.

EE1101: Circuits and Network Analysis

Lecture 03: Circuit Domain Essentials

August 1, 2025

Topics :

1. Power and Energy
2. Two Teriminal Elements in DC Circuits

Energy and Power in Circuits

from potential ⇒ external energy req to move a unit positive charge can be computed

W_{ext}

What is W_{ext} in moving a unit positive charge from b to a? (V_b) (V_a) $W_{ext} = V_a - V_b = V_{ab}$.

W_{ext} in moving a charge q from b to a? (V_b) (V_a) $W_{ext} = q(V_{ab})$

Scenario I:- $V_a > V_b$:

$W_{ext} = q V_{ab} > 0$.

(from b to a)

$W_{sys} = -W_{ext} < 0$

(energy in the elec form)

charge moving from lower Potential to higher potential ⟹ system gaining some energy.

Scenario II $V_a < V_b$:

$W_{ext} = q V_{ab} < 0$.

(from b to a)

$W_{sys} = -W_{ext} > 0$ → System is (energy in the elec form) dissipating energy.

charge moving from higher Potential to lower potential ⟹ Sys dissipates energy.

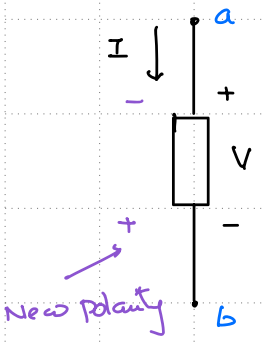
Energy and Power in Circuits

Power = rate of change of W or $\frac{dW}{dt}$

$$= \frac{dW}{dq} \times \frac{dq}{dt}$$

$$= vi$$

for DC CKTs $P = VI$



$V>0$ and $I>0$ | energy in the electrical form?

↓

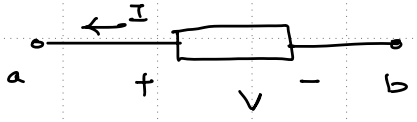
Node a is at a higher potential than node b. } ⇒ energy is dissipated } $P = VI > 0$

Charge flow from a to b. Power is "

Same scenario with a different polarity

Under new polarity $V<0$, $I>0$, energy | power is dissipated, $P<0$

Example 3:-



observation: $V>0$ and $I>0$

$V_a > V_b$ Charge flow from b to a.

energy is generated ⇒ $P>0$.

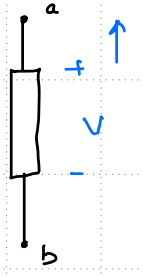
Active and Passive Sign Convention

A systematic way to assign polarity & reference

↓

Should help us in infering whether energy/power is gen/dissipated from the sign of P.

Active Sign Convention



→ for a chosen polarity for voltage, current ref is chosen to be out of the +ve terminal

→ for active convention

$P > 0 \Rightarrow$ elem is gen energy/power

↓

elem is a source.

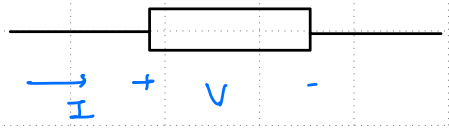
$P < 0 \Rightarrow$ elem is dissipating power/energy

↓

elem is a sink/load.

typically used for sources

Passive Sign Convention

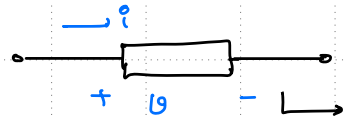


ref for current is into the +ve terminal

$P > 0 \Rightarrow$ sink and $P < 0 \Rightarrow$ source.

typically used for sink

Circuit Elements from the Point of View of Terminal Characteristics

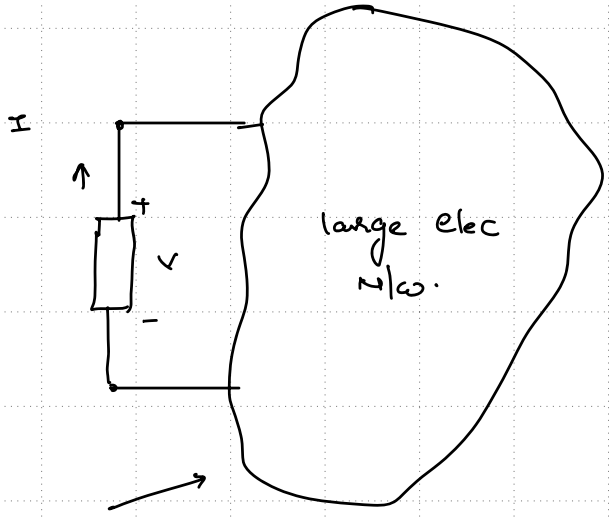


→ elements are defined based on voltage across it and the current through it } for circuits

