Obj

- Big Picture
- 2^{nd} order circuits
- Initial Conditions

Big Picture

	1st order	2nd order	any order
1 (L or C) 0 R	1 (L or C) 1 R DC stepped response	1 R, 1 C, 1 L DC stepped response	lots R, C, L sinusoid sources

$\int$ or $\frac{d}{dt}$

$i_c = C v_c'$

$v_L = L i_L'$

$v_c = \frac{1}{C}\int_{t_0}^{t} i_c(t)\,dt + v_c(t_0)$

$i_L = \frac{1}{L}\int_{t_0}^{t} v_L(t)\,dt + i_L(t_0)$

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

$i_L(t) = I_\infty + (I_0 - I_\infty)e^{-t/\tau}$

Initial Conditions
Source-free ckts
step response

phasors!

Test 1 (3 weeks)

Test 2 (3 weeks)

Test 3 (3 weeks)

Second Order Circuits

- Find Initial Conditions

  First order no matter what asked to find, $v_c: t<0 \Rightarrow V_c(0^+) + V_c(\infty)$

  $i_L: t<0 \Rightarrow I_L(0^+) + I_L(\infty)$

  Second order find what you are asked to find

  eg. $v_R(t)$ $v_R(0^+)$

  $v_R'(0^+)$

  $v_R(\infty)$

- Plug n Chug

  First Order $A + Be^{-kt}$ $V_\infty + (V_0 - V_\infty)e^{-t/\tau}$

  Second Order

  - $Ae^{-k_1 t} + Be^{-k_2 t}$
  - $Ate^{-kt} + Be^{-kt}$
  - $[A\cos(\omega t) + B\sin(\omega t)]e^{-kt}$

Initial Conditions

1st Order Circuits	$t=0^+$	$\boxed{v_c(0^+)}$ $\boxed{i_L(0^+)}$		no matter what we were asked to find !
	☆ $t=\infty$	$\boxed{v_c(\infty)}$ $\boxed{i_L(\infty)}$		
2nd Order Circuits	$t=0^+$	$\boxed{X(0^+)}$ $\boxed{X'(0^+)}$	eg	$\boxed{v_R(0^+)}$ $\boxed{v_R'(0^+)}$
	☆ $t=\infty$	$\boxed{X(\infty)}$		$\boxed{v_R(\infty)}$

Method 2nd Order I. C.

① Goal : $\boxed{V_{C0}, I_{L0}}$

- Draw $t<0$, DCSS
- capacitor $\Rightarrow$ open, $+\ V_{C0}\ -$; inductor $\Rightarrow$ short, $\downarrow I_{L0}$
- Find V_{C0}, I_{L0}

② Goal : $\boxed{X(0^+)}$ ex. $v_R(0^+)$

- Draw $t=0^+$
- capacitor $\Rightarrow$ $\downarrow i_c$ voltage source V_{C0} ; inductor $\Rightarrow$ v_L current source I_{L0}
- Find the requested $X(0^+)$ ex $v_R(0^+)$

③ Goal : $X'(0^+)$ ex $v_R'(0^+)$

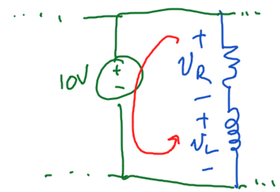
- Use $t=0^+$ diagram
- $v_L = L\, i_L' \Rightarrow \boxed{i_L'} = \frac{1}{L} v_L$ definitely use
  $i_c = C\, v_c' \Rightarrow \boxed{v_c'} = \frac{1}{C} i_c$

$v' = i'R$ — Ω Law
$i_1' + i_2' = 0$ — KCL
$v_1' + v_2' = 0$ — KVL
may or may not use

④ $\boxed{\text{Goal : } X(\infty)}$ ex $v_R(\infty)$

- Draw $t=\infty$ DCSS
- capacitor $\Rightarrow$ open, $+\ v_c\ -$; inductor $\Rightarrow$ short, $\downarrow i_L$
- Find $X(\infty)$ ex $v_R(\infty)$

