Al-Mustaqbal University
College Of Engineering Technology
Department Of Cyber Security Techniques Engineering
Class: 1st
Subject: fundamental of electrical engineering
Lecturer: Dr. Rami Qays Malik
1st term – Lecture: 5- Delta to Star Conversions

الكلية التقنية الهندسية

قسم هندسة تقنيات الامن السيبراني

# Lecture: 5- Delta to Star Conversions

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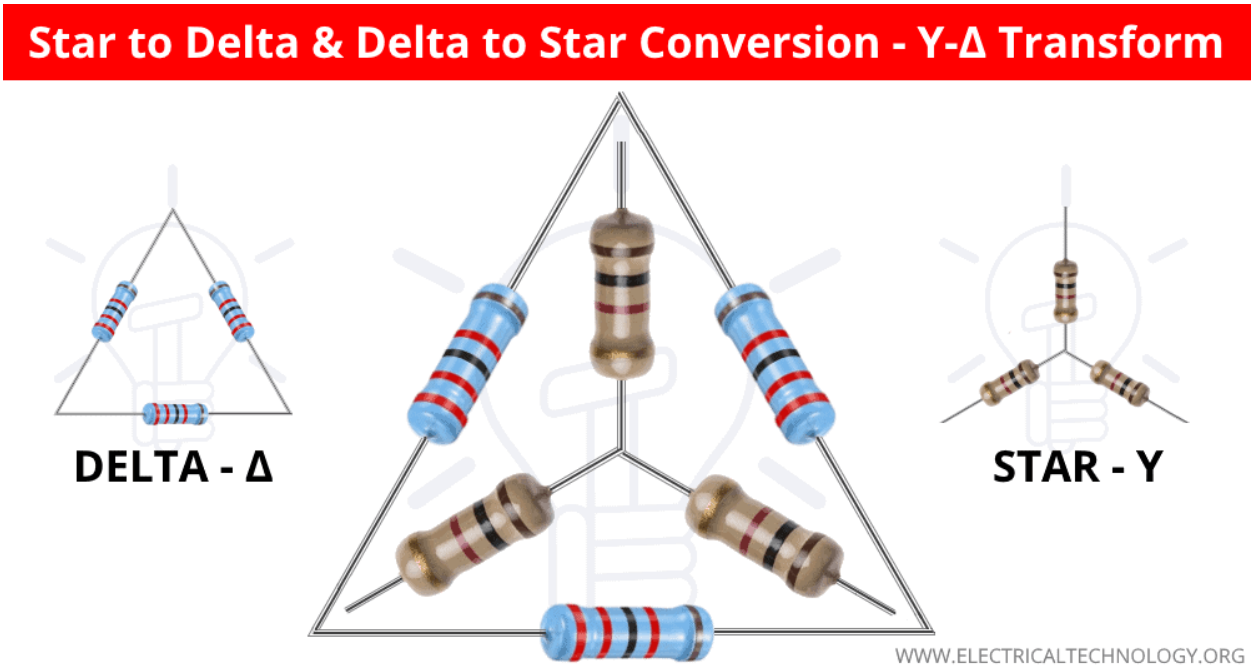
## Star Delta Conversion

We know the basic of series, parallel or combo of series and parallel connection but Y-Δ is another little bit complex configuration of components. The 3-phase networks have three wires and usually, the networks are connected in star & delta configuration. The 3 phase supply or the load connected in either formation can be converted into its equivalent counterpart. We use such conversion to simplify the mathematical calculations required for circuit analysis of a complex electrical network.




To solve complex electrical networks or simplify it, we use the star-delta conversion technique. It replaces any star connected network with its equivalent delta connected network & vice versa.

