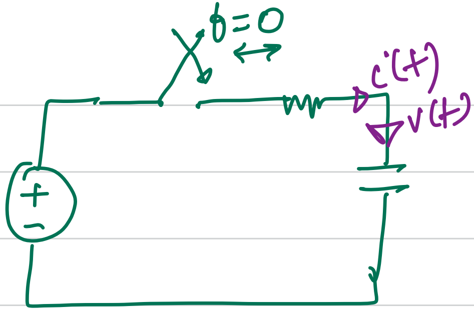
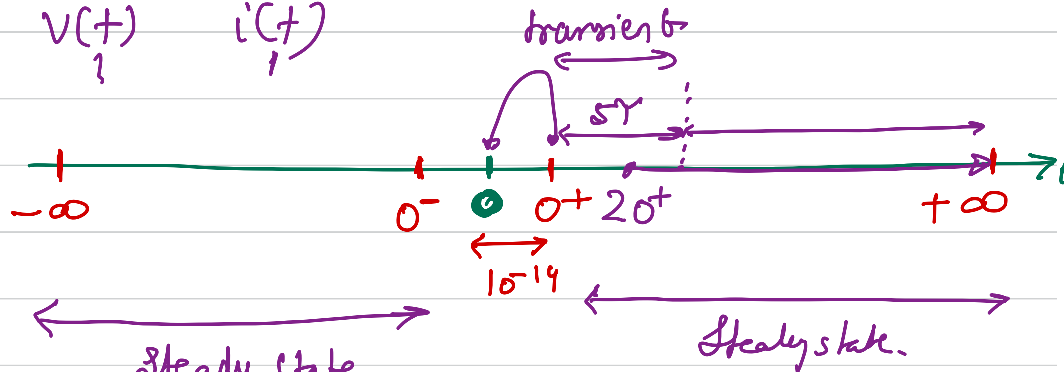
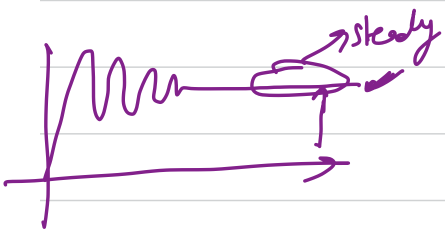


diff: eq:

v(t)   i(t)





{boundary values}

$v(0-)$ $v(0+)$ $v(-\infty)$ $v(+\infty)$

$i(0-)$ $i(0+)$ $i(-\infty)$ $i(+\infty)$

"C"

