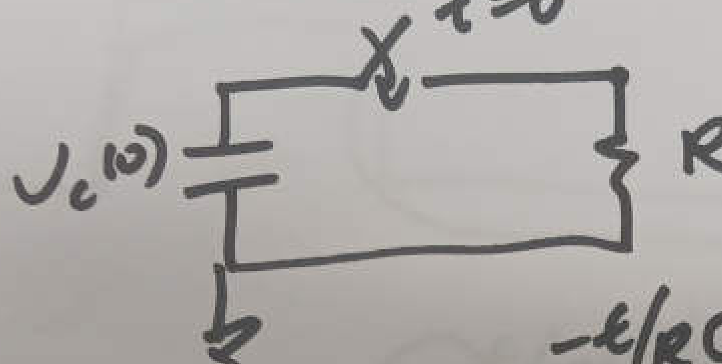
①

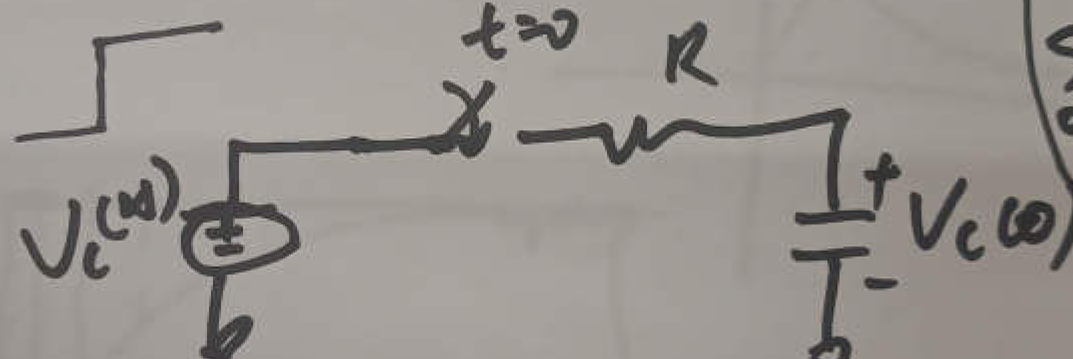
$I_c(t) = C\frac{dV(t)}{dt}$



$\boxed{\text{Natural Response}}$

$V_c(t) = V_c(0)e^{-t/RC}$ → time constant

②

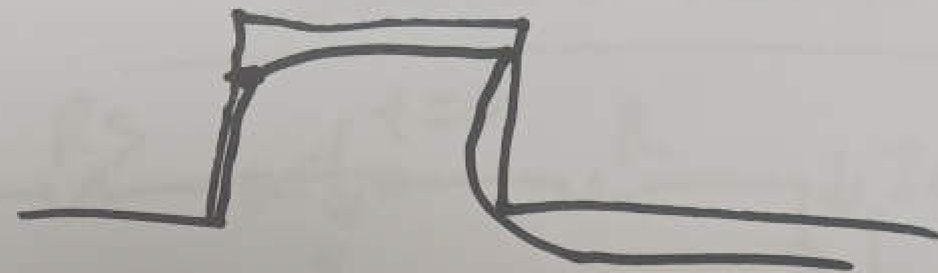


$\boxed{\text{Step Response or Forced Response}}$

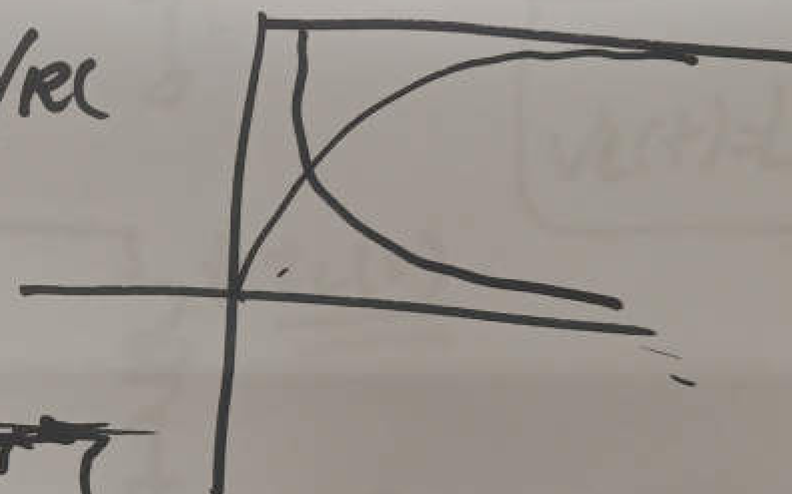
$$V_c(t) = V_c(\infty) + (V_c(0) - V_c(\infty))e^{-t/RC}$$

