# 1. Basic circuit elements: Resistor, Inductor, Capacitor

**Resistor**: A material that opposes the flow of current

   SI unit: ohms ($\Omega$)

   Symbol:  ———ʌʌʌ———
                  R

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

   SI unit: Henry (H)

   Symbol: ——ooo——
                  L

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

   SI unit: Farad (F)

   Symbol: ———| |———
                    C

## 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 stores 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**
  - 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
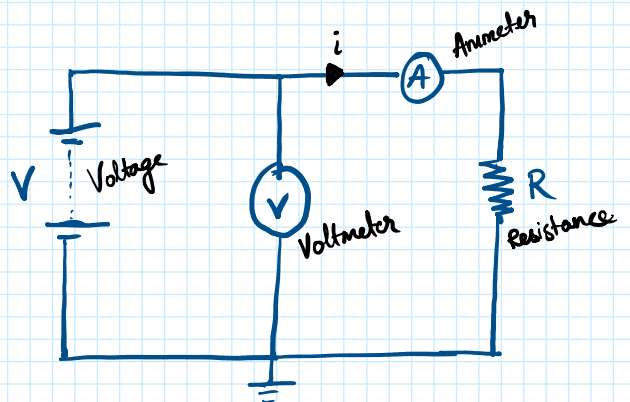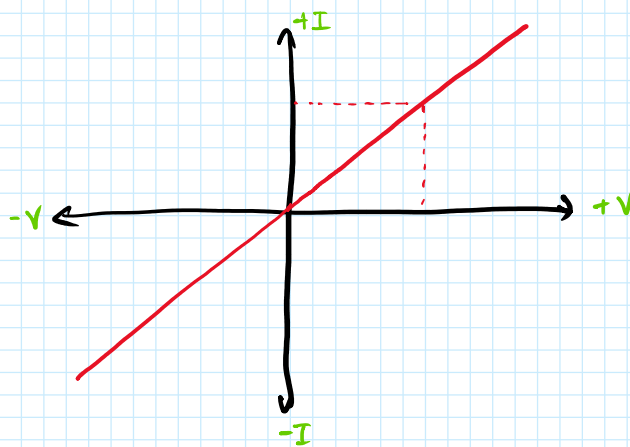
transformer          battery

## OHM'S LAW

$$V \propto I$$

$$\boxed{V = IR}$$

→ resistance: proportionality constant





Anmeter

$i$

R
Resistance
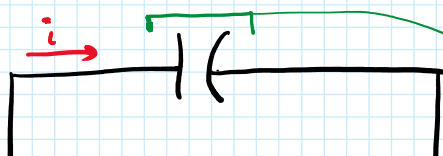
V    Voltage

Voltmeter

## VOLTAGE-CURRENT RELATION IN CAPACITOR

Voltage is proportional to integral of current

$$V \propto \int I \, dt$$

$$\boxed{V = \frac{1}{C} \int_{t_0}^{t_1} I \cdot dt}$$

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

Doubt

$i$

→ polarized capacitor: has +ve and -ve
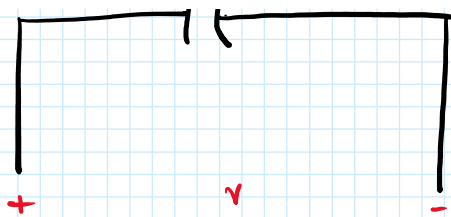
→ polarized capacitor: has +ve and -ve

$+$  $v$  $-$

## VOLTAGE - CURRENT RELATION IN INDUCTOR

Voltage is proportional to the differential of the current in inductor
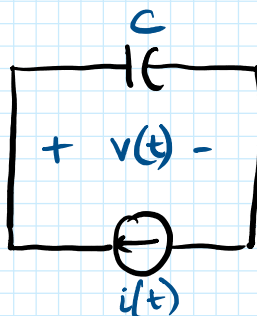
$$V \propto \frac{dI}{dt}$$

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

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

## PROBLEMS

① The input to the circuit shown in figure ① is the current $i(t) = 3.75 e^{-1.2t} A$ for $t > 0$.

The output is the capacitor voltage $v(t) = 4 - 12.5 e^{-1.2t}$ V for $t > 0$.

Find capacitance C.

$C$

$+ \; v(t) \; -$

$i(t)$

soln: $v(t) = \frac{1}{C} \int_{t_0}^{t_p} i(t) \, dt$

$$4 - 12.5 e^{-1.2t} = \frac{1}{C} \int_{0}^{t} 3.75 e^{-1.2t} \, dt$$

$$4 - 12.5 e^{-1.2t} = \frac{3.75}{C} \left[ \frac{e^{-1.2t}}{-1.2} \right]_{0}^{t}$$

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

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

$$4 - 12.5 e^{+.2t} = -3.125 e^{-1.2t} + 3.125$$
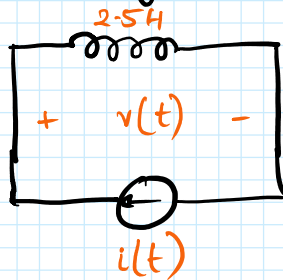
$$4 - 12.5 e^{+1.2t} = \underbrace{\frac{-3.125 e^{-1.2t}}{C}} + \frac{3.125}{C}$$

<span style="color:green">equating coefficients</span>

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

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

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

2.5 H

+  v(t)  −

i(t)

<u>Soln:</u>  $v(t) = L \frac{dI}{dt}$

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

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

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

Say for $t = 1$,

$$v(t) = 0.167 \text{ V}$$