Basic Electrical / Electronic Circuit Components

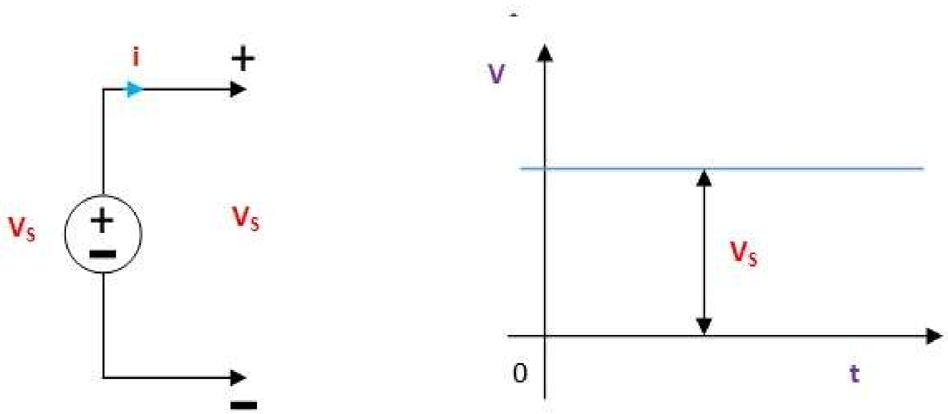
Circuit Components

Passive Components: Resistors, Capacitors, Inductors, transformer etc.

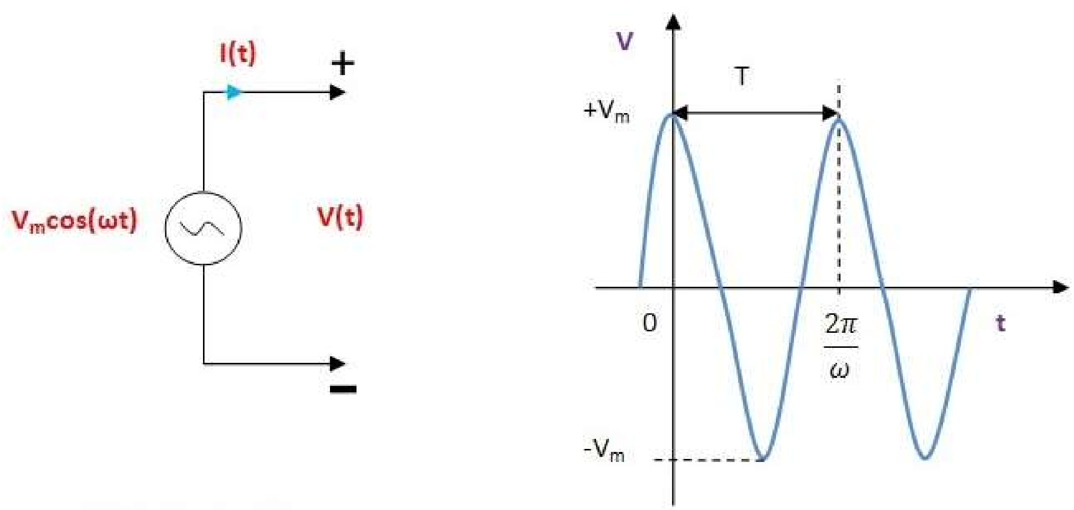
Active Components: Power sources (voltage/current),
Transistors (BJT/ MOSFET),
Generators etc

(Ideal Voltage Sources)

DC Voltage Source



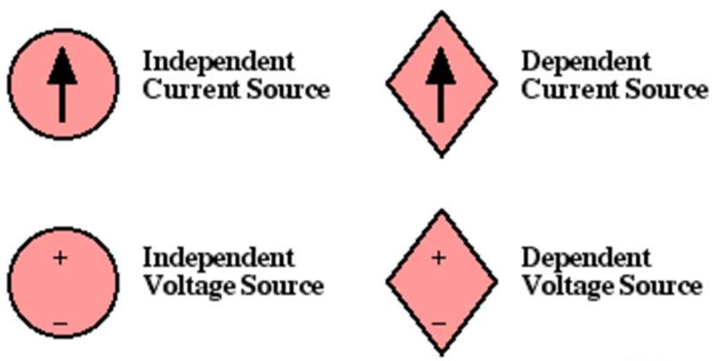
Alternating Voltage Source



Sources Types (DC/AC)

