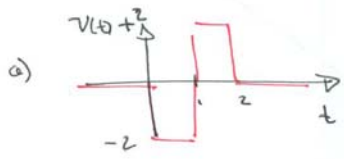
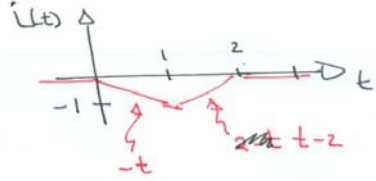
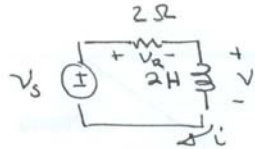
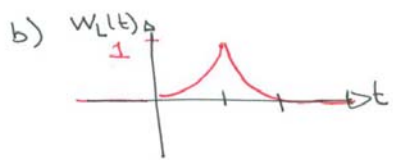


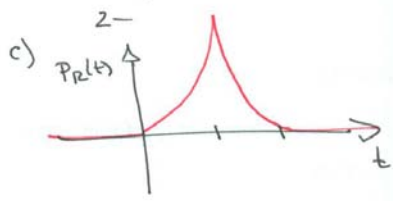
3.2



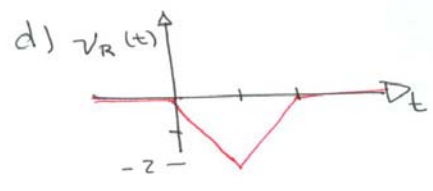
$$v_L(t) = L \frac{di}{dt} = 2 \frac{di}{dt}$$



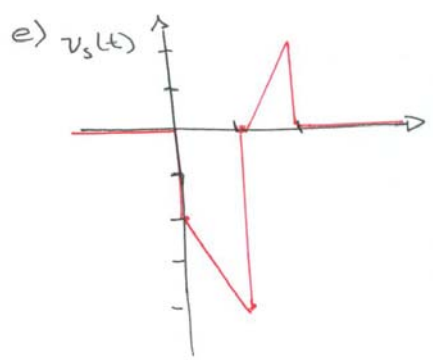
$$w_L(t) = \frac{1}{2} L i^2(t) = \frac{1}{2} (2H) i^2(t)$$



$$p_R(t) = i v = R i^2(t) = 2 i^2(t)$$

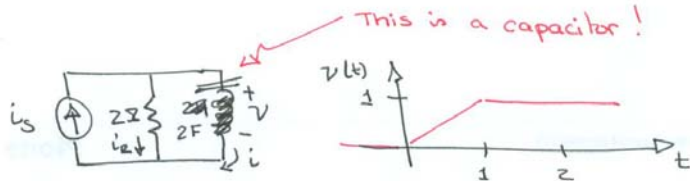


$$v_R(t) = i R = 2 i(t)$$

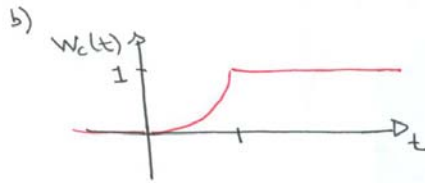


$$v_s(t) = v_R(t) + v_L(t)$$

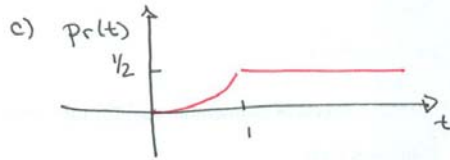
3.8



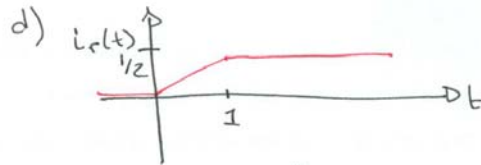
$$i(t) = C \frac{dv}{dt} = 2 \frac{dv}{dt}$$



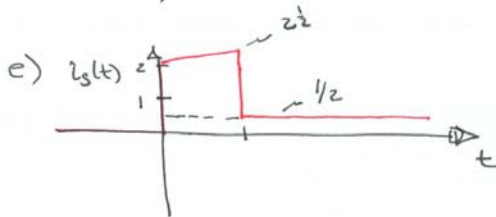
$$w_c(t) = \frac{1}{2} C v^2(t) = \frac{1}{2} (2) v^2$$