Constants which are appearing when we solve diff: equation

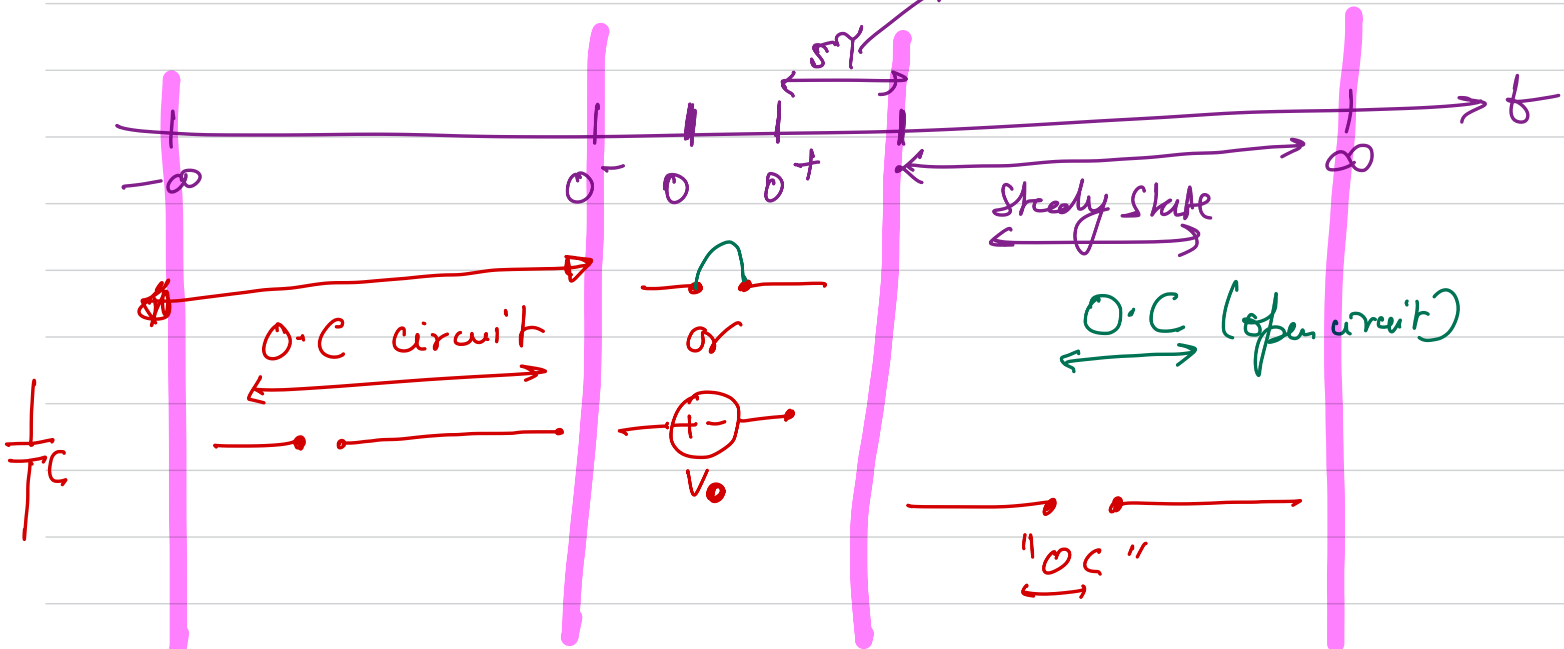
Capacitor

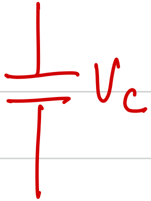
$i(t) = C \frac{dv(t)}{dt}$

$v(t)$

$i(t) = 0$

τ time constant





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

$$\{V_c(0+) = V_c(0-) = 0V\}$$

$$V_c(0-) = 0V$$

$$V_c(0+) = \text{"}V_1\text{"}$$

$$V_c(0-) = V_1$$

