Basic circuit elements: Resistor, Inductor, Capacitor

04 September 2023 11:51

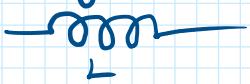
Resistor: A material that opposes the flow of current

SI unit: ohms (Ω)

Symbol: 

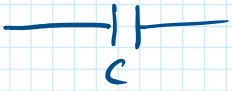
Inductor: That which stores the charges in the form of magnetic field

SI unit: Henry (H)

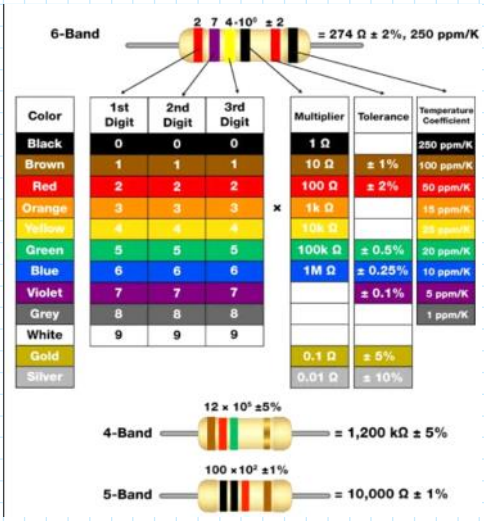
Symbol: 

Capacitor: That which stores charges in the form of electric field

SI unit: Farad (F)

Symbol: 

RESISTOR COLOUR CODING



BASIC CIRCUIT ELEMENTS

They are of two types:

Passive Elements: An electronic component which can only receive energy.

- Either dissipates, absorbs or store energy in an electric field [or] a magnetic field.
- Do not need any form of electrical power to operate
- Eg: Resistor, inductor, capacitor

Active Elements: Components that supply energy to the circuit

- EXAMPLES

Active Elements: components that supply energy to the circuit

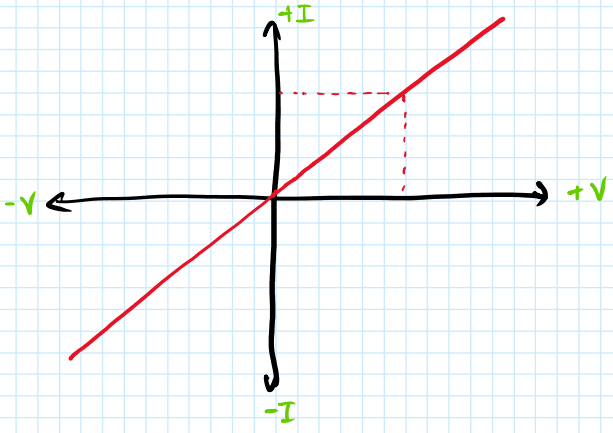
- **Examples**
  - Voltage Source: used to create potential difference b/w two points in the circuit (eg: battery)
  - Current Source: supplies current to the circuit (eg: DC current source, AC current source)
- Voltage / current sources are of two types: dependent and independent
  - dependent → transformer
  - independent → battery

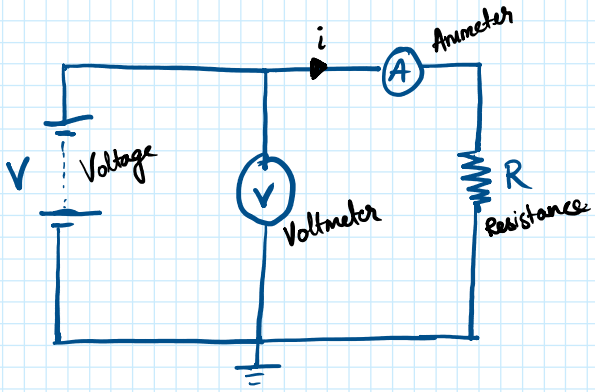
Ohm's Law

$V \propto I$

$$V = IR$$

R → resistance: proportionality constant





Voltage - Current Relation in Capacitor

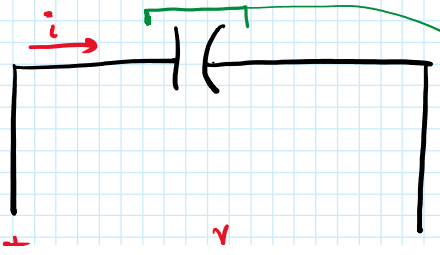
Voltage is proportional to integral of current

$V \propto \int I \, dt$

$$V = \frac{1}{C} \int_{t_0}^{t} I \cdot dt$$

$$I = C \frac{dv}{dt}$$

∫ Doubt



→ polarized capacitor: has +ve and -ve

VOLTAGE - CURRENT RELATION IN INDUCTOR

Voltage is proportional to the differential of the current in inductor

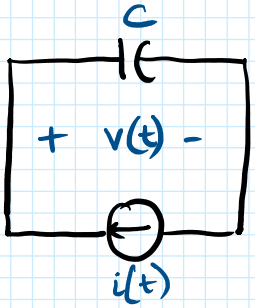
$$V \propto \frac{dI}{dt}$$

$$V = L\frac{dI}{dt}$$

$$I_L = \frac{1}{L}\int_{t_0}^{t} V_L\,dt$$

PROBLEMS

① The input to the circuit shown in figure ① is the current $i(t) = 3.75e^{-1.2t}$ A for $t > 0$.
The output is the capacitor voltage $v(t) = 4 - 12.5e^{-1.2t}$ V for $t > 0$.
Find capacitance C.



Soln. $v(t) = \frac{1}{C}\int_{t_0}^{t} i(t)\,dt$

$$4 - 12.5e^{-1.2t} = \frac{1}{C}\int_0^t 3.75e^{-1.2t}\,dt$$

$$4 - 12.5e^{-1.2t} = \frac{3.75}{C}\left[\frac{e^{-1.2t}}{-1.2}\right]_0^t$$

$$= \frac{3.75}{-1.2C}\left[e^{-1.2t} - 1\right]$$

$$= \frac{-3.125}{C}\left[e^{-1.2t} - 1\right]$$

$$4 - 12.5e^{-1.2t} = \frac{-3.125e^{-1.2t}}{C} + \frac{3.125}{C}$$

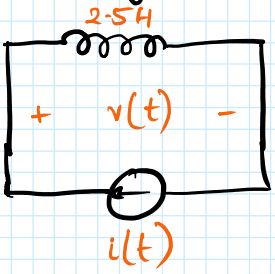
equating coefficients

equating coefficients

$$12.5 = \frac{3.125}{C}$$

$$\Rightarrow C = \frac{3.125}{12.5} = 0.25\ F$$

② Input to given circuit is $i(t) = 3 - 4.5e^{-6t}\ A$ for $t > 0$.
Determine the inductor voltage $v(t)$ for $t > 0$



Soln: $v(t) = L\frac{dI}{dt}$

$$v(t) = (2.5)\frac{d}{dt}(3 - 4.5e^{-6t})$$

$$= (2.5)((-4.5)(-6)e^{-6t})$$

$$v(t) = 67.5e^{-6t}$$

Say for $t = 1$,

$v(t) = 0.167\ V$