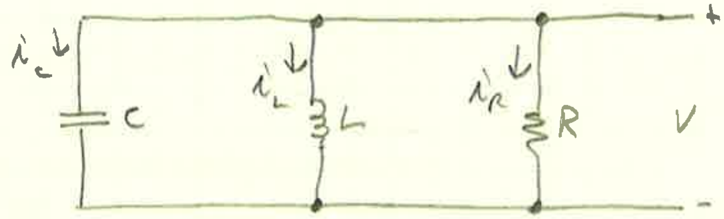
$L = 10\,mH$

for $t \geq 0$,

$v(t) = 40e^{-1000t} - 90e^{-4000t}$ V



a) Find ω_0, α, C, and R

$$s_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2} = -1000$$
$$s_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2} = -4000$$

adding, $-5000 = -2\alpha \Rightarrow \boxed{\alpha = 2500 \text{ rad/s}}$

$$-\alpha + \sqrt{\alpha^2 - \omega_0^2} = -1000$$
$$-2500 + \sqrt{2500^2 - \omega_0^2} = -1000 \Rightarrow \boxed{\omega_0 = 2000 \text{ rad/s}}$$

$\omega_0 = \dfrac{1}{\sqrt{LC}} \Rightarrow \boxed{C = 25\,\mu F}$

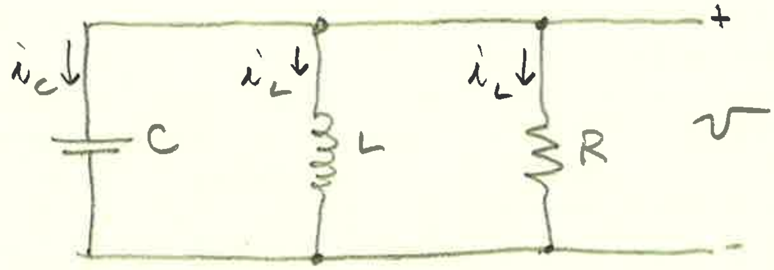
$\alpha = \dfrac{1}{2RC} \Rightarrow \boxed{R = 8\,\Omega}$

b) FIND $i_R(t)$, $i_L(t)$, and $i_C(t)$ for $t \geq 0^+$

$$i_R(t) = \frac{V(t)}{R} = 5e^{-1000t} - 11.25e^{-4000t} \text{ A} \longleftarrow$$

$$i_C(t) = C\frac{dv_c}{dt} = (25\times10^{-6})\left[-40000e^{-1000t} + 90(4000)e^{-4000t}\right]$$
$$= -e^{-1000t} + 9e^{-4000t} \text{ A} \longleftarrow$$

$$i_L(t) = -(i_r + i_c) = -4e^{-1000t} + 2.25e^{-4000t} \text{ A} \longleftarrow$$



L = 10mH

$v(t) = 40e^{-1000t} - 90e^{-4000t}$ V for $t \geq 0$

a) FIND ω_0, α, C, + R

system is overdamped

$S_1 = -1000 = -\alpha + \sqrt{\alpha^2 - \omega_0^2}$
$S_2 = -4000 = -\alpha - \sqrt{\alpha^2 - \omega_0^2}$

adding the 2 equation, $-5000 = -2\sigma$

$\boxed{\sigma = 2500}$

So $-1000 = -2500 + \sqrt{2500^2 - \omega_0^2}$ or $\boxed{\omega_0 = 2000 \text{ rad/s}}$

$\omega_0 = \frac{1}{\sqrt{LC}} \Rightarrow \boxed{C = 25\mu F}$

$\alpha = \frac{1}{2RC} \Rightarrow \boxed{R = 8\Omega}$

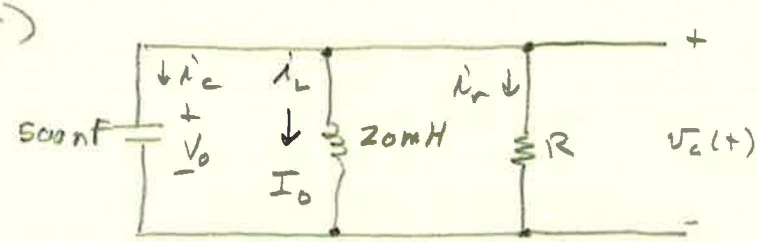
b) Find $i_R(t)$, $i_L(t)$, $i_C(t)$ for $t \geq 0$

