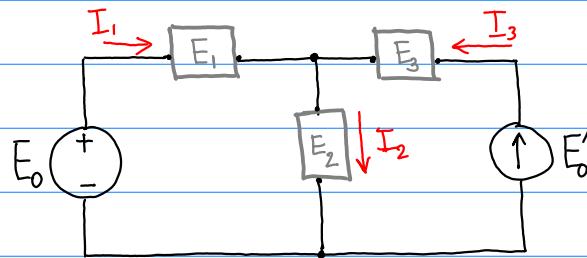


Lecture # 01Electric Circuits: Circuit Elements

Electric Circuits: An electric circuit (or network) is an interconnection of electrical circuit elements linked together in a closed path so that an electric current may continuously flow.



Electric circuit →
Sources & Sinks.

here, E_0 = Voltage Source

E' = Current Source

E_1, E_2, E_3 = Elements (Resistor, Capacitor, Inductor...
...)

Circuit Elements
Sources
Sinks

We define two kinds of ckt. elements

1) Active Elements

2) Passive Elements

1) Active Elements : Capable to supply non-zero average power to the ckt (ext'l/int'l.) over an infinite time interval.

Examples :

1) Sources : Voltage source, Current Source

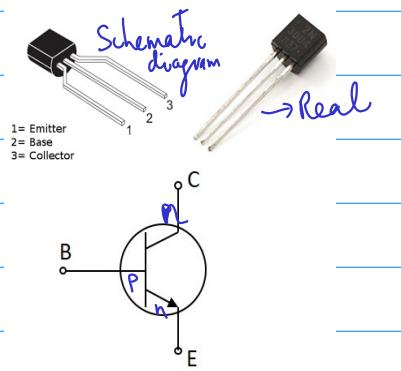


Battery

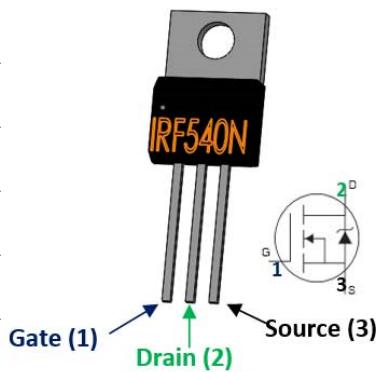
DC power Supply (Lab.)

2) Semiconductor Devices : Transistors (BJTs, MOSFETs)
Op-Amp. etc.

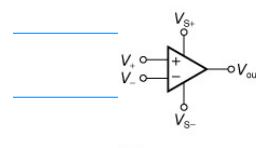
- Power gain in the ckt.



BJTs



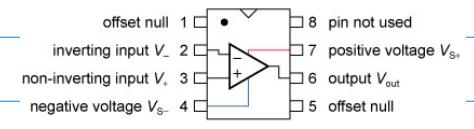
MOSFETs



(a)



(b) 1 2 3 4

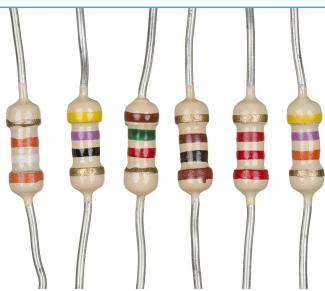


Op-Amp.

2) Passive Elements : Not capable to supply non-zero average power to the ckt. over an infinite time interval.

- No power gain.

