Network Theory - Star to Delta Conversion

In the previous chapter, we discussed about the conversion of delta network into an equivalent star network. Now, let us discuss about the conversion of star network into an equivalent delta network. This conversion is called as **Star to Delta Conversion**.

In the previous chapter, we got the **resistances of star network** from delta network as

$$R_A = \frac{R_1 R_2}{R_1+R_2+R_3} \qquad \textbf{Equation 1}$$

$$R_B = \frac{R_2 R_3}{R_1+R_2+R_3} \qquad \textbf{Equation 2}$$

$$R_C = \frac{R_3 R_1}{R_1+R_2+R_3} \qquad \textbf{Equation 3}$$

Delta Network Resistances in terms of Star Network Resistances

Let us manipulate the above equations in order to get the resistances of delta network in terms of resistances of star network.

- **Multiply** each set of two equations and then **add**.

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_1 R_2^2 R_3 + R_2 R_3^2 R_1 + R_3 R_1^2 R_2}{(R_1 + R_2 + R_3)^2}$$

$$\Rightarrow R_A R_B + R_B R_C + R_C R_A = \frac{R_1 R_2 R_3 (R_1 + R_2 + R_3)}{(R_1 + R_2 + R_3)^2}$$

$$\Rightarrow R_A R_B + R_B R_C + R_C R_A = \frac{R_1 R_2 R_3}{R_1+R_2+R_3} \qquad \textbf{Equation 4}$$

- By dividing Equation 4 with Equation 2, we will get

$$\frac{R_A R_B + R_B R_C + R_C R_A}{R_B} = R_1$$

$$\Rightarrow R_1 = R_C + R_A + \frac{R_C R_A}{R_B}$$

- By dividing Equation 4 with Equation 3, we will get

$$R_2 = R_A + R_B + \frac{R_A R_B}{R_C}$$

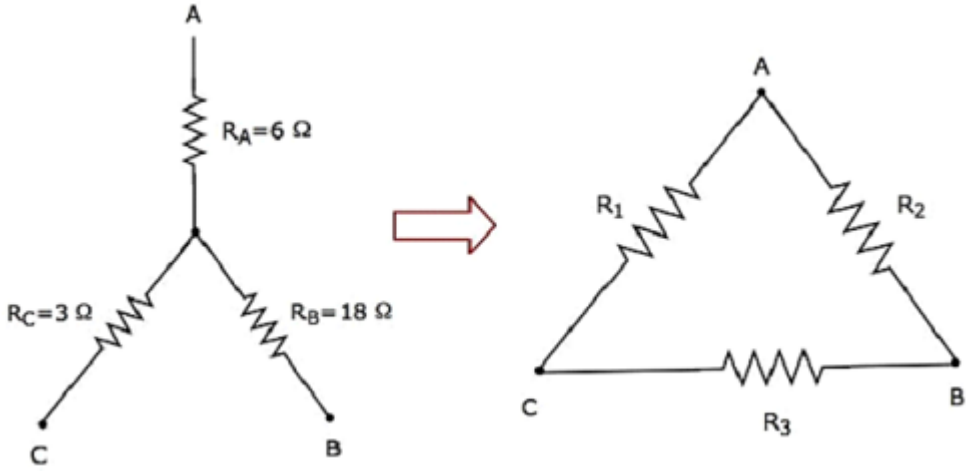
- By dividing Equation 4 with Equation 1, we will get

$$R_3 = R_B + R_C + \frac{R_B R_C}{R_A}$$

By using the above relations, we can find the resistances of delta network from the resistances of star network. In this way, we can convert **star network into delta network**.

Example

Let us calculate the **resistances of delta network**, which are equivalent to that of star network as shown in the following figure.



Given the **resistances of star network** as R_A = *6 Ω,* R_B = *18 Ω* and R_C = *3 Ω*.

We know the following relations of the **resistances of delta network** in terms of resistances of star network.

$$R_1 = R_C + R_A + \frac{R_C R_A}{R_B}$$

$$R_2 = R_A + R_B + \frac{R_A R_B}{R_C}$$

$$R_3 = R_B + R_C + \frac{R_B R_C}{R_A}$$

Substitute the values of R_A, R_B and R_C in the above equations.

$$R_1 = 3 + 6 + \frac{3 \times 6}{18} = 9 + 1 = 10\Omega$$

$$R_2 = 6 + 18 + \frac{6 \times 18}{3} = 24 + 36 = 60\Omega$$

$$R_3 = 18 + 3 + \frac{18 \times 3}{6} = 21 + 9 = 30\Omega$$

So, we got the resistances of delta network as **R_1 = 10 Ω, R_2 = 60 Ω** and **R_3 = 30 Ω**, which are equivalent to the resistances of the given star network.