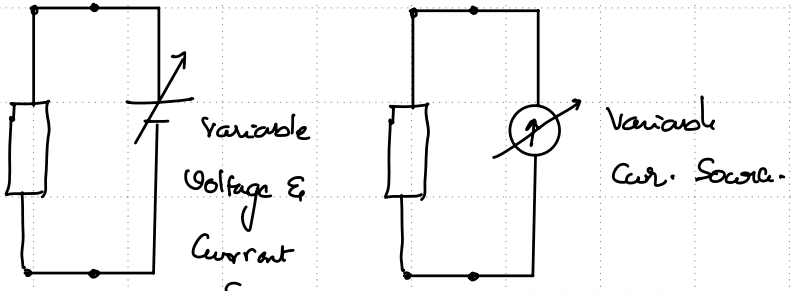
in EM → interested in internal behavior as well.

↓

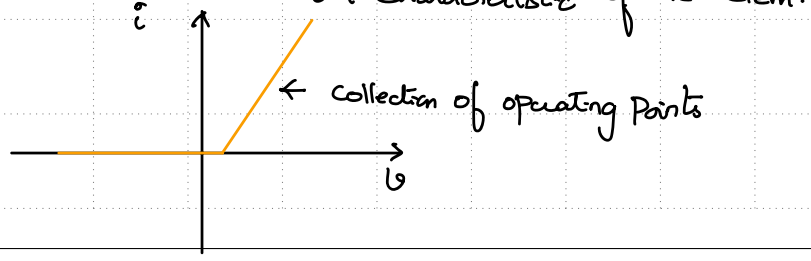
v-i characteristic



(V, I) is one point on the v-i characteristic

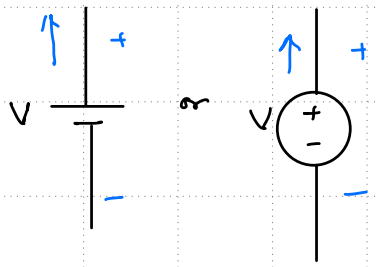


useful to build / determine the v-i characteristic of the elem.

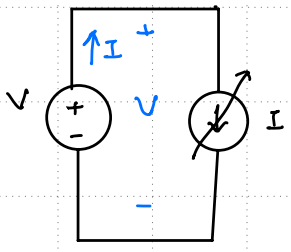


Ideal Voltage Source (DC)

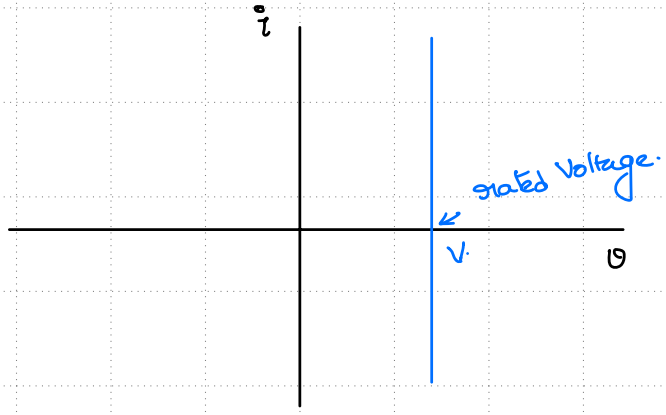
Circuit symbol / representation



Characterizing ckt



→ Voltage across the terminals is independent of the current through / out of the element



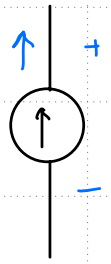
operating points lie in Quad I and IV.

P > 0 ↓ Source

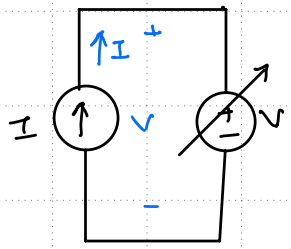
P < 0 ↓ Sink (charging mode)

Ideal Current Source (DC)

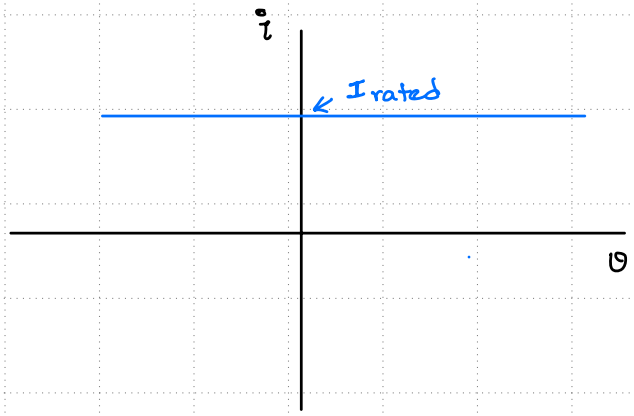
Circuit symbol / representation



Characterizing ckt



→ Current is independent of Vol across the element



operating points lie in Quad I and II

P > 0 ↓ Source

P < 0 ↓ Sink