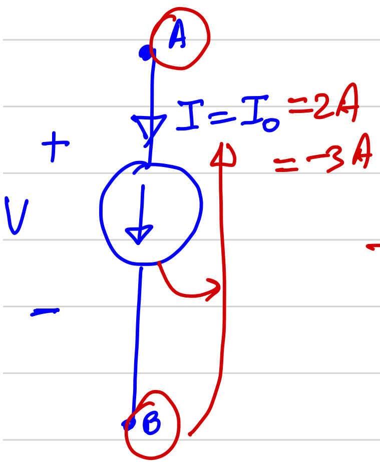
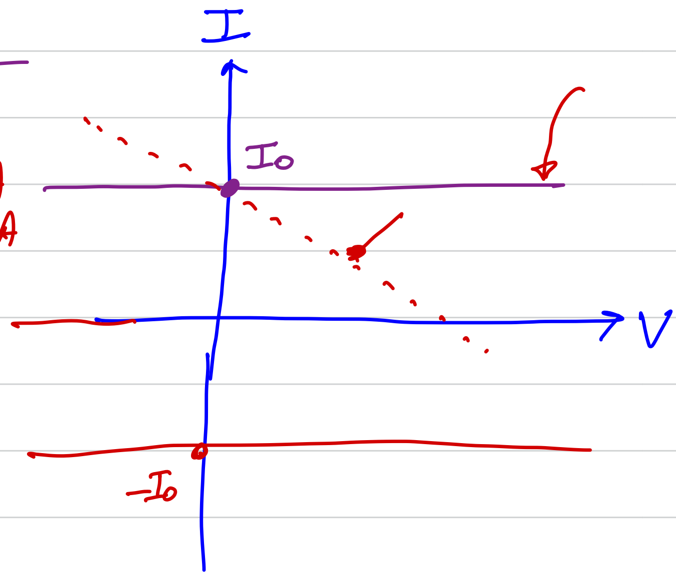
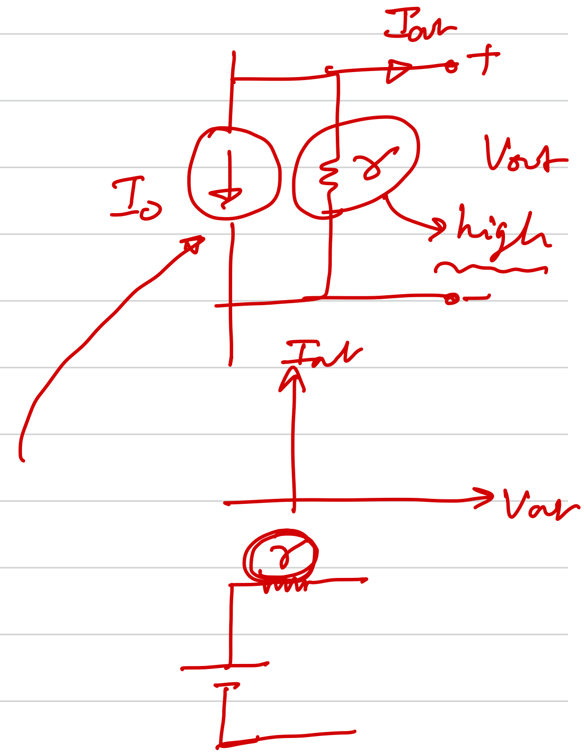
# Lecture 3

## (2) Current Sources

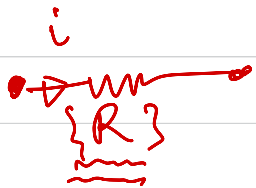


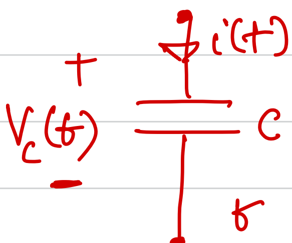
# Passive Component

- Resistors → R
- Capacitor → C
- Inductors → L
- Transformer




$$\boxed{V = iR}$$

2. Capacitors

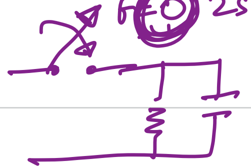


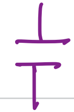

$$\left[\, i(t) = C\,\frac{dV_c(t)}{dt} \,\right] \rightarrow 0 \quad 2s \quad 4s$$

$$\int_{V_c(-\infty)}^{V_c(t)} dV_c(t) = \frac{1}{C}\int_{-\infty}^{t} i(t)\,dt = \frac{1}{C}\left[\int_{-\infty}^{t_0} i(t)\,dt + \int_{t_0}^{t} i(t)\,dt\right]$$

