EXPERIMENT 1

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Familiarisation with Resistor

1. Aim of the experiment:

- To understand the functioning of resistors.
- To measure the resistance and tolerance of a resistor.

2. Tools used:

- Resistors of different types, with different resistances and tolerance.

3. Background knowledge:

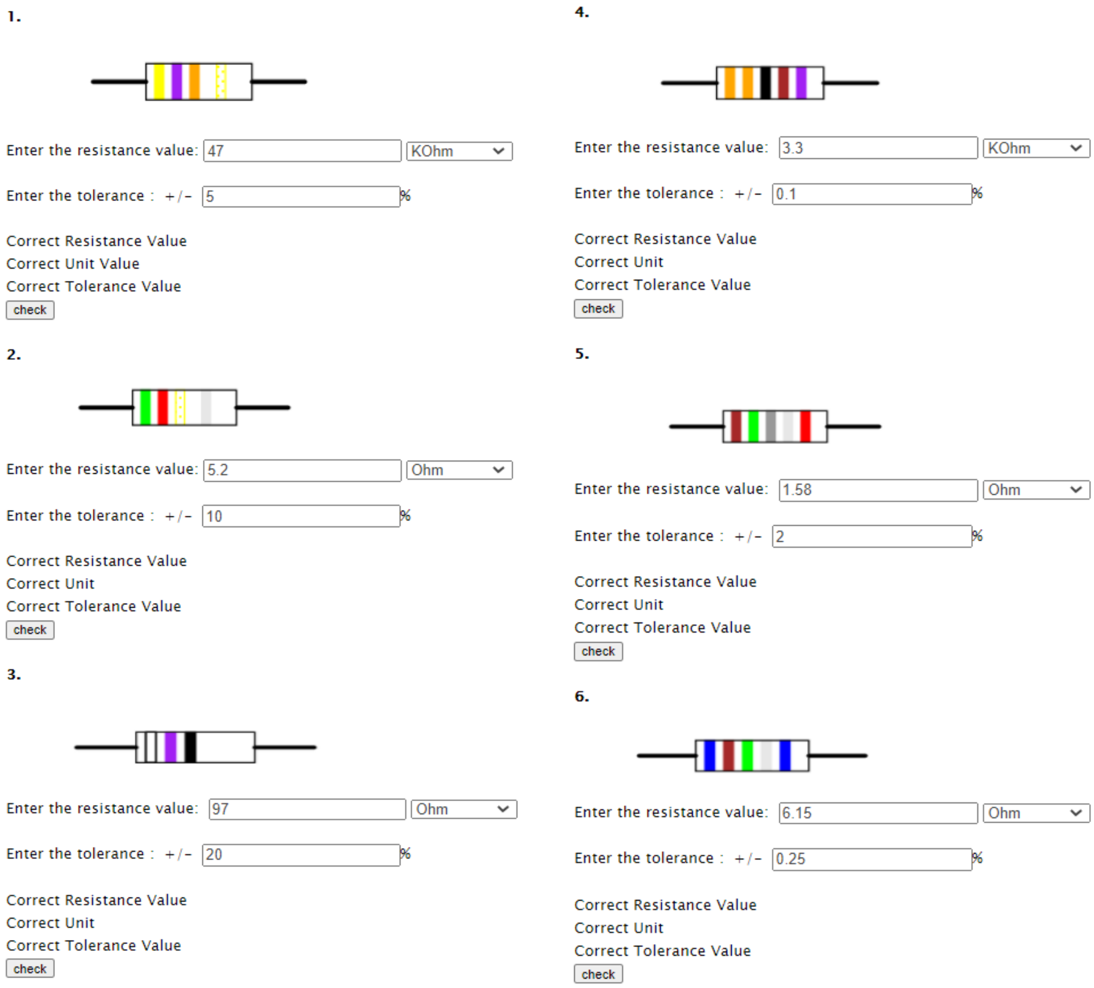
- There are two types of resistors viz. fixed and variable resistors.
- A fixed resistor is the one whose value cannot be changed (Eg.: Carbon film, wire film and wire wound resistors.)
- A variable resistor is the one whose resistance can be changed. (Eg.: Semi fixed resistor, completely variable resistor, potentiometer)
- Reading the value of fixed resistors: Resistors are color coded with 4 or 5 bands of color. This is done as they are too small to have actual value written on them. Decoding these colors can give the value of resistance and tolerance of the resistor.

