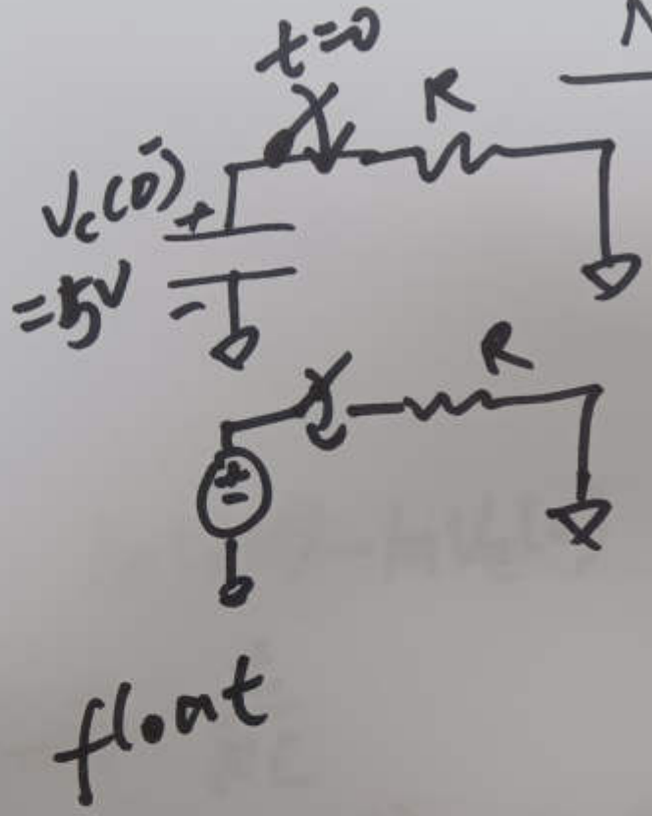
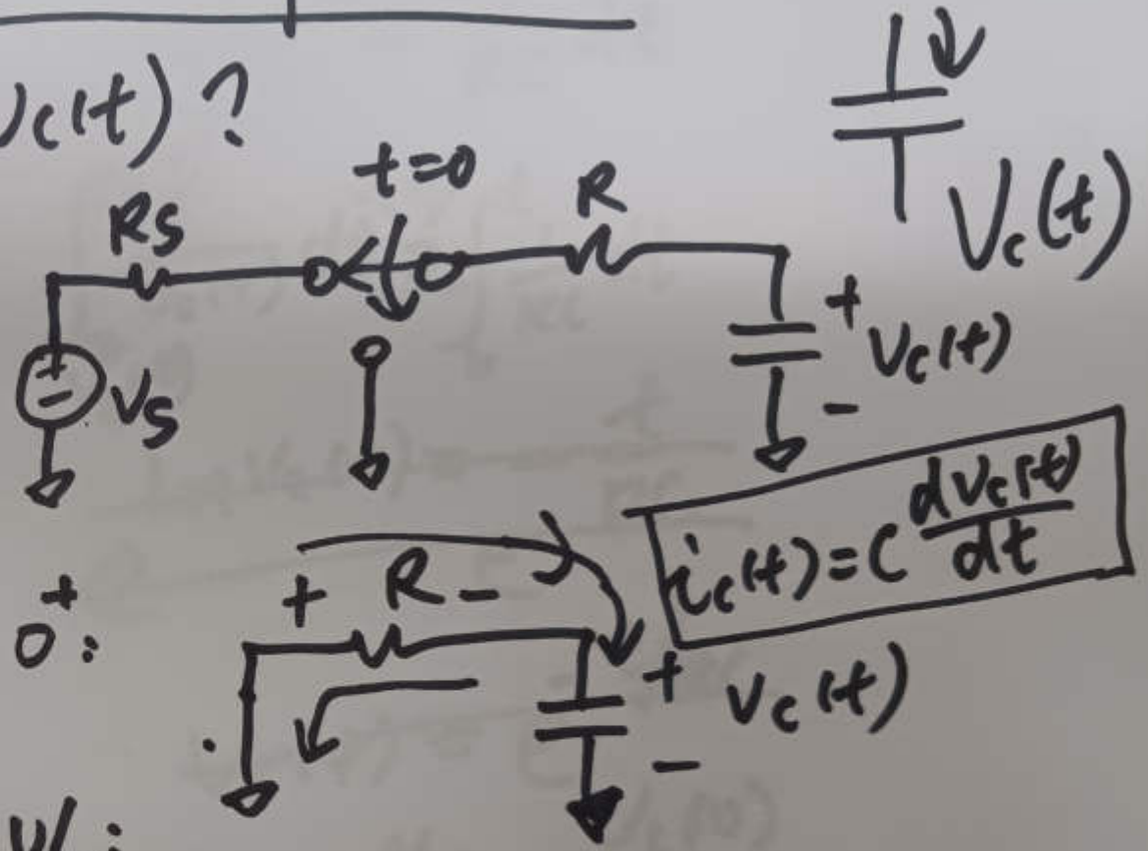
Natural Response



