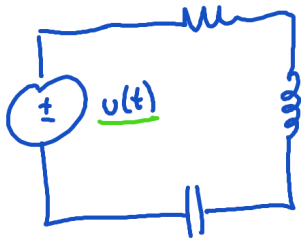
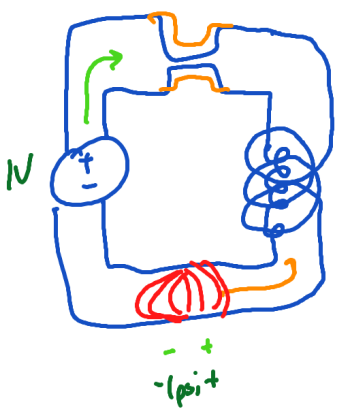
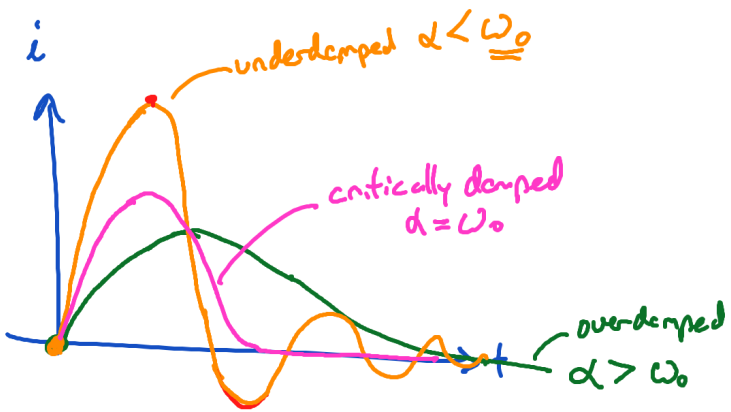
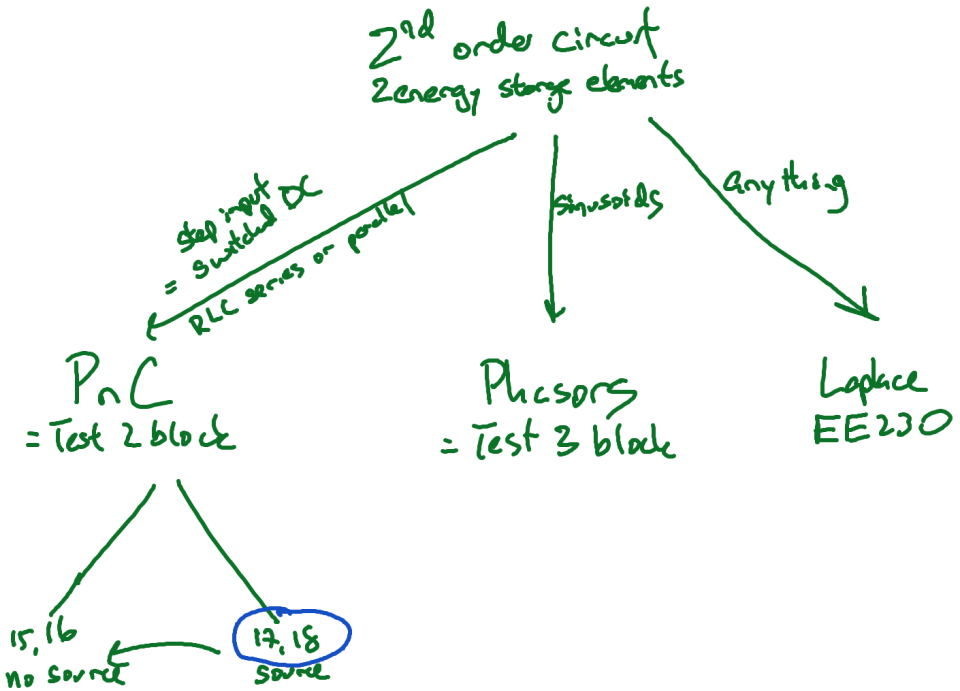
Intuition


u(t)