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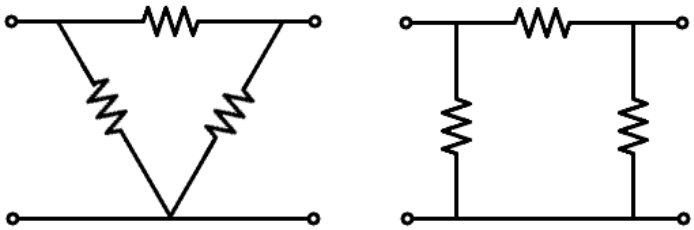
## Delta Connected Network

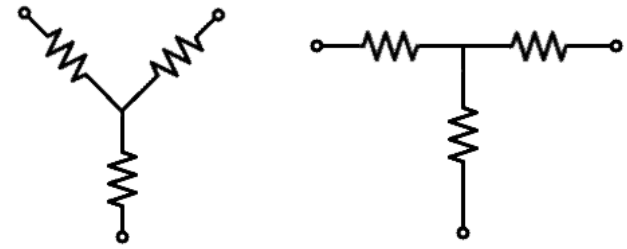
The delta connected network is formed when three network branches or impedances are connected to form a loop in such a way that their heads are connected to the tails of the adjacent branch. The resultant network forms a triangle shape that resembles a Greek letter Delta "Δ" which is why it's named after it.



Delta (Δ) Network  Delta Pi (π) Network

## Star Connected Network

The Star connected network is formed when three branches or impedances are connected together at a common point. The other ends of the branch networks are free. The resultant shape resembles the letter "Y" which is why it is also called "Y" or "Wye" connected network. It is also known as "T" connected network due to its shape after rearranging the network branches.



Star Wye(Y) Network  Star (T) Network

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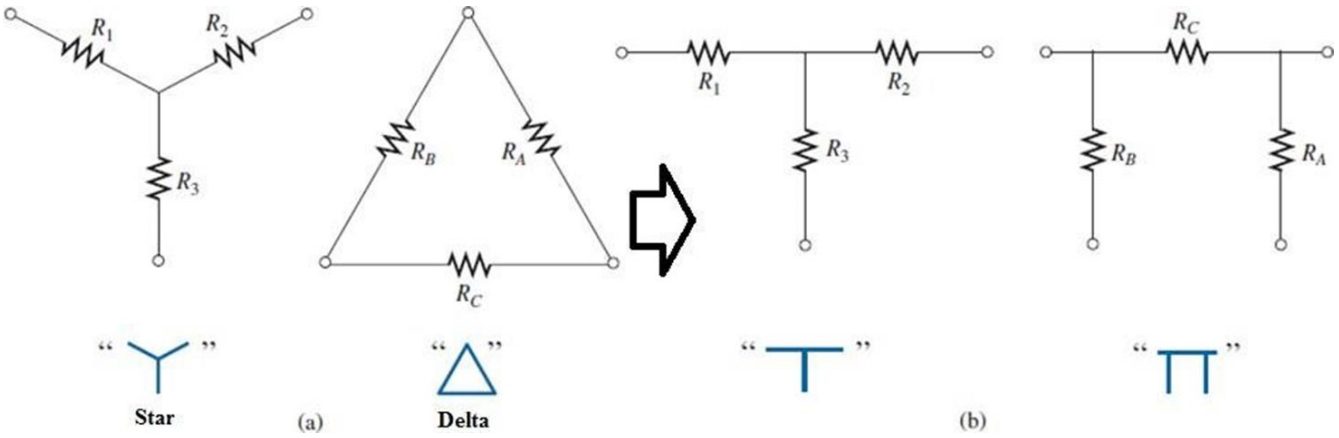
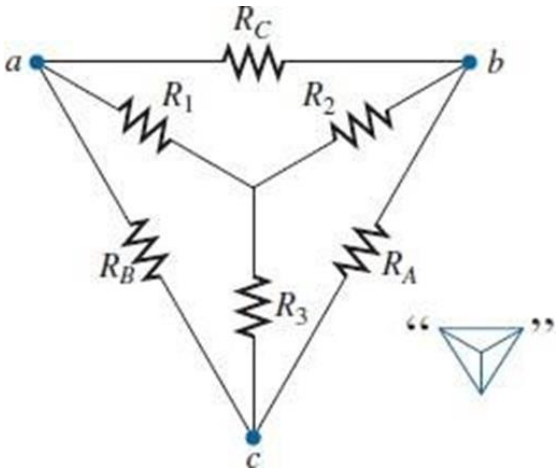
## Delta to Star & Star to Delta Conversion

The delta connected network can be transformed into star configuration using a set of electrical formula.