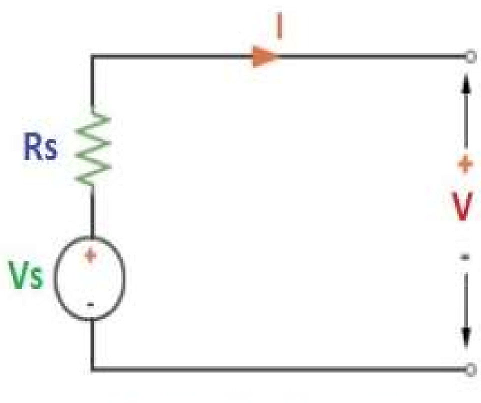
A. Independent

1. Voltage
2. Current

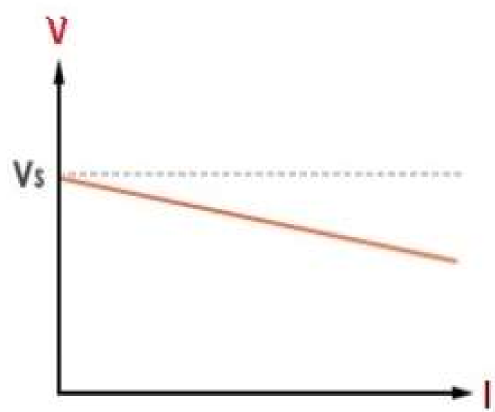


B. Dependent

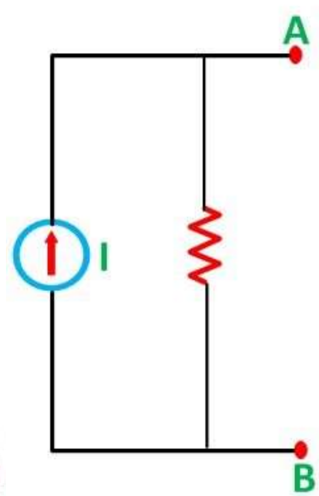
1. Voltage dependent Voltage Source, $v(v_x)$
2. Current dependent Voltage Source, $v(i_x)$
3. Voltage dependent Current Source, $i(v_x)$
4. Current dependent Current Source, $i(i_x)$