4. Reference Table:

Color	Digit	Multiplier	Tolerance (%)
Black	0	10^0 (1)	
Brown	1	10^1	1
Red	2	10^2	2
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	0.5
Blue	6	10^6	0.25
Violet	7	10^7	0.1
Grey	8	10^8	
White	9	10^9	
Gold		10^{-1}	5
Silver		10^{-2}	10
(none)			20

Table with band colors and their respective number, multiplier, and tolerance values.

5. Image/Screenshot:



Screenshots of Quiz given on recognizing resistance and tolerance values of resistors
(vlabs.iitkgp.ernet.in)

6. Conclusion:

- Resistance is a measure of the opposition to current flow in an electrical circuit. It is measured in ohms.
- A resistor is a passive two-terminal electrical component that implements electrical resistance in a circuit.
- The tolerance of a resistor is the maximum difference between its actual value and the required value and is generally expressed as a plus or minus percentage value.
- A resistor might have 4 or 5 color coded bands.
- For a 4 banded resistor, first 2 bands give the number, 3^{rd} band gives the multiplier value and the last band represents the tolerance value.
- For a 5 banded resistor, first 3 bands give the number, 4^{th} band gives the multiplier and the last band represents the tolerance value.
- To find the resistance and tolerance, we need to recognize which band represents what, and then recognize the color and decode its value according to the reference table (shown on page 1).

7. Discussions:

- We need to place the resistor in such a way that the closely packed color bands are on the left else we might end up reading the wrong value.
- We also need to check if a resistor is 4 banded or 5 banded before reading its value. If 3 bands are closer to each other and 1 band is far apart or is missing then the resistor is a 4 banded resistor. If 4 bands are closer and 1 other band is either far apart or missing then it is a 5 banded resistor.

Familiarisation with Capacitor

8. Aim of the experiment:

- Define capacitor and identify the value of its capacitance.
- Understand their construction and functioning.
- Find energy associated with a capacitor.

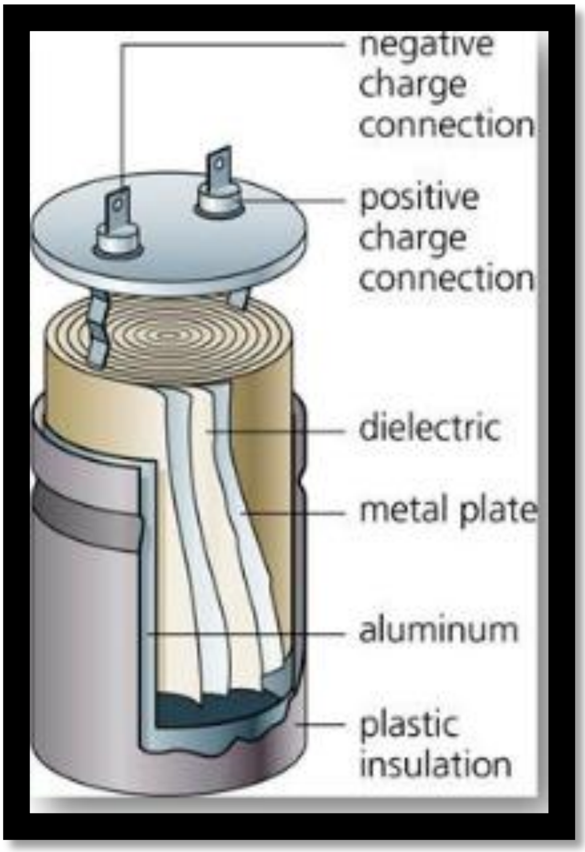
9. Tools used:

- Capacitors with different values of capacitance.

