# EE 100/42 Spring 2009

# Solutions to Homework 3

P 2.75 First, zeroing the source: voltage source ➔ short, current source ➔ open

$$R_t = \frac{5\times 10}{5+10} = 3.333\,\Omega$$

Then, write the node voltage equation: $\frac{10-v_{OC}}{10} + 1 = \frac{v_{OC}}{5}$, $v_{OC} = 6.667V$

Therefore, the Thevenin equivalent circuit is a 6.667 V voltage source in series with $R_t$ = 3.333Ω, and the Norton equivalent circuit is a 2A current source in parallel with $R_t$ = 3.333Ω.

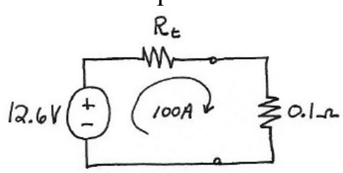
P 2.79 First, zeroing the source: $R_t = \frac{12\times 24}{12+24} = 8\,\Omega$

Notice that the 10 Ω resistor has no effect on the equivalent circuit because the voltage across the 12V source is independent of the resistor value.

Then, write the node voltage equation: $1 + \frac{v_a}{24} + \frac{v_a + 12}{12} = 0$, $v_a = -16V$

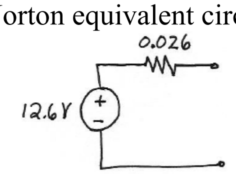
Therefore, the Thevenin equivalent circuit is a −16 V voltage source ($V_{ab} = -16V$) in series with $R_t$ = 8 Ω, and the Norton equivalent circuit is a −2 A current source ($I_{ab} = -2A$) in parallel with $R_t$ = 8 Ω.

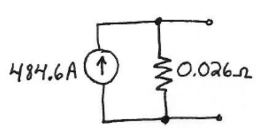
P 2.80 The Thevenin equivalent circuit is a 12.6 V voltage source in series with $R_t$ and 0.1 Ω load.




We then have $i = 100A = \frac{12.6}{R_t + 1}$, from which we find $R_t = 0.026\,\Omega$

The Thevenin equivalent circuit is a 12.6 V voltage source in series with $R_t$ = 0.026 Ω, and the Norton equivalent circuit is a 484.6 A current source in parallel with $R_t$ = 0.026 Ω.




Since no energy is converted from chemical form to heat in a battery under open-circuit conditions, the Thevenin equivalent seems more realistic from an energy conversion standpoint.

P 2.82 For a load of 7 ohm,

$$i_L = 7/7 = 1A$$

$$v_L = V_t - R_t i_L \quad \Rightarrow \quad 7 = V_t - R_t$$

For a load of 10 ohm

$$i_L = 8/10 = 0.8A$$

$$v_L = V_t - R_t i_L \quad \Rightarrow \quad 8 = V_t - 0.8R_t$$

Solve above equations, we can obtain $V_t = 12V$, $R_t = 5\Omega$

P 2.84 The maximum power is obtained for a load resistance equal to the Thevenin resistance.

Therefore, from P 2.75, $P_{\max} = \frac{(V_t/2)^2}{R_t} = \frac{(6.666/2)^2}{3.333} = 3.333W$

P 2.89 First, zero the current source and get the current due to the voltage source: $i_V = \frac{30}{15} = 2A$

Then, zero the voltage source and get the current due to the current source: $i_C = 3 \times \frac{10}{5+10} = 2A$

Therefore, the total current $i = i_V + i_C = 4A$

P 3.5 $Q = CV = (10 \times 10^{-6})(50) = 500\mu C$

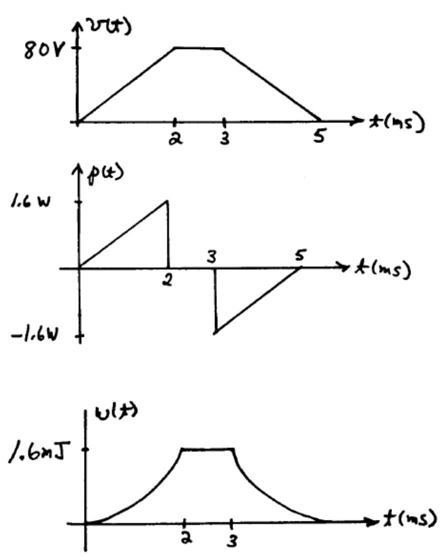
One plate has a net positive charge of 500 μC and the other has a net negative charge of 500 μC. The total net charge on both plates is zero.

P 3.11

$$v(t) = \frac{1}{C}\int_0^t i(t)dt + v(0) = 2 \times 10^6 \int_0^t i(t)dt$$

$$p(t) = v(t)i(t)$$

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




P 3.24 (a) $C_{eq} = 1 + \frac{1}{\frac{1}{2} + \frac{1}{2}} = 2\mu F$

(b) $$C_{eq} = \left( \left( \frac{1}{\frac{1}{4}+\frac{1}{4}} + 2 \right)^{-1} + \frac{1}{12} \right)^{-1} + 5 = 8\mu F$$

P 3.25 (a) $$C_{eq} = 3 + \left( \frac{1}{10} + \frac{1}{15} \right)^{-1} + \left( \frac{1}{12} + \frac{1}{(5+1)} \right)^{-1} = 13\mu F$$

(b) $$C_{eq} = \left( \frac{1}{10+8} + \frac{1}{4+5} \right)^{-1} = 6\mu F$$

P 10.22 If remove the diode, the Thevenin equivalent circuit consists of a 12V voltage source in series with a 3 kΩ resistor. Since this diode offers constant-current when V is greater than 1 V, we have $i_1 = 3.0mA$ and $i_2 = 6 - i_1 = 3.0mA$