

Topic Covered

UNIT I

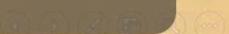
D C Circuit Analysis and Network Theorems:

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation,

Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

Aishvarya N

...

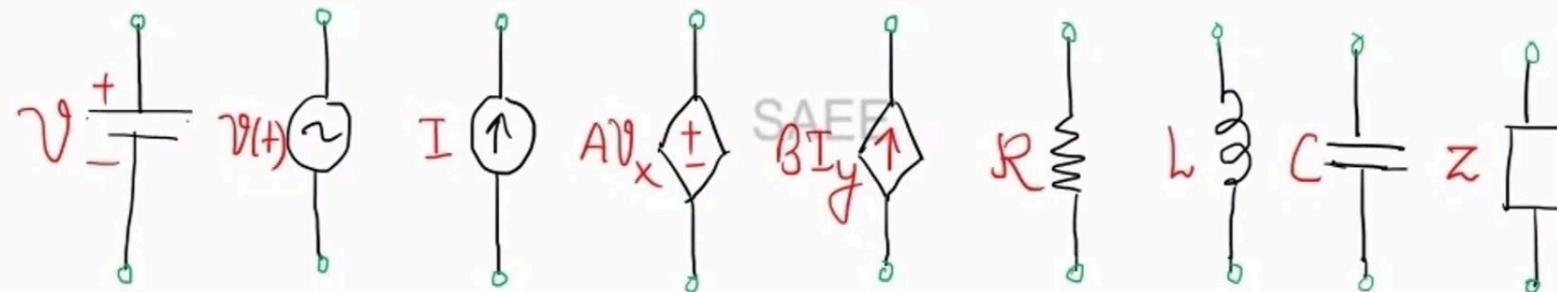


...



WHAT IS ELEMENT?

A two terminal component that connected to an electric circuit is an **element**.



All are electrical "ELEMENTS".

Aishvarya N ...



Linear or Nonlinear Elements

Aishvarya N ...

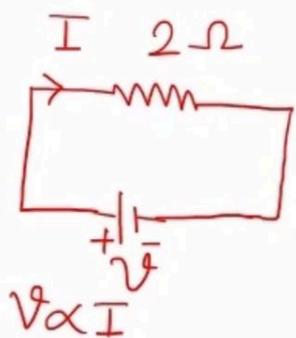


...



LINEAR ELEMENTS

- ❖ A circuit whose **values does not changed** with respect to **Current and Voltage** is called Linear Circuit.



3 H
SAEE

$\propto I$
 $L = \text{Constant}$

6 MF

$\propto V$
 $C = \text{Constant}$

Aishvarya N $R = \text{Constant}$

LINEAR ELEMENTS

- ❖ Linear Elements obeys the law of **superposition and homogeneity**.

$$F(x+y) = F(x) + F(y) \quad \text{---(1)}$$

$$F(ax) = aF(x) \quad \text{---(2)}$$

SAEE

Aishvarya N ...



...



Linearity

- In a Resistive Circuit governed by Ohm's Law, **Linearity** implies both **Homogeneity** and **Additivity**:

Homogeneity: If $V=IR$, then $kV = kIR$

Additivity: If $V_1 = I_1R$ and $V_2 = I_2R$, then when $I_1 + I_2$ is applied through R , the resulting voltage is V , where

$$V = (I_1 + I_2)R = V_1 + V_2$$

Aishvarya N ...



AM



Aishvarya N



...