N
-
+
-(psi)+


i
underdamped $\alpha < \omega_0$
critically damped
$\alpha = \omega_0$
overdamped
$\alpha > \omega_0$
t

Big Picture



Review

① Calc - DSC "Disc"

$$\frac{d}{dt}\sin(2t) = 2\cos 2t$$

$$\frac{d}{dt}\cos(2t) = -2\sin 2t$$

② Product rule

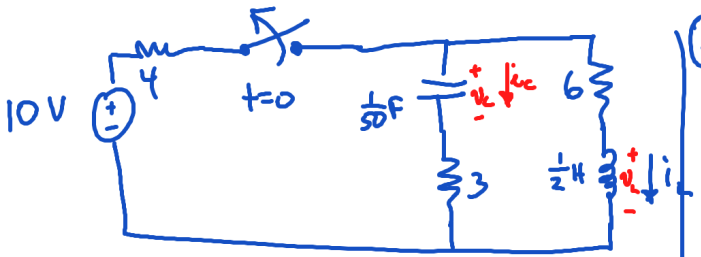
$$[f(t)\cdot g(t)]' = f'(t)g(t) + f(t)g'(t)$$

③

$$v_L = L i_L'$$

$$i_C = C v_C'$$

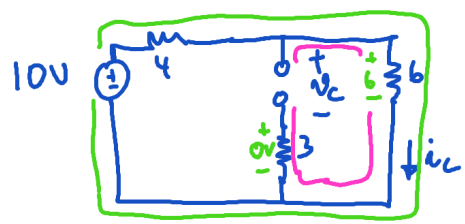
Ex



Find i_L

① Find IC

ⓐ $t<0$ i_L, v_C



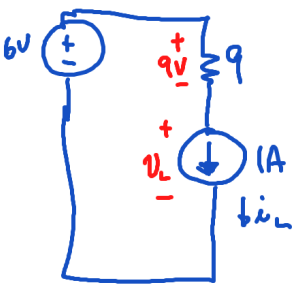
$i_L = \frac{10V}{4+6} = 1A$

$v_c = 6V$

ⓑ $t=0^+$

$i_L(0^+) = 1A$

$i_L'(0^+) = -6A/s$



$-6+9+v_L=0$

$v_L = -3V$

$i_C = C v_C'$

$v_L = L i_L'$ ←

$i_L'(0^+) = \frac{1}{L} v_L(0^+)$

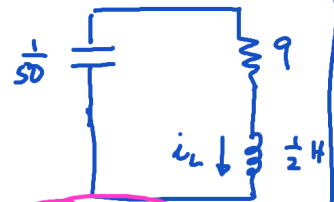
$= 2(-3)$

$= -6 A/s$

$\frac{d}{dt} i(t) =$

A/s

② $t>0$ natural solution $i_n(t)$



$\alpha = \frac{R}{2L} = 9$

$\omega_0 = \frac{1}{\sqrt{LC}} = 10$

$s = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$

$= -9 \pm j4.36$

α ω_d

$\alpha < \omega_0$ ← underdamped = oscillate

$\alpha = \omega_0$

$\alpha > \omega_0$

$i_n(t) = e^{-\alpha t}[C_1 \cos(\omega_d t) + C_2 \sin(\omega_d t)]$

③ $t=\infty$ forced solution $i_f(t)$

$i_f(\infty) = 0$

homogenous = natural
particular = forced

④ $i_L = i_n + i_f$ DSC

$i_L = e^{-9t}[C_1 \cos(4.36t) + C_2 \sin(4.36t)]$

$1 = 1[C_1 + 0] \Rightarrow C_1 = 1$

$i_L = e^{-9t}[\cos(4.36t) + C_2 \sin(4.36t)]$

$-6 = -9e^0[1+0] + 1[-4.36 \sin(0) + 4.36 C_2 \cos(0)]$

$-6 = -9 + 4.36 C_2$

$C_2 = 0.688$

$i_L = e^{-9t}[\cos(4.36t) + 0.688 \sin(4.36t)]$ A