$t_0$

$t = 0,\ 2s,\ 4s$





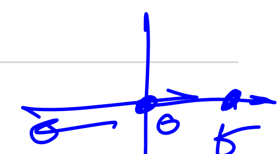
"0"

$$V_c(t) - V_c(-\infty) = \frac{1}{C}\left[\int_{-\infty}^{t_0} i(t)\,dt\right] + \frac{1}{C}\left[\int_{t_0}^{t} i(t)\,dt\right]$$

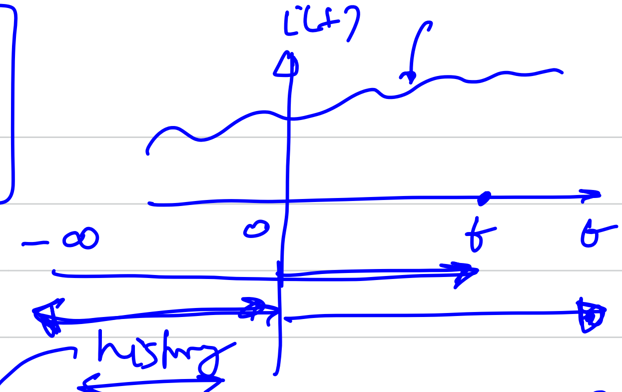
$$V_c(t) = \frac{1}{C}\int_{-\infty}^{t_0} i(t)\,dt + \left\{\frac{1}{C}\int_{t_0}^{t} i(t)\,dt.\right\}$$

past history

$t_0 = 0\,s.$



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




$$V_C(t) = V_c(t_0) + \frac{1}{C}\int_{t_0}^{t} i(t)\,dt.$$

{initial conditions of the cap:}

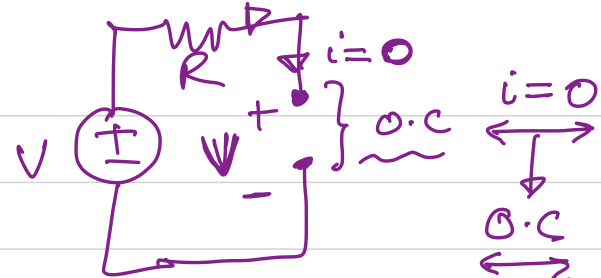
memory, I.C

V = constant = dc

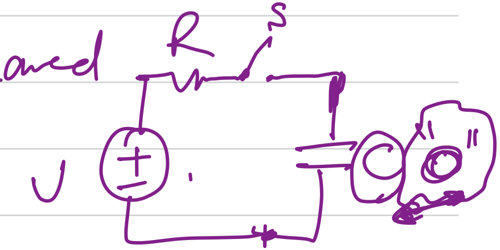
① Voltage across the cap: is constant. then no current flows through this capacitor.

$$i_c = C\frac{dV_c}{dt} = 0$$

$i_c = 0 \longrightarrow$ open circuit (O.C)