S

SRISHTI



SP

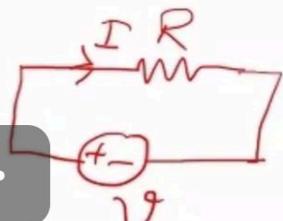


LINEAR ELEMENTS

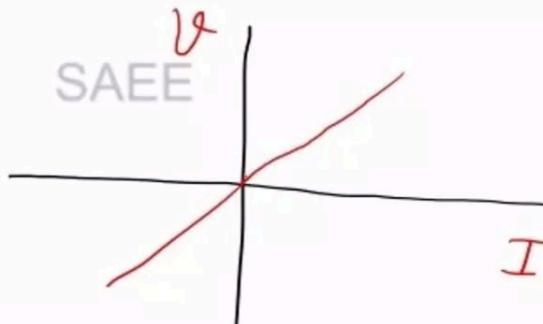
- ❖ They obeys properties **of ohm's law**
- ❖ These are elements in which the relation between **voltage and current is a linear function.**

$$I \propto V$$

$$I = \frac{V}{R} - *$$



Aishvarya N ...



AM



Aishvarya N



...



S

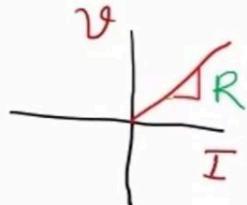
SRISHTI



SR

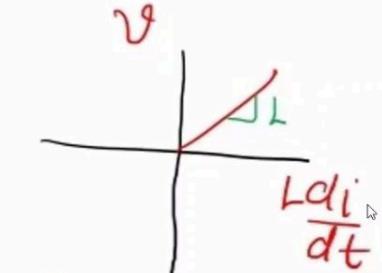
LINEAR ELEMENTS

Examples of linear elements are **resistor, inductors & capacitors**

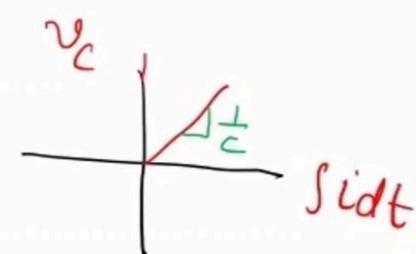


$$V \propto I$$

Aishvarya N ...



$$V_L = L \frac{di}{dt}$$



$$V_C = \frac{1}{C} \int idt$$

AM



Aishvarya N



...



S



SRISHTI



NONLINEAR ELEMENTS

- ❖ These are elements in which the relation between voltage and current is a nonlinear function.
- ❖ It **does not obey** the law of **superposition and homogeneity**.
- ❖ They does not obeys properties **of ohm's law**

Aishvarya N ...

AM



Aishvarya N



...



S

SRISHTI

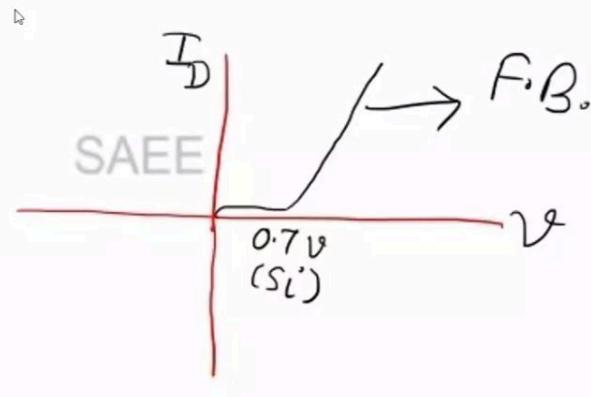
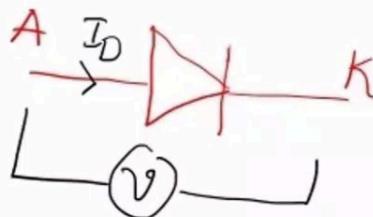


SR



NONLINEAR ELEMENTS

An example is a **diode**, in which the current is an exponential function of the voltage.



Aishvarya N ...

AM



Aishvarya N

...



S



SRISHTI



SR

Concept of Network/Circuit: Linear Or Nonlinear

Aishvarya N ...

AM



Aishvarya N



...