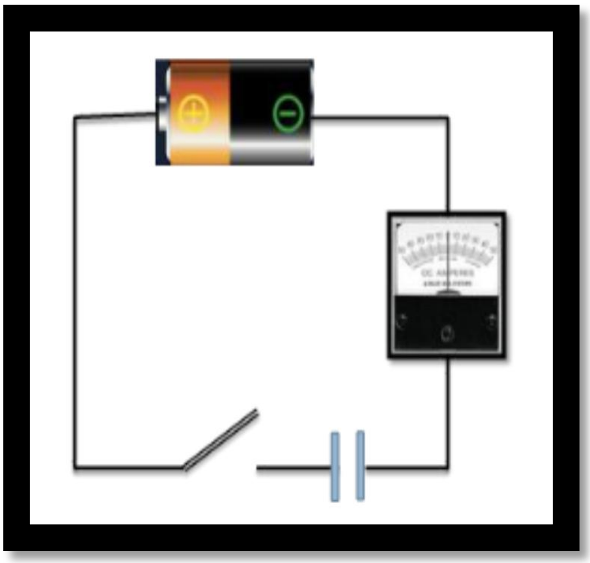
10. Background knowledge:

- A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals. The effect of a capacitor is known as capacitance measured in Farads.
- The higher the value of capacitance, the more charge the capacitor can store.
- A basic capacitor consists of two metal plates separated by a dielectric (insulating materials like air, glass etc).

11. Image/Circuit:



Construction of a capacitor



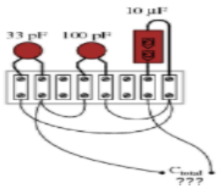
A basic circuit connecting a dc voltage source(battery), a galvanometer, a capacitor and a switch.

12. Screenshots:

✓ 1. Two 33 µF capacitors are connected in series with each other. What will their combined capacitance be in Farads?

- ◉ 16.5 µF
- ○ 120 µF
- ○ 66 µF
- ○ 200 µF

✓ 2. Calculate the total capacitance in this collection of capacitors, as measured between the two wires:



Calculate total capacitance given the values of inductors C1, C2, and C3

- ○ 130.990 pF
- ○ 200.8 pF
- ○ 130 pF
- ◉ 132.998 pF

✓ 3. A 10µF capacitor is charged to a voltage of 20 volts.How many coulombs of electric charge are stored in this capacitor?

- ○ 20µC of charge
- ○ 120µC of charge
- ○ 20mC of charge
- ◉ 200µC of charge

✓ 4. Two 470µF capacitors connected in series are subjected to a total applied voltage that changes at a rate of 200 volts per sec. How much current will there be through these capacitors?
(Hint :The total voltage is divided evenly between the two capacitors.)

- ◉ 47 mA
- ○ 470 mA
- ○ 94 mA
- ○ 940 mA

✓ 5. Two capacitors 470µF capacitors connected in parallel are subjected to a total applied voltage that changes at a rate of 200 volts per sec.How much total current will there be through these capacitors?

- ○ 47 mA
- ○ 18 mA
- ◉ 188 mA
- ○ 18.8 mA

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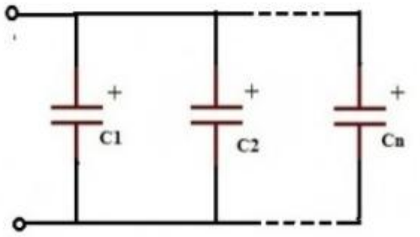
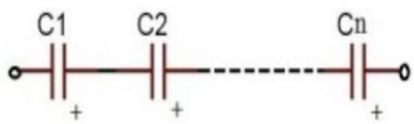
Screenshots of Quiz given on recognizing capacitance of various combinations of capacitors, current flowing through them and charge stored in them. (vlabs.iitkgp.ernet.in)

13. Conclusion:

- The capacitance C is the ratio of the amount of charge q on either conductor to the potential difference V between the conductors. [C = q/V]
  Here:
  C -> Capacitance
  q -> Charge
  V -> Potential Difference
- Differentiating the above equation with respect to time, we get the equation for current flow through the capacitor in the presence of variable potential difference. [I= C(dv/dt)]
  Here:
  C -> Capacitance
  t -> Time
  v -> Potential Difference
  I -> Current
- The equivalent capacitance (C) of n capacitors (C1,C2,C3,...,Cn) connected in parallel is given by:
  C=C1+C2+C3+…+Cn



- The equivalent capacitance (C) of n capacitors (C1,C2,C3,...,Cn) connected in series is given by:
  $C^{-1}=C1^{-1}+C2^{-1}+C3^{-1}+\ldots+Cn^{-1}$