$$V_L = L\frac{di}{dt} = \text{"}0\text{"}$$

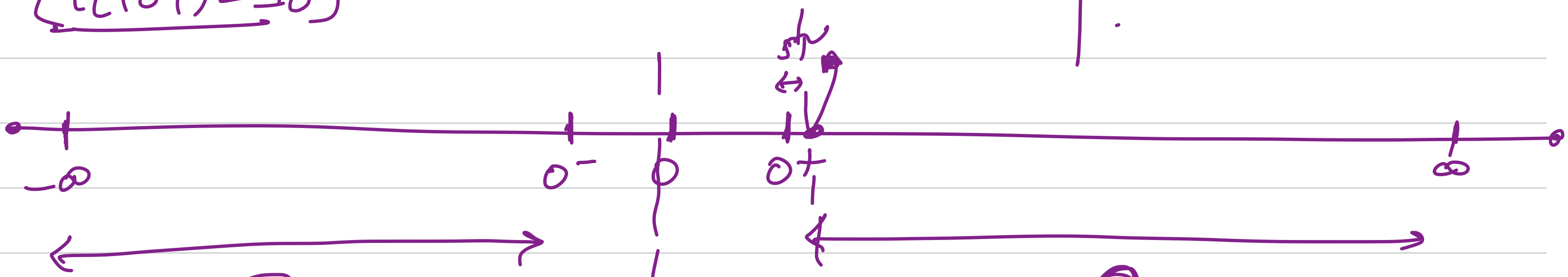
$$i_L(0+) = i_L(0-)$$

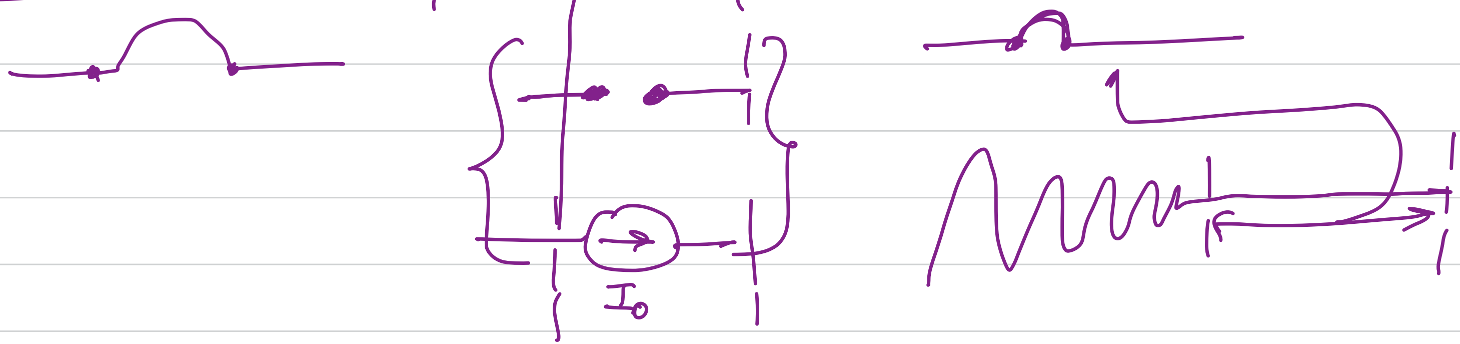
$$i_L(0-) = 0\,A$$

$$i_L(0+) = 0\,Amp$$

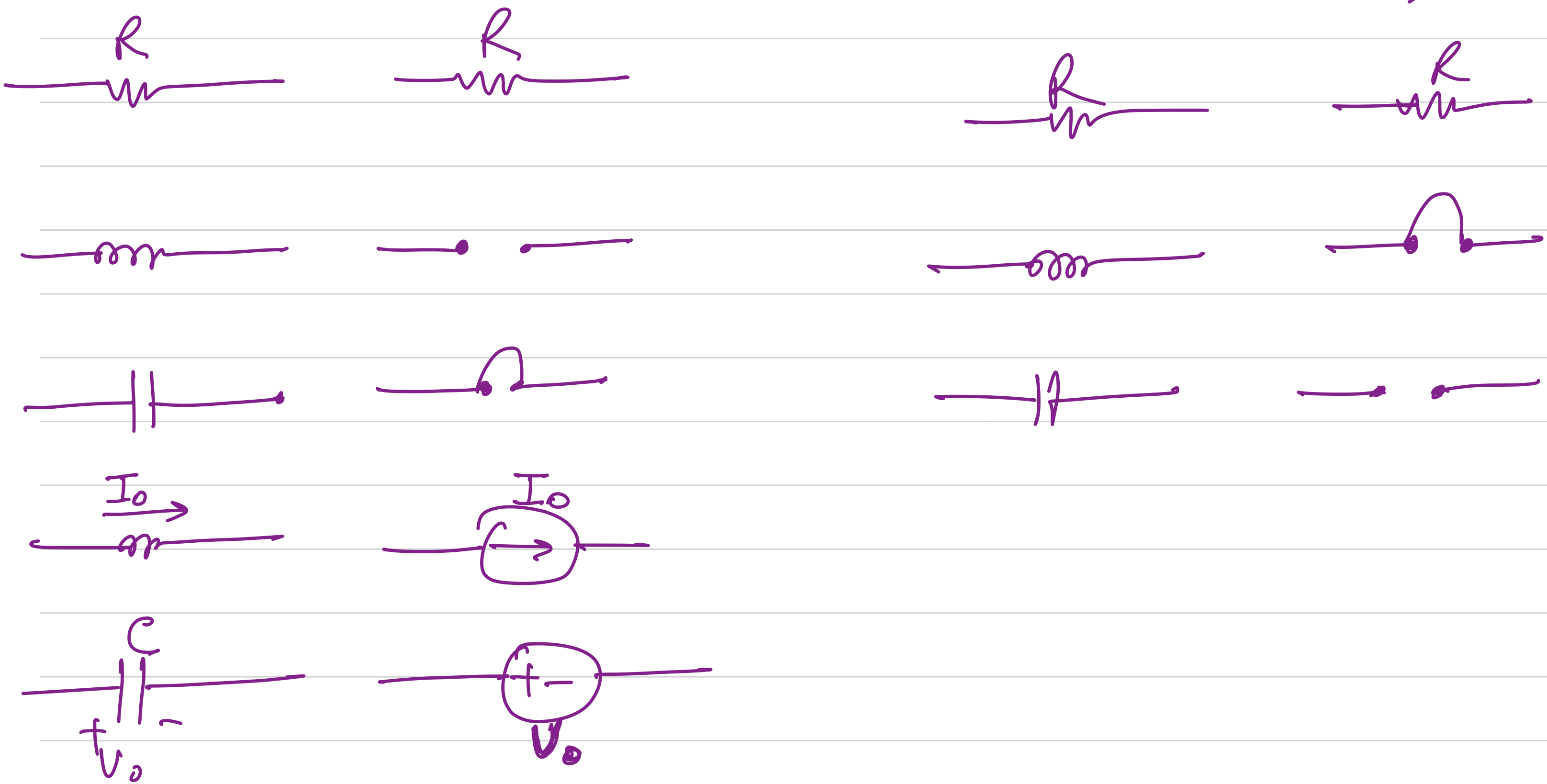
$$i_L(0-) = I_0$$

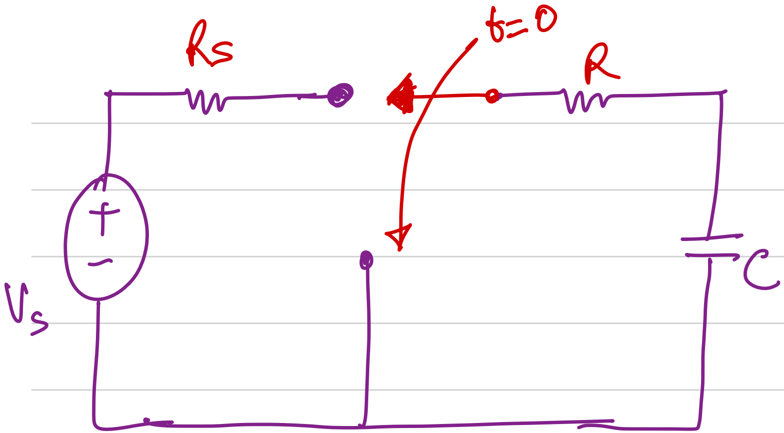
$$\{i_L(0+) = I_0\}$$



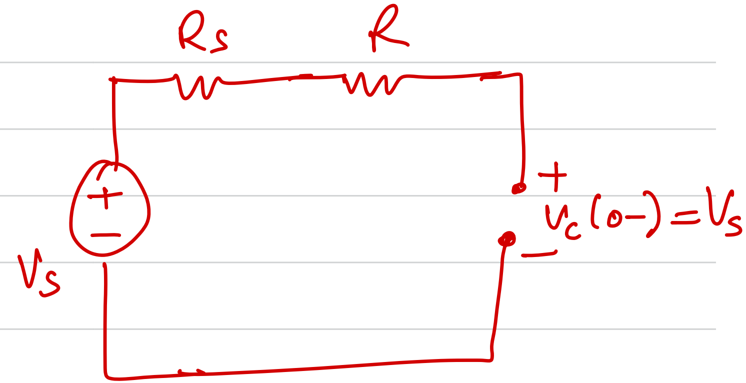


Element | $t = 0^-$ | Eq: circuit $(0 \to 5\tau)$ | $(t = \infty)$