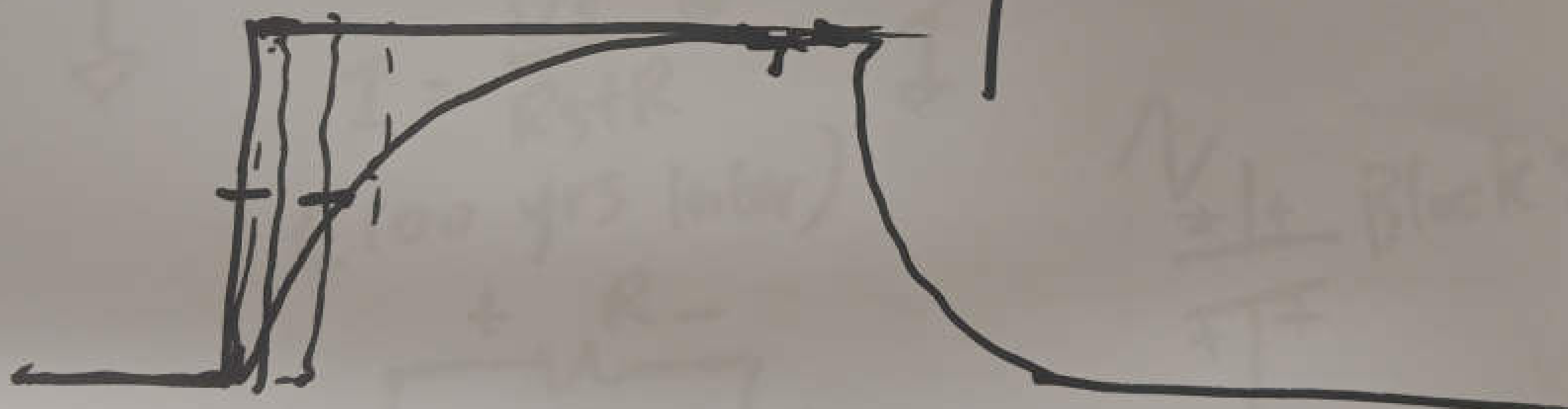
③ $V_c(0) = 0$, $V_c(t) = V_c(\infty) - V_c(\infty)e^{-t/RC}$