$i_R(t) = \frac{V_R(t)}{R} = \frac{v(t)}{R} = \boxed{5e^{-1000t} - 11.25e^{-4000t} \text{ A} = i_R(t)}$

$i_C(t) = C\frac{dv(t)}{dt} = \boxed{-e^{-1000t} + 9e^{-4000t} \text{ A} = i_C(t)}$

$i_L(t) = -(i_C(t) + i_R(t)) = \boxed{-4e^{-1000t} + 2.25e^{-4000t} \text{ A} = i_L(t)}$

$V_c(0) = 40V$ (missing in text)
$I_{0_L} = 120 mA$
R adjusted for Critical Damping.



a) Find R

$$\omega_0 = \frac{1}{\sqrt{LC}} = 10{,}000$$

$$\alpha = 10{,}000 = \frac{1}{2RC} \Rightarrow \boxed{R = 100\Omega}$$

b) Find $V_c(t)$ for $t \geq 0$

$$V_c(t) = A_1 t e^{-\alpha t} + A_2 e^{-\alpha t}$$

$$V_c(0) = 40 = A_2$$

$$V_c(t) = A_1 t e^{-10{,}000t} + 40 e^{-10000t} \; V$$

to find initial Capacitor current, $V_c(0^+) = 40V$ which means $I_R = \frac{40}{100} = .4A \downarrow$

$i_L = .12A \downarrow$ So $I_C = .52A \uparrow$

$$i_c(t) = C\frac{dV_c}{dt} = -.52A = C\left[A_1 t(-10000)e^{-10000t} + A_1 e^{-10000t} + 40(-10000)e^{-10000t}\right]$$

$$-.52 = C\left[A_1 - 400000\right] \Rightarrow A_1 = -640{,}000$$

$$\boxed{V_c(t) = (-640{,}000t + 40)e^{-10{,}000t} \; V}$$

c) Find $v(t)$ when $i_c(t) = 0$

$i_c(t) = 0$ when $\frac{dV_c(t)}{dt} = 0$

$$i_c(t) = C\frac{dV_c}{dt} = C\left[-640{,}000t(-10000)e^{-10000t} + e^{-10000t}(-640{,}000) + 40(-10000)e^{-10000t}\right]$$

$\frac{dV_c}{dt} = 0$ when $-640{,}000t(-10{,}000) - 640{,}000 + 40(-10000) = 0$

$t = 162.5\mu s$

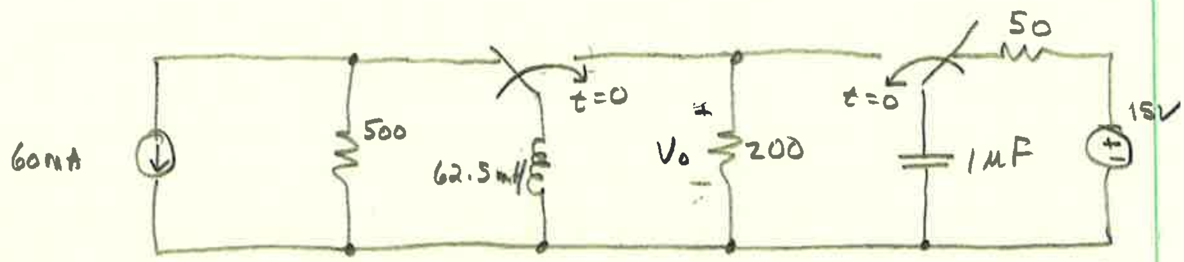
$$\boxed{v(162.5\mu s) = -12.60\,V}$$

d) what % of initial energy is stored when $i_c(t) = 0$?

$$W_0 = \tfrac{1}{2}CV_0^2 + \tfrac{1}{2}L i_L^2 = 544\mu J$$

$$W(162.5\mu s) = \tfrac{1}{2}(C)(-12.6)^2 + \tfrac{1}{2}(.02)\left(\frac{-12.6}{100}\right)^2 = 198.5\,\mu J$$

$$\%\text{ remaining} = \frac{200.7}{544} \times 100\,\% = \boxed{36.5\%}$$



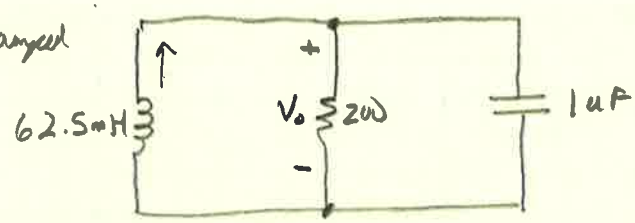
FIND $V_o(t)$ for $t \geq 0$

1) FIND I.C.'s Before switches are flipped

$i_L(0) = 60$ mA $\quad V_c(0) = 15V$

2) Find $V_o(t)$ For $t \geq 0$.