14. Discussions:

- Every capacitor has a maximum working voltage beyond which, the insulator between the plates fails and charge passes from one plate to the other. To avoid this situation we need to ensure (especially for AC circuits) that the voltage across the capacitor is always less than about two thirds of this value.
- Capacitor is a basic storage device to store electrical charges during a process called charging and release it as it is required by the circuit in a process called discharging.
- Charging:
  1 . A battery is connected to an uncharged capacitor.
  2 . Due to the applied potential difference, electrons start moving from the plate connected to negative terminal.
  3 . This creates a potential difference between the plates.
  4 . This process continues till the potential difference between the plates becomes equal to the potential difference offered by the battery.
  5 . Once this point is reached, the capacitor is said to be charged and has the same voltage as the battery.
- Discharging:
  1 . The charged capacitor now behaves like a battery.
  2 . Until it is discharged completely, it keeps acting like a battery.
  3 . The potential difference it offers is not constant and keep decaying until the point of complete discharge.

<u>**Familiarisation with Inductor**</u>

15. Aim of the experiment:

- Understanding the basic functioning of inductors
- Evaluating the inductance

16. Tools used:

- Inductors of different values of inductance.

17. Background knowledge:

- An inductor is a passive electrical component that stores energy in a magnetic field when electric current flows through it. The effect of inductor is known as inductance measured in Henry.
- Inductance is the tendency of an electrical conductor to oppose a change in the electric current flowing through it.
- An inductor is constructed by winding a wire around a hollow or solid core.

18. Image:

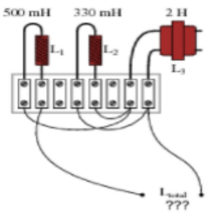
Construction of a simple inductor

19. Screenshots:

✓ 1. . Two 50 mH inductors are connected in parallel with each other. What will their combined inductance be in Henrys?

- 200 mH
- 50 mH
- 100 mH
- 25 mH

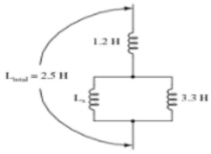
✓ 2. Calculate the total inductance in this collection of inductors, as measured between the two wires:



calculates total inductance given the values of inductors L1, L2, and L3.

- 700 mH
- 783.26 mH
- 689.09 mH
- 583.26 mH

✓ 3. How large must Inductor Lx be in order to provide a total inductance of 2.5 H in this network of inductors?



- 214.5 H
- 2.145 H
- 1.245 H
- 12.45 H

✓ 4. Two 5 H inductors connected in series are subjected to an electric current that changes at a rate of 4.5 amps per sec.How much voltage will be dropped across the series combination?

- 45 V
- 22.5 V
- 11.25 V
- 90 V

✓ 5. Two 5 H inductors connected in parallel are subjected to an electric current that changes at a rate of 4.5 amps per sec.How much voltage will be dropped across the series combination?(Hint: The total current is divided evenly between the two inductors).

- 45 V
- 22.5 V
- 11.25 V
- 90 V

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Screenshots of Quiz given on recognizing inductance of various combinations of inductors and voltage drop across them. (vlabs.iitkgp.ernet.in)

20. Conclusion:

- The equation showing current-voltage relationship in an inductor is given by: $V=L(dI/dt)$
  Here:
  V -> Voltage drop across the Inductor
  L -> Inductance of the inductor
  I -> Current
  t -> Time
- Inductance of an inductor is given by the following expression: $L= (n_r\, n_o\, A\, N^2)/l$
  Here:
  L -> Inductance
  n_r -> Relative permeability of core
  n_o -> Permeability of the free space
  A -> Cross-section area of the core
  N -> Number of turns of the wire
  l -> Length of the coil
- The equivalent inductance (L) of n inductors (L1,L2,L3,...,Ln) connected in series is given by: $L=L1+L2+L3+\ldots+Ln$
- The equivalent inductance (L) of n inductors (L1,L2,L3,...,Ln) connected in parallel is given by: $L^{-1}=L1^{-1}+L2^{-1}+L3^{-1}+\ldots+Ln^{-1}$

21. Discussions:

- Inductance is the property of the inductor through which it opposes change in electric current through it.
  Inductance of an inductor is dependent on various factors as follows:
  1 . Increases with increase in number of turns.
  2 . Increases with increase in cross sectional area of the core.
  3 . Decreases with increases in length of the solenoid/coil.
  4 . Increases with increase in permeability of core.
  By changing these parameters we can vary the inductance according to our convenience.