② Sudden change in voltage is ~~prohibit~~ $\boxed{\text{not}}$ allowed




$$V_C(t=0^-) = V_c(t=0^+) \qquad V_C(t_0^+) = V_c(t_0^-)$$

$$V_C(t_0^-) = V_C(t_0^+) \qquad V_C(0^+) = V_C(0^-)$$

t = 0

$t_0 = 0, 1, 2, 3 -$

$0 - 0^- \quad 10^{-24}$

$0^+ - 0 = 10^{-24}$

$0 - 0^-$

$0^- \quad 0^+$

t

0

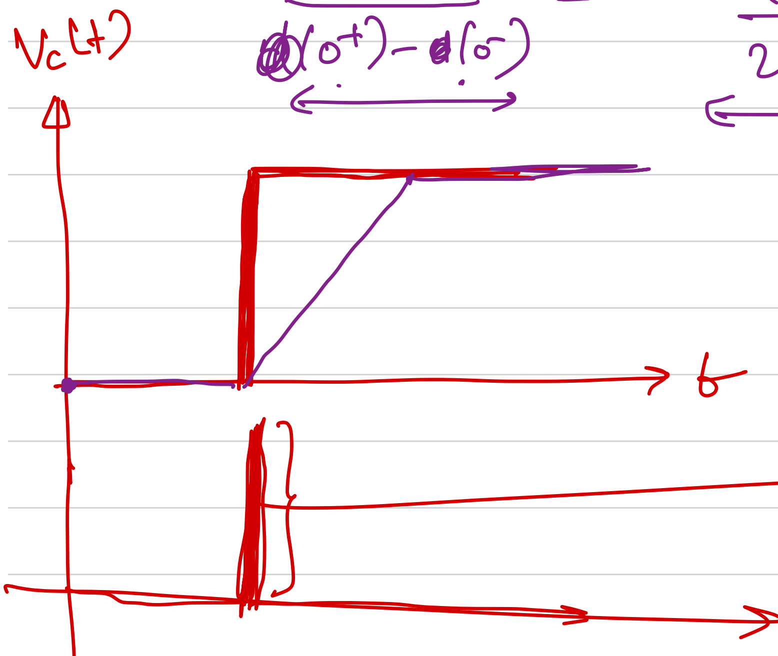
$$i_c = C\frac{dV_c}{dt}$$

$V_c \to 2 \to 3V$

$0^- \to 0^+ \Rightarrow 0^- \to 0 \to 0^+$

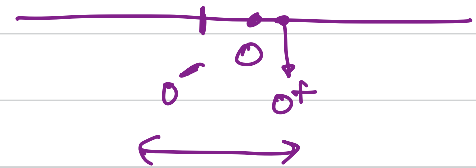
$10^{-24} \quad 10^{-24} = 2\times10^{-24}$

$$= C\frac{(3-2)}{t(0^+)-t(0^-)} = \frac{C(3-2)}{2\times10^{-24}} \to 10^{24} \to \text{"}\infty\text{"}$$




impulse

$$i_c(t) = C\,\frac{dV_c(t)}{dt}$$




$$dV_c(t) =$$

$$V_c(t) = \frac{1}{C}\int_{-\infty}^{t} i_c(t)\,dt$$

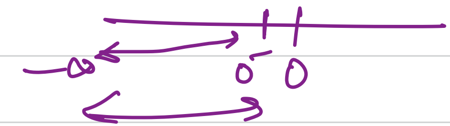
$$V_c(t=0^+) = \frac{1}{C}\int_{-\infty}^{0^+} i_c(t)\,dt = \frac{1}{C}\left[\int_{-\infty}^{0^-} i_c(t)\,dt + \int_{0^-}^{0^+} i_c(t)\,dt\right]$$

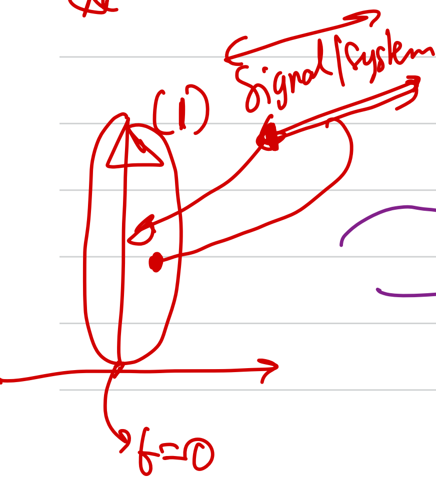
$$V_c(t=0^+) = \frac{1}{C}\int_{-\infty}^{0^-} i_c(t)\,dt + \left\{ \frac{1}{C}\int_{0^-}^{0^+} i_c(t)\,dt \right\}$$

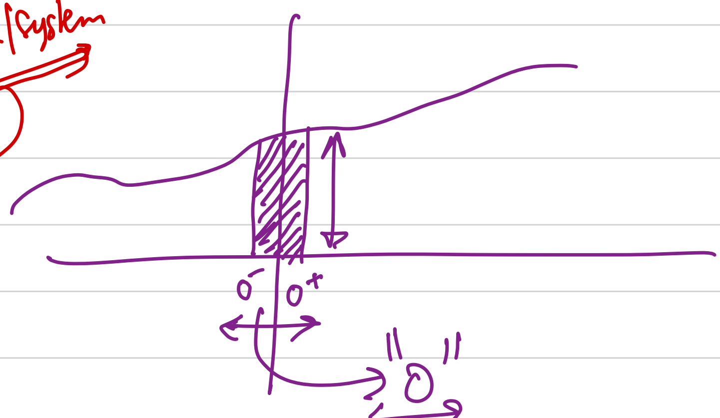
"0"

