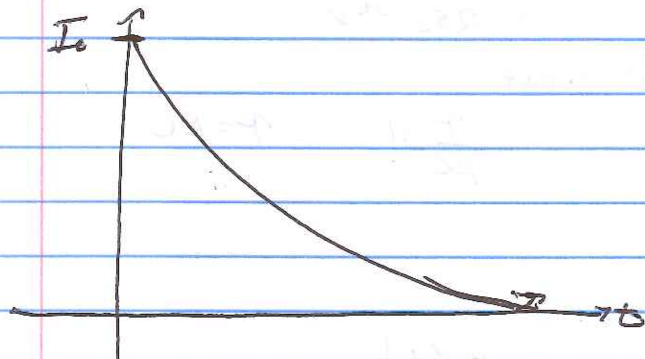
Tuesday Jan 27th → Tuesday May 5th

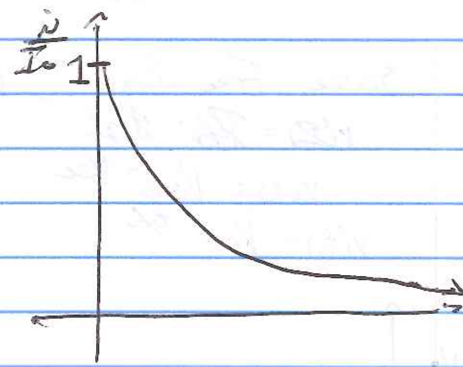
Tuesday 3/31/2015      Pgs. 275-294

Review
- Natural Response → general nature
- Transient Response → dies out
- Forced Response → steady-state transition

Source Free: $i(t) = I_o e^{-Rt/L}$

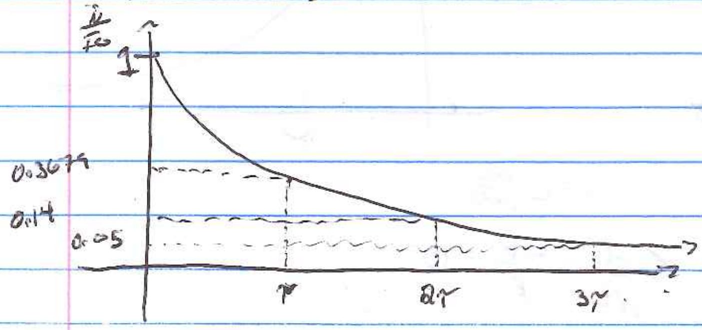
Exponential Response   at $t=0$ current = $I_o$
current decreases as time increases, exponential decay
decay function: $e^{-Rt/L}$
Same function for RL Series circuit as long as $L/R$ ratio is the same



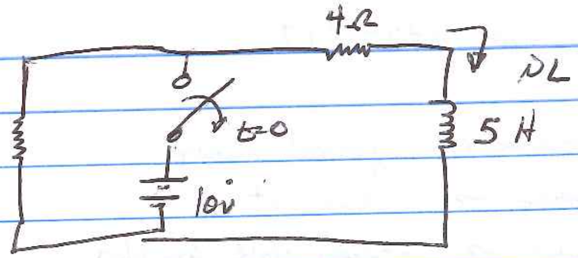




Larger $\frac{L}{R}$ = larger decay      $\tau$ = time constant $\frac{L}{R}$

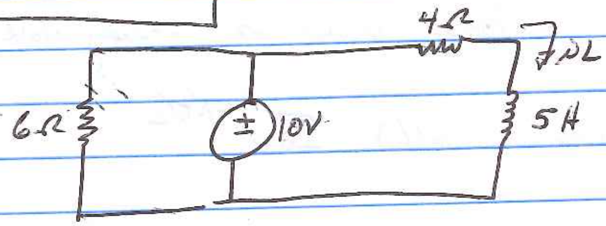
$\tau$ = 0.3679s      $5\tau \sim 6\tau$ negligible current