float

$V_c(t)$?



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

KVL:

$$R \cdot i_c(t) + V_c(t) = 0$$

$$R \cdot C\frac{dV_c(t)}{dt} + V_c(t) = 0$$

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

(1)

$$\frac{1}{V_c(t)}\,dV_c(t) = -\frac{1}{RC}\,dt$$

$$\int_{V_c(0)}^{V_c(t)} \frac{1}{V_c(t)}\,dV_c(t) = -\int_0^t \frac{1}{RC}\,dt$$

$$\ln V_c(t) - \ln V_c(0) = -\frac{t}{RC}$$

$$\ln V_c(t) = -\frac{t}{RC}$$

$$e^{\ln \frac{V_c(t)}{V_c(0)}} = e^{\frac{-t}{RC}}$$

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

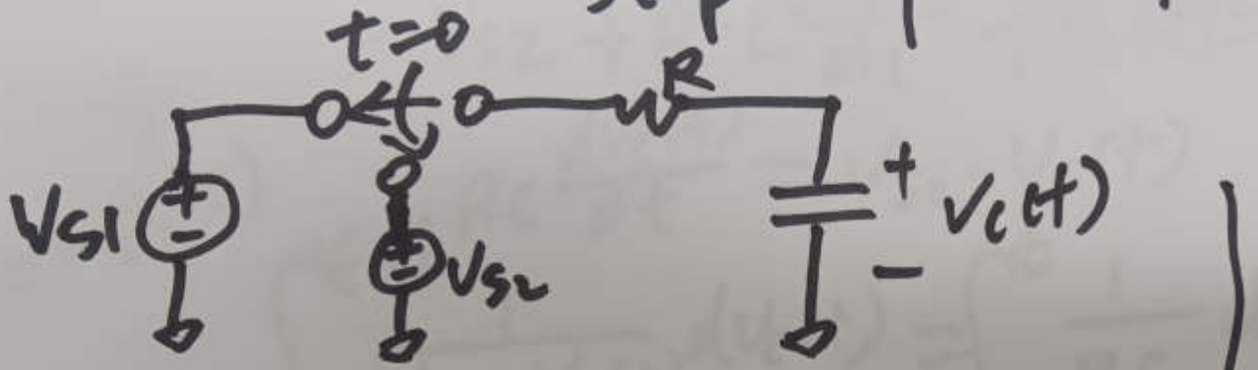
$$\Rightarrow \frac{V_c(t)}{V_c(0)} = e^{-t/RC}$$