Examples :



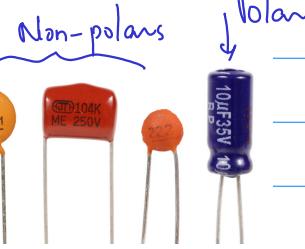
Resistors

$$I^2 R$$

Polar/electrolyte



Non-polars



Inductors

$$\frac{1}{2} L I^2$$



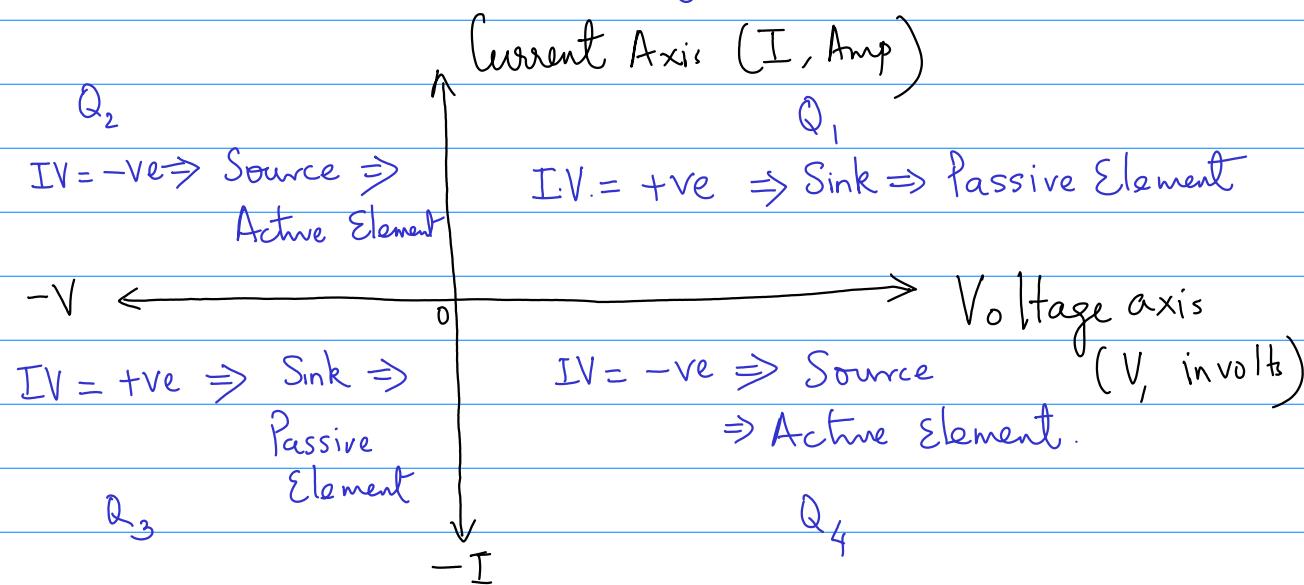
Transformers

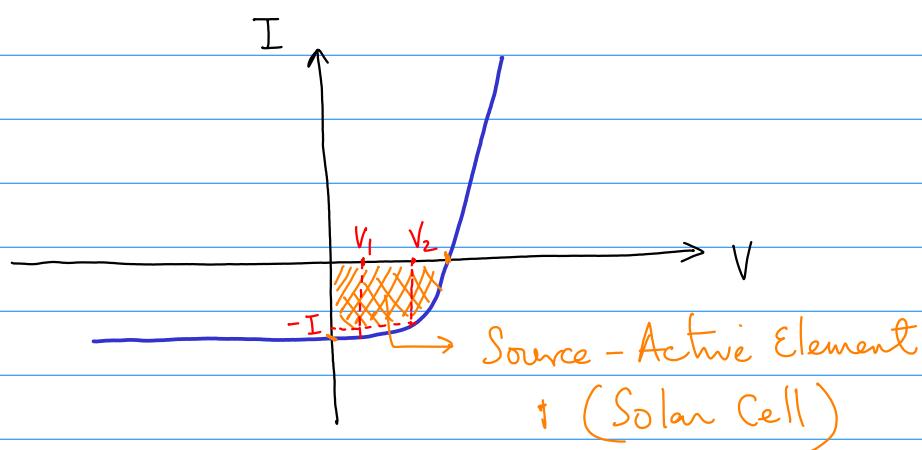
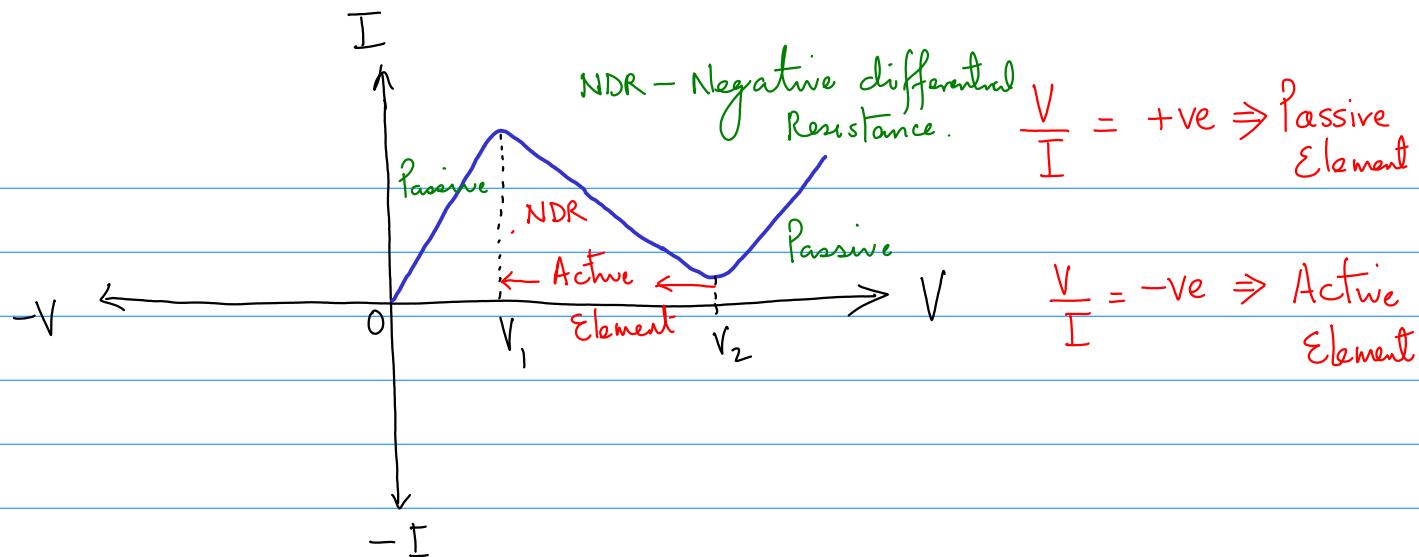
$$P_{in} = P_{out} \text{ (ideal)}$$

$$I_p V_p = I_s V_s$$

- ideal transformer

Identification of the type of ckt. elements





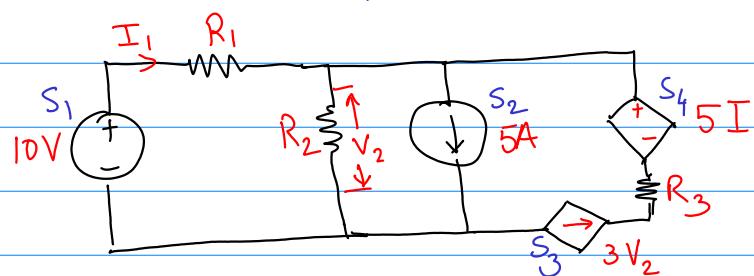
Sources :

Independent Sources

Dependent Sources

Independent Sources : The element for which both voltage and current don't depend on the voltage or current elsewhere in the ckt.

Dependent Sources : The element for which both voltage & current depend on the voltage & current elsewhere in the ckt.

