HW8 Chapter 6

Saturday, January 16, 2010
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6.46

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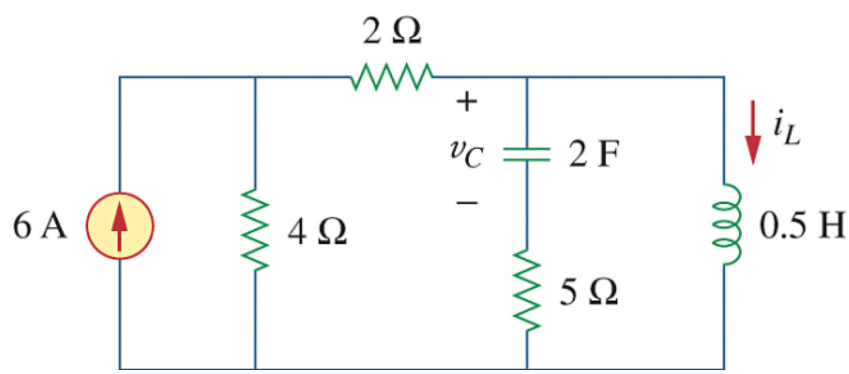
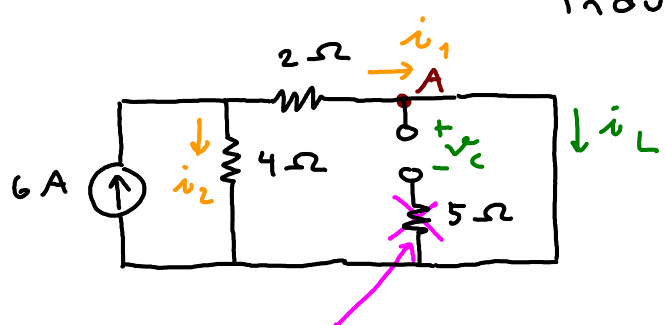


Under DC conditions, capacitor → open circuit
inductor → short circuit



No current through this resistor because of the open connection at the capacitor.

By current divider formula, $i_1 = 4\,A$
$i_2 = 2\,A$

$i_L = i_1 = 4\,A$

$v_c = v_A = 0\,V$ (There is a short connection from the top to the bottom of the circuit)

no current through the 5Ω resistor

The energy stored in the capacitor is $w_c = \frac{1}{2} C \overset{0}{v_c^2} = 0\,J$

The energy stored in the inductor is $w_L = \frac{1}{2} L i_L^2$

$$= \frac{1}{2} \times \frac{1}{2} \times 4^2 = 4\ J$$

$$\boxed{\begin{array}{ll} v_c = 0\ V & w_c = 0\ J \\ i_L = 4\ A & w_L = 4\ J \end{array}}$$

6.49

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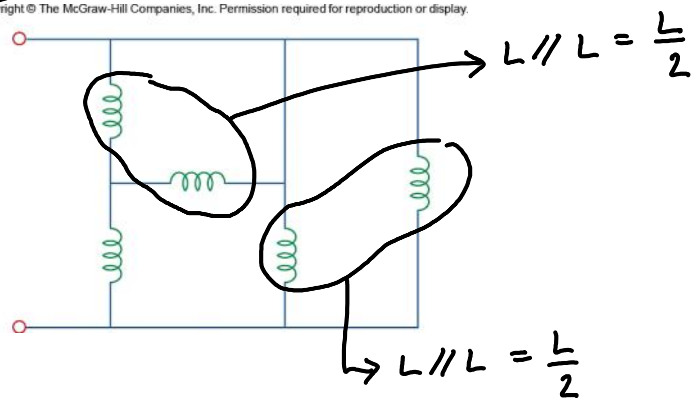
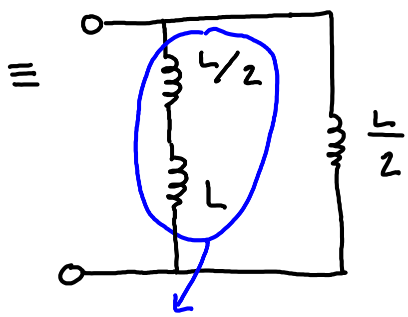


