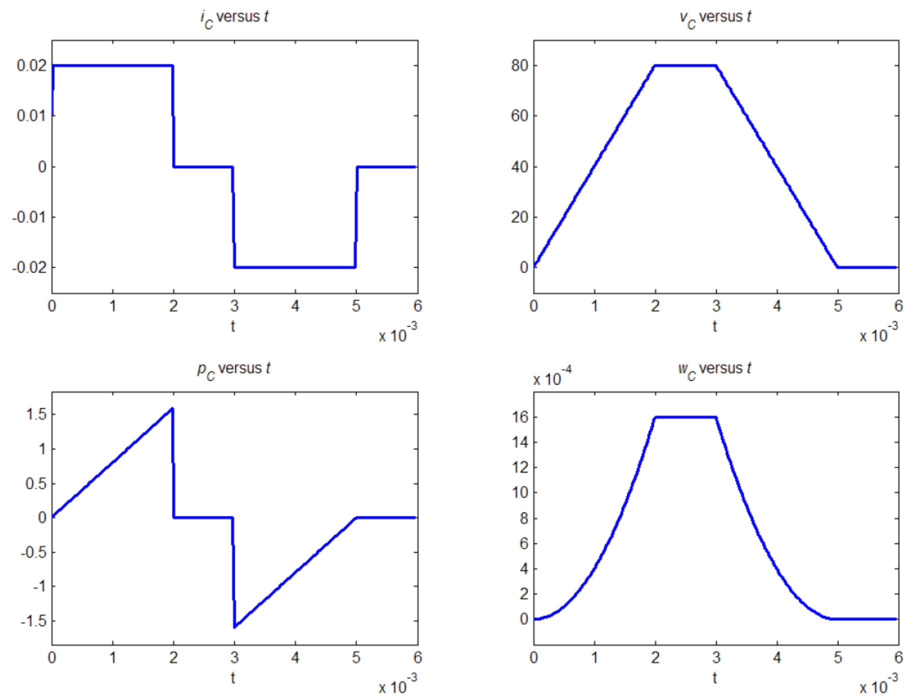
P3.14 $v(t) = \frac{1}{C}\int_0^t i(t)dt + v(0)$

$$v(t) = 2 \times 10^6 \int_0^t i(t)dt \qquad\qquad p(t) = v(t)i(t)$$

$$w(t) = \frac{1}{2}Cv^2(t) = 0.25 \times 10^{-6} \times v^2(t)$$

The sketches should be similar to the following plots. The units for the quantities in these plots are A, V, W, J and s.



P3.24* (a) $C_{eq} = 1 + \frac{1}{1/2 + 1/2} = 2\ \mu\text{F}$

(b) The two 4- F capacitances are in series and have an equivalent capacitance of $\frac{1}{1/4 + 1/4} = 2\ \mu\text{F}$. This combination is a parallel with the 2- F capacitance, giving an equivalent of 4 F. Then the 12 F is in series, giving a capacitance of $\frac{1}{1/12 + 1/4} = 3\ \mu\text{F}$. Finally, the 5 F is in parallel, giving an equivalent capacitance of $C_{eq} = 3 + 5 = 8\ \mu\text{F}$.

P3.27 We obtain the maximum capacitance of 6 μ F by connecting a 2- μ F capacitor in parallel with a 4- μ F. We obtain the minimum capacitance of 1.33 μ F by connecting the 2- μ F capacitor in series with the 4- μ F.

P3.35 The capacitance of the microphone is

$$C = \frac{\varepsilon_0 A}{d} = \frac{8.85 \times 10^{-12} \times 10 \times 10^{-4}}{100[1 + 0.003\cos(1000t)]10^{-6}}$$