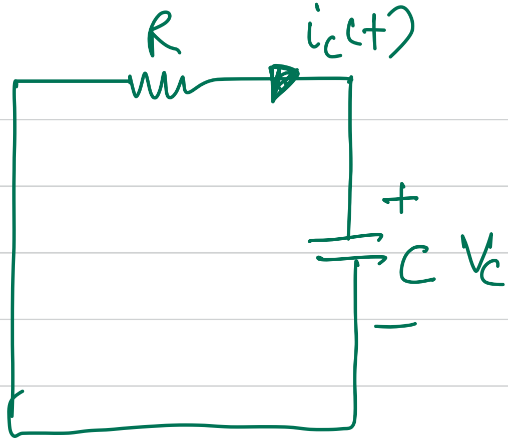




$(-\infty \text{ to } 0^-)$ Steady state



$$V_c(0-) = V_c(0+) = \text{"}V_s\text{"} \quad \text{———} \; (1)$$



$t=0 \rightarrow$

$$-V_c - i_c R = 0$$

$$V_c + i_c R = 0$$

$$V_c(t) + RC\frac{dV_c(t)}{dt} = 0$$

$$\left\{ \frac{dv_c(t)}{dt} + \frac{1}{RC} v_c(t) = 0 \right\}$$

$a = \left(\frac{1}{RC}\right)$

Source free first order diff. eq:

$$\frac{d v_c(t)}{dt} + a\, v_c(t) = 0$$

$t \to t'$ $\quad (e^{at'})$

$$\frac{d}{dt'} v_c(t') + a v_c(t') = 0$$

$$\frac{d v_c(t')}{dt'} e^{at'} + a\, v_c(t') e^{at'} = 0$$

$$\Rightarrow \frac{d}{dt'}\left(v_c(t) e^{at'}\right) = 0 \qquad \int_0^t \frac{d}{dt'}\left(v_c(t) e^{at'}\right) dt' = 0$$

$$v_c(t) e^{at'} \Big|_0^t = 0 \Rightarrow v_c(t) e^{at} - v_c(0) = 0$$

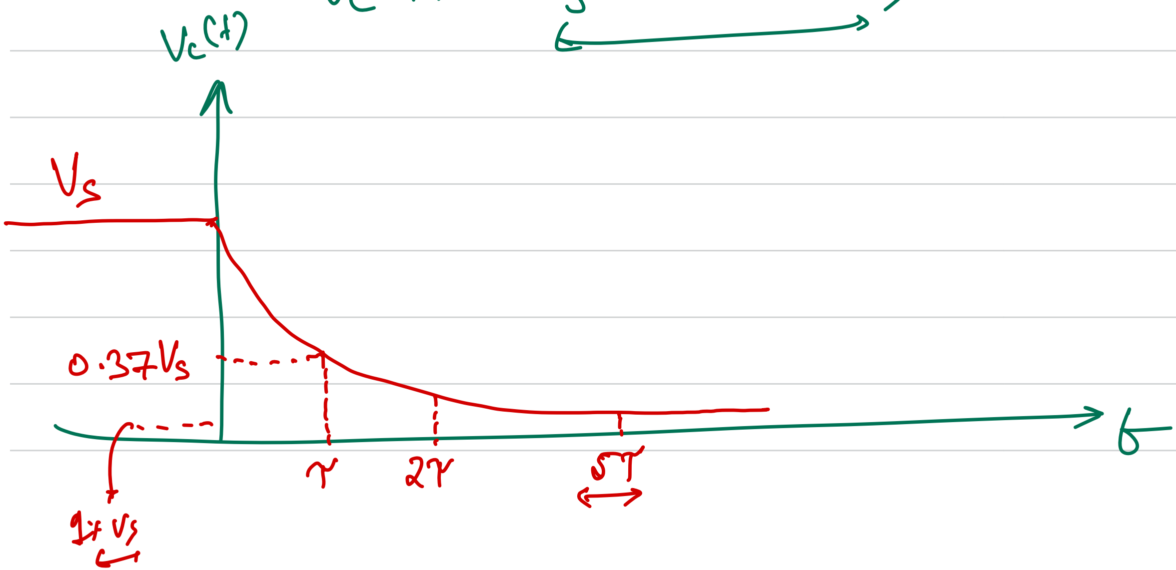
$$v_c(t) = v_c(0) e^{-at} = \left(V_s e^{-at}\right)$$

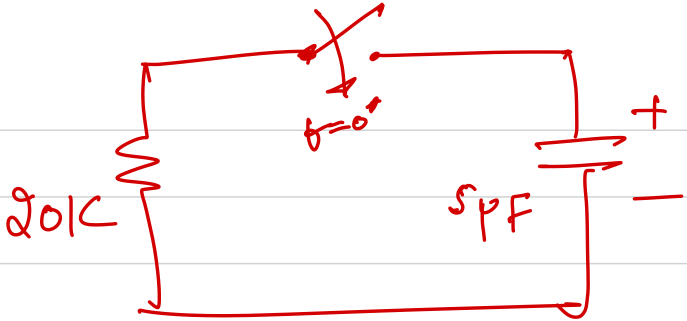
$$V_c(t) = V_s e^{-at} = V_s e^{-t/RC}$$