S

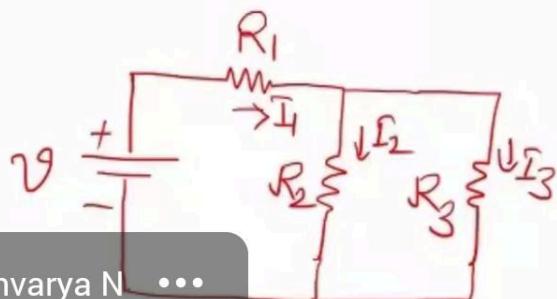
SRISHTI



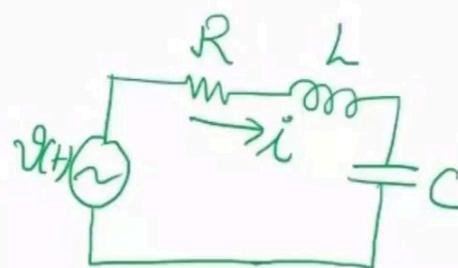
SR

LINEAR NETWORK/CIRCUIT

- ❖ Linear circuit in which circuit parameters (**Resistance, inductance, capacitance, etc**) are **constant**. In other words, a circuit whose parameters are **not changed with respect to Current and Voltage** is called **Linear Circuit**.



Aishvarya N ...



AM



Aishvarya N

...



S



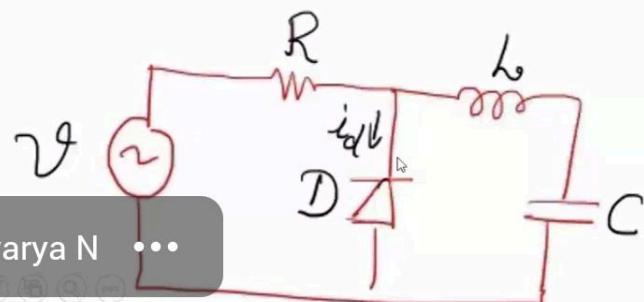
SRISHTI



SR

NONLINEAR NETWORK/CIRCUIT

- ❖ A circuit in which circuit parameters (**Resistance, inductance, capacitance, etc**) are **not constant**. In other words, a circuit whose parameters are **changed with respect to Current and Voltage is called Linear Circuit.** SAEE



Aishvarya N

...



AM



Aishvarya N

...



S

SRISHTI



SR

Active and Passive elements

Aishvarya N ...

AM



Aishvarya N



...



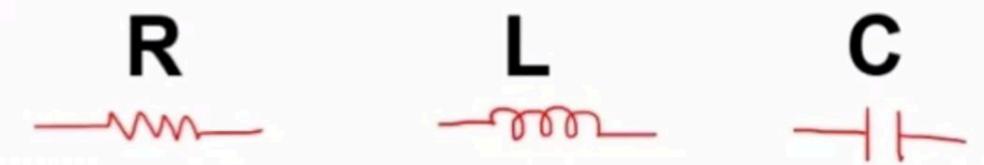
S

SRISHTI



SR

R L C



ACTIVE OR PASSIVE?

Aishvarya N ...

AM



Aishvarya N

...