Practice 8.2




$t<0$ ~




$V = IR$

$i_L(t<0) = \frac{V}{R} e^{-\frac{10}{5}t} = \frac{10}{4} = I_0 = 2.5$

$i_L(t>0) = 2.5 e^{-2t}$

$v_L = L\frac{di}{dt} = (-2)(5)(2.5)e^{-2t}$

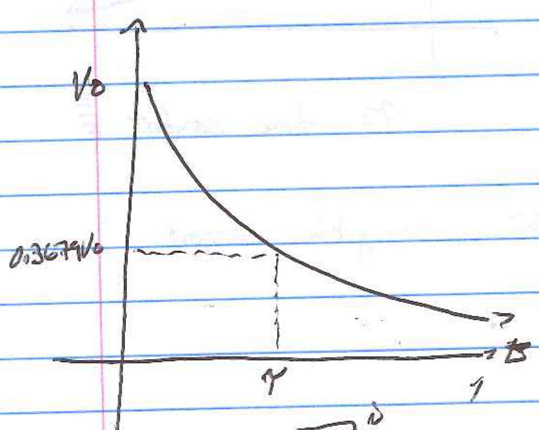
$= -25e^{-2t}\,V$

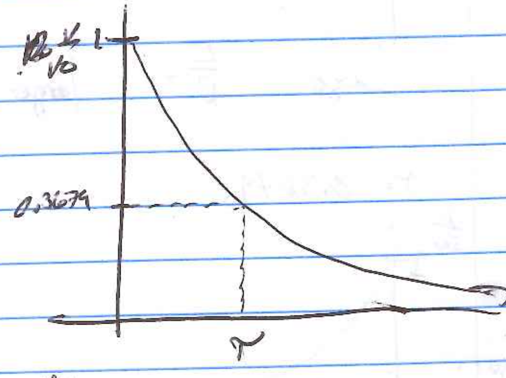
Source Free Parallel RC circuit

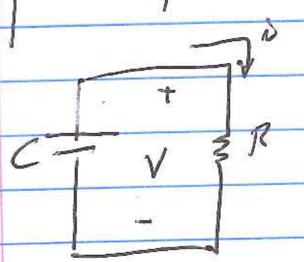
$v(t) = \frac{\tau}{RC} = 1 \qquad \tau = RC$

$v(t) = V_0 e^{-t/RC}$

$v(t) = V_0 e^{-t/\tau}$



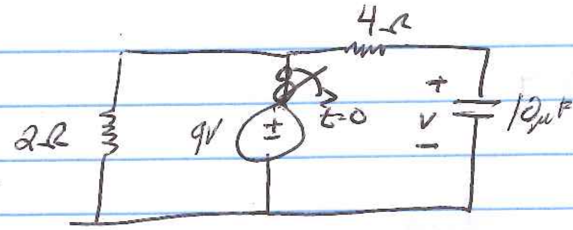



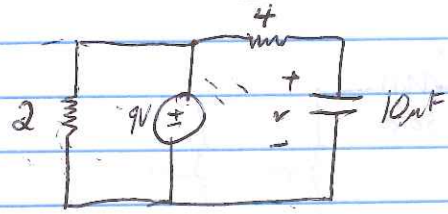

$i = C\frac{dv}{dt}$

$C\frac{dv}{dt} + \frac{V}{R} = 0$

Example 8.3




t<0

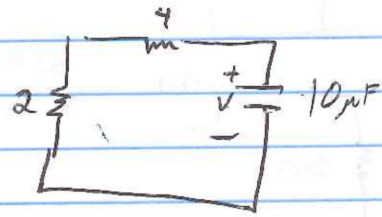



$V(t<0) = 9V$

$i_c(t<0) = 0A$

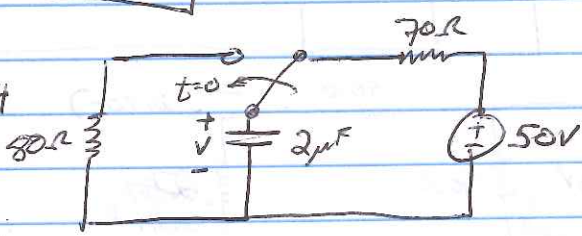
$\tau = 6 \times 10 \times 10^{-6}$
$= 60 \times 10^{-6}$