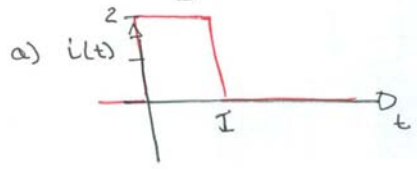
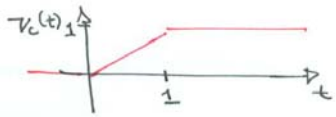
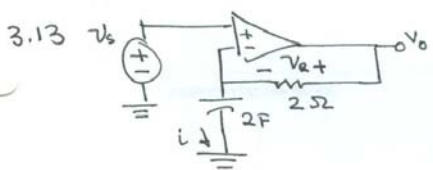
$$p_r(t) = v_R i_R = v_R^2(t) / R = v_c^2 / 2$$



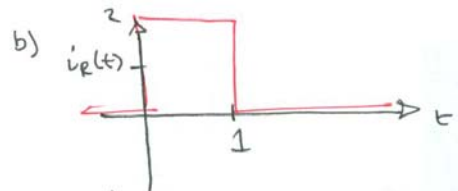
$$i_R(t) = v_R(t) / R = v_c(t) / 2$$



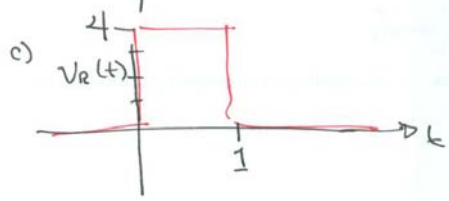
$$i_s(t) = i_R(t) + i_c(t)$$



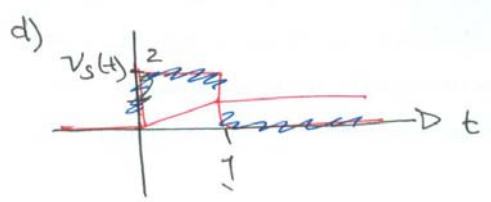
$$i(t) = C \frac{dV}{dt} = 2 \frac{dV}{dt}$$



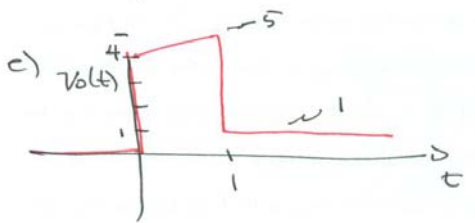
$$i_R(t) = i_C(t)$$



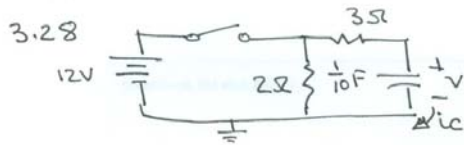
$$v_R(t) = i_R(t) R = 2 i_R$$



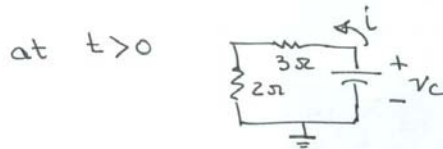
$$v_s(t) = v_c(t)$$



$$v_o(t) = v_c(t) + v_R(t)$$



Switch opens at $t=0$
 at $t < 0$, $v_c = 12\text{V}$



$$v_c + 3i + 2i = 0$$

$$v_c + 5i = 0$$

$$i_c = C \frac{dv}{dt} \Rightarrow \frac{1}{10} \frac{dv}{dt} + v_c + 5 \left(\frac{1}{10} \frac{dv}{dt} \right) = 0$$

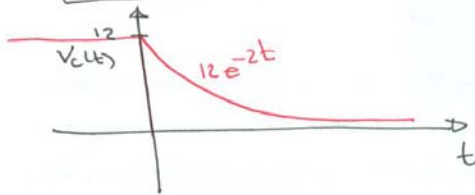
$$\boxed{v_c(t) + \frac{1}{2} \frac{dv}{dt} = 0} \quad \text{or} \quad \boxed{2v_c(t) + \frac{dv}{dt} = 0}$$