$\sigma = \frac{1}{2RC} = 2500$
$\omega_0 = \sqrt{\frac{1}{LC}} = 4000$ } underdamped



$S_{1,2} = -2500 \pm j\,3122.5$ Rad/s

$\omega_d = 3122.5$

$v_o = B_1 e^{-2500t} \cos 3122.5t + B_2 e^{-2500t} \sin 3122.5t$

(1) $v_o(0^+) = B_1 = 15$

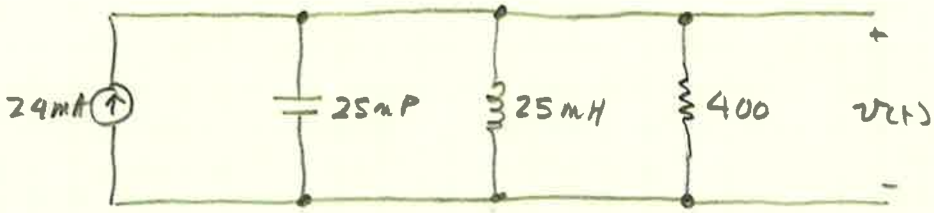
$$\frac{d v(0^+)}{dt} = -\alpha B_1 + \omega_d B_2 = \frac{1}{C}\left(-\frac{V_0}{R} - I_0\right)$$

$$-2500 B_1 + 3122.5 B_2 = -15{,}000$$

$B_2 = 7.206$

$$v_o(t) = 15 e^{-2500t} \cos 3122.5t + 7.206 e^{-2500t} \sin 3122.5t$$

Given :



$i_L(0) = v_c(0) = 0$

$i_L(t) = (24 - 32e^{-20,000t} + 8e^{-80,000t})\text{ mA} \quad t \geq 0$

---

a) Find $v(t)$ for $t \geq 0$

$v_L = L\frac{di_L}{dt} = v(t)$

$= (.025)[640{,}000e^{-20,000t} - 640000e^{-80,000t}] \times 10^{-3}$

$\boxed{v(t) = 16[e^{-20,000t} - e^{-80,000t}]\text{ V}}$

b) Find $i_R(t)$

$i_r(t) = \frac{V_R(t)}{R} = \frac{v(t)}{R} = \boxed{40[e^{-20,000t} - e^{-80,000t}]\text{ mA}}$

c) Find $i_c(t)$

$i_c(t) = C\frac{dv_c(t)}{dt} = 25\times10^{-9}[16(-20{,}000)e^{-20,000t} + 16(80{,}000)e^{-80,000t}]$

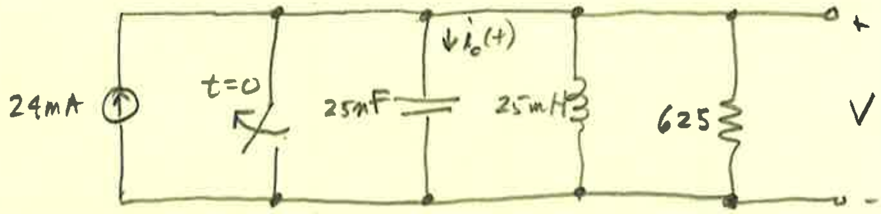
$\boxed{i_c(t) = -8e^{-20,000t} + 32e^{-80,000t}\text{ mA}}$

For $t \geq 0$, Find $v(t)$ + $i_c(t)$

$v_c(0) = i_L(0) = 0$

$i_c(\infty) = V(\infty) = 0$

$i_L(\infty) = 24mA$



$$\alpha = \frac{1}{2RC} = \frac{1}{2(625)(25\times10^{-9})} = 32{,}000 \text{ Rad/sec}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{25\times10^{-3}(25\times10^{-9})}} = 40{,}000 \text{ Rad/sec}$$