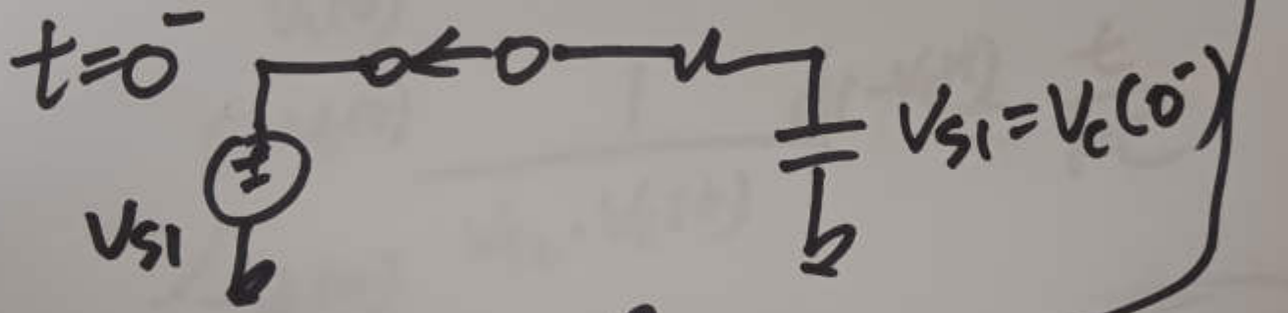
$$V_c(t) = V_c(0)\, e^{-t/RC}$$

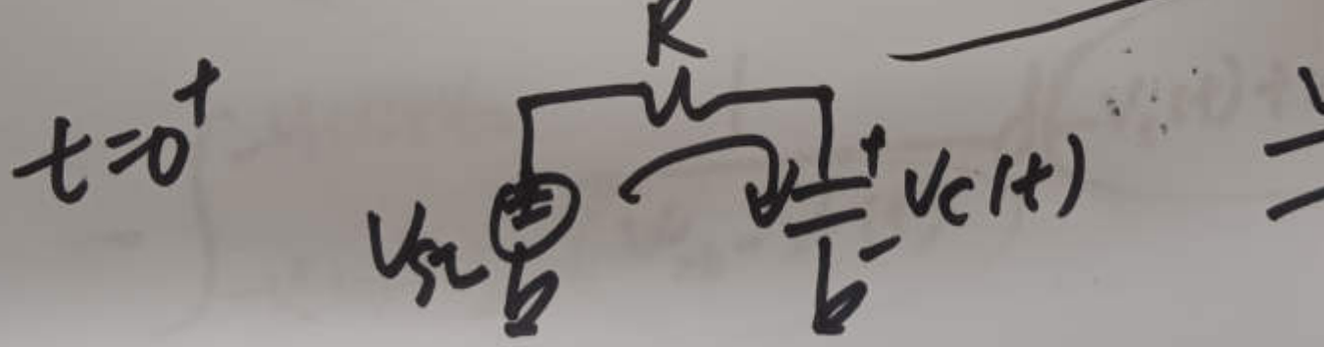
$e = 2.7$

$2.7^{-1} = 0.36$

Step Response (Forced Response)







$$\frac{\text{보}}{\text{T}} \quad i_c(t) = C\frac{dv_c(t)}{dt}$$

$$v_c(t) = \frac{1}{C}\int i_c(t)\,dt$$

$$-V_{S2} + R \cdot C \frac{d(V_c(t))}{dt} + V_c(t) = 0$$

~~$ax + by + y = 0$~~

$V_c(0) = V_{S1}$

$V_{S2} = V_c(\infty)$

$$RC \frac{dV_c(t)}{dt} = V_{S2} - V_c(t)$$

$$\int_{V_c(0)}^{V_c(t)} \frac{1}{V_{S2} - V_c(t)} d(V_c(t)) = \int_0^t \frac{1}{RC} dt$$

$$-\int_{-V_c(0)}^{-V_c(t)} \frac{1}{V_{S2} - V_c(t)} d(-V_c(t)) = \frac{t}{RC}$$

$$-\int_{-V_c(0)+V_{S2}}^{-V_c(t)+V_{S2}} \frac{1}{V_{S2} - V_c(t)} d(-V_c(t) + V_{S2}) = \frac{t}{RC}$$

$$e^{\left(\ln \frac{-V_c(t)+V_{S2}}{-V_c(0)+V_{S2}}\right)} = e^{\frac{-t}{RC}}$$

