Discussion 4 Notes

Friday, April 22, 2022 9:31 PM

First Order Circuits

Time Constant → τ $\quad e^{-t/\tau}$

- Settling time for 63% to final value.

"The switch has been closed for a long time."

Capacitor (V cannot change instantly)

$\tau = RC$

$V_c(t \le 0) = 10V$

$V_c(t \ge 0) = 10e^{-t/RC}$

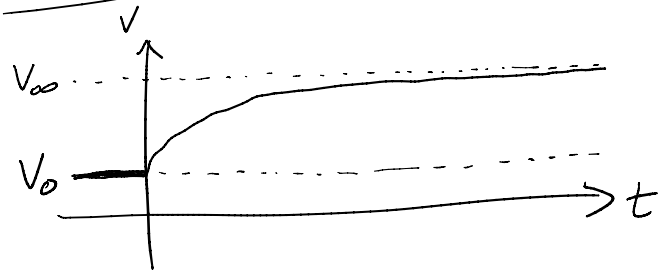
Inductor (I cannot change instantly)

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

$I_L(t \le 0) = 10A$

$I_L(t \ge 0) = 10e^{-tR/L}$

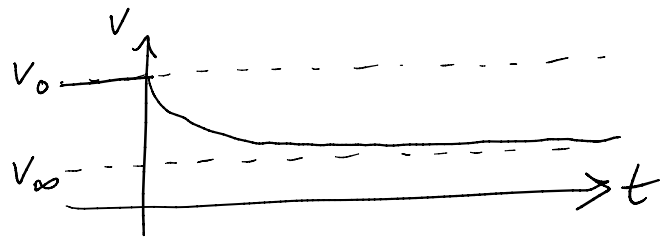
First Order Circuit Response



$V(t \le 0) = V_0$

$V(t \to \infty) = V_\infty$

$V(t \ge 0) = V_0 + (V_\infty - V_0)(1 - e^{-t/\tau})$

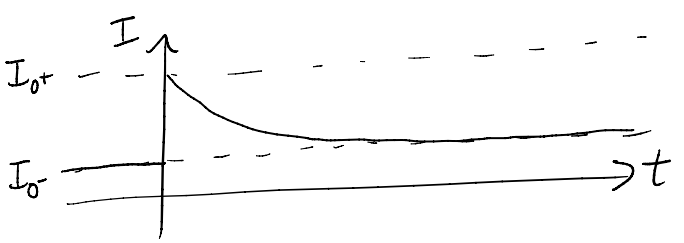


$V(t \le 0) = V_0$

$V(t \to \infty) = V_\infty$

$V(t \ge 0) = V_\infty + (V_0 - V_\infty)e^{-t/\tau}$

V for Cap or I for Ind



$I(t < 0) = I_{0-}$

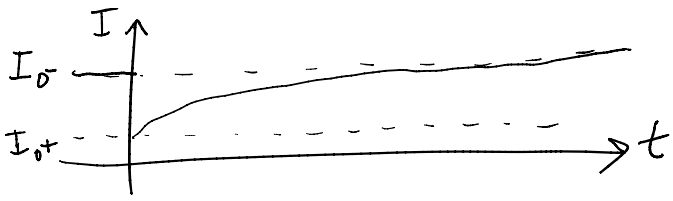
$I(t \to \infty) = I_{0-}$

$I(t > 0) = I_{0-} + (I_{0+} - I_{0-})e^{-t/\tau}$

$I(t < 0) = I_{0-}$

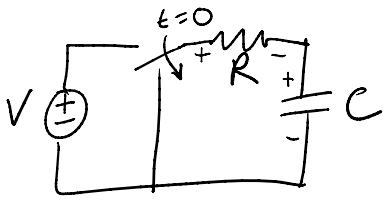
$I(t \to \infty) = I_{0-}$

$I(t > 0) = I_{0+} + (I_{0-} - I_{0+})(1 - e^{-t/\tau})$



$I(t\to\infty) = I_{0^-}$

$I(t>0) = I_{0^+} + (I_{0^-} - I_{0^+})(1-e^{-t/\tau})$

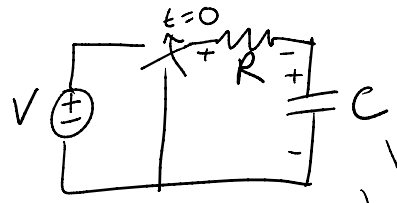


