P2.57* $v_x = v_2 - v_1$

Writing KCL at nodes 1 and 2:

$$\frac{v_1}{5} + \frac{v_1 - 2v_x}{15} + \frac{v_1 - v_2}{10} = 1$$

$$\frac{v_2}{5} + \frac{v_2 - 2v_x}{10} + \frac{v_2 - v_1}{10} = 2$$

Substituting and simplifying, we have

$15v_1 - 7v_2 = 30$ and $v_1 + 2v_2 = 20$.

Solving, we find $v_1 = 5.405$ and $v_2 = 7.297$.

P2.59 First, we can write:

$$i_x = \frac{5i_x - v_2}{10}$$

Simplifying, we find $i_x = -0.2v_2$.

Then write KCL at nodes 1 and 2:

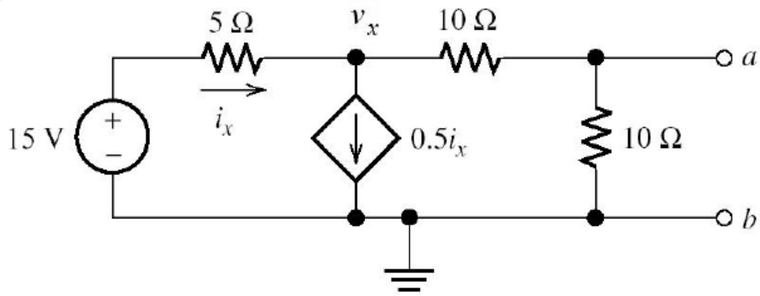
$$\frac{v_1 - 5i_x}{5} = 3 \qquad \frac{v_2}{10} - i_x = -1$$

Substituting for i_x and simplifying, we have

$v_1 - v_2 = 15$ and $0.3v_2 = -3$

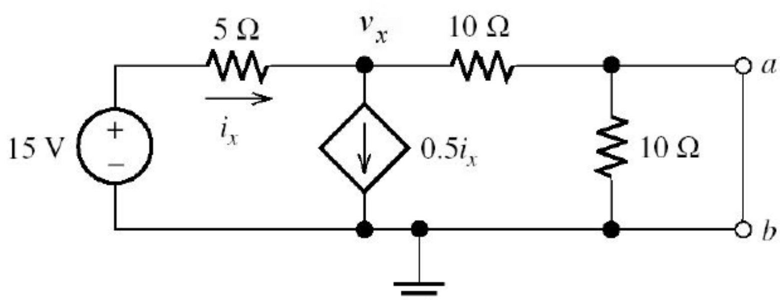
which yield $v_1 = 25$ V and $v_2 = -10$ V.

P2.88 Open-circuit conditions:

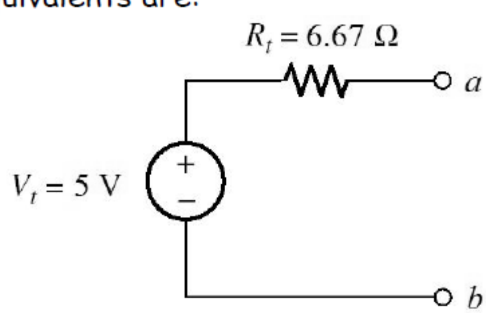


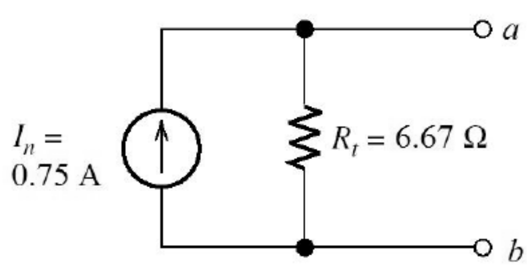
$$i_x = \frac{15 - v_x}{5} \qquad \frac{v_x}{10+10} - i_x + 0.5 i_x = 0$$ Solving, we find $v_x = 10$ V and then we have $V_t = v_{oc} = v_x \dfrac{10}{10+10} = 5$ V.

Short-circuit conditions:

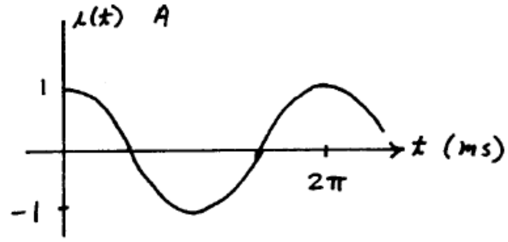


$$i_x = \frac{15 - v_x}{5} \qquad \frac{v_x}{10} - i_x + 0.5 i_x = 0$$ Solving, we find $v_x = 7.5$ V and then we have $i_{sc} = \dfrac{v_x}{10} = 0.75$ A. Then, we have $R_t = v_{oc}/i_{sc} = 6.67\ \Omega$. Thus the equivalents are:

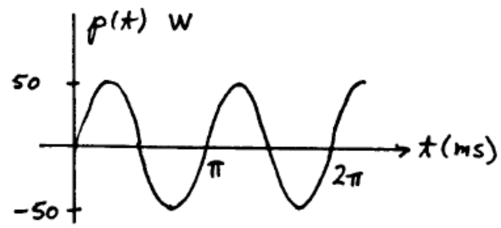




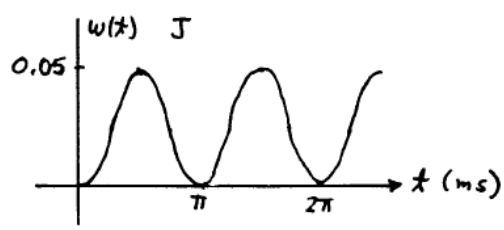
P3.6* $i(t) = C\dfrac{dv}{dt} = 10^{-5}\dfrac{d}{dt}(100\sin 1000t) = \cos(1000t)$



$p(t) = v(t)i(t) = 100\cos(1000t)\sin(1000t) = 50\sin(2000t)$



$w(t) = \dfrac{1}{2}C[v(t)]^2 = 0.05\sin^2(1000t)$



P3.7*

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

$$v(t) = 2\times 10^4 \int_0^t 3\times 10^{-3} dt - 20$$

$$v(t) = 60t - 20 \text{ V}$$

$$p(t) = i(t)v(t) = 3\times 10^{-3}(60t - 20)\text{ W}$$

Evaluating at $t = 0$, we have $p(0) = -60\text{ mW}$. Because the power has a negative value, the capacitor is delivering energy.
At $t = 1\text{ s}$, we have $p(1) = 120\text{ mW}$. Because the power is positive, we know that the capacitor is absorbing energy.

P3.8*

$$W = \text{power}\times\text{time} \quad = 5\text{ hp}\times 746\text{ W/hp}\times 3600\text{ s}$$

$$= 13.4\times 10^6\text{ J}$$

$$V = \sqrt{\frac{2W}{C}} = \sqrt{\frac{2\times 13.4\times 10^6}{0.01}} = 51.8\text{ kV}$$

It turns out that a 0.01-F capacitor rated for this voltage would be much too large and massive for powering an automobile. Besides, to have reasonable performance, an automobile would need much more than 5 hp for an hour.

P3.11

$$Q = Cv = 15\times 10^{-6}\times 500 = 7.5\text{ mC}$$

$$W = \frac{1}{2}Cv^2 = \frac{1}{2}\times 15\times 10^{-6}\times (500)^2 = 1.875\text{ J}$$

$$P = \frac{\Delta W}{\Delta t} = \frac{1.875}{4\times 10^{-6}} = 468.75\text{ kW}$$