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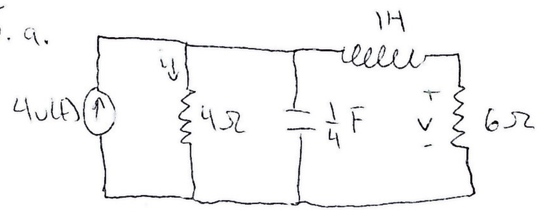
EECS 215 HW 8

5. a.



when $t<0$, source free circuit $\therefore$ $\boxed{\begin{array}{l} i(0^+) = 0\text{ A} \\ v(0^+) = 0\text{ V} \end{array}}$

b. KCL: $-4 + i(0^+) + i_c(0^+) + i_L(0^+) = 0$

$-4 + 0 + i_c(0^+) + 0 = 0$

$i_c(0^+) = 4\text{ A}$

$C \dfrac{dv_c(0^+)}{dt} = i_c(0^+)$

$\dfrac{dv_c(0^+)}{dt} = 4 \cdot 4 = 16\text{ V/s}$

$V_L(0^+) = L \dfrac{di_L(0^+)}{dt}$

$0 = \dfrac{di_L(0^+)}{dt}$

$i(0^+) = \dfrac{V_c(0^+)}{4}$

$\dfrac{di(0^+)}{dt} = \dfrac{1}{4} \dfrac{dV_c(0^+)}{dt} = \dfrac{16}{4} = \boxed{4\text{ A/s}}$

$V(0^+) = i_L(0^+) R$

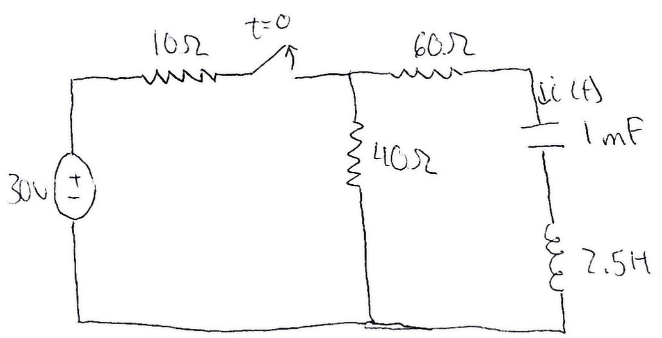
$= \boxed{0\text{ V/s}}$

c. $i(\infty) = 4\left(\frac{6}{10}\right) = \boxed{2.4\text{A}}$

$i_L(\infty) = 4 - i(\infty) = 1.6\text{A}$

$v(\infty) = i_L(\infty) R = \boxed{9.6\text{V}}$

16.



for t<0:

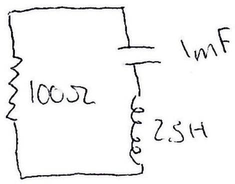
$i(0^-) = 0\,A$

$V_c(0^-) = 30\left(\frac{40}{40+10}\right) = 24V$

$i(0) = 0\,A$

$V(0) = 24\,V$

for t>0



KVL

$$Ri(t) + V_c(t) + L\frac{di(t)}{dt} = 0$$

$$i(t) = C\frac{dV_c(t)}{dt}$$

$$RC\frac{dV_c(t)}{dt} + V_c(t) + \frac{LC\,d\left(\frac{dV_c(t)}{dt}\right)}{dt} = 0$$

$$\frac{d^2 V_c(t)}{dt} + \frac{R}{L}\frac{dV_c(t)}{dt} + \frac{1}{LC}V_c(t) = 0$$