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

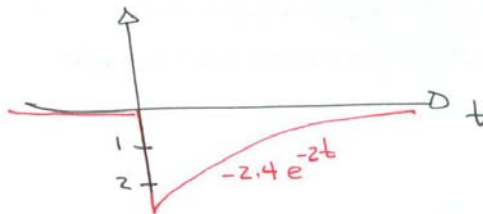
$$\tau = RC = (5\Omega)(\frac{1}{10}\text{F}) = \frac{1}{2}\text{sec}$$

$$V_0 = 12\text{V}$$

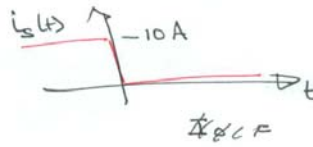
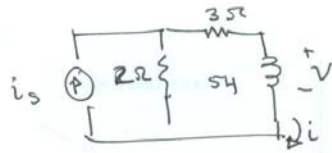
$$\boxed{v_c(t) = 12 e^{-2t}}$$



$$i_c(t) = -\frac{v_c(t)}{R} = -\frac{12}{5} e^{-2t} = \boxed{-2.4 e^{-2t}}$$



3.30



after $t=0$

$$\text{KVL: } i(2\Omega) + i(3\Omega) + L \frac{di}{dt} = 0$$

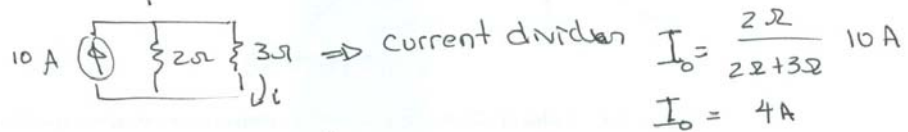
$$5i + 5 \frac{di}{dt} = 0$$

$$i(t) + \frac{di}{dt} = 0$$

$$\tau = \frac{L}{R} = \frac{5}{5} = 1 \text{ sec}$$

$$i(t) = I_0 e^{-t/\tau}$$

at $t < 0$, inductor is open circuit

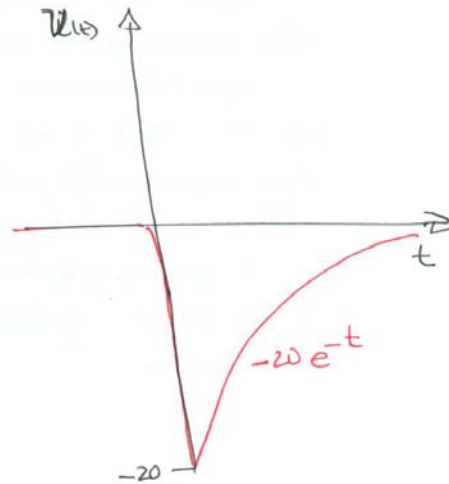
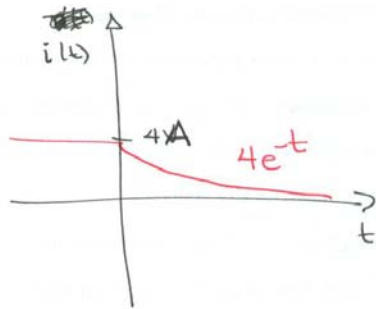


$$I_0 = \frac{2\Omega}{2\Omega + 3\Omega} 10 \text{ A}$$

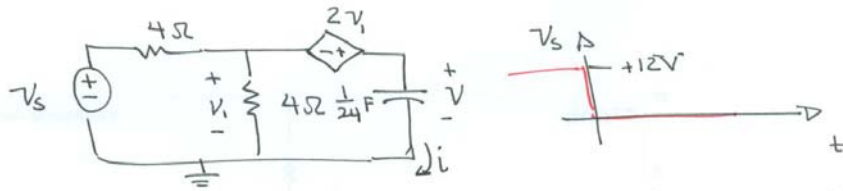
$$I_0 = 4 \text{ A}$$

$$i(t) = (4 \text{ A}) e^{-t}$$

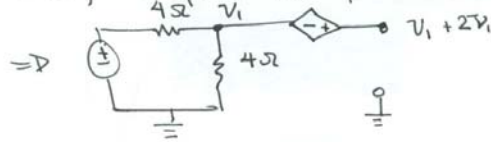
$$v(t) = L \frac{di}{dt} = 5 (-1)(4 \text{ A}) e^{-t} = -20 e^{-t}$$



