National university
Faculty of Engineering and Architecture

Int. to electrical Eng.

2nd year-Civil Department

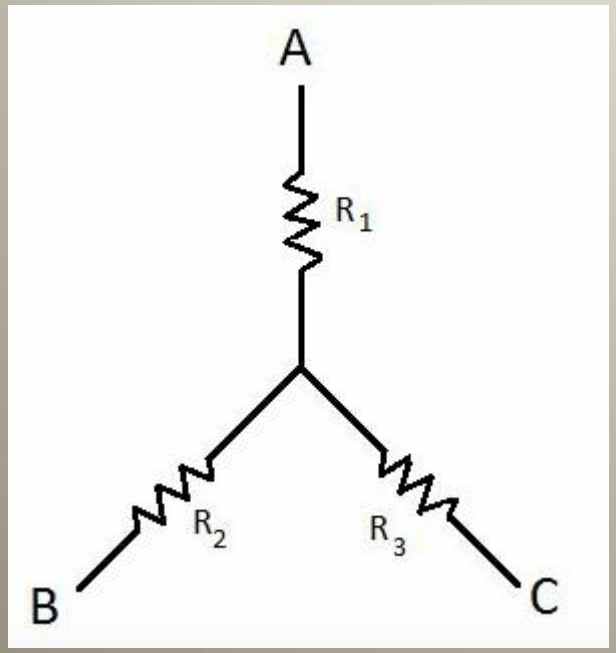
Delta-Star Transformation

Definition:

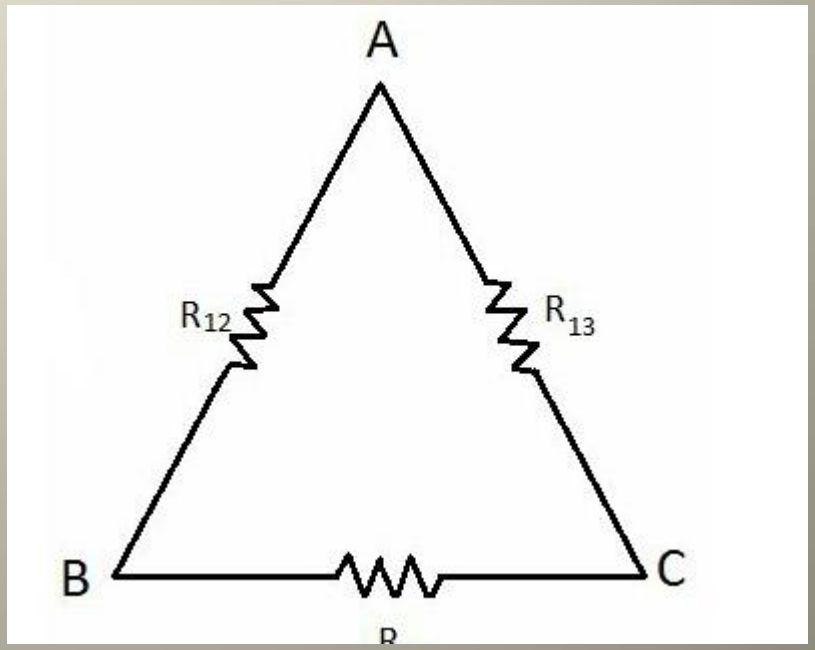
Transformation of Resistances (**Star** to **Delta** and **Delta** to **Star**) **Transformation** of resistances is a key tool in solving many **problems** related to equivalent resistance around a given circuit, etc. It reduces the math work

Continued:

Star formation of resistances looks like this:



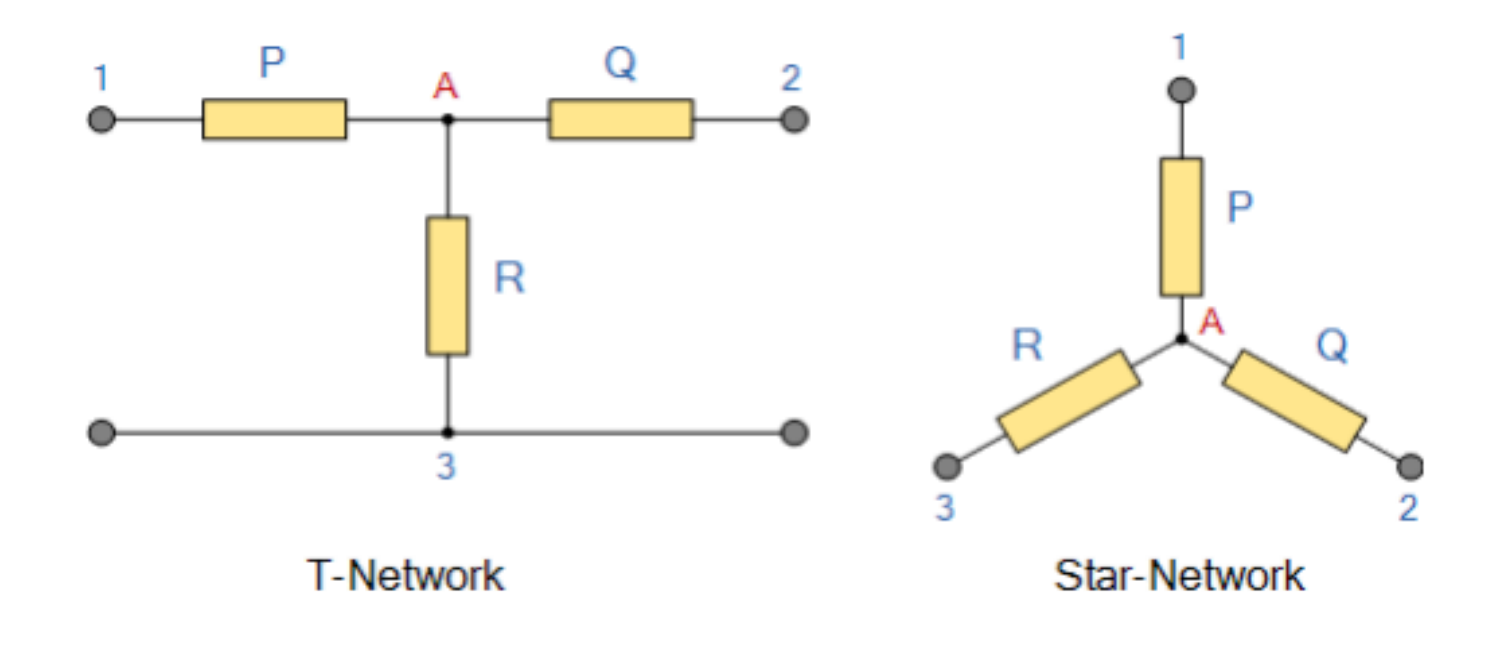
Delta formation of resistances looks like this:



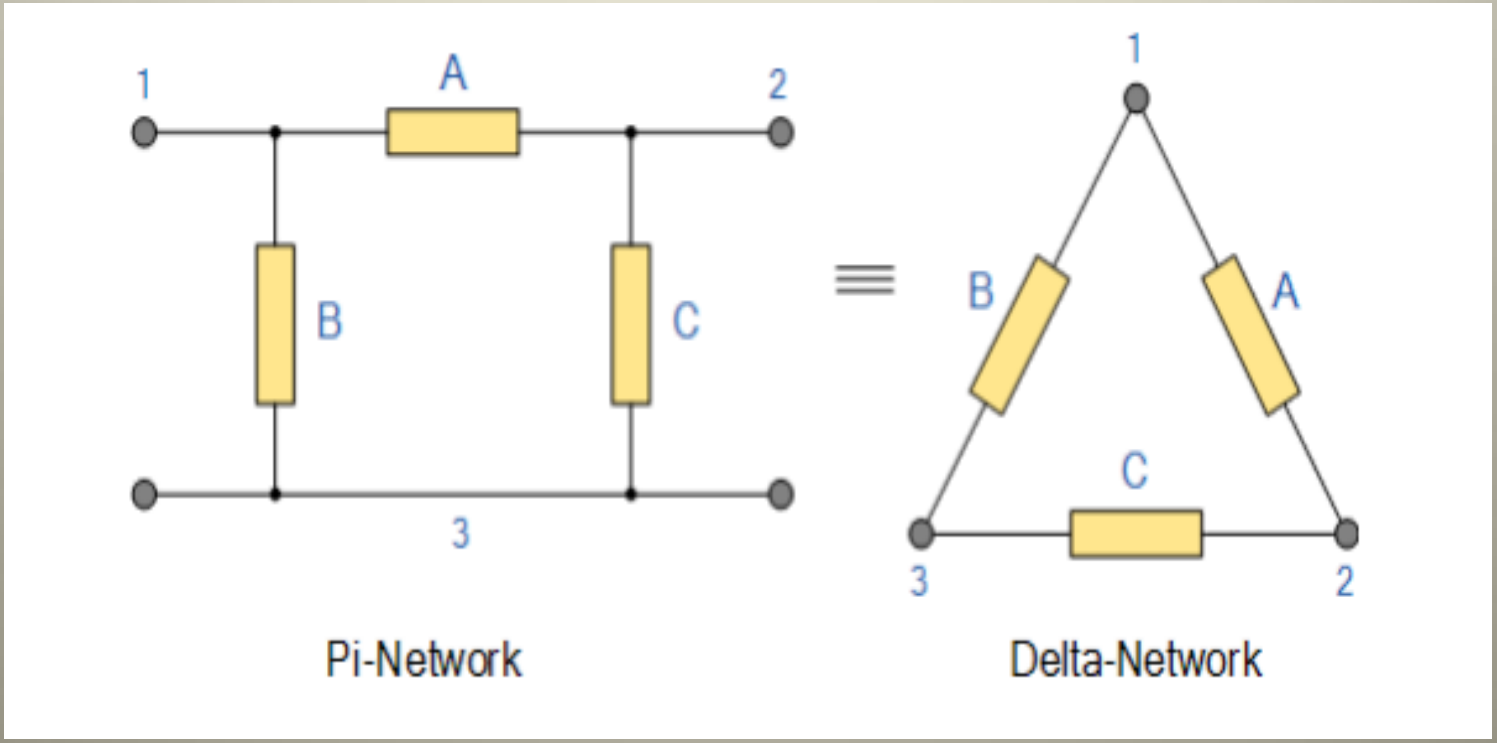
Continued:

- **If a 3-phase, 3-wire supply or even a 3-phase load is connected in one type of configuration, it can be easily transformed or changed it into an equivalent configuration of the other type by using either the Star Delta Transformation or Delta Star Transformation process. A resistive network consisting of three impedances can be connected together to form a T or "Tee" configuration but the network can also be redrawn to form a Star or Y type network as shown below.**

T-connected and Equivalent Star Network :



Pi-connected and Equivalent Delta Network:

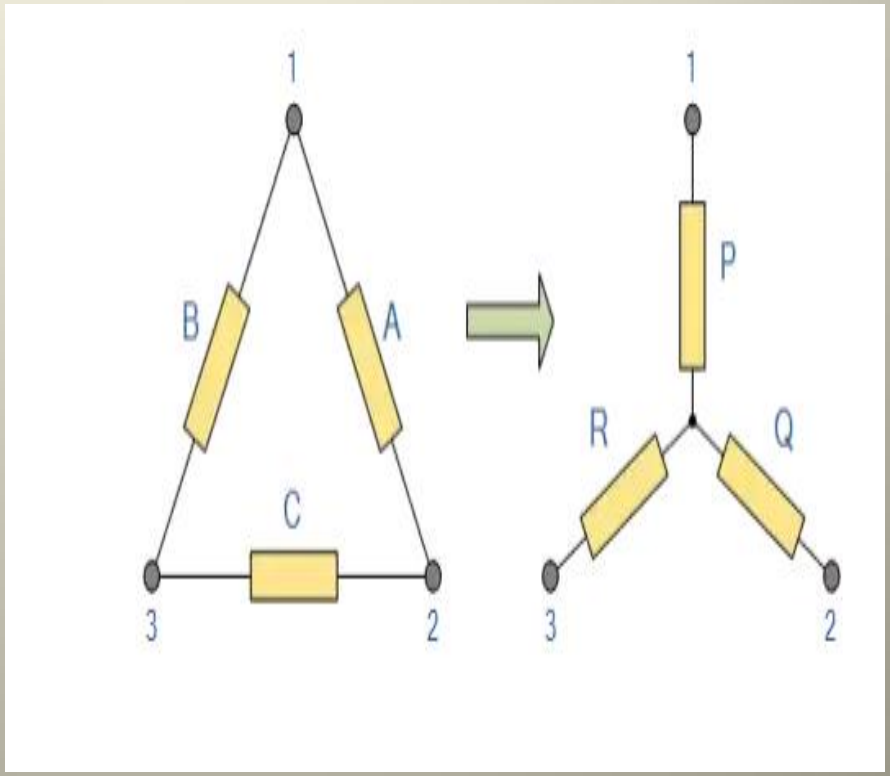


Continued:

- **Having now defined exactly what is a Star and Delta connected network it is possible to transform the Y into an equivalent Δ circuit and also to convert a Δ into an equivalent Y circuit using a the transformation process. This process allows us to produce a mathematical relationship between the various resistors giving us a Star Delta Transformation as well as a Delta Star Transformation.**

Delta Star Transformation

To convert a delta network to an equivalent star network we need to derive a transformation formula for equating the various resistors to each other between the various terminals. Consider the circuit below.



Continued:

$$P = \frac{AB}{A+B+C} \quad Q = \frac{AC}{A+B+C} \quad R = \frac{BC}{A+B+C}$$

Example:

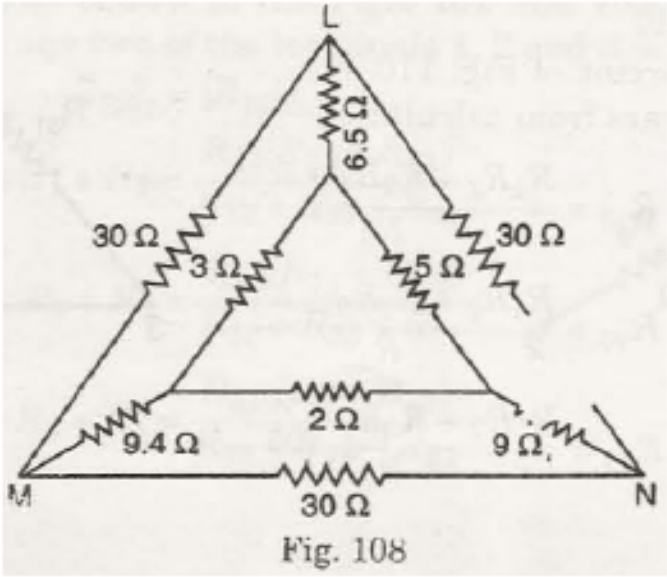


Fig. 108

Solution. Connecting the 1 2 3 delta [Fig. 109 (i)] to equivalent star [Fig. 109 (ii)]

$R_1 = R_{12} R_{31} / R_{12} + R_{23} + R_{31} = 5 \times 3 / 5 + 2 + 3 = 1.5$

$R_2 = R_{23} R_{12} / R_{12} + R_{23} + R_{31} = 2 \times 5 / 5 + 2 + 3 = 1$

$R_3 = R_{31} R_{23} / R_{12} + R_{23} + R_{31} = 3 \times 2 / 5 + 2 + 3 = 0.6$

Continued:

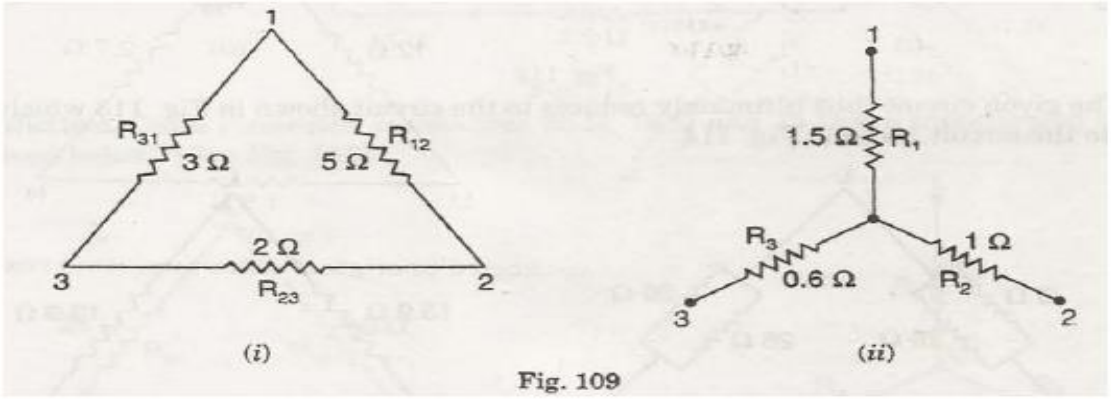


Fig. 109

Thus the original circuit reduces to that shown in Fig. 110 which further reduces to the circuit shown in Fig. 111.