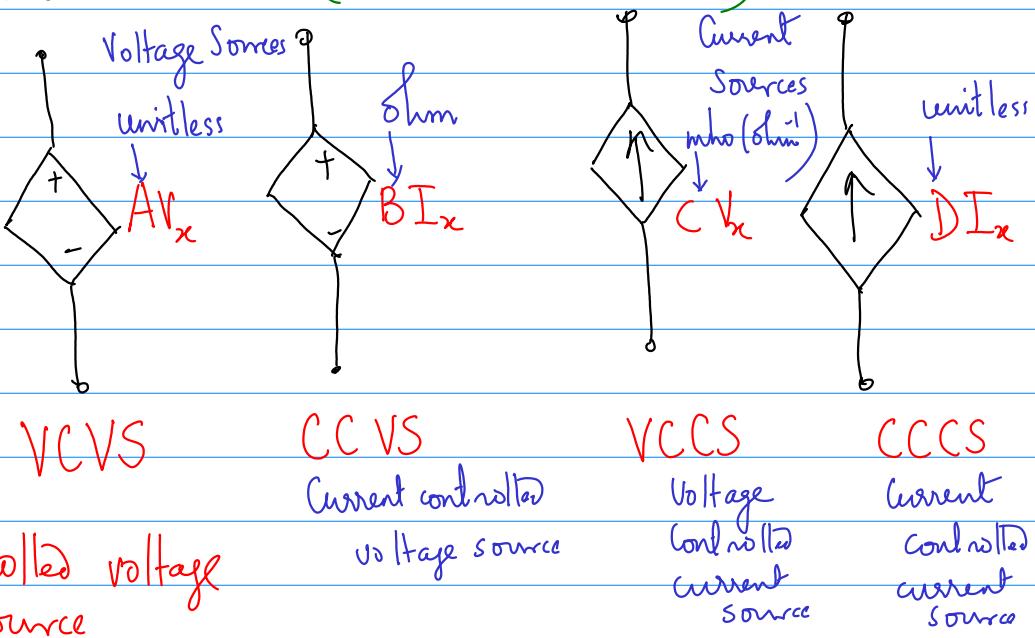


S_1 = Independent Source

S_2 = "

S_3 } Dependent Sources
 S_4 }

Dependent Sources (Controlled Sources)



Voltage Controlled voltage
Source

.... Continued

24.12.2021

Active and Passive Ckt. Elements

1) Judgement based on power activity.

Active Element : Those which outsource electric energy

- Sources - Voltage / Current sources

They provides electrical power to the ckt. continuously.

- Amplifiers : They amplify low power signals to high power signals. at the cost of bias power.
— Power gain.

