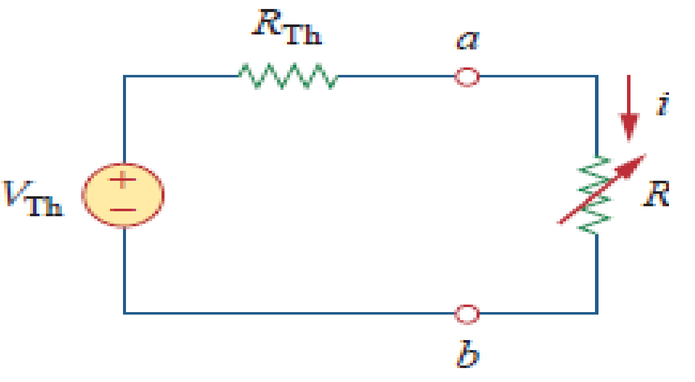
Chapter 5

Circuit Analysis Techniques
Maximum power transfer
And delta wye conversion

Maximum Power Transfer

Applicable on Thevenin or Norton circuits

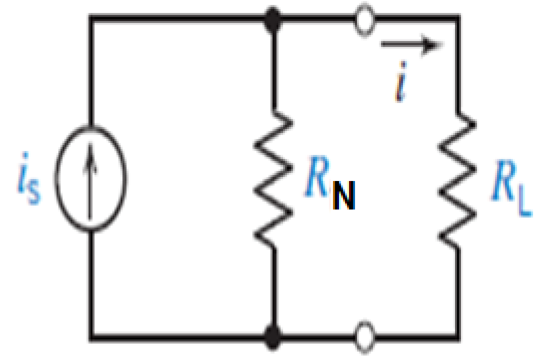
Maximum power occurs for R if
$R=R_{th}=R_N$



$$i=\frac{V_{th}}{R_{th}+R}=\frac{V_{th}}{R_{th}+R_{th}}=\frac{V_{th}}{2.R_{th}}$$

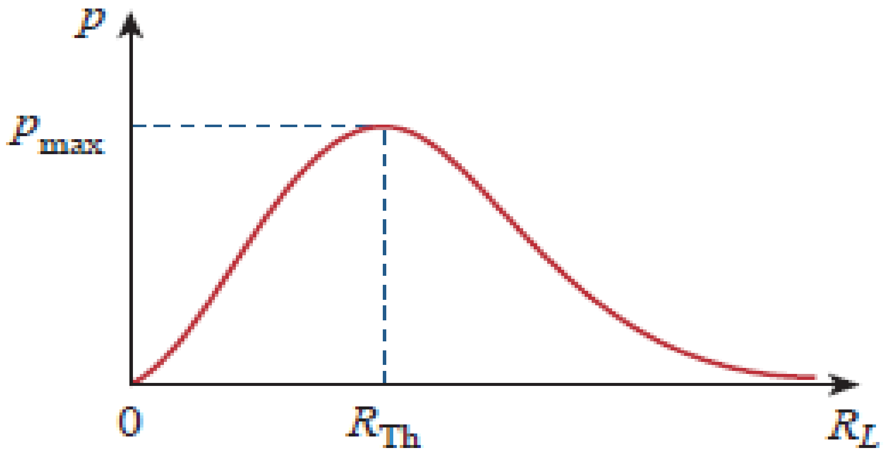
$$P_{\max}=i^2.R=\left(\frac{V_{th}}{2.R_{th}}\right)^2.R_{th}=\frac{V_{th}^2}{4.R_{th}}$$