$\equiv$



$$\frac{L}{2} + L = \frac{3L}{2}$$

$$L_{eq} = \frac{3L}{2} /\!/ \frac{L}{2}$$

$$= \frac{L}{2}(3 /\!/ 1)$$

$$= \frac{L}{2}\,\frac{3}{4} = \frac{3L}{8}$$

When $L = 10$,

$$L_{eq} = \frac{3 \times 10}{8} = \boxed{3.75\ H}$$

6.56

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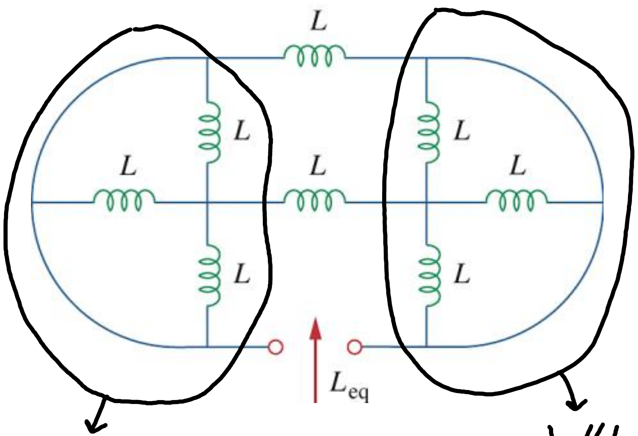
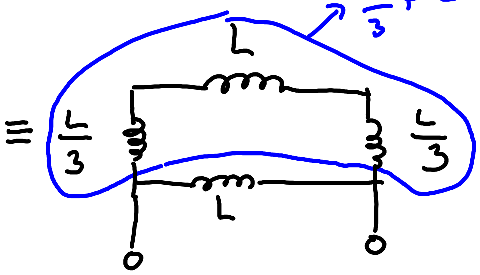


$L // L // L = \frac{L}{3}$

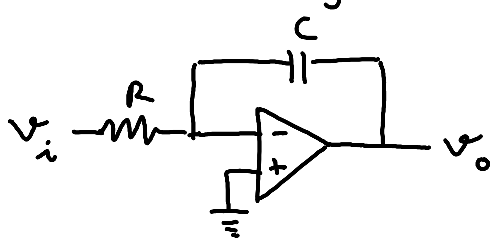
$L // L // L = \frac{L}{3}$

$\frac{L}{3} + L + \frac{L}{3} = \frac{5L}{3}$

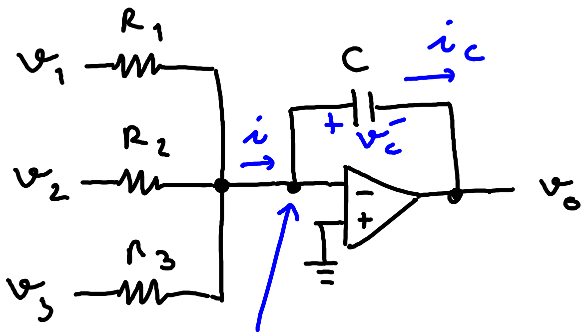


$L\left(\frac{5}{3} // 1\right) = \frac{\frac{5}{3}}{\frac{5}{3}+1} L = \boxed{\frac{5}{8} L}$

(6.71) In class, an integrator circuit is given in the following form:



We have seen how to extend an inverting amplifier into a summer. Here, we will use a similar extension:



$v_- = v_+ = 0$ V

In which case, we have

In which case, we have

$$i_C = i$$

$$C\frac{dv_C}{dt} \qquad i = \frac{v_1 - 0}{R_1} + \frac{v_2 - 0}{R_2} + \frac{v_3 - 0}{R_3}$$

$$v_C = 0 - v_o = -v_o$$

Therefore,

$$-C\frac{dv_o}{dt} = \frac{v_1}{R_1} + \frac{v_2}{R_2} + \frac{v_3}{R_3}$$

$$v_o(t) = -\int_0^t \frac{1}{R_1 C} v_1(\alpha) + \frac{1}{R_2 C} v_2(\alpha) + \frac{1}{R_3 C} v_3(\alpha)\, d\alpha$$

We want

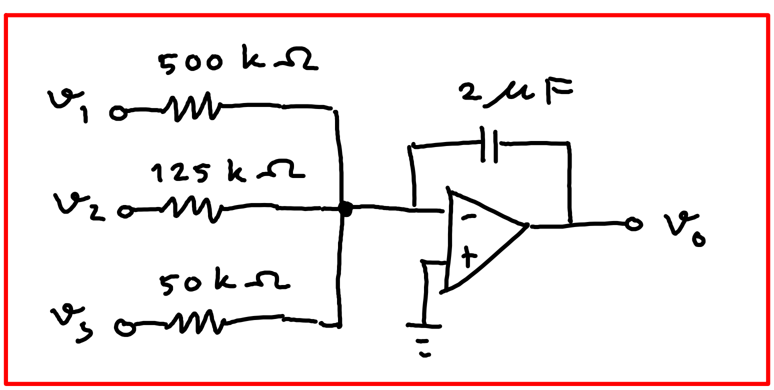
$$v_o(t) = -\int_0^t 1\, v_1(\alpha) + 4\, v_2(\alpha) + 10\, v_3(\alpha)\, d\alpha.$$