$V_c(t\le 0) = V$

$V_c(t\to\infty) = 0$

$V_c(t\ge 0) = Ve^{-t/RC}$

$V_R(t>0) = -Ve^{-t/RC}$



$V_c(t\le 0) = 0$

$V_c(t\to\infty) = V$

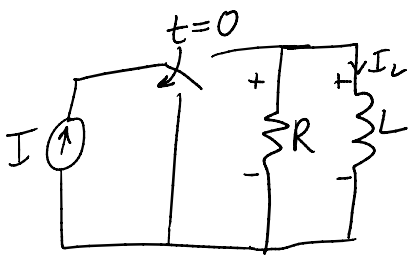
$V_c(t\ge 0) = V(1-e^{-t/RC})$

$V_R(t<0) = 0$

$V_R(t\to\infty) = 0$

$V_R(t>0) = V - V(1-e^{-t/RC})$

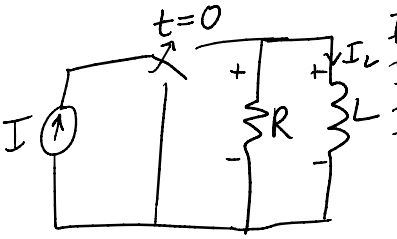
$V_R(t>0) = Ve^{-t/RC}$



$I_L(t\le 0) = I$

$I_L(t\to\infty) = 0$

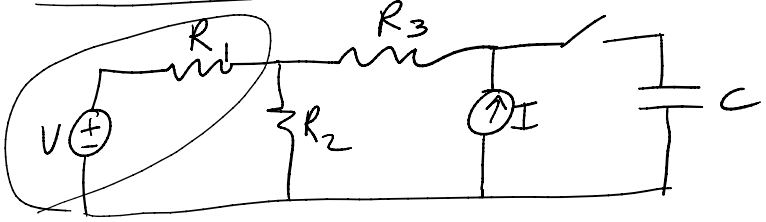
$I_L(t\ge 0) = Ie^{-tR/L}$

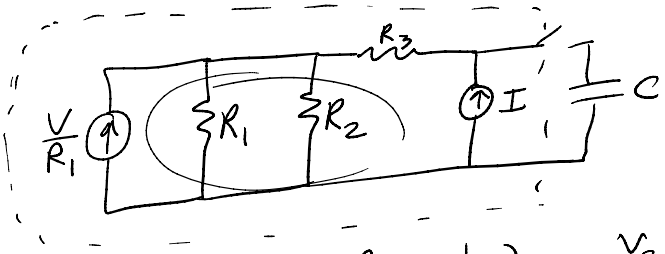


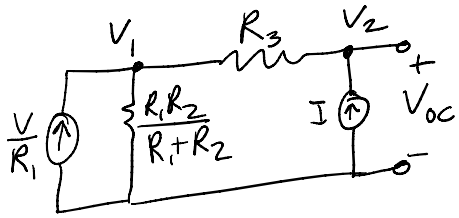
$I_L(t\le 0) = 0$

$I_L(t\to\infty) = I$

$I_L(t\ge 0) = I(1-e^{-tR/L})$





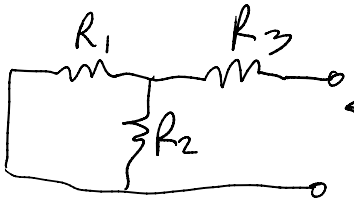


① $\frac{V}{R_1} = \frac{V_1(R_1+R_2)}{R_1R_2} + \frac{V_1-V_2}{R_3} = \left(\frac{R_1+R_2}{R_1R_2} + \frac{1}{R_3}\right)V_1 - \frac{V_2}{R_3}$

② $I = \frac{V_2-V_1}{R_3} \Rightarrow V_2 = IR_3 + V_1$

$\frac{V}{R_1} = \left(\frac{R_1+R_2}{R_1R_2} + \frac{1}{R_3}\right)V_1 - \frac{IR_3+V_1}{R_3} = \frac{R_1+R_2}{R_1R_2}V_1 - I$

$\left(\frac{V}{R_1} + I\right)\frac{R_1R_2}{R_1+R_2} = V_1$



$\leftarrow R_{eq} = R_3 + \frac{R_1R_2}{R_1+R_2}$

$V_2 = V_{OC} = V_{Th} = IR_3 + \frac{VR_2}{R_1+R_2} + \frac{IR_1R_2}{R_1+R_2}$

$\tau = \left(R_3 + \frac{R_1R_2}{R_1+R_2}\right)C$


Th
C
V_{Th}