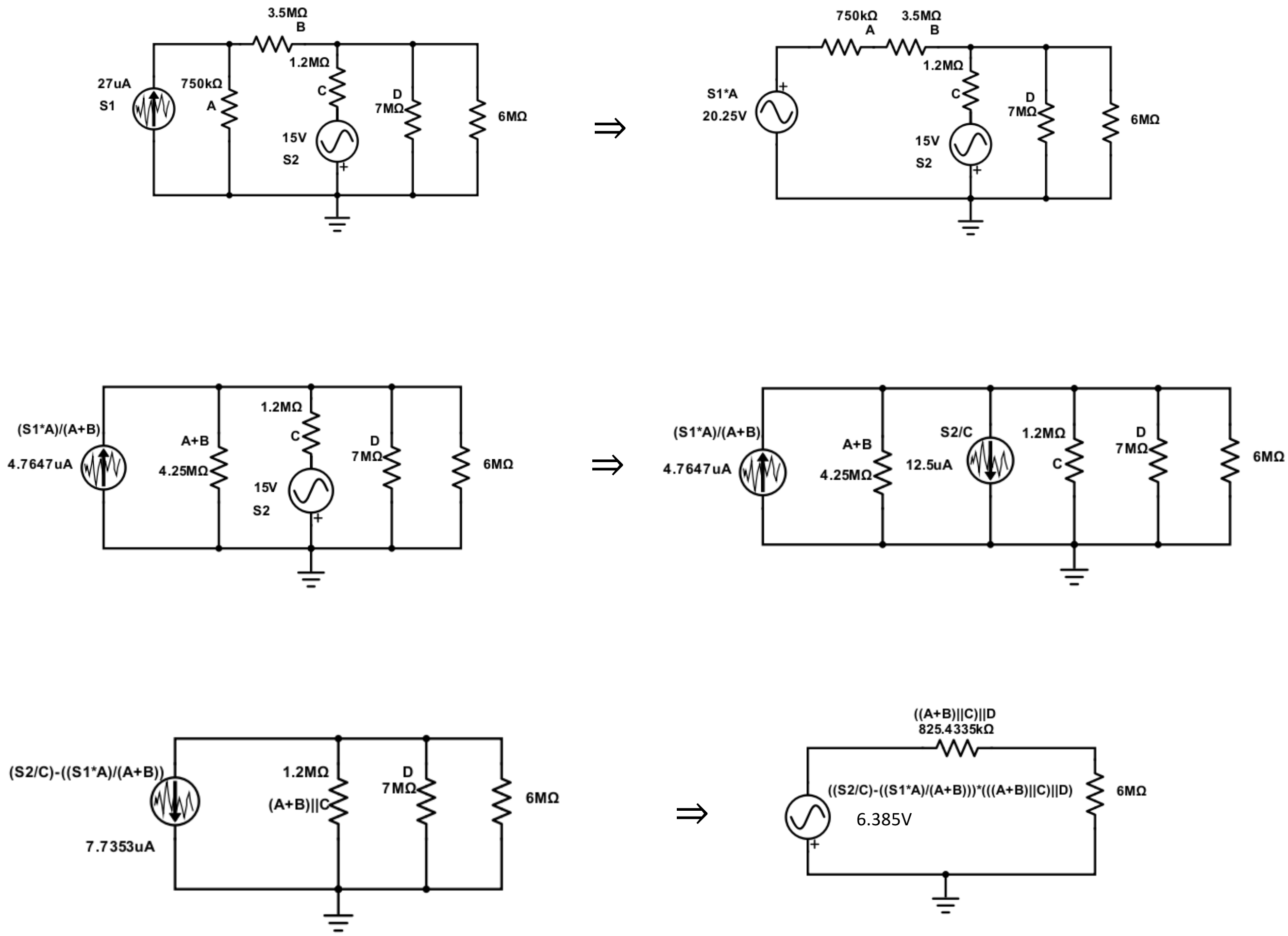
EEE 31 HW 3 Answer Key

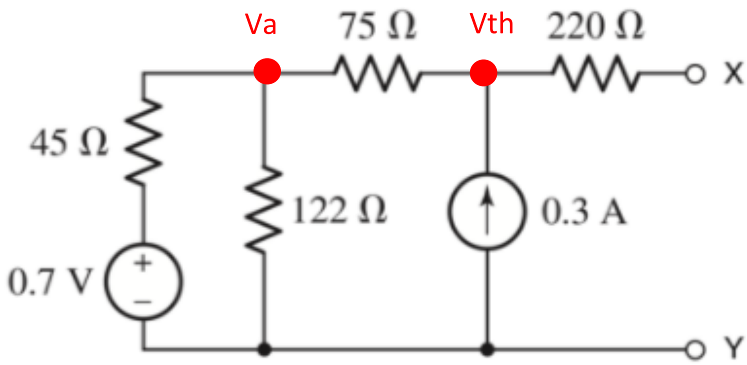
1. Follow the figure below to obtain the Thevenin equivalent circuit seen by the 6MΩ resistor.



$$V_{6M\Omega} = \frac{6M\Omega}{6M\Omega + 825.4335k\Omega}(6.358V) = -5.6128V$$

$$P_{6M\Omega} = \frac{(-5.6128V)^2}{6M\Omega} = 5.2506uW$$

2.