3.34



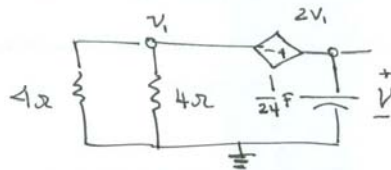
at $t < 0$, cap is an open circuit (fully charged)



We get v_1 from voltage division, $v_1 = \frac{4}{4+4} 12 = 6V$

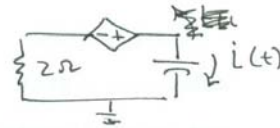
$$V(t < 0) = 6V + 2(6V) = 18V$$

for $t > 0$



$$v(t) = 3v_1(t)$$

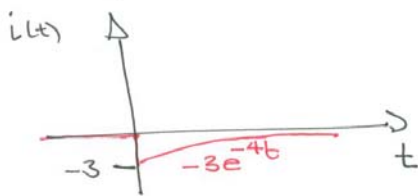
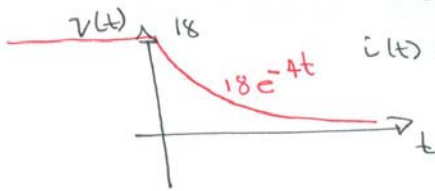
$$R_{11} = \frac{(4)(4)}{4+4} = 2\Omega$$



$$i(t)(2\Omega) + 2v_1 - v(t) = 0$$

$$6i(t) - v(t) = 0$$

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



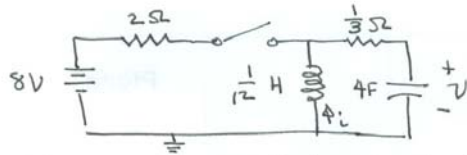
$$6\left(-\frac{1}{24} \frac{dv}{dt}\right) - v(t) = 0$$

$$4v(t) + \frac{dv}{dt} = 0$$

$$v(t) = 18e^{-4t}$$

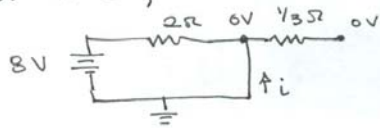
$$i(t) = -3e^{-4t}$$

3.57



switch opens at $t=0$
find $v(t)$ and $i(t)$

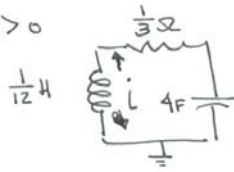
for $t < 0$, Inductor is short circuit, capacitor is open circuit



$$v(t < 0) = 0V$$

$$i(t < 0) = -\frac{8V}{2\Omega} = -4A$$

for $t > 0$



SERIES RLC

$$\alpha = \frac{R}{2L} = \frac{\frac{1}{3}\Omega}{2 \cdot \frac{1}{2}H} = 2$$

$$\omega_n = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{\frac{1}{2} \cdot 4}} = \frac{1}{\sqrt{1/3}} = \sqrt{3} \approx 1.7$$

$\alpha > \omega_n \Rightarrow$ overdamped

$$s_1 = -\alpha - \sqrt{\alpha^2 - \omega_n^2} = -2 - \sqrt{4 - 3} = -2 - 1 = -3$$

$$s_2 = -\alpha + \sqrt{\alpha^2 - \omega_n^2} = -2 + 1 = -1$$

$$v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

@ $t=0 \Rightarrow A_1 + A_2 = 0V$
 $A_1 = -A_2$

$$i(t) = C \frac{dv}{dt} = 4 (A_1 s_1 e^{s_1 t} + A_2 s_2 e^{s_2 t})$$

$$= -12 A_1 e^{s_1 t} - 4 A_2 e^{s_2 t}$$

@ $t=0 \Rightarrow -12 A_1 - 4 A_2 = -4$

for $t > 0$

$$v(t) = \frac{1}{2} e^{-3t} - \frac{1}{2} e^{-t}$$

$$i(t) = -6 e^{-3t} + 2 e^{-t}$$

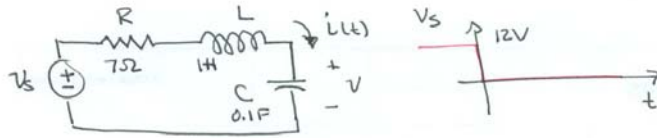
$$12 A_1 + 4(-A_1) = 4$$

$$8 A_1 = 4 \Rightarrow A_1 = \frac{1}{2}$$

$$A_2 = -\frac{1}{2}$$

For those who use $-8V$ source, all signs change.