$$\tau = RC$$

$$V_c(t) = V_s e^{-t/\tau} \qquad t > 0$$

$$V_c(t) = V_s e^{-t/\tau} u(t)$$



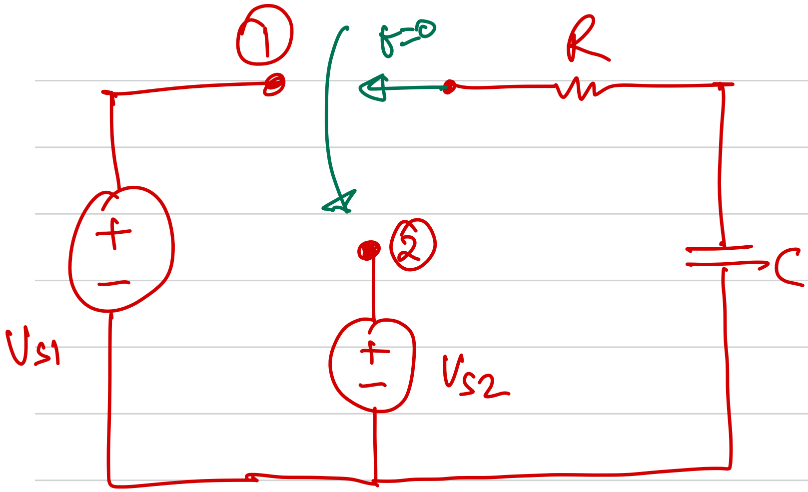


$V_c(0^-) = 24\ V$

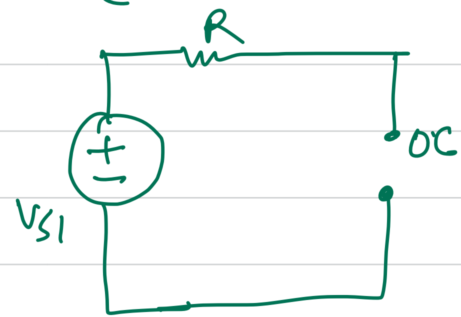
$V_c(0^+) = 24$

$V_c(t) = 24e^{-10t} \quad t > 0$

$\tau = RC$



$t = -\infty$ to 0^-

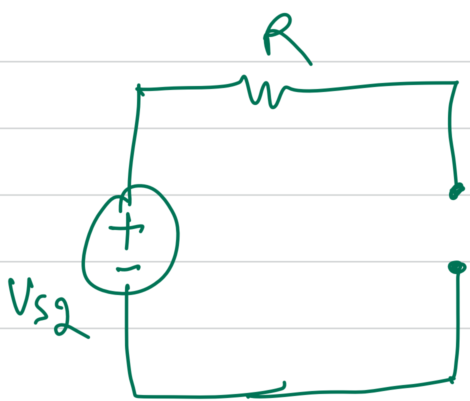


$V_C(0-) = V_{s1}$

$V_C(0-) = V_C(0+) = V_{s1}$

"0"

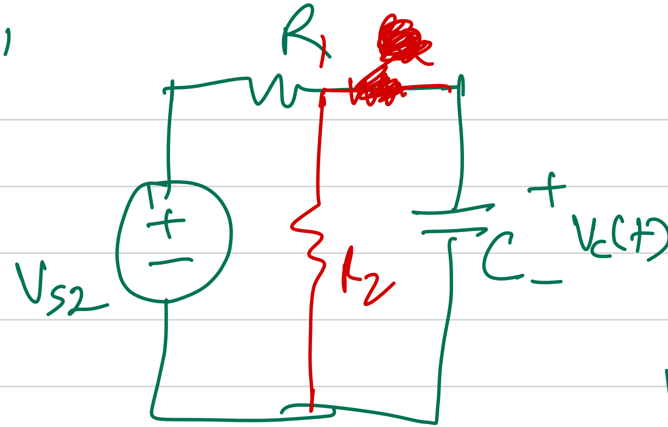
$t = \infty$



$V_C(\infty) = \text{"}V_{s2}\text{"}$

$\tau = RC$

"$t=0$"