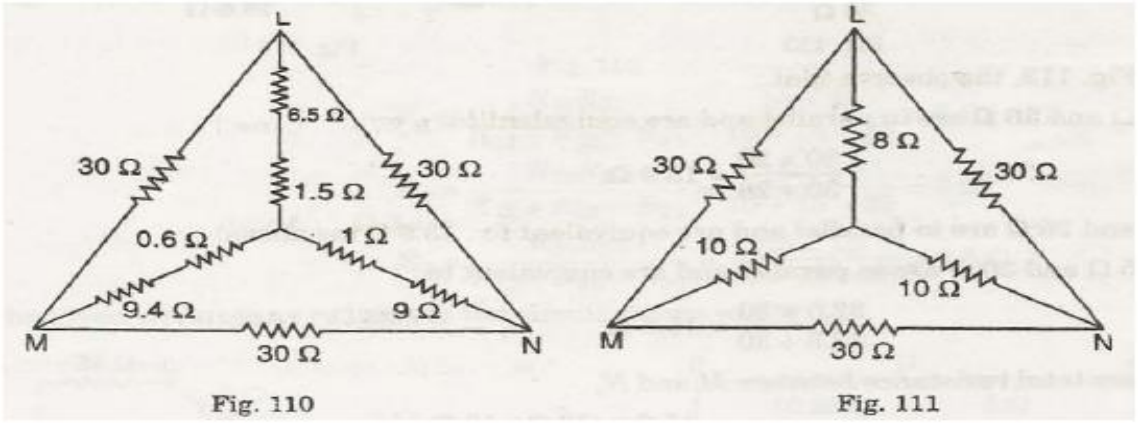


Fig. 110 Fig. 111

Now, the inner star circuit of Fig. 110 shown as Fig. 111 is equivalent to the delta circuit

Continued:

shown in Fig. 112 (ii) as appears from calculations given below :

$R_{12} = R_1 R_2 + R_2 R_3 + R_3 R_1 / R_3 = 8 \times 10 + 10 \times 10 + 10 \times 8 / 10 = 26\ \Omega$

$R_{23} = R_1 R_2 + R_2 R_3 + R_3 R_1 / R_1 = 8 \times 10 + 10 \times 10 \times 10 / 8 = 32.5\ \Omega$

$R_{31} = 8 \times 10 + 10 \times 10 \times 10 \times 8 / 10 = 26\ \Omega$

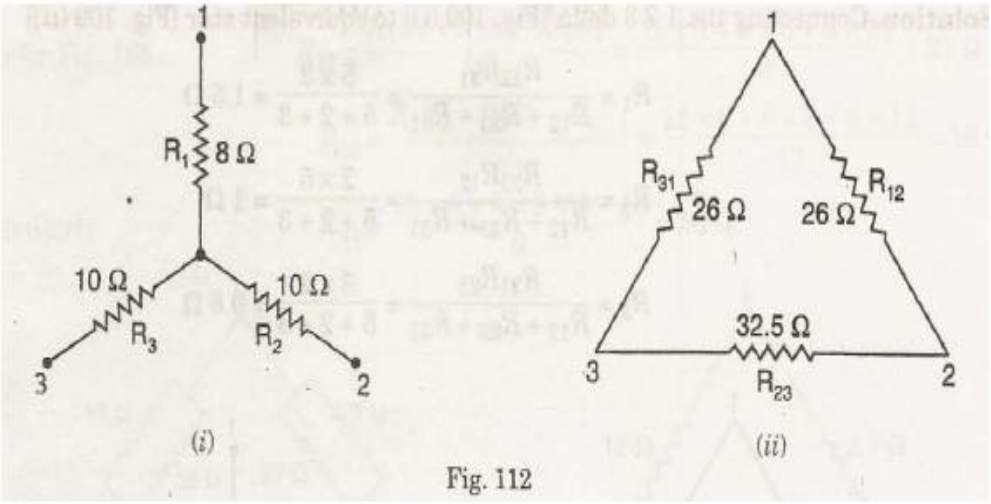


Fig. 112

The given circuit thus ultimately reduces to the circuit shown in Fig. 113 which in turn is equivalent to the circuit given in Fig. 114.