Hence,

$$\frac{1}{R_1 C} = 1 \Rightarrow R_1 = \frac{1}{C} = \frac{1}{2\mu} = 500\,k\Omega$$

$$\frac{1}{R_2 C} = 4 \Rightarrow R_2 = \frac{1}{4C} = 125\,k\Omega$$

$$\frac{1}{R_3 C} = 10 \Rightarrow R_3 = \frac{1}{10C} = 50\,k\Omega$$



6.73

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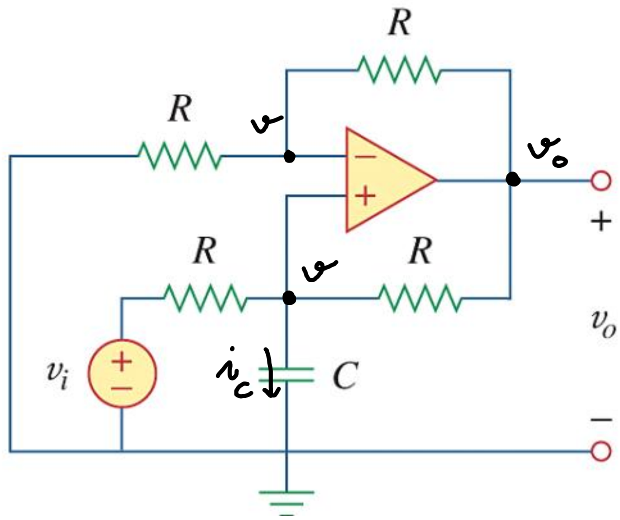

For ideal op amp: $v_- = v_+ \equiv v$

$i_- = i_+ = 0$

At the negative input terminal:

$$\frac{v-0}{R} + \frac{v-v_o}{R} = 0$$

$$2v = v_o \Rightarrow v = \frac{v_o}{2}$$

At the positive input terminal:

$$\frac{v-v_i}{R} + i_c + \frac{v-v_o}{R} = 0$$

$$i_c = C\frac{dv_c}{dt} = C\frac{d}{dt}(v-0) = C\frac{d}{dt}\left(\frac{v_o}{2}\right)$$

$$= \frac{C}{2}\frac{dv_o}{dt}$$

$$\cancel{\frac{v_o}{2}} - v_i + \frac{RC}{2}\frac{dv_o}{dt} + \cancel{\frac{v_o}{2}} - \cancel{v_o} = 0$$

$$\frac{dv_o}{dt} = \frac{2}{RC}v_i$$

$$\boxed{v_o(t) = v_o(t_o) + \frac{2}{RC}\int_{t_o}^{t} v_i(\alpha)\, d\alpha}$$

HW8 Ch7

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7.1

Remark: can find C by $i = C\frac{dv_c}{dt}$

Note that $v_c = -v$.

(b) $\tau = \frac{1}{200} = \boxed{5\ ms}$

(a) $R = \frac{v}{i} = \frac{56}{8\,m} = \boxed{7\ k\Omega}$

$C = \tau/R = \frac{5}{7k}\ mF = \boxed{0.714\ \mu F}$

$\tau = RC$

(c) $v(0) = v(0^+) = 56\ V$

no voltage jump for capacitor

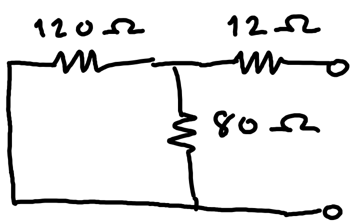
We want to find t such that

$v(t) = 56\,e^{-200t} = \frac{56}{2} = 28\ V$

$e^{-200t} = \frac{1}{2}$

$t = \frac{\ln 2}{200} = \boxed{3.466\ ms}$

7.2 First, find the Thevenin equivalent R at the capacitor's terminals



$R_{TH} = 12 + 120 // 80$

$= 12 + 48 = 60\ \Omega$

$\tau = R_{TH} \times C = 60 \times 0.5\ m = \boxed{30\ ms}$

7.3 R_{TH} at the terminals of capacitor

$= 10 + 40 // (20 + 30)\ k\Omega$

$$= 10 + 40 // 50 = 290/9 \ k\Omega$$

$$\tau = R_{TH} \times C = \frac{290}{9} k \times 100 \times 10^{-12} = \boxed{3.22 \ \mu s}$$

7.8

(b) $\tau = \boxed{\frac{1}{4} s}$

(a) $R = \frac{v}{i} = \frac{10}{0.2} = \boxed{50 \ \Omega}$

$$C = \frac{\tau}{R} = \frac{1}{4 \times 50} = \boxed{5 \ mF}$$

(c) $v(0^+) = 10 V = v(0)$

↑ no voltage jmp across capacitor

$$w_c = \frac{1}{2} \times C \times v_c^2 = \frac{1}{2} \times 5 \times 10^{-3} \times 10^2 = \boxed{0.25 J}$$

(d) $w_c(t) = \frac{1}{2} C \times v_c^2(t)$

$$w_c(0) = \frac{1}{2} C v_c^2(0)$$

Want to find t such that

$$w_c(t) = \frac{1}{2} w_c(0)$$

$$\cancel{\frac{1}{2}} \cancel{C} v_c^2(t) = \cancel{\frac{1}{2}} \times \frac{1}{2} \cancel{C} v_c^2(0)$$

$$v_c(t) = \frac{1}{\sqrt{2}} v_c(0)$$

$$\cancel{10} e^{-4t} = \frac{1}{\sqrt{2}} \cancel{10}$$

$$t = \frac{\ln \sqrt{2}}{4} = \boxed{87 \ ms}$$