$$\frac{-V_c(t)+V_{S2}}{-V_c(0)+V_{S2}} = e^{-t/RC}$$

$$-V_c(t)+V_{S2} = (-V_c(0)+V_{S2})e^{-t/RC}$$

$$V_c(t) = V_{S2} - (-V_c(0)+V_{S2})e^{-t/RC}$$

$$= V_{S2} + (V_c(0)-V_{S2})e^{-t/RC}$$

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

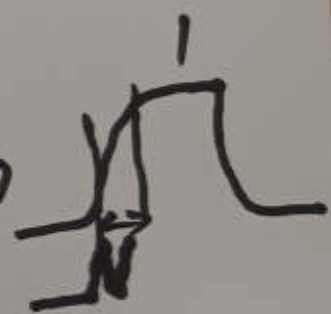
$v_c(0) = 0$

special case for step response

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

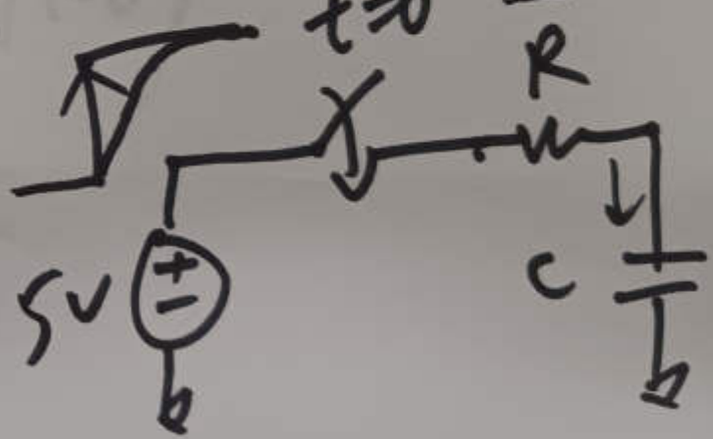
$$= v_c(\infty) - v_c(\infty)\, e^{-t/RC}$$

$$= v_c(\infty)\left(1 - e^{-t/RC}\right)$$

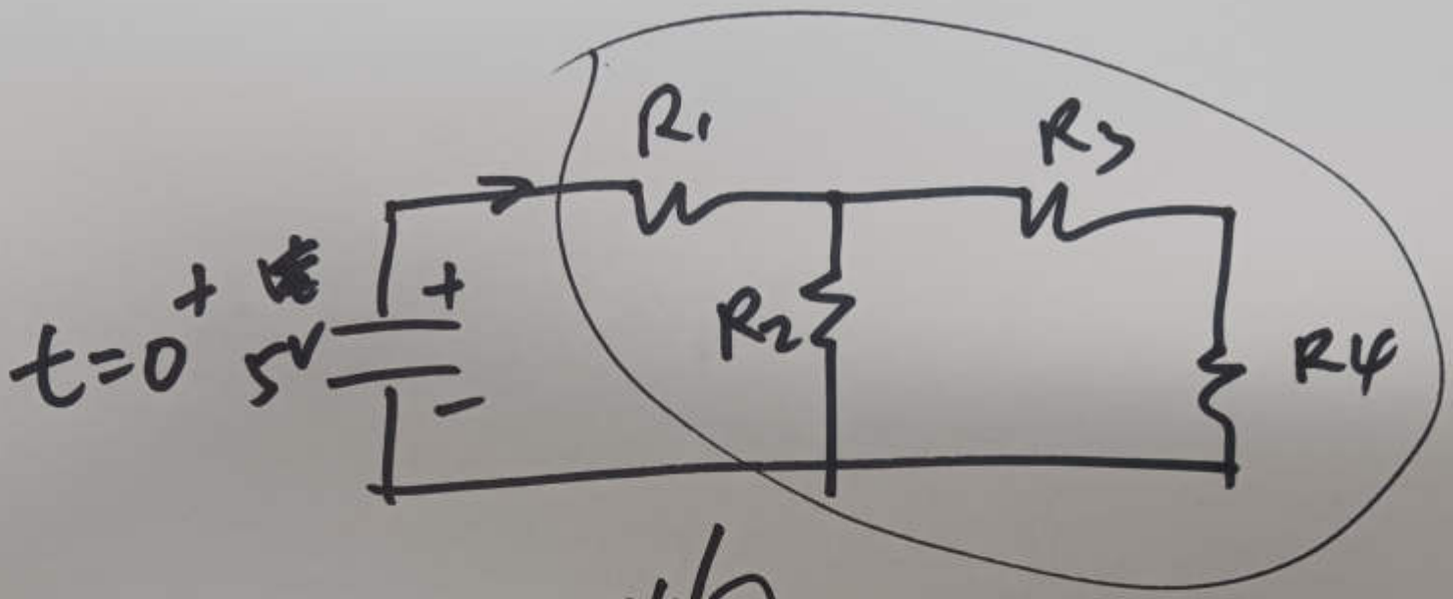


RC unit is time

↳ time constant



RC



$$v_c(t) = v_c(0)\, e^{-t/R_L}$$

$$R = R_{TH} = R_1 + \left((R_3 + R_4) \,||\, R_2\right)$$