$$= V_c(\infty)(1 - e^{-t/RC})$$

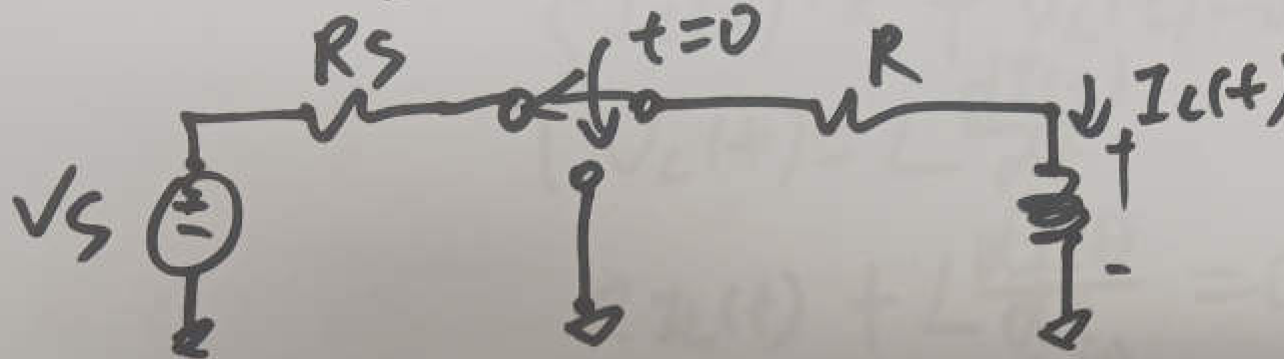


$e^{-t/RC}$





Inductors Natural Response



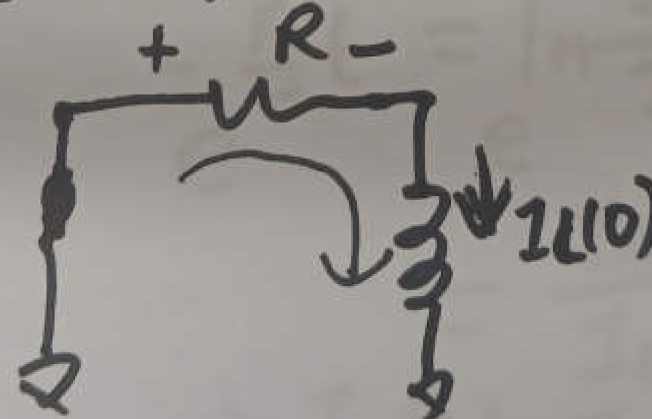
$$\boxed{V_L(t) = L\frac{di(t)}{dt}}$$

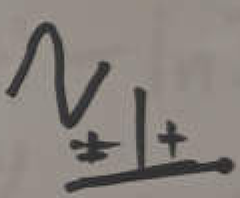
0^- :

$$I = \frac{V_s}{R_s + R}$$

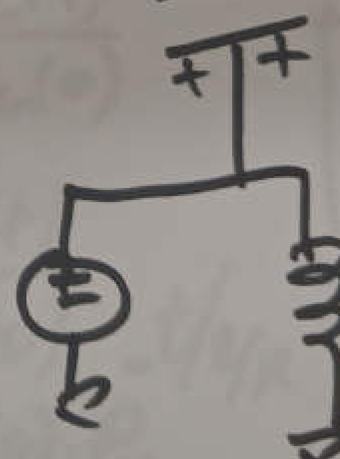
(100 yrs later)

0^+ :





Blocks DC.



Block AC

KVL:

$$\begin{cases} I_L(t)\cdot R + V_L(t) = 0 \\ V_L(t) = L\dfrac{dI(t)}{dt} \end{cases}$$

$$R I_L(t) + L\frac{dI(t)}{dt} = 0$$

$$\int_0^t -\frac{R}{L}\,dt = \int_{I_L(0)}^{I_L(t)} \frac{1}{I_L(t)}\,dI(t)$$

$$-\frac{R}{L}t = \ln I_L(t) - \ln I_L(0)$$

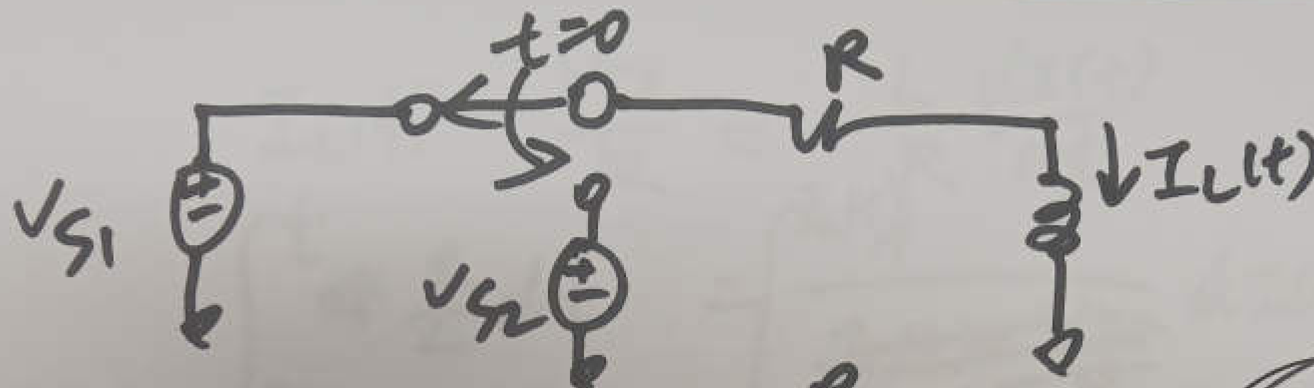
$$-\frac{R}{L}t = \ln\frac{I_L(t)}{I_L(0)}$$