Passive Elements : Consumes electrical power or,
stores electrical power

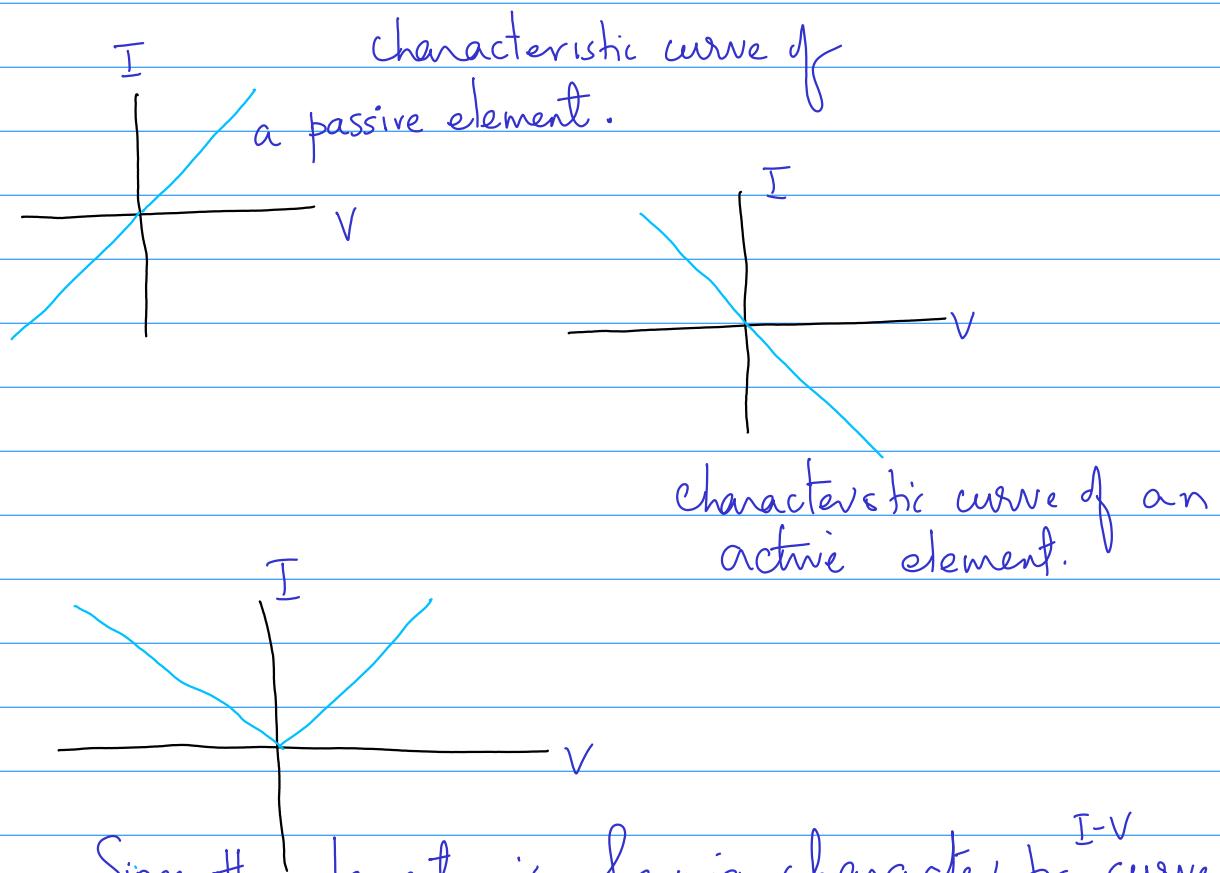
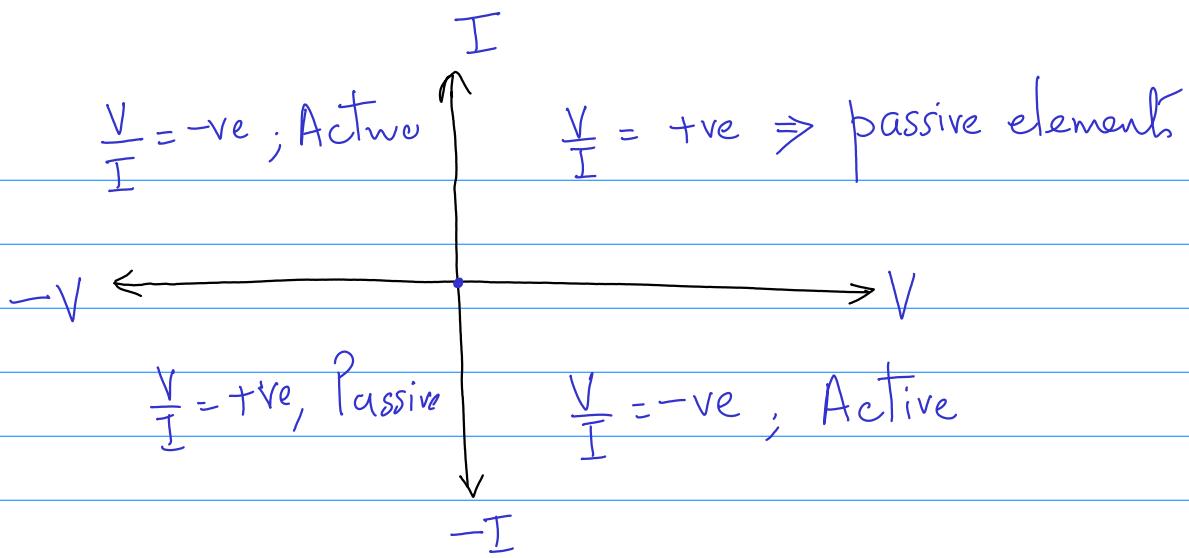
- Resistors, capacitors, Inductors, Transformer.