For Norton when $R_L = R_N$

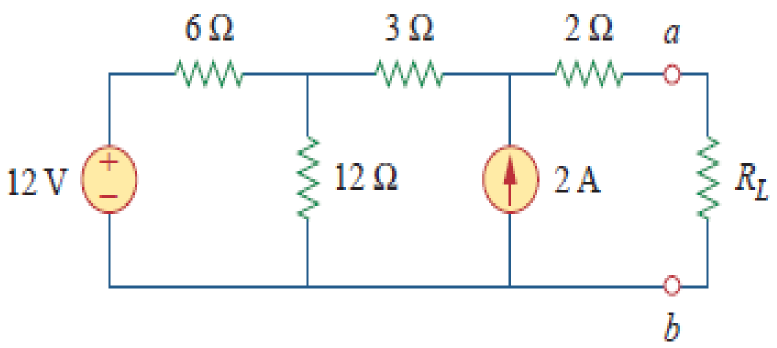


$$i = \frac{i_s}{2}$$

$$P_{max} = i^2 . R_L = \left(\frac{i_s}{2}\right)^2 R_N = \frac{i_s^2 . R_N}{4}$$

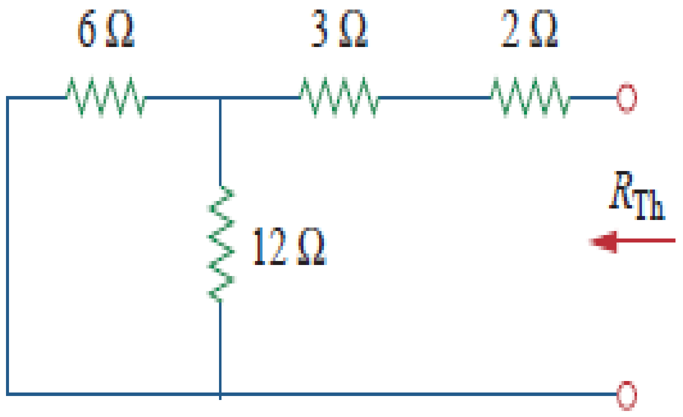


Find the value of RL for maximum power and find value of maximum power

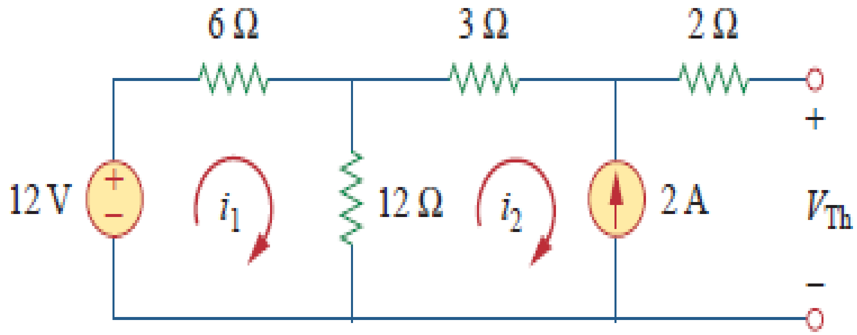


First we have to find Thevenin

$$R_{Th} = 2 + 3 + 6 \| 12 = 5 + \frac{6 \times 12}{18} = 9\ \Omega$$



Mesh Analysis