$\alpha = 20$ rad/sec

$\omega = 20$ rad/sec

∴ critically damped

$V_c(t) = (A_1 + A_2 t)e^{-20t}$

~~$v(0) = (24 + A_2 t)$~~

$A_1 = 24V$

$\frac{dv_c(t)}{dt} = -20A_1 + A_2$

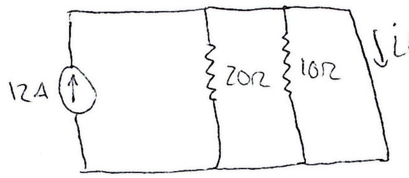
$0 = -20(24) + A_2$

$A_2 = 480$

$i(t) = 10^{-3} \cdot (-9600\,te^{-20t})$

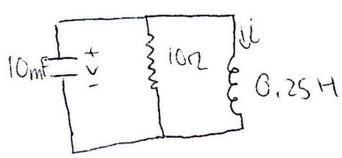
$\boxed{i(t) = -9.6\,te^{-20t}\ A}$

24. for $t<0$



$i(0^-) = 12\text{ A}$

for $t>0$



$\alpha = 5 \text{ rad/s}$ → under damped

$W_0 = 20 \text{ rad/s}$

$\omega = \sqrt{20^2 - 5^2} = 19.365$

$$i(t) = e^{-\alpha t}(B_1 \cos \omega t + B_2 \sin \omega t)$$

$$= e^{-5t}(B_1 \cos 19.365t + B_2 \sin 19.365t)$$

$$i(0) = (1)(B_1(1) + B_2(0)) = 12$$

$$12 = B_1$$

$$\frac{di(t)}{dt} = e^{-5t}(-5B_1 \cos 19.365t - 5B_2 \sin 19.365t - 19.365 B_1 \sin 19.365t + 19.365 B_2 \cos 19.365t)$$

$$\frac{di(0)}{dt} = 0 = -5B_1 + 19.365 B_2$$

$B_2 = 3.098$ $\therefore$ $\boxed{i(t) = e^{-5t}(12 \cos 19.365t + 3.098 \sin 19.365t)\text{ A}}$

29. a. $\dfrac{d^2v}{dt^2} + 4v = 12$

$v(0) = 0$

$\dfrac{dv(0)}{dt} = 2$

$W_0 = 2$

$V_s = 3$

under damped

$A_1 = -3$

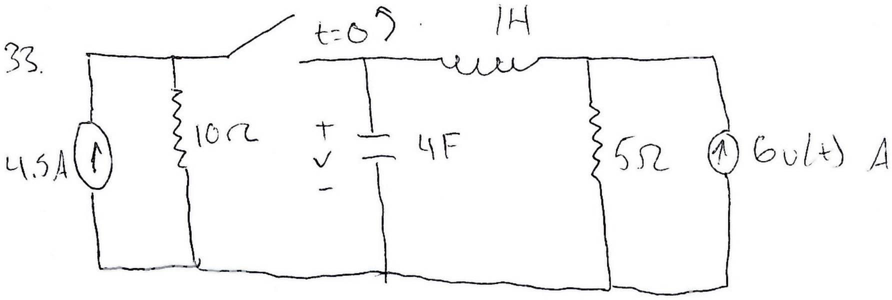
$2A_2 = 2$

$A_2 = 1$

$\boxed{v(t) = (3 - 3\cos 2t + \sin 2t)\text{ V}}$

$$v(t) = V_s + (A_1 \cos \omega_d t + A_2 \sin \omega_d t)e^{-\alpha t}$$

33.



for t<0

$i_L = \frac{10}{10+5} \cdot 4.5 = 3A$

$V_c = 3 \cdot 5 = 15V$

$\boxed{v(t) = 30 + 0.3077e^{-4.95t} + 14.693e^{-0.05t}}$

for t>0

$V = 6 \cdot 5 = 30V$

$\alpha = 2.5$

$\omega_0 = 0.5 \rightarrow$ overdamped

$s_1 = -0.0505$

$s_2 = -4.944$

$V_{ss} = 30V$

$15 = A_1 + A_2 + 30$

$0.202(-15 = A_1 + A_2)$

$-3 = -0.202A_1 + 19.796A_2$

$-6.03 = -19.594A_2$

$A_2 = +.3077$

$A_1 = -14.6923$

55.

$i(0^+) = 2A$

Apply La Place Transform

$$\frac{V(s)}{10s} + \frac{V(s)+4}{2+2s} = I_1 + 15$$

$$I_1 = \frac{V(s)}{10}$$

$$\frac{V(s)+4}{2+2(s)} = I(s)$$

$$V(s) = 2I(s)$$

$$\frac{V(s)+4}{2+2s} = \frac{V(s)}{2}$$

$$2V(s) + 8 = 2V(s) + 2sV(s)$$

$V(s) = \frac{8}{2s} \rightarrow$ inverse La Place $\rightarrow$ $\boxed{v(t) = 4u(t)}$