The given figure shows a delta network having A, B, C terminals with the impedances R1, R2, R3. The equivalent star connected network with RA, RB & RC where they are connected to their corresponding terminals as shown in the figure.



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## Delta → Wye Transformations

Each resistor in the Y network is the product of the resistors in the two adjacent Δ branches, divided by the sum of the three Δ resistors.

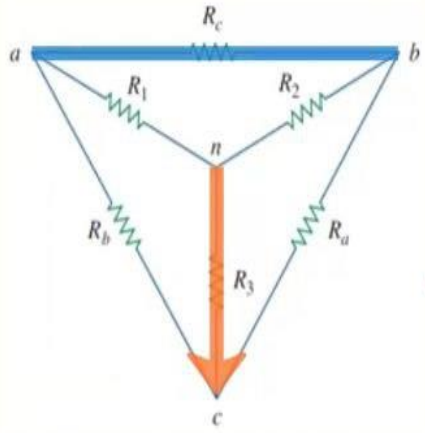
$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

## Wye → Delta Transformations

Each resistor in the Δ network is the sum of all possible products of Y resistors taken two at a time, divided by the opposite Y resistor.




$$R_a = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

$$R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}$$

$$R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

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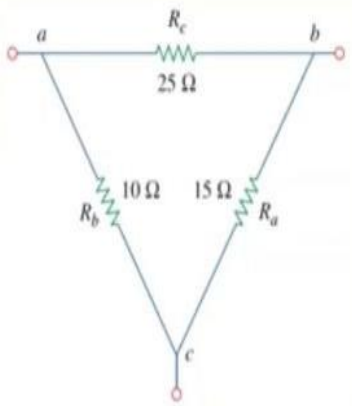
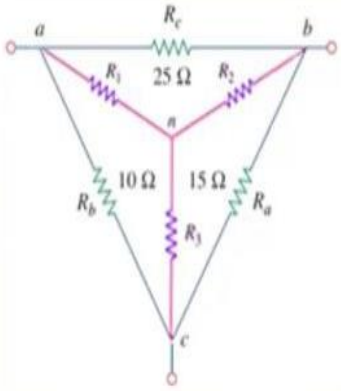
## Example 2.14

Convert the Δ network to an equivalent Y network.

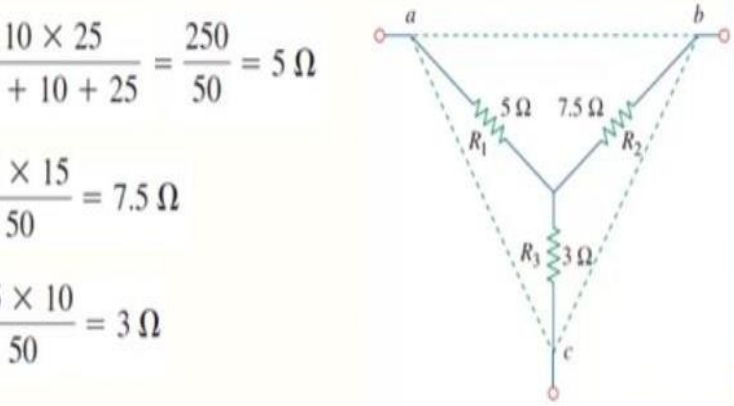



$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{10 \times 25}{15 + 10 + 25} = \frac{250}{50} = 5\ \Omega$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c} = \frac{25 \times 15}{50} = 7.5\ \Omega$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c} = \frac{15 \times 10}{50} = 3\ \Omega$$



