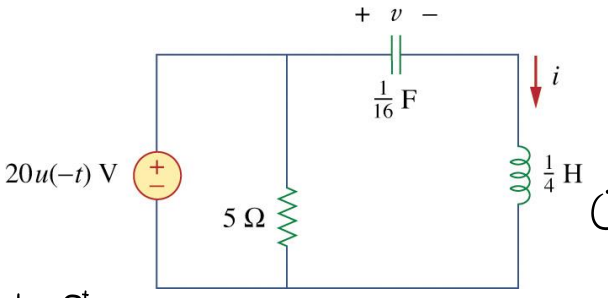
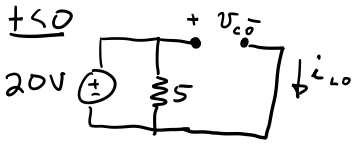
P1 Find i(t) for t>0 in the circuit below. Hint: answer has all integer coefficients.



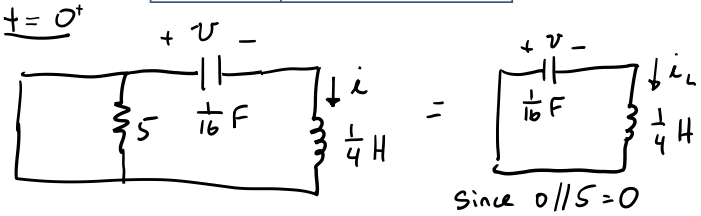
To see what u(-t) does, plug in different values for t
For t=-2 or -4 or any t<0, u(-t) = 1
For t= 2 or 4 or any t>0, u(t) = 0

① $t<0$



By inspection $v_{co} = 20V$, $i_{Lo} = 0A$

$t = 0^+$

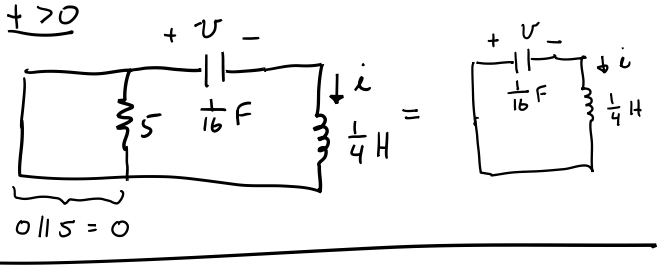


Since $0 \| 5 = 0$

So $i_o = 0A$, $i_o' = -\frac{1}{L}(i_{Lo}R + v_{co}) = -4(20) = -80$ A/s

② • Series RLC
• $\alpha = R/2L = 0$
• $\omega_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{\frac{1}{64}}} = \frac{1}{\frac{1}{8}} = 8$
• $s = -\alpha \pm \sqrt{\alpha^2 - \omega_o^2} = \pm j8$

$t > 0$



$0 \| 5 = 0$

③ $i_n(t) = C_1 \cos(8t) + C_2 \sin(8t)$

④ $t = \infty$

By inspection $v_{c\infty} = 0$, $i_{L\infty} = 0$

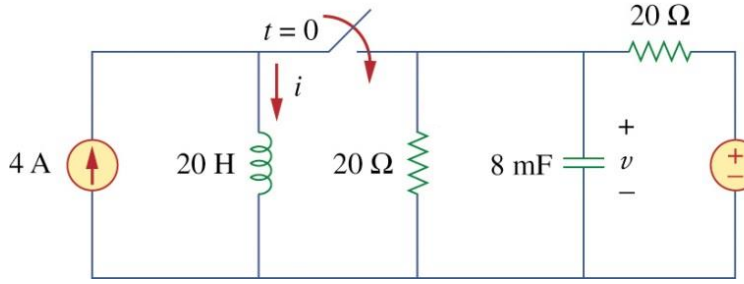
$\Rightarrow$ $i_f(t) = 0$

⑤ total

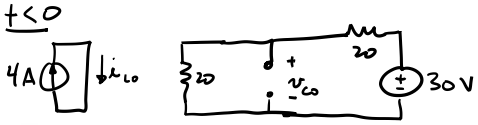
$i(t) = i_n + i_f$
$= C_1 \cos(8t) + C_2 \sin(8t)$
$i(0) = C_1 = 0 \Rightarrow C_1 = 0$
$i(t) = C_2 \sin(8t)$
$i'(t) = C_2 8 \cos(8t)$
$i'(0) = 8C_2 = -80 \Rightarrow C_2 = -10$

$i(t) = -10 \sin(8t)$ A, $t \geq 0$

P2 Find i(t), t>0. Hint: 2 exponentials with nasty coefficients plus an integer



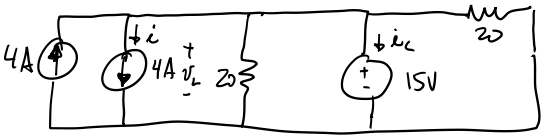
① $t<0$



$i_{L0} = 4$ by inspection

$v_{C0} = 30\left(\frac{20}{20+20}\right) = 15$ by $V_{divider}$

② $t = 0^+$

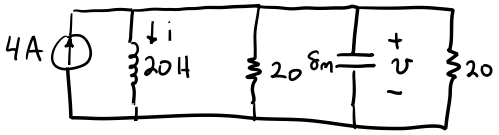


by inspection, $i(0^+) = 4$ A

$i'(0^+) = \frac{1}{L} v_L(0^+) = \frac{1}{20}(15) = 0.75$ A/s

$\boxed{i(0^+) = 4\text{A}, \quad i'(0^+) = 3/4\text{ A/s}}$

③ $t > 0$



$\omega = \frac{1}{\sqrt{LC}} = 2.5$

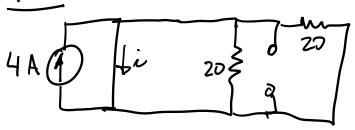
$\alpha = \frac{1}{2RC} = \frac{1}{2(20 \| 20)8m} = 6.25$

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

$= -12, -0.522$

$\boxed{v_n(t) = c_1 e^{-12t} + c_2 e^{-0.522t} \text{ V}}$

④ $t = \infty$



by inspection $i(\infty) = 4$

$\Rightarrow i_f(t) = 4$

⑤ $i(t) = i_n + i_f$

$= c_1 e^{-12t} + c_2 e^{-0.522t} + 4$ match IC's

$i(0) = c_1 + c_2 + 4 = 4 \Rightarrow c_1 + c_2 = 0$

$i'(0) = -12c_1 - 0.522c_2 = 0.75$

$$\begin{bmatrix} 1 & 1 \\ -12 & -0.522 \end{bmatrix} \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0.75 \end{bmatrix} \Rightarrow \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} = \begin{bmatrix} -0.0653 \\ 0.0653 \end{bmatrix}$$

$\boxed{i(t) = -0.0653e^{-12t} + 0.0653e^{-0.52t} + 4 \text{ A}}$