$$\cong 88.5 \times 10^{-12}[1 - 0.003\cos(1000t)]$$

The current flowing through the microphone is

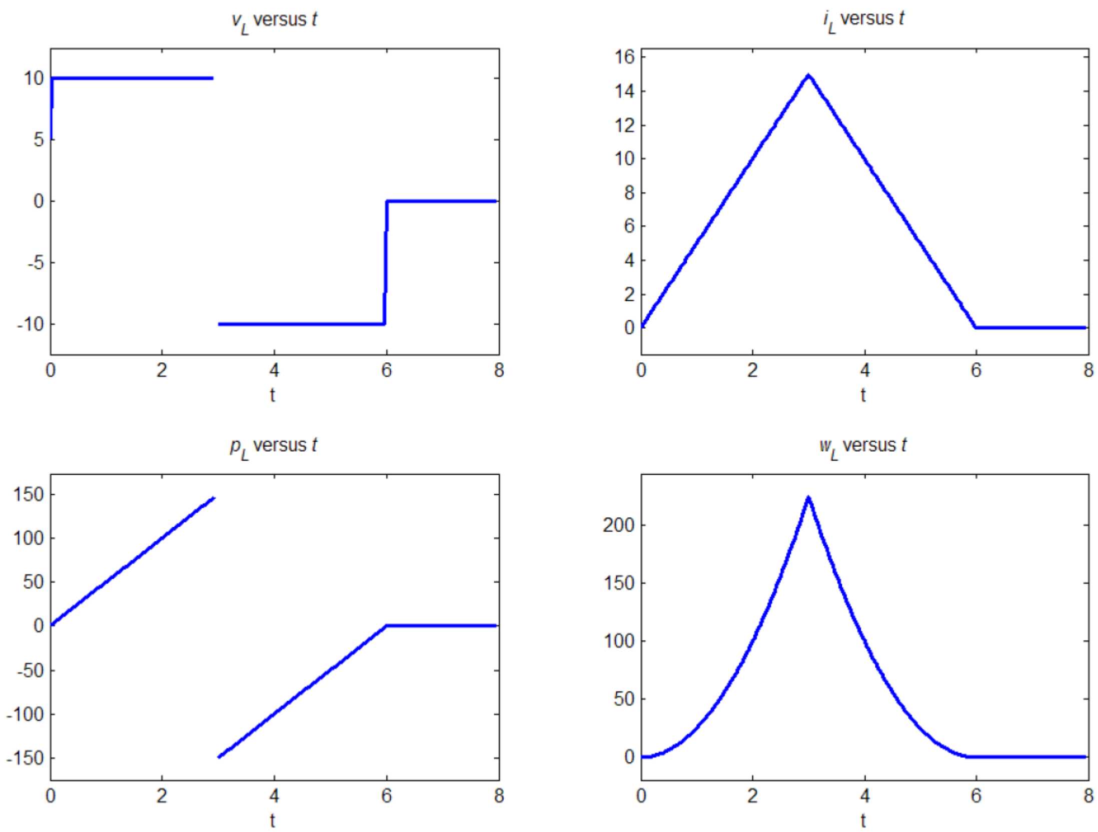
$$i(t) = \frac{dq(t)}{dt} = \frac{d[Cv]}{dt} \cong 53.1 \times 10^{-9}\sin(1000t) \quad A$$

P3.51 $L = 2\,\mathrm{H}$

$$i_L(t) = \frac{1}{L}\int_0^t v_L(t)dt + i_L(0) = \frac{1}{2}\int_0^t v_L(t)dt$$

$$w(t) = \frac{1}{2}L[i_L(t)]^2 = [i_L(t)]^2$$

The sketches should be similar to the following plots. The units for the quantities in these plots are A, V, W, J and s



P3.61 (a) The 2 H inductors and 0.5 H inductor have no effect because they are in parallel with a short circuit. Thus, $L_{eq} = 1\,\mathrm{H}$.

(b) The two 2-H inductances in parallel are equivalent to 1 H. Also, the 1 H in parallel with the 3 H inductance is equivalent to 0.75 H. Thus,
$L_{eq} = 1 + \dfrac{1}{1/(1+1) + 1/(2+0.75)} = 2.158\,\mathrm{H}$.