$$e^{-\frac{R}{L}t} = e^{\ln\frac{I_L(t)}{I_L(0)}}$$

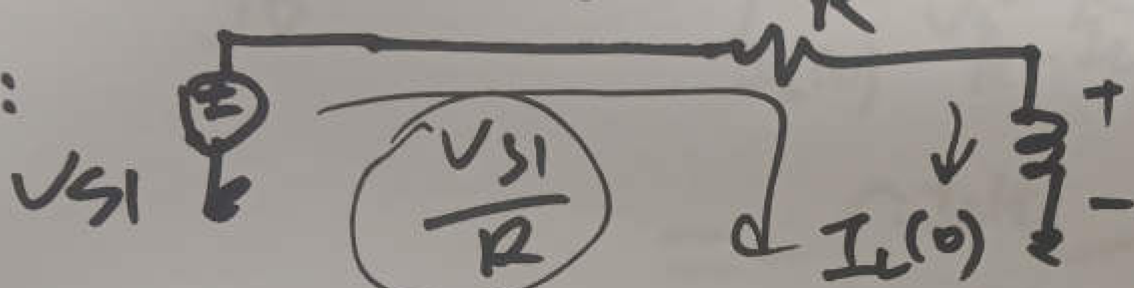
$$= \frac{I_L(t)}{I_L(0)}$$

$$\boxed{\tau = \frac{L}{R}}$$

$$\Rightarrow I_L(t) = I_L(0)\cdot e^{-t/_{L/R}}$$

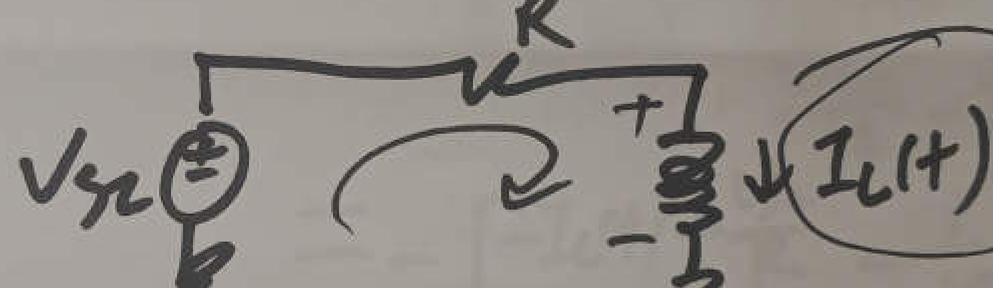


0^- :



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

0^+ :



$$-V_{S2} + I_L(t)\cdot R + L\frac{dI(t)}{dt} = 0$$

$$-\frac{V_{S2}}{R} + I_L(t) + \frac{L}{R}\frac{dI(t)}{dt} = 0$$

$$I_L(t) - \frac{V_{S2}}{R} = -\frac{L}{R}\frac{dI(t)}{dt}$$

$$\int_0^t \frac{R}{L}\,dt = \int_{I_L(0)}^{I_L(t)} \frac{1}{\cancel{I_L(t) - \frac{V_{S2}}{R}}\ \frac{V_{S2}}{R} - I_L(t)}\, dI(t)$$

$$= -\int_{-I_L(0)}^{-I_L(t)} \frac{1}{\cancel{I_L(t) - \frac{V_{S2}}{R}}\ \frac{V_{S2}}{R} - I_L(t)}\, d(-I(t))$$

$$= -\int_{-I_L(0)+\frac{V_{S2}}{R}}^{-I_L(t)+\frac{V_{S2}}{R}} \frac{1}{\frac{V_{S2}}{R} - I_L(t)}\, d\left(-I(t) + \frac{V_{S2}}{R}\right)$$

$$= -\left(\ln\left(\frac{V_{S2}}{R} - I_L(t)\right) - \ln\left(\frac{V_{S2}}{R} - I_L(0)\right)\right)$$

6

$$e^{-\frac{R}{L}t} = e^{\left(\ln \frac{\frac{V_{S2}}{R} - I_L(t)}{\frac{V_{S2}}{R} - I_L(0)}\right)}$$

$$e^{-\frac{R}{L}t} = \frac{\frac{V_{S2}}{R} - I_L(t)}{\frac{V_{S2}}{R} - I_L(0)}$$

$$\left(\frac{V_{S2}}{R} - I_L(0)\right)e^{-\frac{R}{L}t} = \frac{V_{S2}}{R} - I_L(t)$$

$$I_L(t) = \frac{V_{S2}}{R} - \left(\frac{V_{S2}}{R} - I_L(0)\right)e^{-t/4R}$$

$$\boxed{= I_L(\infty) + \left(I_L(0) - I_L(\infty)\right)e^{-t/4R}}$$

$$\frac{V_{S2}}{R} = I_L(\infty)$$