t>0




$V(t) = V_0 e^{-t/\tau}$
$= V_0 e^{-t/RC} \; V$

Practice 8.4




$V(t<0) = 50V$

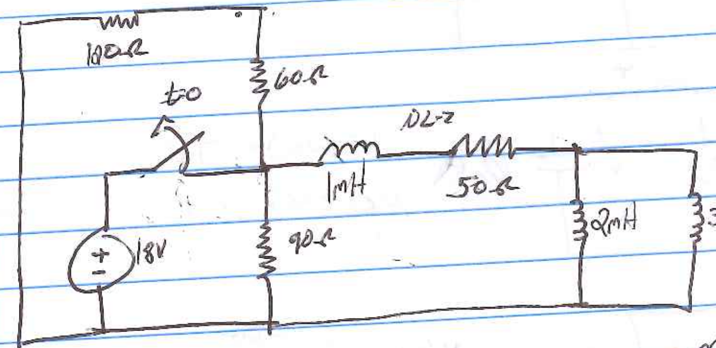
$V(t>0) = 50e^{-t/RC} \quad V = 50e^{-t/80 \times C}$

General Perspective For RL Circuits

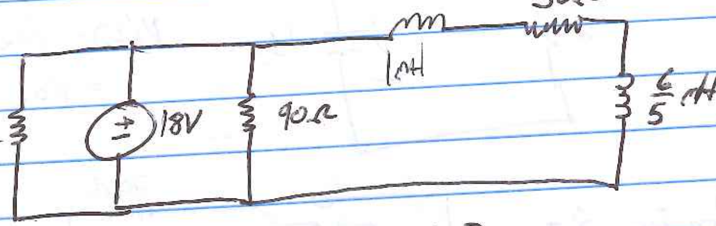
$\tau = \frac{L}{R_{eq}} \rightarrow \tau = \frac{L_{eq}}{R_{eq}}$