S



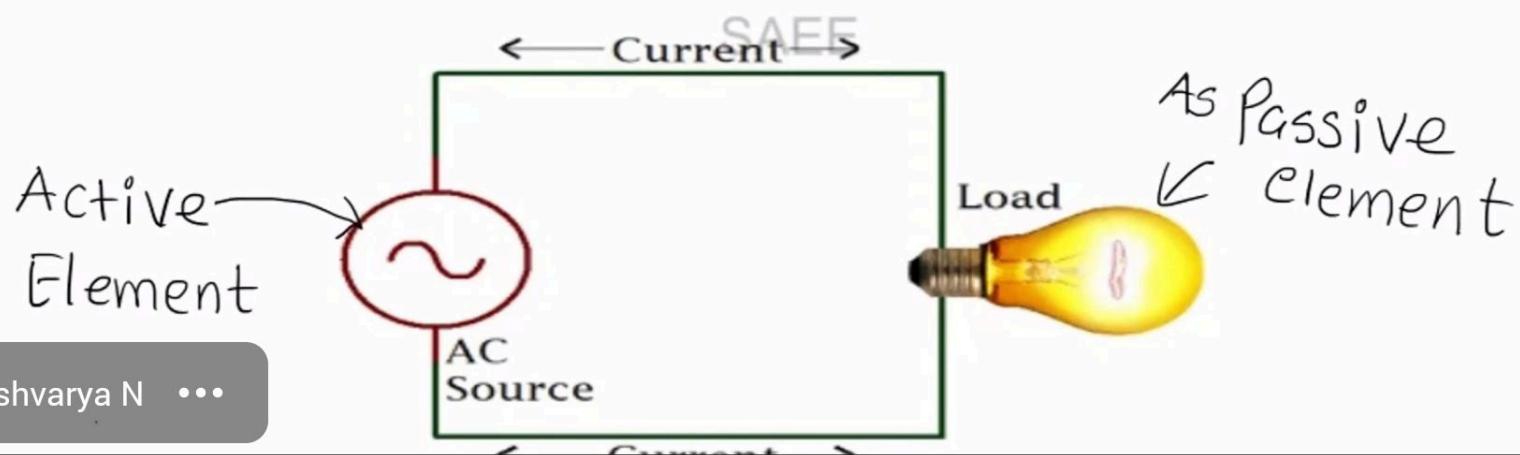
SRISHTI



SR

WHAT IS ACTIVE (सक्रिय) ELEMENTS?

- ❖ An Electrical/Electronic component **which supplies energy to a circuit**.
- ❖ Active elements have the ability to **electrically control electron flow** (i.e. the flow of charge).



AM



Aishvarya N

...



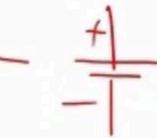
S



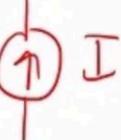
SRISHTI



SR

- ❖ **Voltage sources** -  

- **Battery, Generators** (such as alternators and DC generators)

- ❖ **Current sources** 

- All different types of **transistors** (such as bipolar junction transistors, **MOSFETS, FETs**)

Aishvarya N



AM



Aishvarya N

S

SRISHTI

SR



...



WHAT IS ACTIVE ELEMENTS?

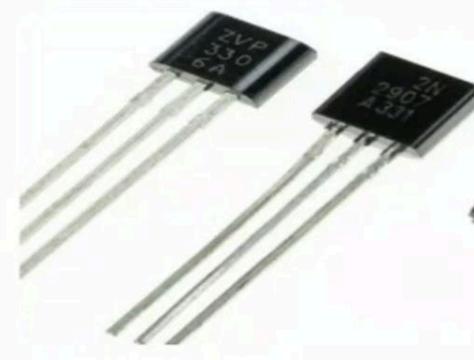
GENERATOR



BATTERIES



TRANSISTOR



PV CELL

Aishvarya N ...



AM



Aishvarya N

S

SRISHTI

SR



...



WHAT IS PASSIVE ELEMENTS?

- ❖ A passive component is an Electrical/Electronic component which can **only receive energy**, which it can either **dissipate, absorb or store** it in an electric field or a magnetic field.
- ❖ Passive components cannot **amplify, oscillate, or generate an electrical signal**.

Aishvarya N ...



AM



Aishvarya N

...



S

SRISHTI

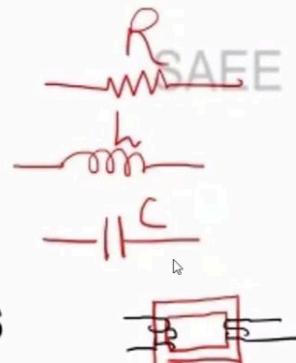


SR



WHAT IS PASSIVE ELEMENTS?