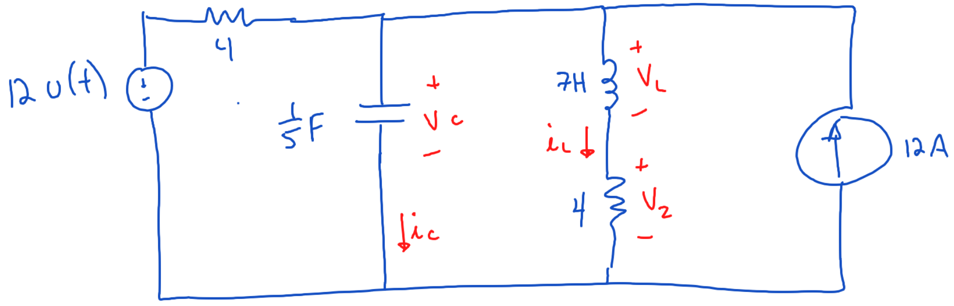
$t=0^+$



① $v_L(0^+)$
② $i_L'(0^+) = \frac{1}{L} v_L(0^+)$
③ $i_R' = i_L'$
$v_R' = R\, i_R'$

$v_L'(0^+)$
$+10 - v_L - v_R = 0$
$-v_L' - v_R' = 0$
$v_L'(0^+) = -v_R'(0^+)$

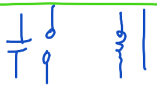
Ex

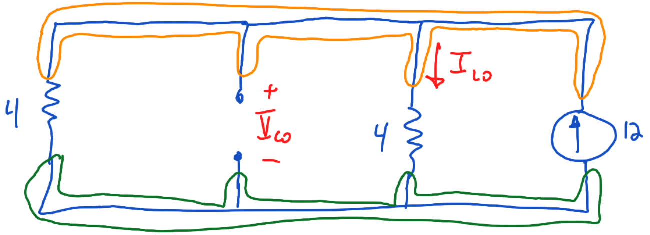


Find

$v_c(0^+) = 24V$	$v_c'(0^+) = 15V/s$
$i_L(0^+) = 6A$	$i_L'(0^+) = 0A/s$
$v_2(0^+) = 24V$	$v_2'(0^+) = 0V/s$
$v_L(0^+) = 0V$	$v_L'(0^+) = 15V/s$

① Draw $t<0$ I_{L0}, V_{c0} always



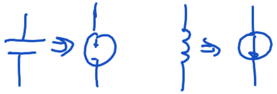


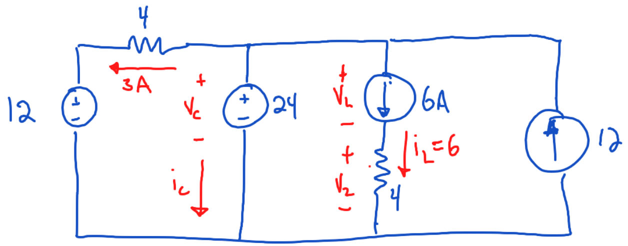
$$I_1 = I_s \frac{R_2}{R_1 + R_2}$$

$$I_{L0} = 12 \frac{4}{4+4} = \boxed{6A}$$

$$V_{c0} = (4\Omega)(6A) = \boxed{24V}$$

② Draw $t=0^+$ $X(0^+)$





$V_2 = (4)(6) = \boxed{24}$

V_L : $-24 + v_2 + 24 = 0$

$V_L = \boxed{0V}$

③ Using the $t=0^+$ diagram, find $X'(0^+)$

$\boxed{\begin{array}{l} i_c = C v_c' \\ v_L = L i_L' \end{array}}$ always!

maybe − $\boxed{\begin{array}{ll} v_R' = i_R' \cdot R & \Omega\text{'s Law} \\ v_1' + v_2' = 0 & \text{KVL} \\ i_1' + i_2' = 0 & \text{KCL} \end{array}}$

$v_c' = \frac{1}{C} i_c$
$= (5)(3)$
$= \boxed{15V/s}$

KCL: $3 + i_c + 6 - 12 = 0$
$\Rightarrow i_c = 3$

$i_L' = \frac{1}{L} v_L = \frac{1}{7}(0) = \boxed{0A/s}$

v_2' : $\cancel{+v_L' + v_2' - v_c' = 0}$
$\cancel{v_2' = v_c' - v_L' = 15 - v_L'}$
$v_2' = 4 i_L' = 4(0) = \boxed{0V/s}$

v_L' : $v_L' + v_2' - v_c' = 0$
$v_L' = v_c' - v_2'$
$= 15 - 0$
$= \boxed{15 V/s}$