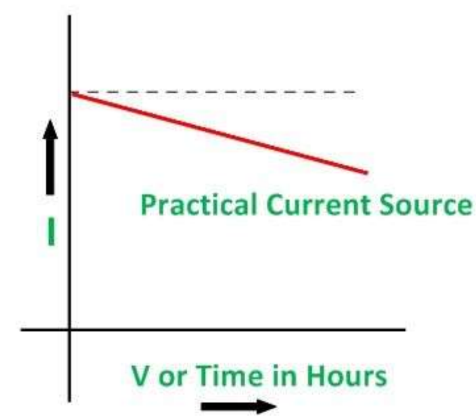


Practical Voltage Source

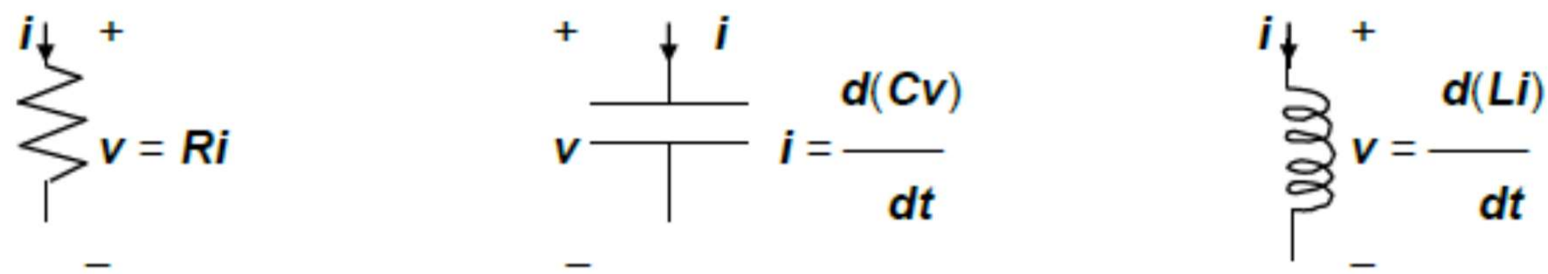


Practical Voltage Source Graph





Linear Time Invariant Passive Elements

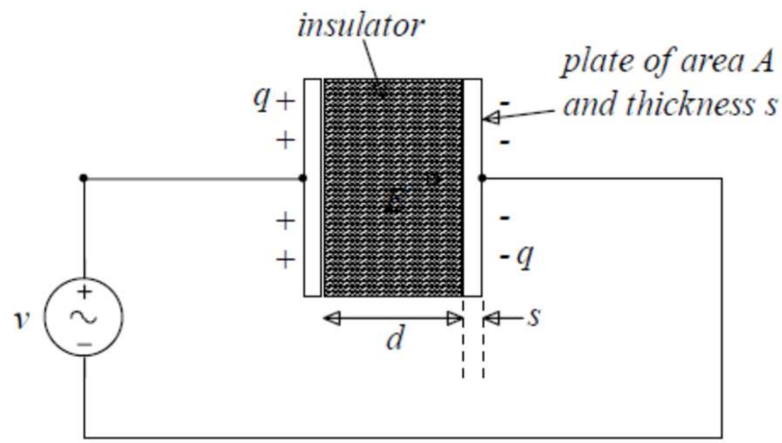


Linear Resistor | Linear Capacitor | Linear Inductor

For <u>linear time-invariant</u> capacitors and inductors, $\boldsymbol{i} = \boldsymbol{C}(\boldsymbol{dv/dt})$ and $\boldsymbol{v} = \boldsymbol{L}(\boldsymbol{di/dt})$ respectively.

Steady State and Transient Behaviour

Capacitor



A capacitor stores energy in the form of an electric field

Current-voltage relationship $\boxed{i = C\frac{dv}{dt}, \quad v = \frac{1}{C}\int idt}$

In DC the capacitor acts as an open circuit

The capacitance C represents the efficiency of storing charge.

The unit of capacitance is the Farad (F). 1 Farad=1Coulomb/1Vol

Typical capacitor values are in the mF (10^{-3} F) to pF (10^{-12} F)

The energy stored in a capacitor is $E = \frac{1}{2}Cv^2$

Large capacitors should always be stored with shorted leads.

$$\boxed{i = C\frac{dv}{dt}} \qquad \textbf{(1)}$$

Integrating Eq.1

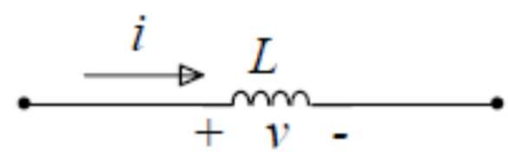
$$\int_{-\infty}^{t} i\,dt = \int_{-\infty}^{t} C\frac{dv}{dt}dt$$

$$v = \frac{1}{C}\int_{-\infty}^{t} i\,dt$$

$$= \frac{1}{C}\int_{0}^{t} i\,dt + v(0)$$

The constant of integration $v(0)$ represents the voltage of the capacitor at time $t=0$.
The presence of the constant of integration $v(0)$ is the reason for the memory properties of the capacitor.

Inductor



A inductor stores energy in a magnetic field

Current-voltage relationship $\boxed{v = L\frac{di}{dt}, \quad i = \frac{1}{L}\int v\,dt}$

The energy stored in an inductor is $E = \frac{1}{2}Li^2$

In DC the inductor behaves like a short circuit

The inductance L represents the efficiency of storing magnetic flux.

$$\boxed{v = L\frac{di}{dt}} \qquad (2)$$

On integrating Eq. 2

$$\int_{-\infty}^{t} v\,dt = \int_{-\infty}^{t} L\frac{di}{dt}dt$$

$$i = \frac{1}{L}\int_{-\infty}^{t} v\,dt$$

$$= \frac{1}{L}\int_{0}^{t} v\,dt + i(0)$$

The constant *i(0)* represents the current through the inductor at time $t=0$. (Note that we have also assumed that the current at $t = -\infty$ was zero.)

Q. 1.

Calculate the energy stored in the capacitor of the circuit to the right under DC conditions.