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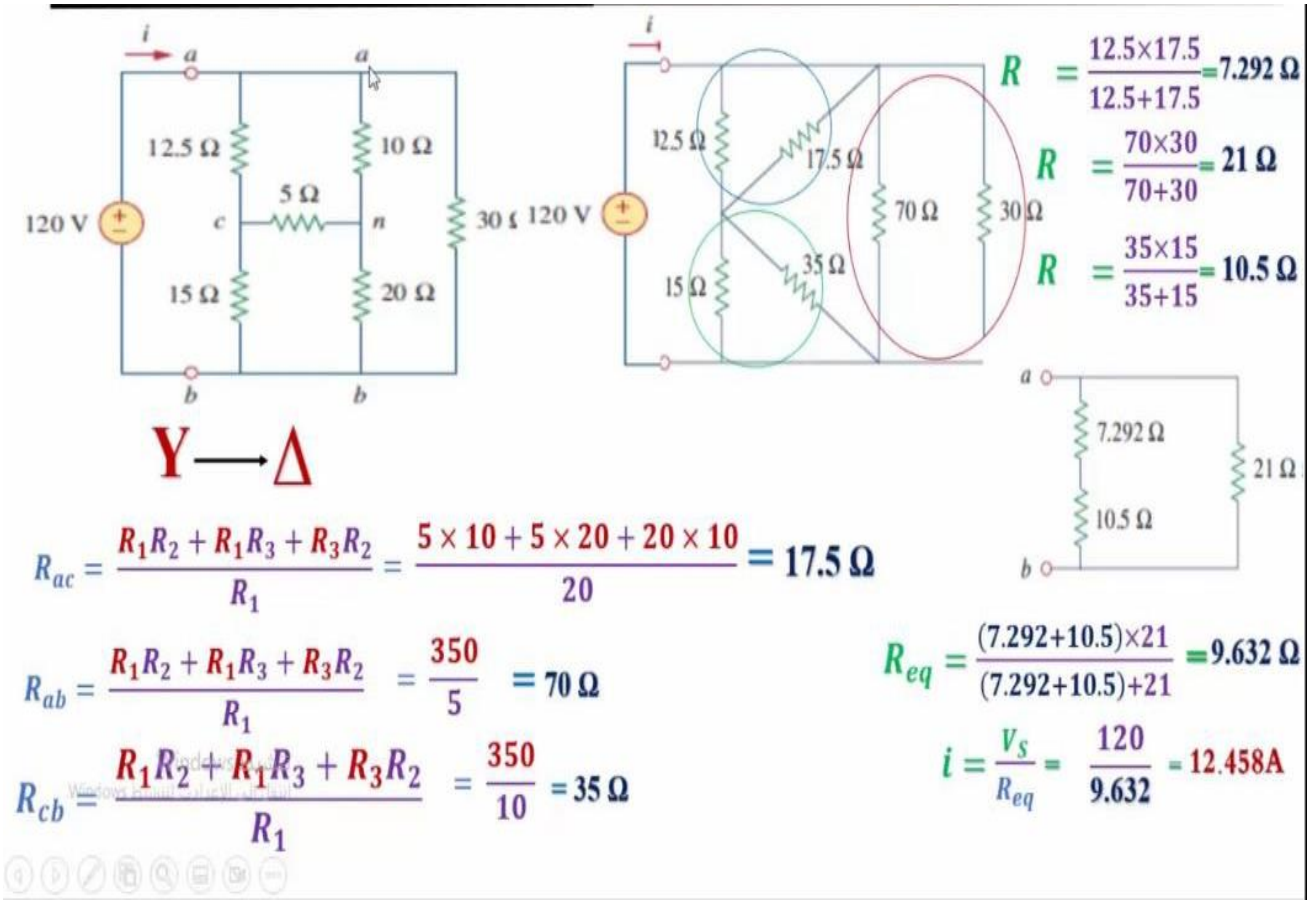


$$R = \frac{12.5\times17.5}{12.5+17.5} = 7.292\ \Omega$$

$$R = \frac{70\times30}{70+30} = 21\ \Omega$$

$$R = \frac{35\times15}{35+15} = 10.5\ \Omega$$

$$Y \longrightarrow \Delta$$

$$R_{ac} = \frac{R_1R_2 + R_1R_3 + R_3R_2}{R_1} = \frac{5\times10 + 5\times20 + 20\times10}{20} = 17.5\ \Omega$$

$$R_{ab} = \frac{R_1R_2 + R_1R_3 + R_3R_2}{R_1} = \frac{350}{5} = 70\ \Omega$$

$$R_{cb} = \frac{R_1R_2 + R_1R_3 + R_3R_2}{R_1} = \frac{350}{10} = 35\ \Omega$$

$$R_{eq} = \frac{(7.292+10.5)\times21}{(7.292+10.5)+21} = 9.632\ \Omega$$

$$i = \frac{V_S}{R_{eq}} = \frac{120}{9.632} = 12.458\text{A}$$