- ❖ Common examples of passive components include:
 - ✓ **Resistors**
 - ✓ **Inductors**
 - ✓ **Capacitors**
 - ✓ **Transformers**



Aishvarya N ...



AM



Aishvarya N

...



S

SRISHTI

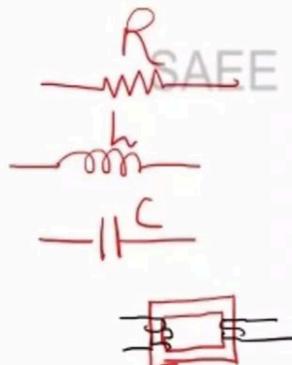


SR



WHAT IS PASSIVE ELEMENTS?

- ❖ Common examples of passive components include:
 - ✓ **Resistors**
 - ✓ **Inductors**
 - ✓ **Capacitors**
 - ✓ **Transformers**



Aishvarya N ...

This can seem **surprising** since transformers are often used to raise voltage levels – remember that power is kept constant.

When transformers step up (or step down) voltage, power and energy remain the same on the primary and secondary side. As energy is not actually being amplified – a transformer is classified as a passive element.

AM



Aishvarya N

...



S



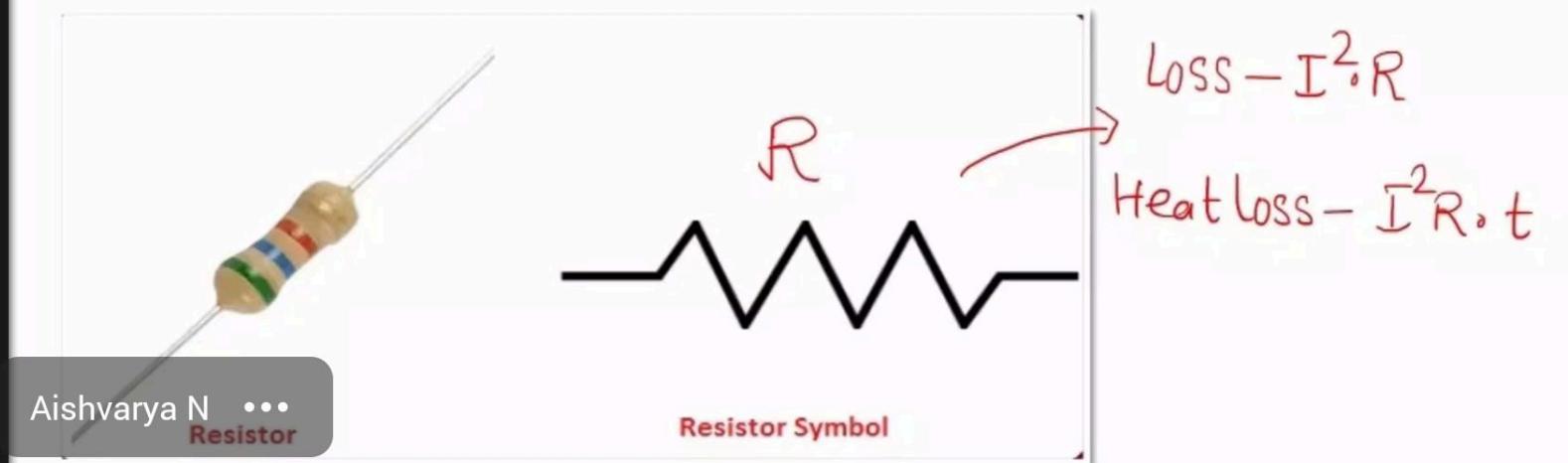
SRISHTI



SR

RESISTOR AS A PASSIVE ELEMENTS

It can not deliver any energy to a circuit. Instead resistors can only receive energy which they can dissipate as heat as long as current flows through it.



AM



Aishvarya N

...



S

SRISHTI



SR

INDUCTOR AS A PASSIVE ELEMENTS?