P3.73 (a) Refer to Figures 3.23 and P3.73. For the dots as shown in Figure P3.73, we have

$$v_1(t) = L_1 \frac{di_1(t)}{dt} + M \frac{di_2(t)}{dt} = 40\cos(20t) - 15\sin(30t)\ \mathrm{V}$$
$$v_2(t) = M \frac{di_1(t)}{dt} + L_2 \frac{di_2(t)}{dt} = 20\cos(20t) - 45\sin(30t)\ \mathrm{V}$$

(b) With the dot moved to the bottom of L_2, we have

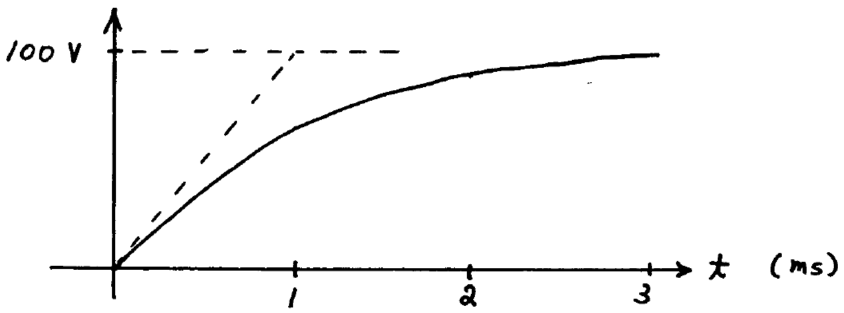
$$v_1(t) = L_1 \frac{di_1(t)}{dt} - M \frac{di_2(t)}{dt} = 40\cos(20t) + 15\sin(30t)\ \mathrm{V}$$
$$v_2(t) = -M \frac{di_1(t)}{dt} + L_2 \frac{di_2(t)}{dt} = -20\cos(20t) - 45\sin(30t)$$

P4.3 The solution is of the form given in Equation 4.19:

$$v_C(t) = V_s - V_s \exp(-t/RC)$$
$$RC = 10^5 \times 0.01 \times 10^{-6} = 1\,\mathrm{ms}$$

Thus, we have

$$v_C(t) = 100 - 100\exp\left(-t/10^{-3}\right)$$



P4.18 (a) The voltages across the capacitors cannot change instantaneously. Thus, $v_1(0+) = v_1(0-) = 100$ V and $v_2(0+) = v_2(0-) = 0$. Then, we can write

$$i(0+) = \frac{v_1(0+) - v_2(0+)}{R} = \frac{100 - 0}{100 \times 10^3} = 1 \text{ mA}$$

(b) Applying KVL, we have

$$-v_1(t) + Ri(t) + v_2(t) = 0$$

$$\frac{1}{C_1}\int_0^t i(t)dt - 100 + Ri(t) + \frac{1}{C_2}\int_0^t i(t)dt + 0 = 0$$

Taking a derivative with respect to time and rearranging, we obtain

$$\frac{di(t)}{dt} + \frac{1}{R}\left(\frac{1}{C_1} + \frac{1}{C_2}\right)i(t) = 0 \qquad (1)$$

(c) The time constant is $\tau = R\dfrac{C_1C_2}{C_1 + C_2} = 50$ ms.

(d) The solution to Equation (1) is of the form

$$i(t) = K_1 \exp(-t/\tau)$$

However, $i(0+) = 1$ mA, so we have $K_1 = 1$ mA and $i(t) = \exp(-20t)$ mA.

(e) The final value of $v_2(t)$ is

$$v_2(\infty) = \frac{1}{C_2}\int_0^\infty i(t)dt + v_2(0+)$$

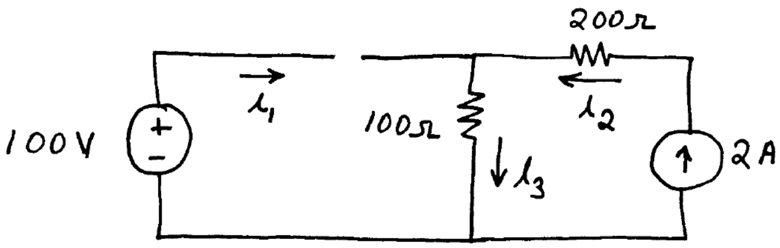
$$= 10^6 \int_0^t 10^{-3} \exp(-t/0.05)dt + 0$$

$$= 10^3(-0.05)\exp(-t/0.05)\Big|_0^\infty$$

$$= 50 \text{ V}$$

Thus, the initial charge on C_1 is eventually divided equally between C_1 and C_2.

