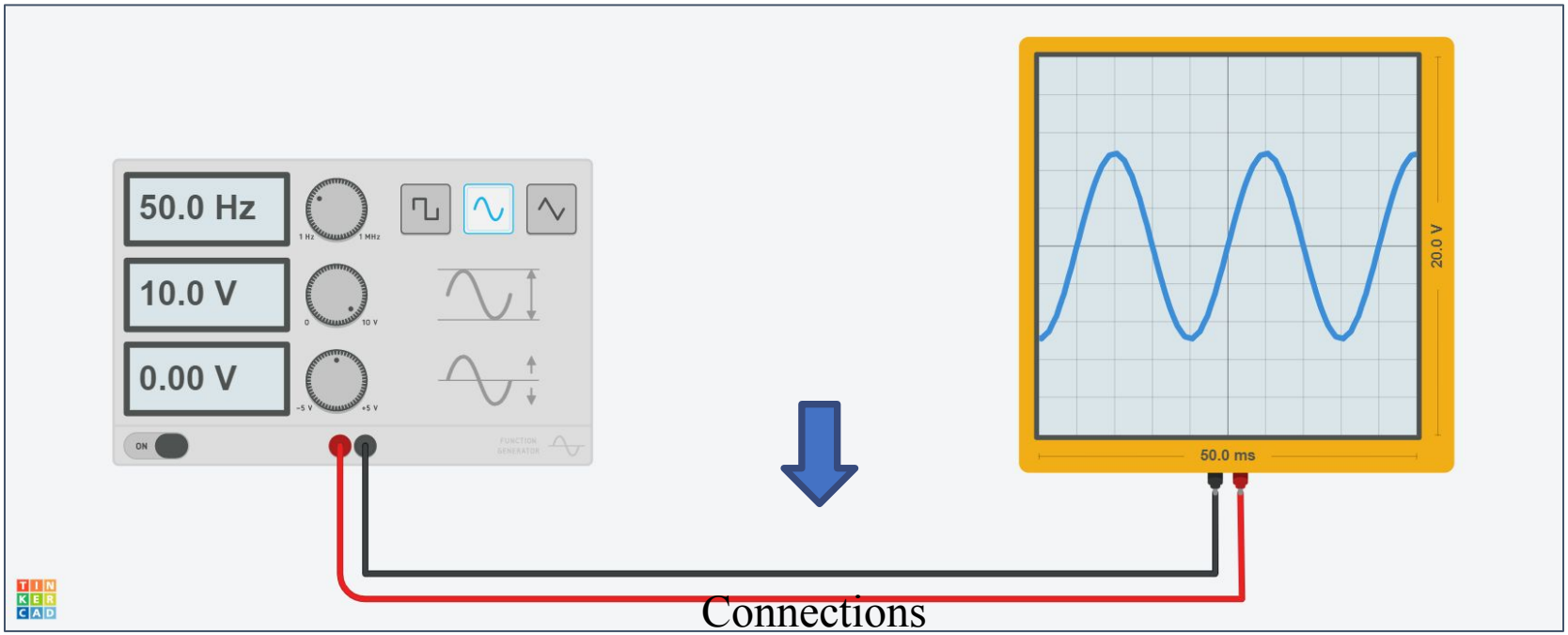
  Create new circuit ->

  In component tab select all
- You will see all components in the section.
- You can design and simulate a simple LED circuit (shown below) using breadboard, Power supply, LED, Resistor.