$$-12 + 18i_1 - 12i_2 = 0, \qquad i_2 = -2\text{ A}$$

$$i_1 = -2/3.$$

$$-12 + 6i_1 + 3i_2 + 2(0) + V_{Th} = 0$$

$$\Rightarrow \qquad V_{Th} = 22\text{ V}$$

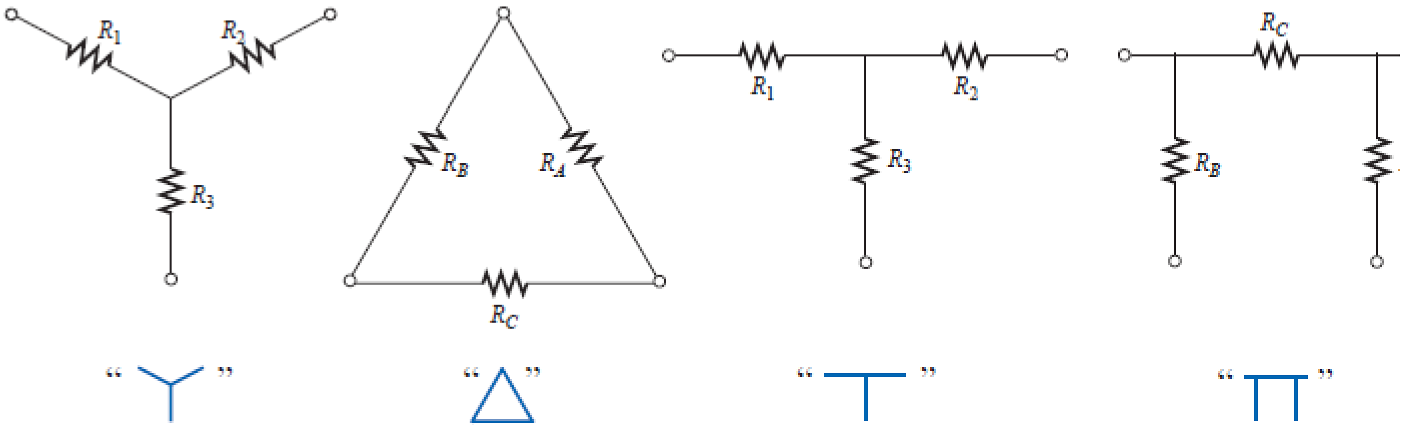
For maximum power transfer,

$$R_L = R_{Th} = 9\ \Omega$$

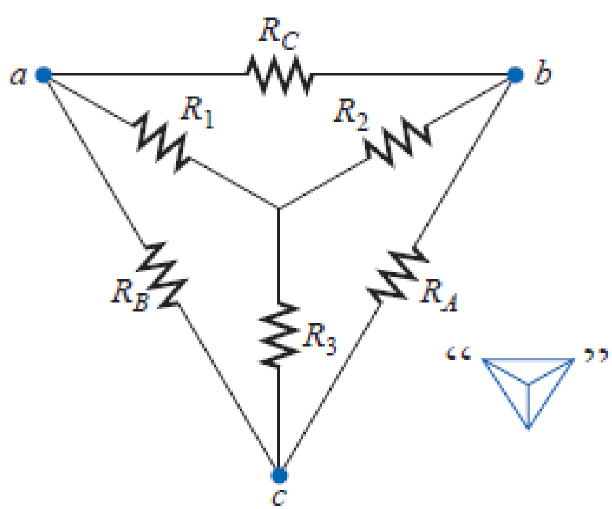
and the maximum power is

$$p_{max} = \frac{V_{Th}^2}{4R_L} = \frac{22^2}{4 \times 9} = 13.44\text{ W}$$

Y-Δ (T-π) AND Δ-Y (π-T) CONVERSIONS



(a) (b)



