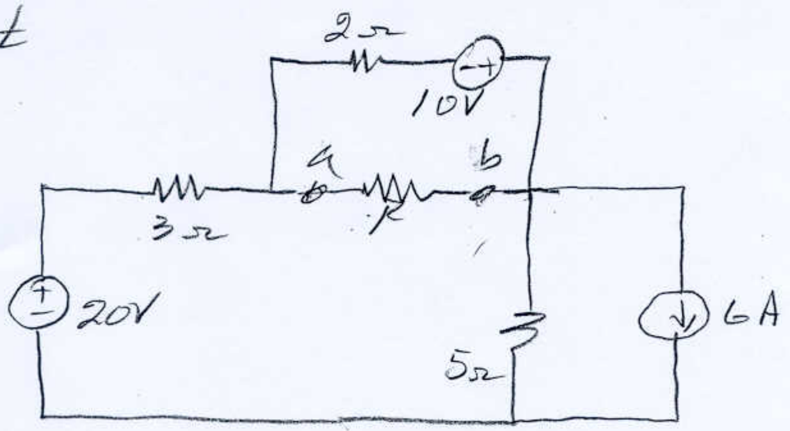
ECE 300
H.W. #4

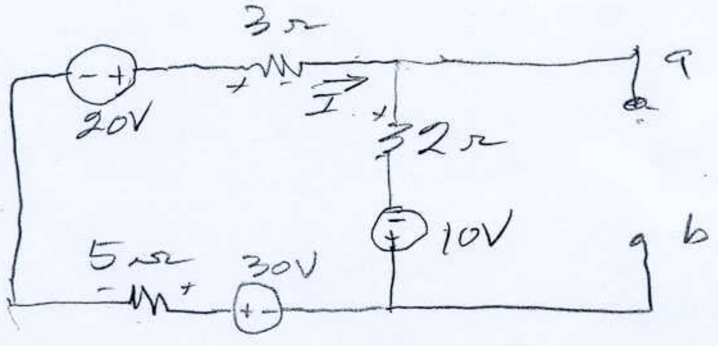
wlg

4.66

Find the maximum power that can be delivered to resistor R in the following circuit



Basically we need to find the Thevenin equivalent ckt looking into terminals a-b. Making a source transformation and re-drawing gives the following



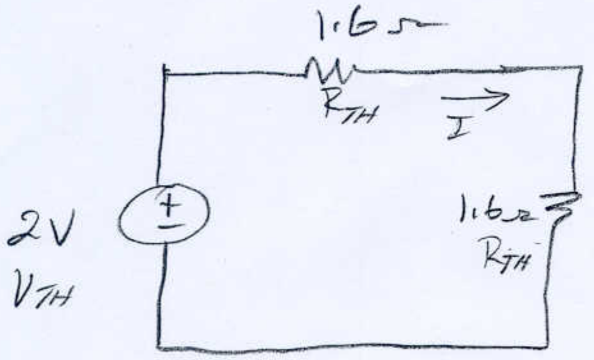
$$-20 + 10I - 10 - 30 = 0$$

$$10I = 60 \quad \text{so} \quad I = 6A$$

$$V_{ab} = -10 + 2\times 6 = \underline{2V}$$

$$R_{TH} = 2 \parallel 8 = \frac{16}{10} = \underline{1.6\Omega}$$

4.66 cont.



$$P_{LOAD} = I^2 R_{TH}$$

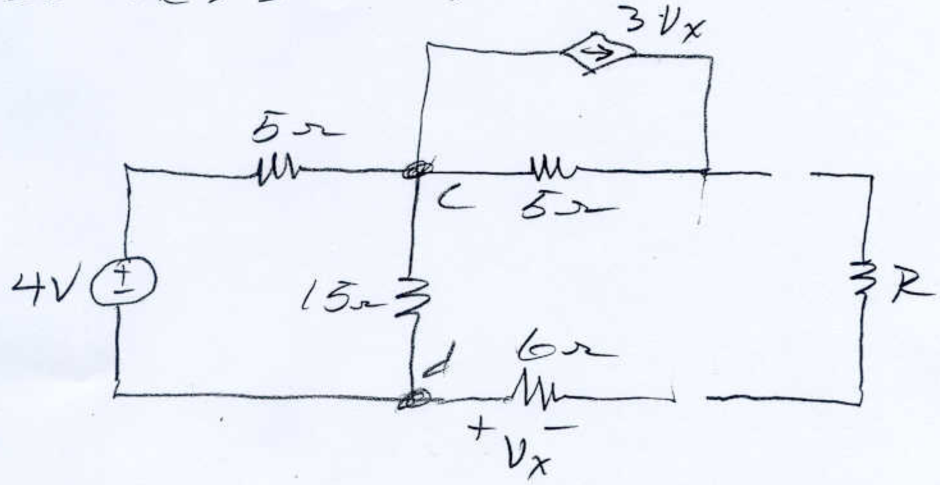
$$I = \frac{V_{TH}}{2R_{TH}}$$

$$P = \frac{V_{TH}^2 R_{TH}}{4R_{TH}^2} = \frac{V_{TH}^2}{4R_{TH}}$$

$$\boxed{P_{LOAD} = \frac{2^2}{4 \times 1.6} = 625\ mW}$$

4.70

Determine the maximum power delivered to resistor R.