- ❖ It is a passive element of circuit, because it can store energy in it as a magnetic field.
- ❖ Although it can deliver that energy to the circuit, but not in continuous basis.
- ❖ The energy absorbing and delivering capacity of an inductor is limited and transient in nature.



Aishvarya N ...

$$L = \frac{1}{T^2}$$

AM



Aishvarya N

...

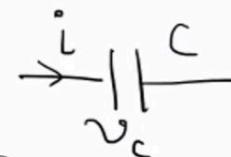


S

SRISHTI 

CAPACITOR AS A PASSIVE ELEMENTS

- ❖ A **capacitor** is considered as a **passive element** because it can **store energy in it as electric field**.
- ❖ The **energy dealing capacity** of a capacitor is limited and transient.
- ❖ It is **not actually supplying energy**, it is storing it for later use.



Aishvarya N ...  $= \frac{1}{2} C V^2$

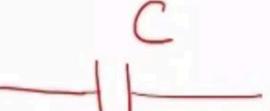


...



INDUCTOR & CAPACITOR

 charged $\frac{1}{2}LI^2$ → Acts as "Current Source"

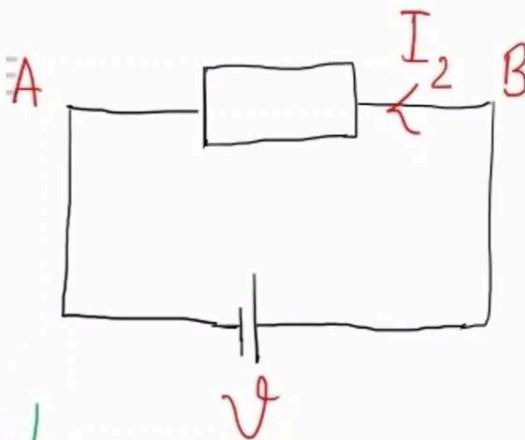
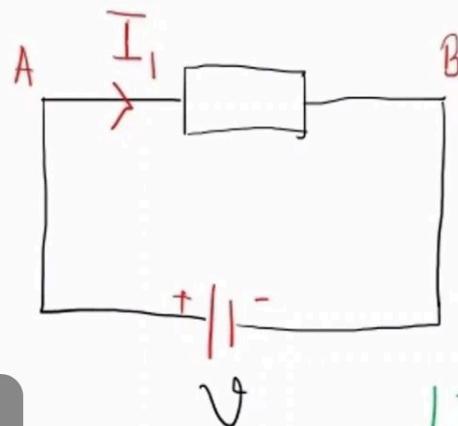
 Charged → Acts as "Voltage Source"

Aishvarya N ... $\frac{1}{2}CV^2$



WHAT IS BILATERAL ELEMENTS?

Conduction of current in **both directions** in a circuit element with same magnitude is termed as a bilateral circuit element.



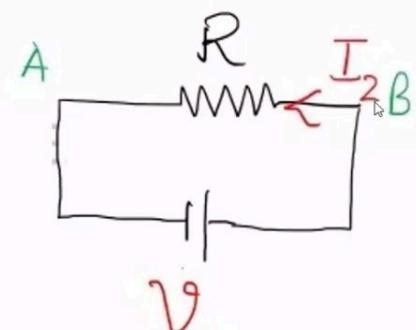
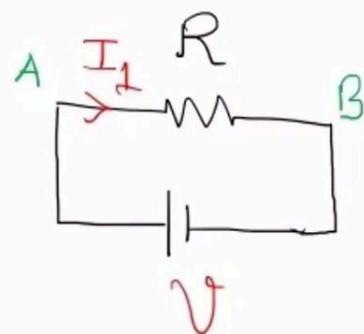
Aishvarya N ...

$$|I_1| = |I_2|$$



WHAT IS BILATERAL ELEMENTS?

Examples: Resistor, Inductor, capacitor etc.