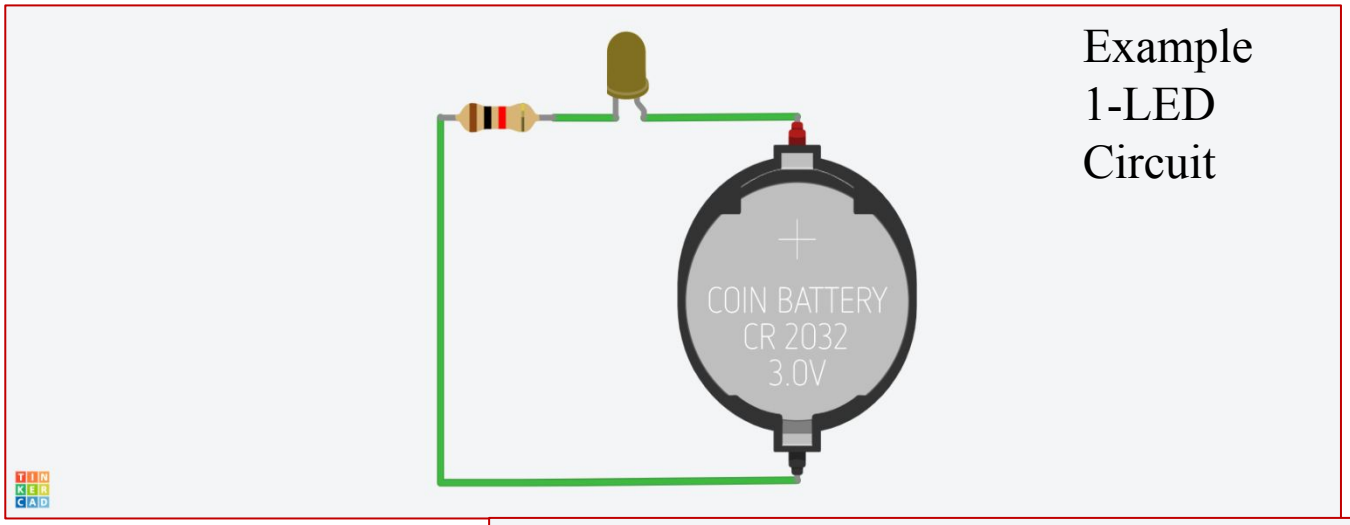
Tinkercad Dashboard



Instruments in Tinkercad

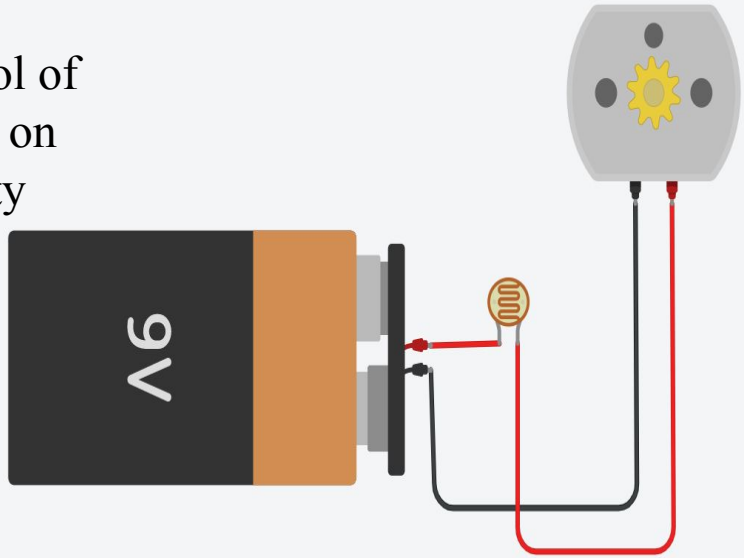


Build and test a circuit in Tinkercad



Example
1-LED
Circuit

Example 2-
Speed control of
motor based on
light intensity



Useful links for YouTube videos of components

- Resistor:

https://www.youtube.com/watch?v=G3H5lKoWPpY&vl=en

- Capacitor:

https://www.youtube.com/watch?v=f_MZNsEqyQw

- Inductor:

https://www.youtube.com/watch?v=ukBFPrXiKWA

- Diode:

https://www.youtube.com/watch?v=vqQQN5yf1Oc

- Zener Diode:

https://www.youtube.com/watch?v=V5nWu8EbMhI

- IC Manufacturing:

https://www.youtube.com/watch?v=4Q_n4vdyZzc

- Transformer:

https://www.youtube.com/watch?v=agujzHdvtjc

Thank You!