$$V_{s2} - iR - V_c(t) = 0$$

$$V_{s2} - \frac{C\,dV_c(t)}{dt} \cdot R - V_c(t) = 0$$

$$V_{s2} = RC\frac{dV_c(t)}{dt} + V_c(t)$$

$$RC\frac{dV_c(t)}{dt} + V_c(t) = V_{s2}$$

forcing function

$$\frac{dV_c(t)}{dt} + \frac{1}{RC}V_c(t) = \frac{V_{s2}}{RC}$$

"$a = \frac{1}{RC}$ $\quad b = \frac{V_{s2}}{RC}$"

$$\frac{dV_c(t)}{dt} + aV_c(t) = b$$

$$\frac{d}{dt'} v_c(t')\, e^{at'} + a v_c(t') e^{at'} = b e^{at'}$$

$$\frac{d}{dt'} \left\{ v_c(t') e^{at'} \right\} = b e^{at'}$$

$$\int_0^t \frac{d}{dt'} \left\{ v_c(t') e^{at'} \right\} dt' = \int_0^t b e^{at'} dt'$$

$$v_c(t') e^{at'} \Big|_0^t = \frac{b}{a} e^{at'} \Big|_0^t = \frac{b}{a} e^{at} - \frac{b}{a}$$

$$v_c(t) e^{at} - v_c(0) = \frac{b}{a} e^{at} - \frac{b}{a}$$

$$V_c(t) = V_c(0)\,e^{-at} + \frac{b}{a}\left(1 - e^{-at}\right)$$

$$V_c(\infty) = V_c(0)\,e^{-a\infty} + \frac{b}{a}\left(1 - e^{-a\infty}\right) = \frac{b}{a} = V_{s2}$$

$$V_c(t) = V_c(0)\,e^{-at} + V_{s2}\left(1 - e^{-at}\right)$$

"RC" "$\frac{}{}$L" ... "L"

$$V_c(t) = V_c(0)\,e^{-at} + V_c(\infty)\left(1 - e^{-at}\right)$$

$$\boxed{V_c(t) = V_c(\infty) + \left(V_c(0) - V_c(\infty)\right) e^{-at}}$$

$$\tau = RC$$

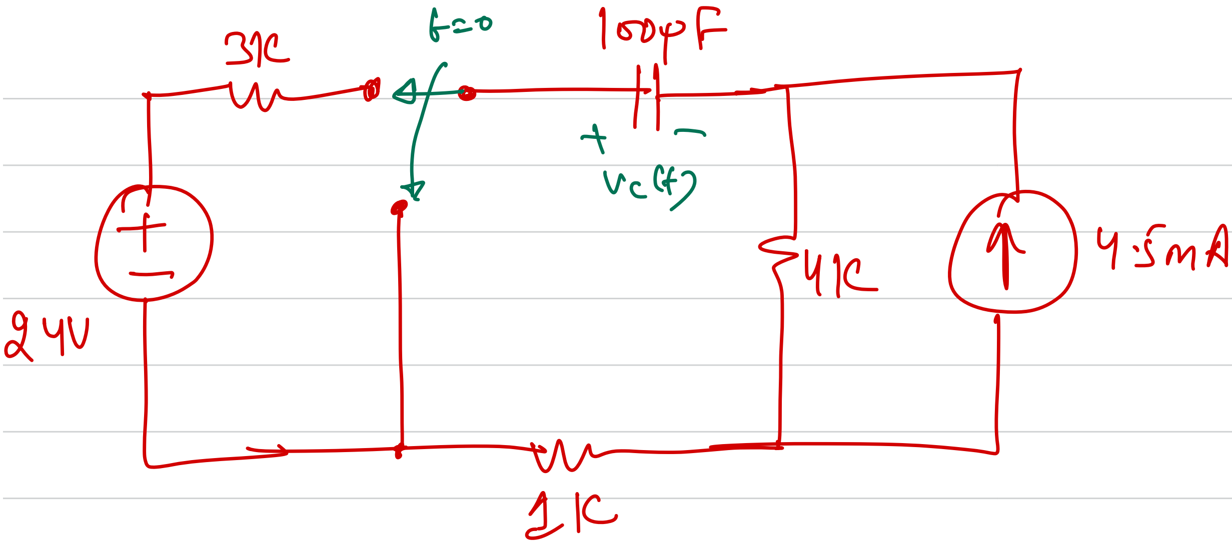
$$V_c(t) = V_c(\infty) + \left(V_c(0) - V_c(\infty)\right) e^{-t/\tau}$$