Continued:

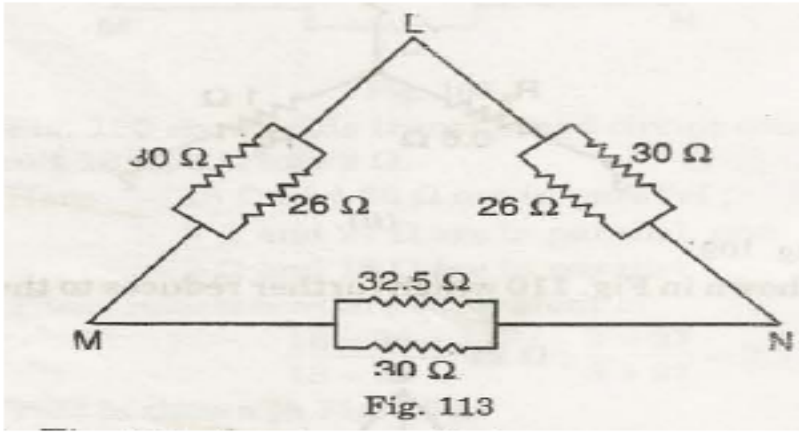


Fig. 113

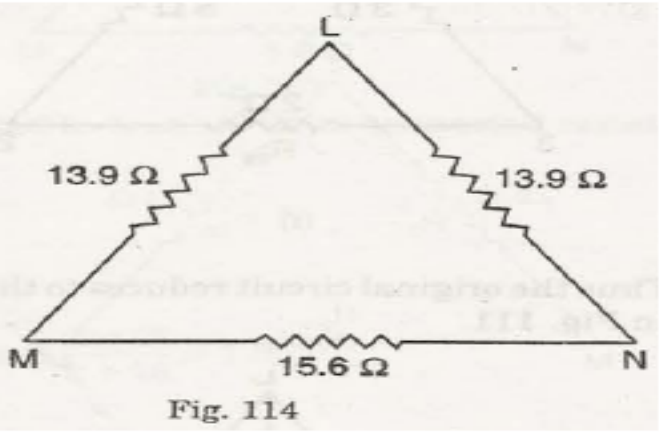


Fig. 114

In Fig. 113, the observe that :

30 Q and 26 Q are in parallel and are equivalent to :

30 x 26 / 30 + 26 = 13.9

30 and 26 n are in parallel and are equivalent to : 13.9 n (as above)

32.5 Q and 30 Q are in parallel and are equivalent to :

32.5 x 30 / 32.5 + 30 = 15.6

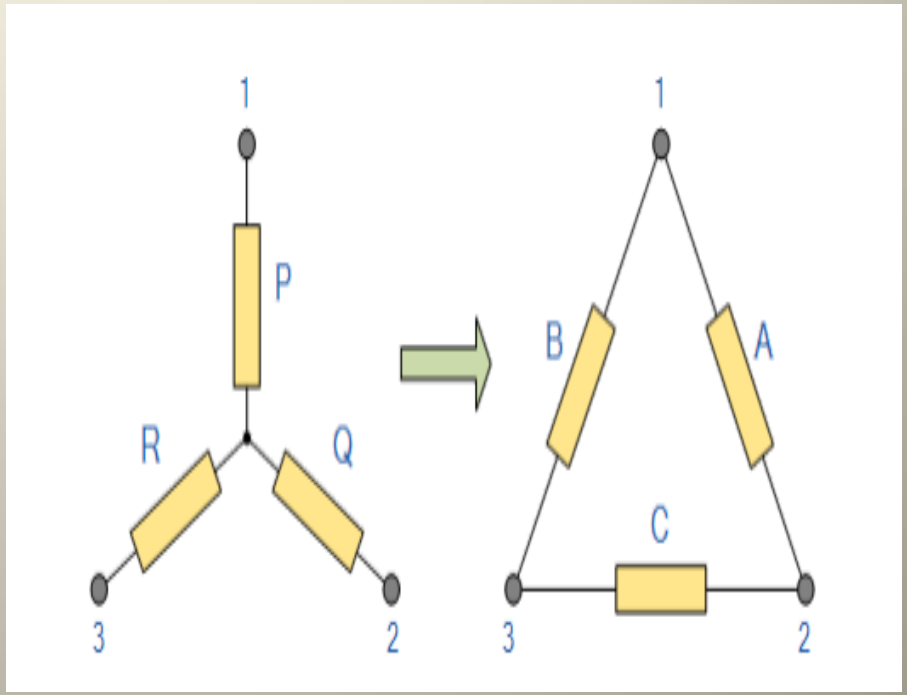
Hence total resistance between M and N,

R_{MN} = 15.6 x (13.9 + 13.9) / 15.6 + (13.9 + 13.9)