Any element behaving as an electric "SOURCE" is active and any element behaving as electric "SINK (LOAD)" is passive.

(2)

Judgement based on the sign of $\frac{V}{I}$ ratio:

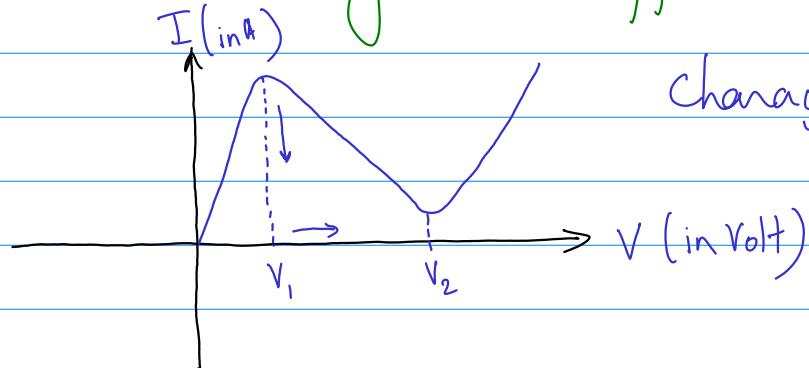
- We know that electric current is driven out from the +ve terminal of the Sources, therefore, $\frac{V}{I}$ ratio is Negative, hence, it is active element.
- Similarly, the electric current is entered into the +ve terminal of the "SINK (LOAD)", therefore, $\frac{V}{I}$ ratio is positive, hence they are passive element.



Since the element is having characteristic curve
 in second quadrant, we can say it is an
 Active element.

Special Cases :

③ Devices with negative differential resistance.



characteristic of a "Tunnel Diode".

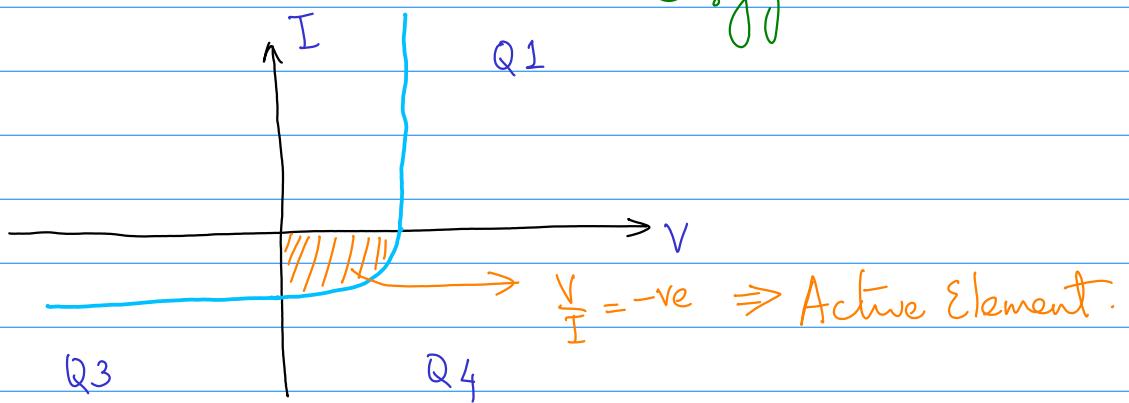
$$\text{Slope} = -ve$$

$$R = \frac{1}{\text{Slope}} = -ve \Rightarrow \text{Source}$$

Therefore, we categorize such element as "Active Element"

⇒ Application : As an amplifiers or oscillators.