$\frac{1}{C}$

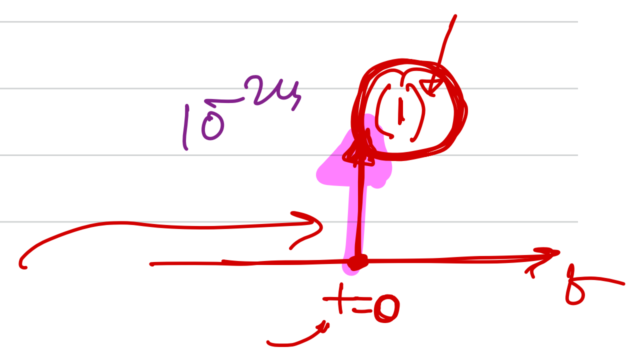
$$V_c(t=0^+) = V_c(t=0^-) + 0$$




impulse



# Inductor

$$V_L(t) = L\,\frac{di(t)}{dt}$$

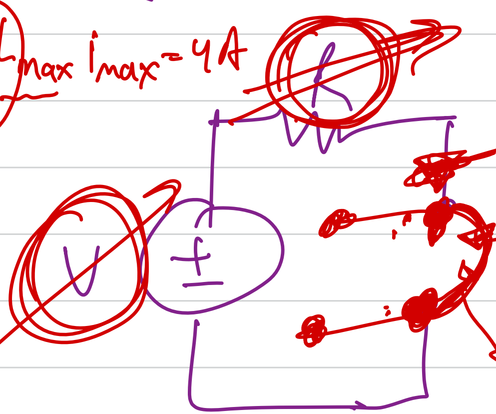
$$i(t) = \left(\frac{1}{L}\int_{t_0}^{t} v(t)\,dt\right) + i(t_0)$$

$$\frac{1}{L}\int_{-\infty}^{t_0} v(t)\,dt$$

(*) Current through the inductor is constant — voltage diff = 0

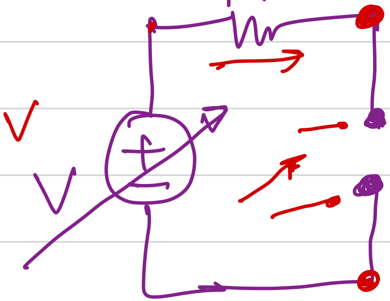
$$V_L(t) = L\frac{di}{dt} = 0 \rightarrow S.C$$

$L_{max}$ $i_{max} = 4A$



$V/R = i$

$2V$ $1V$



$R$ — $V_R = 0$

$1V, 2V$

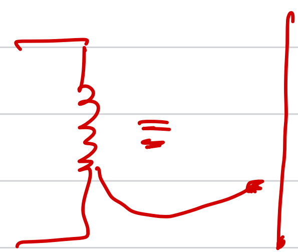
"$i = 0$"

$V$ = anything

S.C → $i$ = anything

$V = 0$

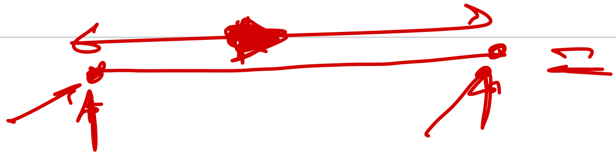
wire



(*) $i$ = constant

dC

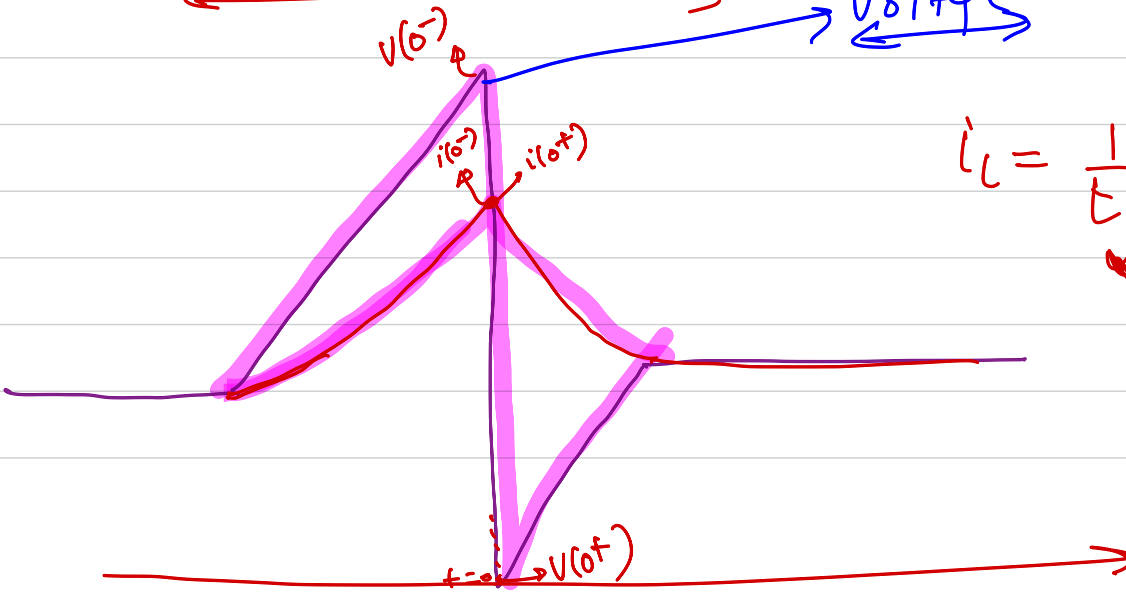
(*)



= 0V

(*) Sudden change in current req: (∞) voltage

$$i_L(t_0^-) = i_L(t_0^+)$$ avoids discont.




$$i_L = \frac{1}{L}\int v(t)\,dt$$

smoothing operator