To find Rth, short voltage source and open current source.
Note: You can only do this when there is no independent source in the circuit.

$$R_{th} = (45||122) + 75 + 220 = 327.8743\Omega$$

To find Vth, find Voc.
Consider node voltage Va and Vth:

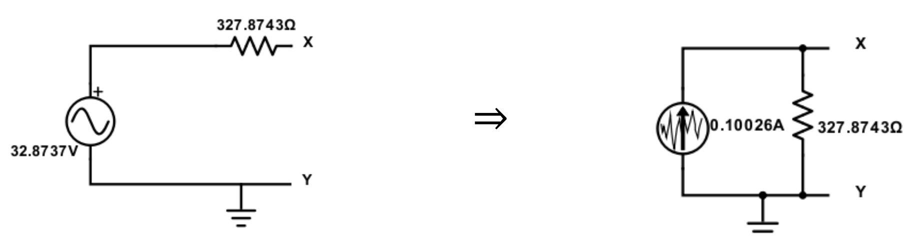
$$Equation\ 1: \quad \frac{V_a - 0.7V}{45\Omega} + \frac{V_a}{122\Omega} + \frac{V_a - V_{th}}{75\Omega} = 0$$

$$Equation\ 2: \quad \frac{V_{th} - V_a}{75\Omega} = 0.3$$

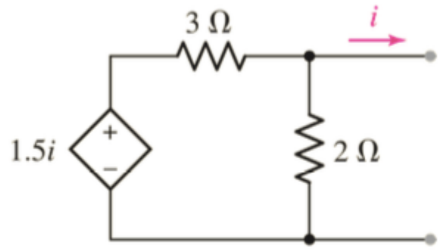
2 equations, 2 unknowns

$$V_{th} = 32.8737\ V$$

$$I_N = \frac{V_{th}}{R_{th}} = \frac{32.8737V}{327.8743\Omega} = 0.10026A$$



3.



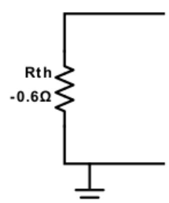
Apply Vtest, the resulting node voltage equation becomes:

$$\frac{V_t - 1.5i_t}{3\Omega} + \frac{V_t}{2\Omega} = i_t$$

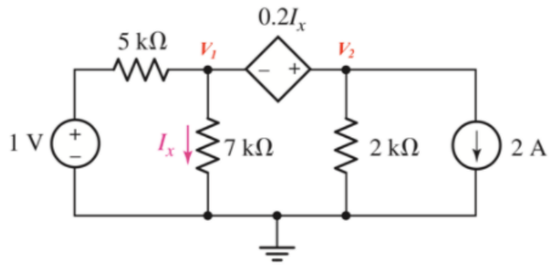
$$V_t(\frac{1}{3} + \frac{1}{2}) = i_t(1 - \frac{1.5}{3})$$

$$\frac{V_t}{i_t} = R_{th} = 0.6\Omega$$

No independent source is present in the circuit; therefore, Vth is ignored.



4.



Open current source:

$$Equation\ 1: \quad \frac{V_1{}' - 1}{5k\Omega} + \frac{V_1{}'}{7k\Omega} + \frac{V_2{}'}{2k\Omega} = 0$$

$$Equation\ 2: \quad V_2{}' - V_1{}' = 0.2I_x = 0.2(\frac{V_1{}'}{7k\Omega})$$

2 equations, 2 unknowns

$$V_1' = 0.2373\ V$$
$$V_2{}' = 0.2373V$$

Short voltage source:

$$Equation\ 1: \quad \frac{V_1{}'}{5k\Omega} + \frac{V_1{}'}{7k\Omega} + \frac{V_2{}'}{2k\Omega} + 2 = 0$$

$$Equation\ 2: \quad V_2{}' - V_1{}' = 0.2I_x = 0.2(\frac{V_1{}'}{7k\Omega})$$

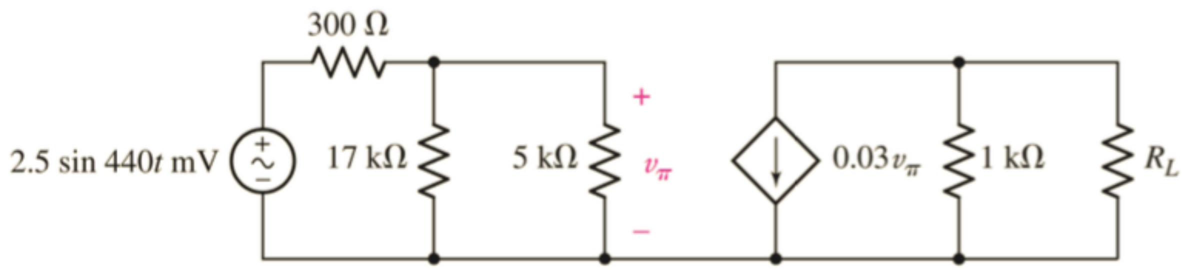
2 equations, 2 unknowns

$$V_1'' = -2372.9216\ V$$
$$V_2'' = -2372.9894\ V$$

Total:

$$V_1 = -2372.6843\ V$$
$$V_2 = -2372.7521\ V$$

5.



a. For maximum power transfer:

$$R_L = 1k\Omega$$

b.

$$v_{eff} = \frac{2.5mV}{\sqrt{2}}$$

$$v_\pi = \frac{17k\Omega||5k\Omega}{17k\Omega||5k\Omega + 300}(v_{eff}) = 1.6404mV$$

$$P_L = {I_L}^2 * R_L = \left(\frac{0.03 * 1.6404mV}{2}\right)^2 * 1k\Omega = 0.6055uW$$