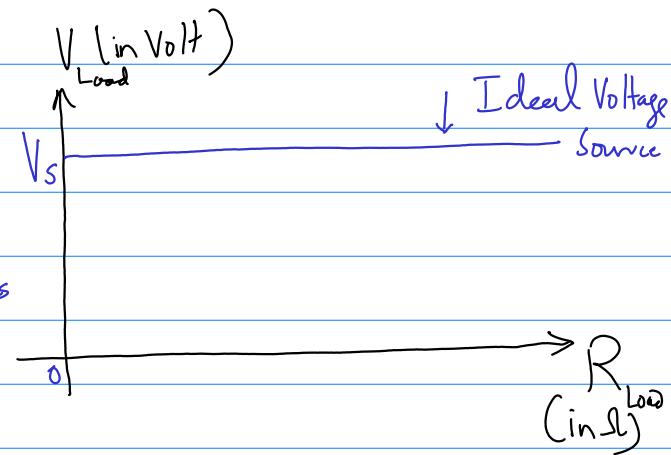
④ Characteristic curve of a solar cells (power generation)
Solar energy to useful electrical energy.



Ideal Voltage Source :

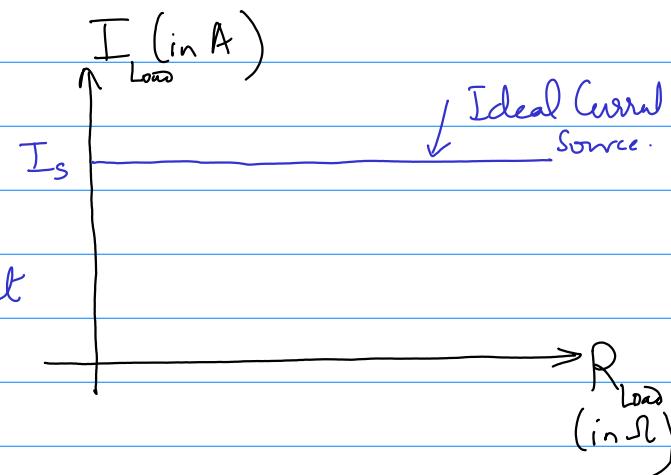
⇒ Voltage drop across

the load resistance remains constant with varying the value of load resistance.

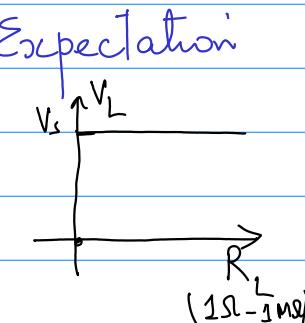
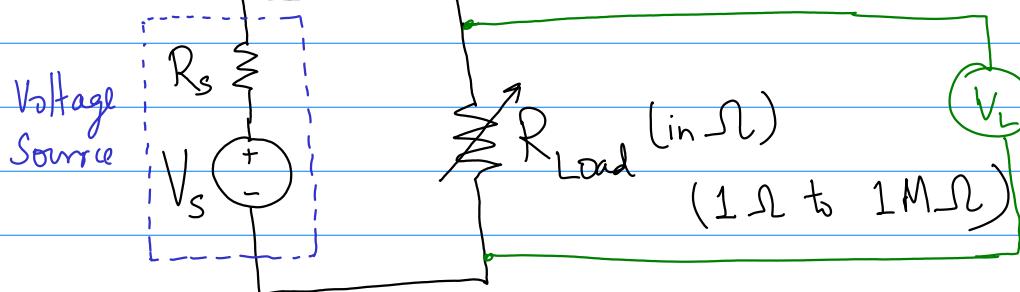


Ideal Current Source :

Current passing through the load resistance remains constant with varying the value of load resistance.



However, in practice, we have real voltage source and real current source.



Reference : Chapter 1 (Malvino & Bates)