3-63



for $t < 0$, Capacitor in open circuit $\Rightarrow I_0 = 0 \text{ A}$
 $V_0 = 12 \text{ V}$

for $t > 0$:

$$\alpha = \frac{R}{2L} = \frac{7\Omega}{2 \cdot 4} = \frac{7}{8} = 3.5$$

$$\omega_n = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1/10}} = \sqrt{10} = 3.16$$

$\alpha > \omega_n \Rightarrow$ overdamped

$$s_1 = -\alpha - \sqrt{\alpha^2 - \omega_n^2} = -3.5 - 1.5 = -5$$

$$s_2 = -\alpha + 1.5 = -2$$

$$v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

$$i(t) = C \frac{dv}{dt} = \frac{1}{10} s_1 A_1 e^{s_1 t} + \frac{1}{10} s_2 A_2 e^{s_2 t}$$

To determine A_1 and A_2 apply the Boundary Conditions @ $t=0$

voltage: $A_1 + A_2 = V_0 = 12 \text{ V}$

current: $-\frac{5}{10} A_1 - \frac{2}{10} A_2 = 0$

$$A_1 = -\frac{2}{5} A_2$$

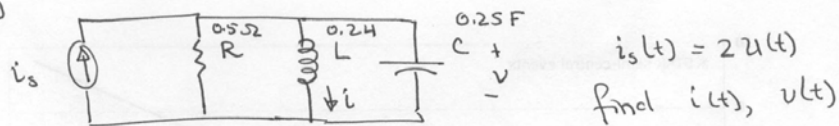
$$-\frac{2}{5} A_2 + A_2 = 12 \text{ V} \Rightarrow \frac{3}{5} A_2 = 12 \text{ V} \Rightarrow A_2 = 20 \frac{\text{V}}{3}$$

$$A_1 = -8$$

$$v(t) = -8 e^{-5t} + 20 e^{-2t}$$

$$i(t) = +4 e^{-5t} - 4 e^{-2t}$$

3.69



at $t < 0$; $i(t < 0) = 0$, $v(t < 0) = 0$

for $t > 0$, for a parallel RLC circuit

$$\frac{d^2 i}{dt^2} + \frac{1}{RC} \frac{di}{dt} + \frac{1}{LC} i = \frac{I}{LC} u(t)$$

$$\frac{d^2 i}{dt^2} + 8 \frac{di}{dt} + 20 i = 40 u(t)$$

$$2\alpha = 8, \quad \omega_n^2 = 20$$

$$\alpha = 4, \quad \omega_0 = \sqrt{20} = 4.47 \Rightarrow \text{underdamped}$$

$$\omega_d = \sqrt{\omega_n^2 - \alpha^2} = \sqrt{20 - 16} = 2 \text{ rad/sec}$$

$$i(t) = 2 + e^{-4t} (A_1 \cos 2t + A_2 \sin 2t)$$

$$v(t) = L \frac{di}{dt} = \frac{1}{5} [(-4e^{-4t})(A_1 \cos 2t + A_2 \sin 2t) + (e^{-4t})(-2A_1 \sin 2t + 2A_2 \cos 2t)]$$

Apply conditions @ $t = 0$

$$i(t=0) = 0 = 2 + (A_1) \Rightarrow A_1 = -2$$

$$v(t=0) = 0 = \frac{1}{5} [(-4)(-2) + (1)(2A_2)]$$

$$-\frac{8}{5} = 2A_2 \Rightarrow A_2 = -\frac{4}{5}$$

$$\therefore \boxed{i(t) = 2 + e^{-4t} (-2 \cos 2t - 4 \sin 2t)}$$

$$v(t) = \frac{1}{5} [e^{-4t} ((-8 + 8) \cos 2t + (16 + 4) \sin 2t)]$$

$$\boxed{v(t) = 4e^{-4t} \sin 2t}$$