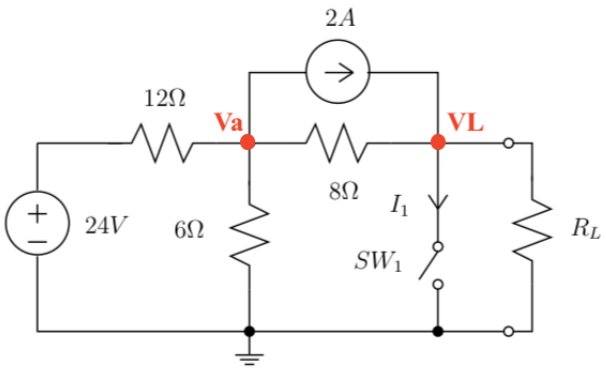
EEE 31 Problem Set 2 Answer Key

1. Consider node V_a and V_L,



For maximum power transfer, R_L should be equal to R_{TH} seen by the load when the switch is open.

$$R_{TH} = 8 + 12||6\ \Omega = 12\ \Omega = R_L$$

The voltage across the load can be computed using (1) and (2):

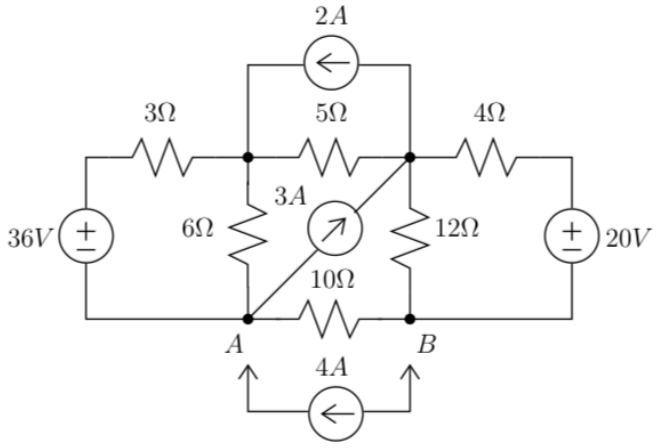
$$\frac{V_a - 24}{12\Omega} + \frac{V_a}{6\Omega} + \frac{V_a - V_L}{8\Omega} + 2 = 0 \quad (1)$$

$$\frac{V_L - V_a}{8\Omega} + \frac{V_L}{R_L} = 2 \quad (2)$$

Two equations two unknowns, V_L =12V.

$$P_L = \frac{{V_L}^2}{12} = 12W$$

2.



Without 4A connected:

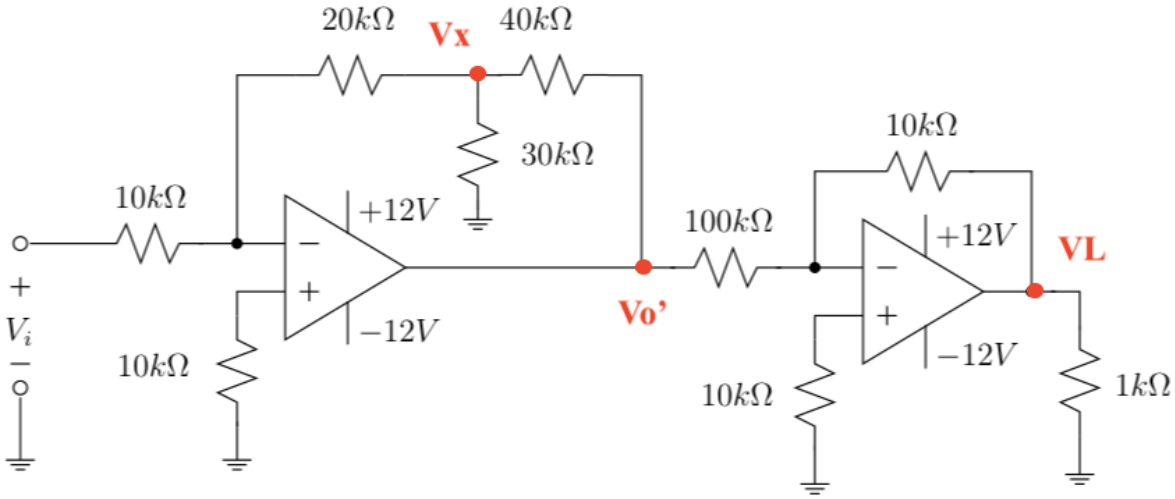
$V_{th,ab} = 10V$

$R_{th,ab} = \left(3\middle||6 + 5 + 4\middle||12\right)||10 = 5\Omega$

When 4A source is connected,

$$V_{ab} = (10 + 5 * 4)V = 30V$$

3.



The first half of the circuit will give a gain of:

$$\frac{0-V_i}{10k\Omega}+\frac{0-V_x}{20k\Omega}=0, \qquad \frac{Vx-0}{30k\Omega}+\frac{Vx-0}{20k\Omega}+\frac{V_x-V_o{}'}{40k\Omega}=0$$

$$V_o'=-\frac{26}{3}V_i=-13V$$

$$V_o'=-13V\rightarrow -12V$$

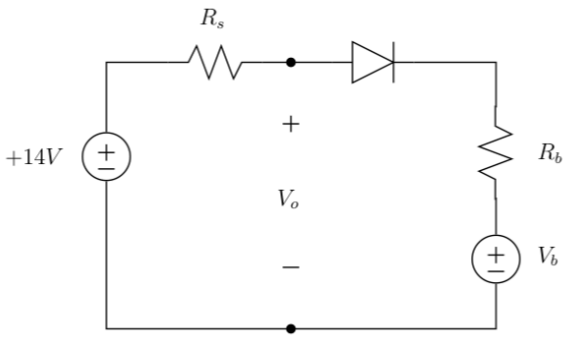
Combine with the gain of the second circuit:

$$\frac{0-V_o{}'}{100k\Omega}+\frac{0-V_L}{10k\Omega}=0$$

$$V_L=-\frac{1}{10}V_o'\rightarrow V_L=-\frac{1}{10}(-12)=1.2V$$

$$P_L=\frac{(1.2)^2}{1000\Omega}=1.44mW$$

4.



For an ideal diode, turn-on voltage is 0V. Let current *I* to be the current around the circuit.

Case 1:

Consider $V_b > 14V$

$$V_{diode}=(14-IR_s)-(V_b+IR_b)$$

For small R_s *and* R_b, we are sure that:

$$V_{diode}<0V \ \therefore Diode\ is\ open$$

$$V_o=14V-0R_s=14V$$

Case 2:

Consider $V_b \leq 14V$

$$V_{diode} = (14 - IR_s) - (V_b + IR_b)$$

For small $R_s \; and \; R_b$, we are sure that:

$$V_{diode} \geq 0V \;\; \therefore Diode \; is \; shorted$$

$$V_o = 14V - IR_s = V_b + IR_b$$

Current I is always positive:

$$V_o \leq 14V$$