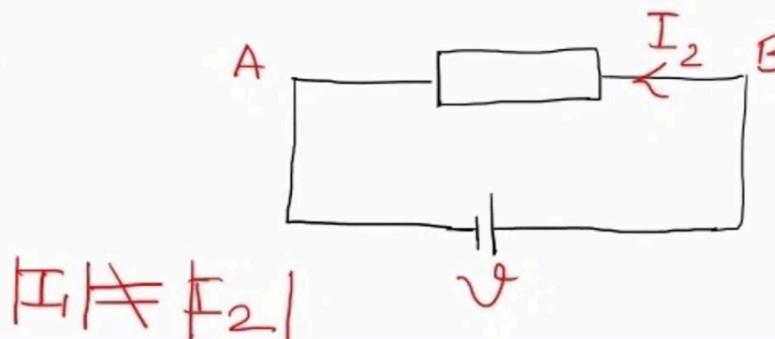
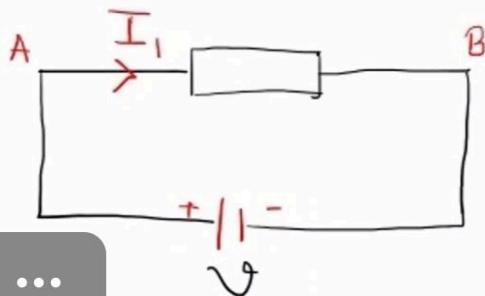
$$|I_1| = |I_2| \rightarrow \text{Bilateral}$$

Aishvarya N ...



WHAT IS UNILATERAL ELEMENTS?

- ❖ The unilateral circuit element does **not offer same resistance** to the current of either direction.
- ❖ The resistance of the unilateral circuit element is **different** for **forward current** than that of **reverse current**.



Aishvarya N ...

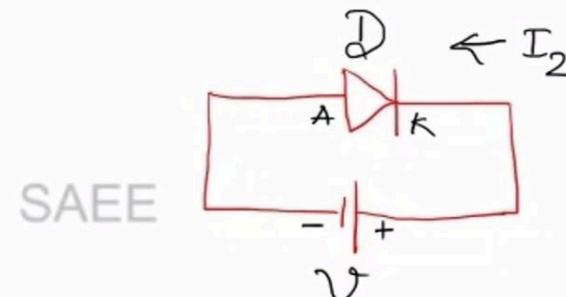
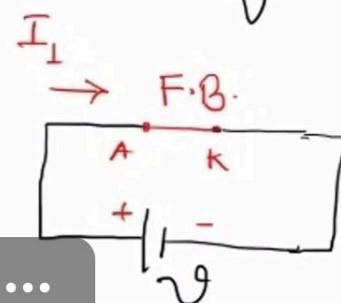
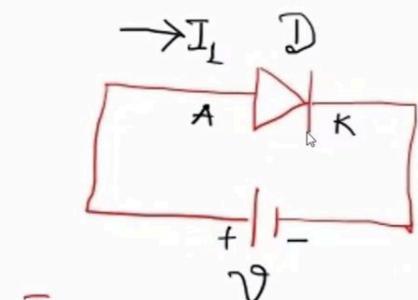


...

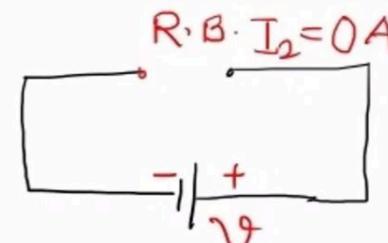


WHAT IS UNILATERAL ELEMENTS?

Examples: Diode, transistor etc.



$$|I_1| \neq |I_2|$$



Aishvarya N ...



Lumped- Distributed Elements/Network

Aishvarya N ...



...



WHAT IS LUMPED ELEMENTS?

In lumped elements **electrical parameters (R, L, C)** are assumed to be concentrated at one place.

Example: **Resistor connected in any electrical circuit**