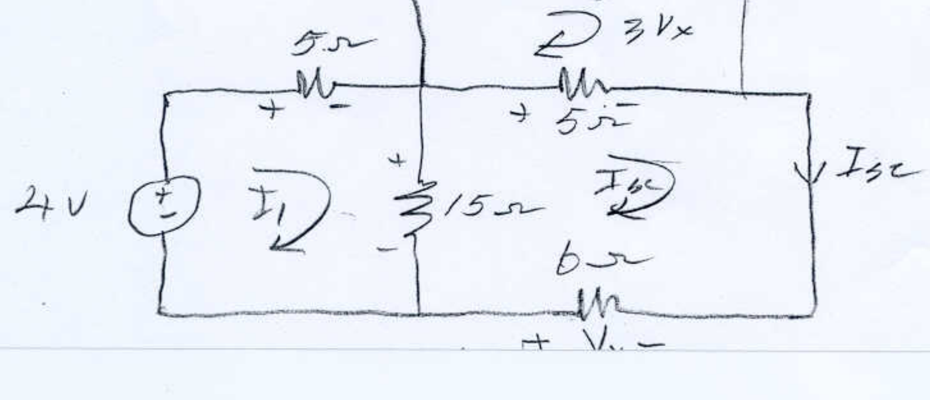
With R removed, there is no current in the 6 Ω resistor and thus $V_x = 0$. With $V_x = 0$, the dependent current source is 0. Therefore, we only need to find V_{cd}. Now

$$V_{cd} = \frac{4 \times 15}{5+15} = 3V = V_{OC} = V_{TH}$$

To find R_{TH} I will use

$$R_{TH} = \frac{V_{OC}}{I_{SC}} = \frac{V_{TH}}{I_N}$$

where I_{SC} comes from



4.70 cont

We have

$$-4 + 5I_1 + 15(I_1 - I_{sc}) = 0$$

$$\boxed{20I_1 - 15I_{sc} = 4} \qquad (1)$$

$$-15(I_1 - I_{sc}) + 5(I_{sc} - 3V_x) - V_x = 0$$

$$-15I_1 + 20I_{se} - 16V_x = 0$$

but $V_x = -6I_{sc}$

$$-15I_1 + 20I_{sc} - 16(-6I_{sc}) = 0$$

$$\boxed{-15I_1 + 116I_2 = 0} \qquad (2)$$

From (1) and (2)

$$\begin{bmatrix} 20 & -15 \\ -15 & 116 \end{bmatrix} \begin{bmatrix} I_1 \\ I_{sc} \end{bmatrix} = \begin{bmatrix} 4 \\ 0 \end{bmatrix}$$

$$I_{sc} = .02864 \text{ A}$$

$$R_{TH} = \frac{V_{oc}}{I_{sc}} = \frac{3}{.02864} = 104.75\,\Omega$$

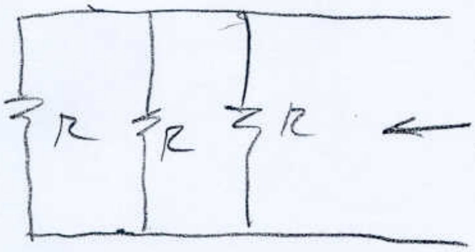
$$\boxed{R_{TH} = 104.75\,\Omega}$$

4.75

For the following circuit determine the value of R_L so that 3 mW will be delivered to R_L.

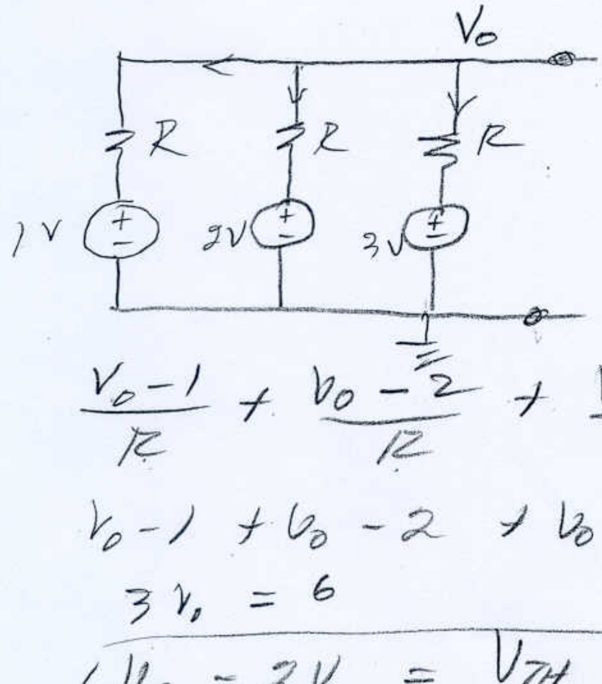
Find the Thevenin ckt.

For R_{TH} De-energize all indepent sources.



$$\boxed{R_{TH} = \frac{R}{3}}$$

We have



$$\frac{V_o - 1}{R} + \frac{V_o - 2}{R} + \frac{V_o - 3}{R} = 0$$

$$V_o - 1 + V_o - 2 + V_o - 3 = 0$$

$$3V_o = 6$$

$$\boxed{V_o = 2V = V_{TH}}$$

4.75 cont

$$P_{LOAD} = \frac{V_{TH}^2}{4R_L} = 3\times10^{-3}$$

$$\frac{2^2 \times \cancel{3}}{4 \times R} = \cancel{3}\times10^{-3}$$

$$\frac{1}{R} = 1\times10^{-3}$$

$$\boxed{R = 1\,k\Omega}$$