R_{th} across "C"

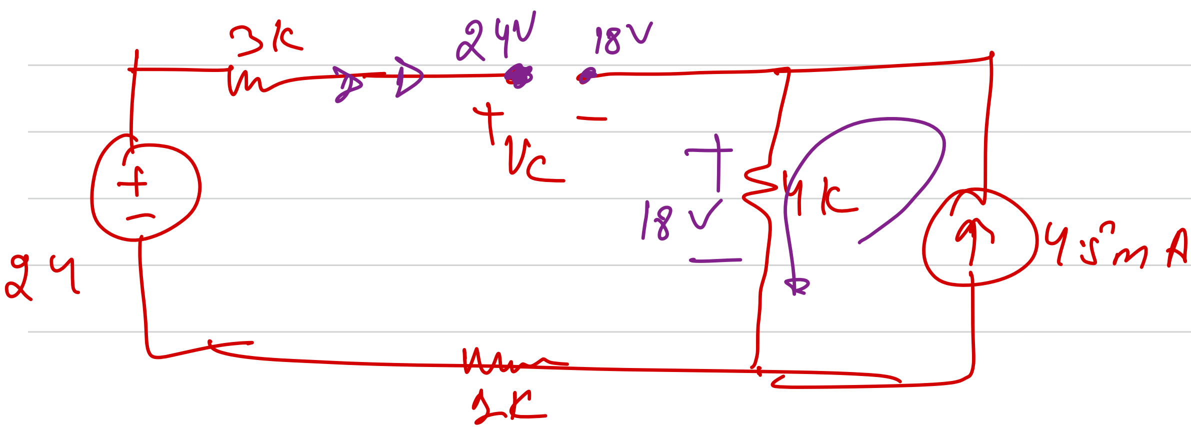
$V_C(\infty)$ $V_C(0)$ τ

$e^{-t/(R_1+R_2)C}$

$e^{-t/(R_1 \| R_2)C}$



$V_c(t)$

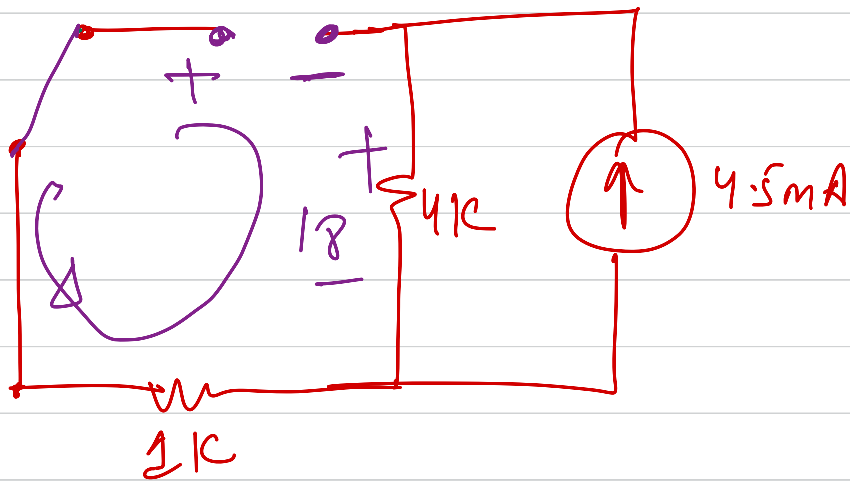


$V_c(0-) = 6V$

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

$v_c(0+) = 6V$

$$V_C(\infty) = -18\,V$$



$$V_C(t) = V_C(\infty) + (V_C(0) - V_C(\infty))\, e^{-t/\tau}$$

$$= -18 + (6 + 18)\, e^{-t/\tau}$$

$$= -18 + 24e^{-t/\tau}$$

$\tau = RC$

("5k")

$$V(t) = \left(-18 + 24e^{-2t}\right) \quad t > 0$$

$\tau = 5k \times C$

"1.8"

$$V(t) = \left(-18 + 24e^{-2t}\right)u(t)$$

$-\infty$ t ∞