$\omega_0 > \alpha$ So roots are underdamped $\omega_d = \sqrt{\omega_0^2 - \alpha^2} = 24{,}000$ Rad/s

$$V_c(t) = v_{cf} + e^{-\alpha t}(B_1 \cos \omega_d t + B_2 \sin \omega_d t)$$

$$= 0 + e^{-32{,}000t}(B_1 \cos 24{,}000t + B_2 \sin 24{,}000t)$$

$V_c(0) = 0 = B_1$

$$V_c(t) = e^{-32{,}000t} B_2 \sin 24{,}000t$$

$i_c(0^+) = 24mA$ since i_L can't change from 0 @ 0^- and i_r " " " " " " or V_c change instantaneously

$$i_c(0^+) = C\frac{dV_c}{dt}\Big|_{t=0^+} = C\left[e^{-32{,}000t} B_2 (24000) \cos 24000t + B_2 \sin \cdots\right]$$

$$24mA = 25\times10^{-9}(24000) B_2 \Rightarrow B_2 = 40$$

$$\boxed{V(t) = 40e^{-32{,}000t} \sin 24{,}000t \ V}$$

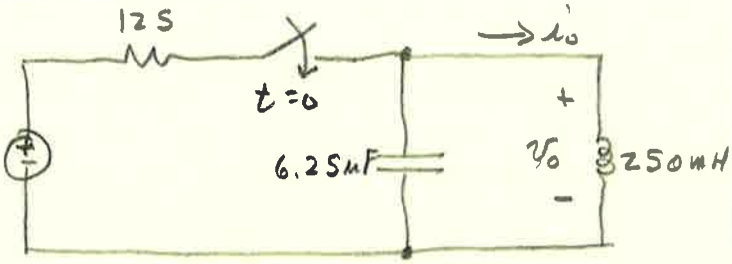
$$i_c(t) = C\frac{dV_c(t)}{dt} = C\left[40(24{,}000)e^{-32000t} \cos 24{,}000t + \sin 24{,}000t\,(40)(-32000)e^{-32000t}\right]$$

$$\boxed{i_c(t) = 24e^{-32{,}000t} \cos 24{,}000t - 32e^{-32{,}000t} \sin 24{,}000t \ mA}$$

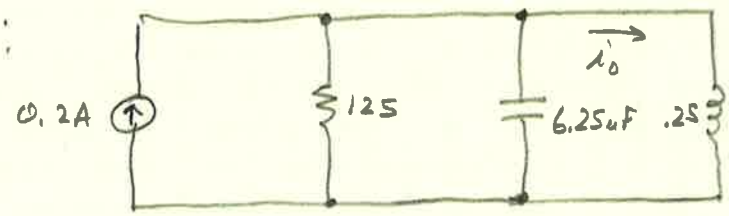
8.30 Nilsson 11th

$V_C(0) = i_L(0) = 0$

FIND $i_o(t)$ for $t \geq 0$.



Do a source transformation:



$\alpha = \frac{1}{2RC} = 640 \qquad \omega_0 = \frac{1}{\sqrt{LC}} = 800$

$\omega_0 > \alpha$ so response is underdamped

$\omega_d = \sqrt{\omega_0^2 - \alpha^2} = 480$

$i_o = i_F + B_1 e^{-640t} \cos 480t + B_2 e^{-640t} \sin 480t$

$i_F = 0.2A$

$i_o(0) = 0 = .2 + B_1 \Rightarrow B_1 = -0.2$

$\frac{di_o}{dt}(0) = B_1 [e^{-640t}(-\sin 480t)(480) + \cos 480t [-640 e^{-640t}]]$

$+ B_2 [e^{-640t} \cos 480t (480) + \sin 480t (e^{-640t})(-640)]$

$= B_1 [-640] + B_2 [480]$

But $L\frac{di_L}{dt}$ cannot change instantaneously so $= 0$ @ $t = 0^+$

So $0 = [-.2(-640)] + B_2(480)] \Rightarrow B_2 = -0.2667$

$i_o(t) = 0.2 - 0.2e^{-640t} \cos 480t - 0.2667e^{-640} \sin 480t$ A $\quad t \geq 0$