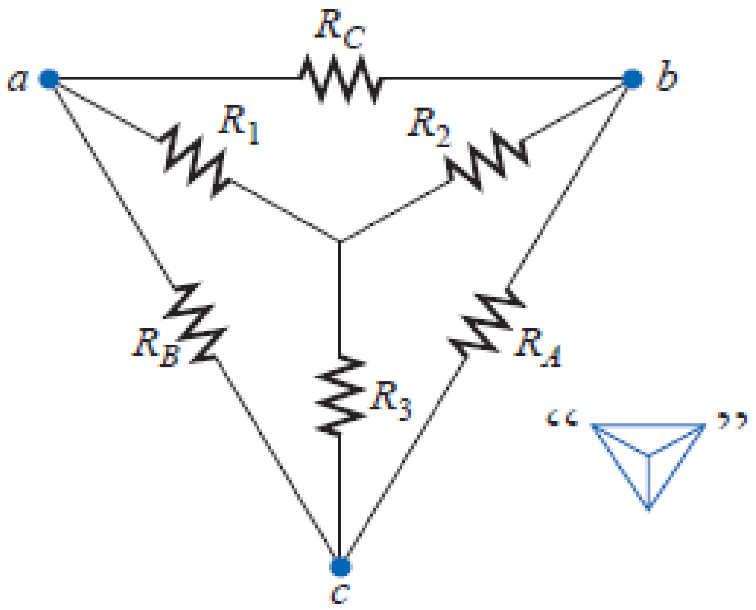
From delta to Y

$$\Delta = R_A + R_B + R_C$$

$$R_1 = \frac{R_B . R_c}{\Delta}$$

$$R_2 = \frac{R_A . R_c}{\Delta}$$

$$R_3 = \frac{R_A . R_B}{\Delta}$$



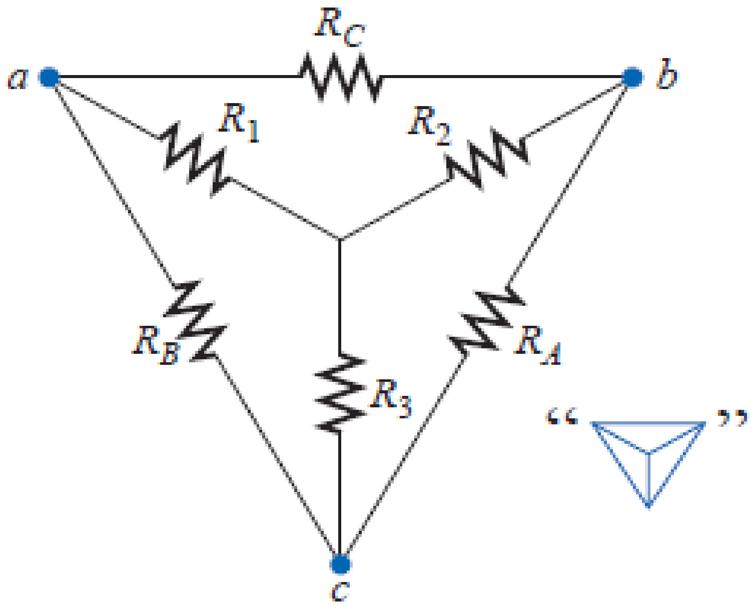
From Y to Delta

$$Y = R_1.R_2 + R_2.R_3 + R_3.R_1$$

$$R_A = \frac{Y}{R_1}$$

$$R_B = \frac{Y}{R_2}$$

$$R_c = \frac{Y}{R_3}$$

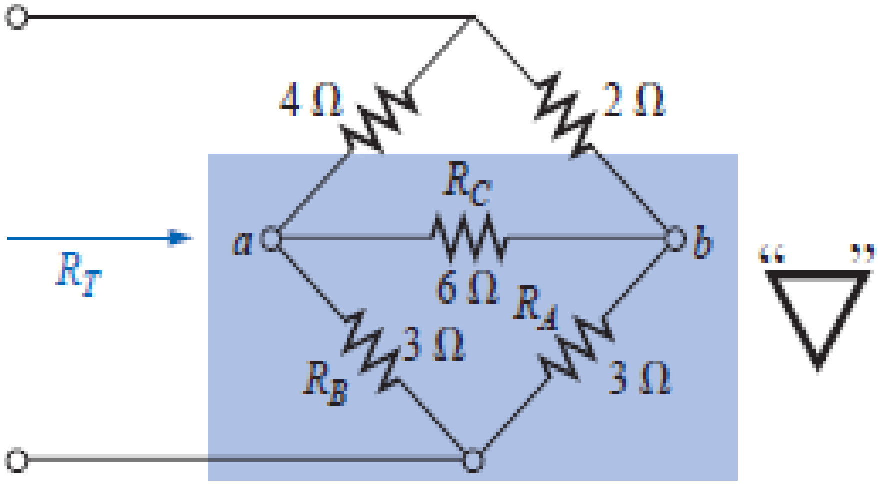


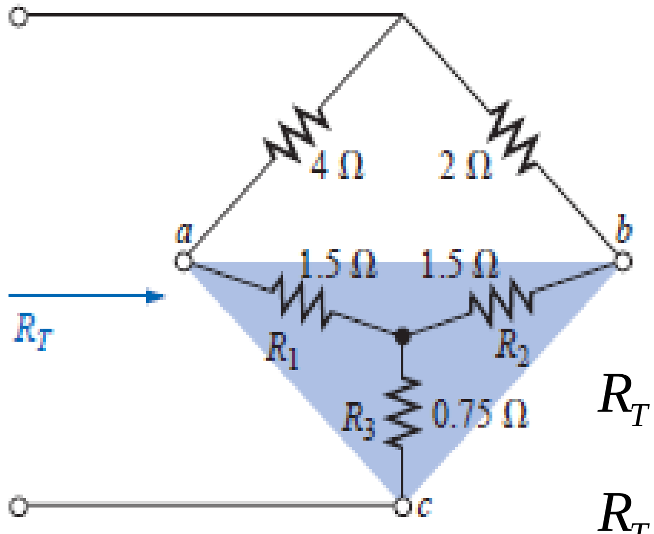
$$\Delta = 6 + 3 + 3 = 12$$

$$R_1 = \frac{6(3)}{12} = \frac{18}{12} = 1.5\Omega$$