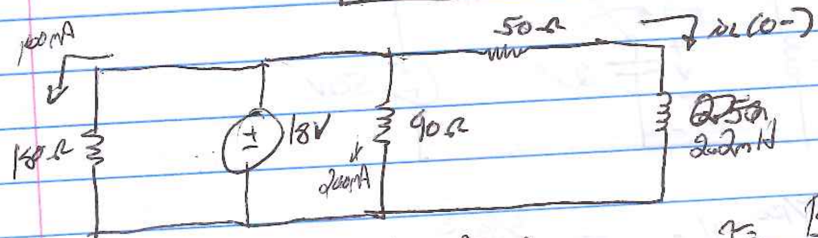
☆ Always $i_L(0^-) = i_L(0^+)$ ☆

Example 8.4




Equivalent $t < 0$




$i_1(0^-) = \frac{18V}{90\Omega} = 200mA$

$\tau = \frac{R_{eq}}{L_{eq}} = 60+50$

$i_L(0^-) = \frac{18}{50} = 360mA$

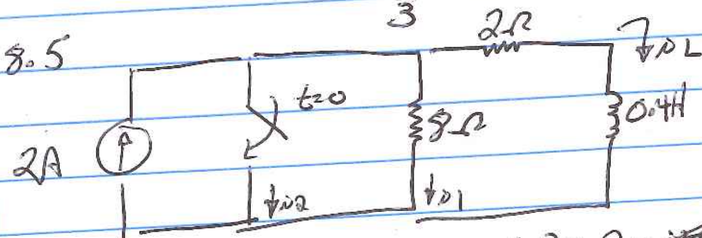
$i_L(0^-) = i_L(0^+) = 360mA$

~~300 = 360 = 240~~ mA

$i_1(0^+) = -i_L(0^+) \times \frac{180}{180+90} = -240mA$

$= -360 \times \frac{2}{3} = -120 \times 2$

Practice 8.5




$\tau = \frac{L}{R} = \frac{0.4}{2} = 0.2$

$i_2(0^+) = 2 - i_L(t>0)$

$i_2(0^-) = 0A$

$i_1(0^-) = \frac{2}{10} \times 2 = 0.4A$

$i_L(0^-) = \frac{8}{10} \times 2 = 1.6A$

$i_L(0^+) = 1.6A$

$\therefore i_L(t) = i_L(0^+)e^{-t/\tau}$

$i_2(t) = 2 - i_L(0^+)e^{-t/\tau}$

General RC circuits

$\tau = R_{eq} C$

$\tau = R C_{eq}$

$\tau = R_{eq} C_{eq}$

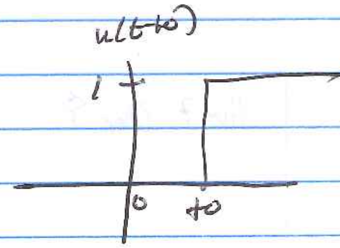
~~Example 8.5~~ Ex 8.5 $\quad v(0^+) = v(0^-) = V_0$

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

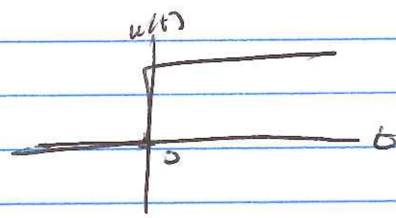
$\cancel{v_0} = v(0) = V_0 \qquad v = V_0 e^{-t/RC} \qquad \tau = \left(\frac{R_1 R_3}{R_1 + R_3} + R_2\right) C$

$i_1 = i_1(0^+) e^{-t/RC}$

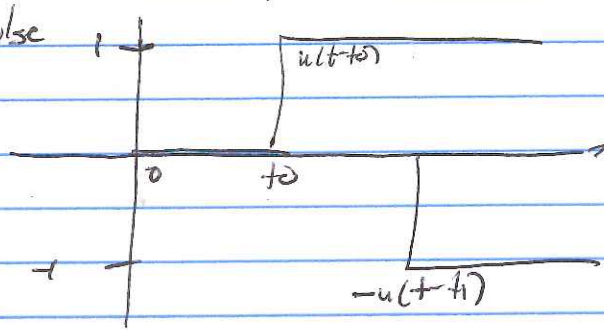
<u>unit Step</u> $\quad u(t - t_0) = \begin{cases} 0 & t < t_0 \\ 1 & t > t_0 \end{cases}$



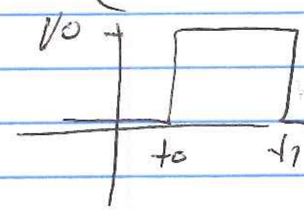

$u(t) = \begin{cases} 0 & t < 0 \\ 1 & t > 0 \end{cases}$



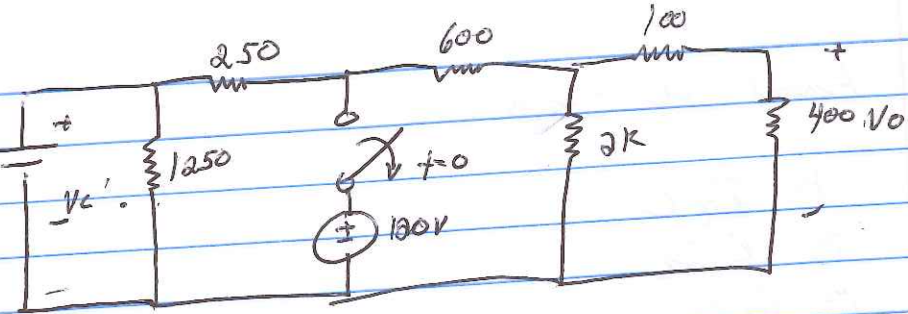

Rectangular Pulse




$v(t) = \begin{cases} 0 & t < t_0 \\ V_0 & t_0 < t < t_1 \\ 0 & t > t_1 \end{cases}$



8.6




$V_c(0^-) = 120 \times \frac{1250}{1500} = 100V = V_c(0^+)$

$V_o(0^-) = \frac{2000 \times 500}{2500} = 400$

$120 \times \frac{400}{1000} = 48V$

$48 \times \frac{400}{500} = 38.4$

HW7 Chap 8 20, 22, 27, 48, 53, 57