P4.21* In steady state, the equivalent circuit is:

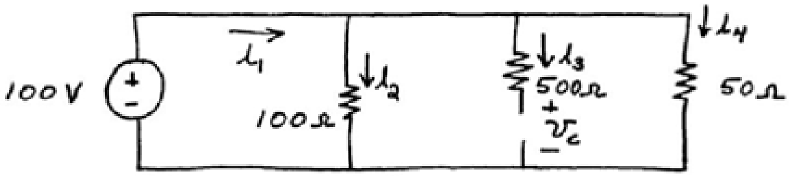


Thus, we have

$$i_1 = 0$$

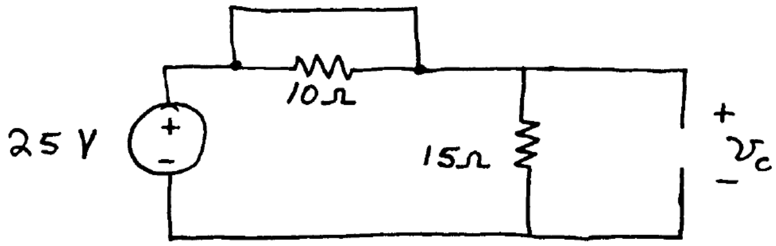
$$i_3 = i_2 = 2 \text{ A}$$

P4.23 In steady state with a dc source, the inductance acts as a short circuit and the capacitance acts as an open circuit. The equivalent circuit is:

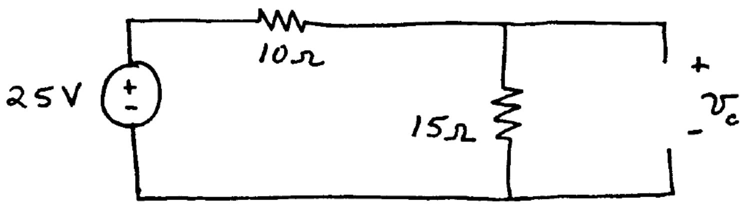


$i_4 = (100\text{V})/(50\Omega) = 2\text{ A}$
$i_3 = 0$
$i_2 = (100\text{V})/(100\Omega) = 1\text{A}$
$i_1 = i_2 + i_3 + i_4 = 3\text{A}$
$v_C = 100\text{ V}$

P4.25 Prior to $t = 0$, the steady-state equivalent circuit is:



and we see that $v_c = 25\text{ V}$.
A long time after $t = 0$, the steady-state equivalent circuit is:



and we have $v_c = 25\dfrac{15}{15+10} = 15\text{ V}$.

P4.33* In steady state with the switch closed, we have $i(t) = 0$ for $t < 0$ because the closed switch shorts the source.

In steady state with the switch open, the inductance acts as a short circuit and the current becomes $i(\infty) = 1\text{ A}$. The current is of the form

$$i(t) = K_1 + K_2 \exp(-Rt/L) \text{ for } t \ge 0$$

in which $R = 20\ \Omega$, because that is the Thévenin resistance seen looking back from the terminals of the inductance with the switch open. Also, we have

$$i(0+) = i(0-) = 0 = K_1 + K_2$$
$$i(\infty) = 1 = K_1$$

Thus, $K_2 = -1$ and the current (in amperes) is given by

$$i(t) = 0 \qquad \text{for } t < 0$$
$$= 1 - \exp(-20t) \qquad \text{for } t \geq 0$$

P4.36 The expression for the current $i_L(t)$ and volatge $v_L(t)$ is given by $i_L(t) = 0.5 - 0.5\exp(-200t)$ and $v_L = 100\exp(-200t)$

The general solution is of the form

$i(t) = K_1 + K_2 \exp(-Rt/L)$

Comparing it with the given expression of current,

$K_1 = 0.5$, $K_2 = -0.5$ and $R/L = 200$

At $t = 0+$, we have

$i(0+) = 0 = K_1 + K_2$

and at $t = \infty$, we have

$i(\infty) = V/R = K_1 = 0.5$

$$v_L(t) = L\frac{di}{dt} = L \times 100\exp(-200t) = 100\exp(-200t)$$

$L = 1$

$R = 200L = 200 \times 1 = 200$

$V = 0.5R = 0.5 \times 200 = 100\text{V}$