$$R_2 = \frac{6(3)}{12} = \frac{18}{12} = 1.5\Omega$$

$$R_3 = \frac{3(3)}{12} = \frac{9}{12} = 0.75\Omega$$





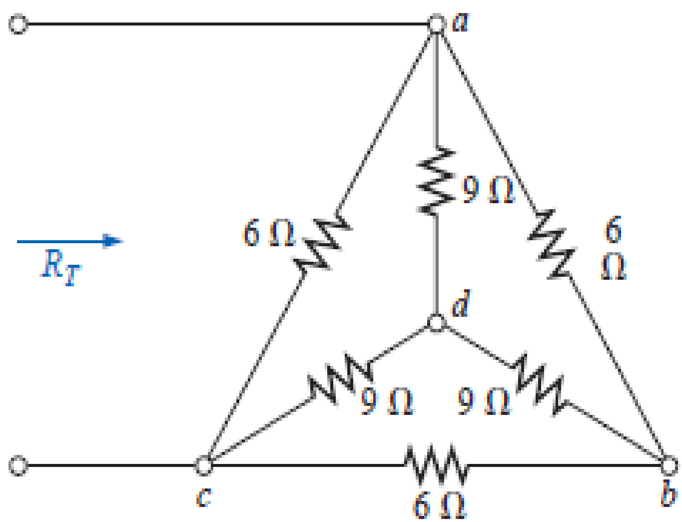
$$R_T = \frac{3.5(5.5)}{3.5 + 5.5} + 0.75$$

$$R_T = 2.889\Omega$$

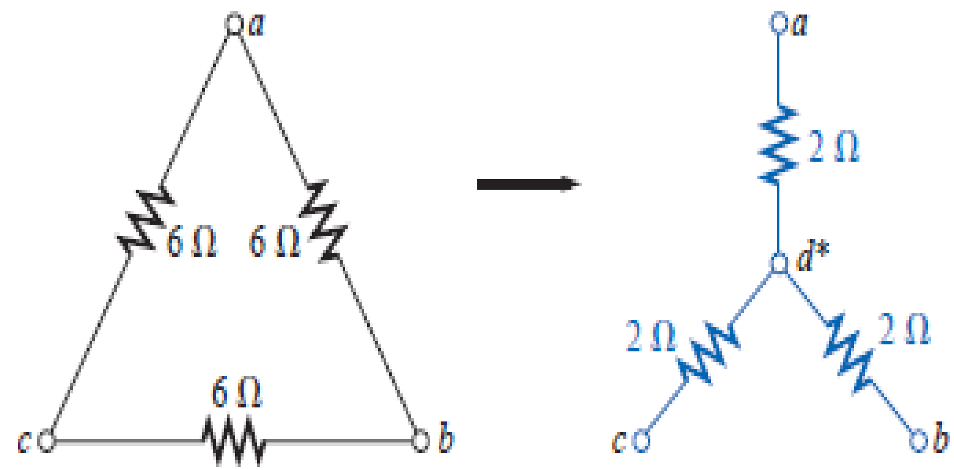
Balanced case

$$R_Y = \frac{R_\Delta}{3}$$

$$R_\Delta = 3R_Y$$



$$R_Y = \frac{R_\Delta}{3} = \frac{6\ \Omega}{3} = 2\ \Omega$$



$$R_T = 2\left[\frac{(2\ \Omega)(9\ \Omega)}{2\ \Omega + 9\ \Omega}\right] = \mathbf{3.2727\ \Omega}$$