= 433.69 / 43.4 = 9.99

Star to Delta Transformation

The value of the resistor on any one side of the delta, Δ network is the sum of all the two product combinations of resistors in the star network divide by the star resistor located "directly opposite" the delta resistor being found. For example, resistor A is given as:



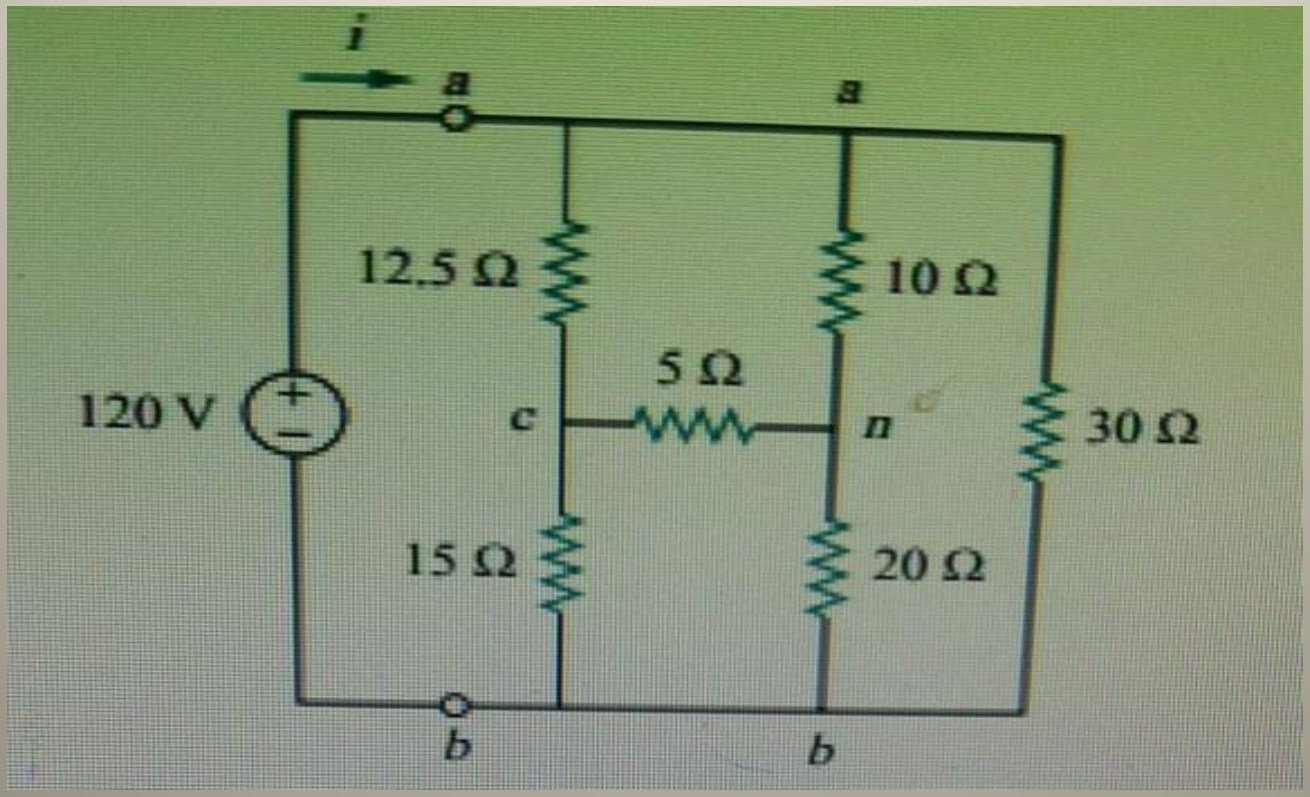
Continued:

$$A = \frac{PQ + QR + RP}{R}$$

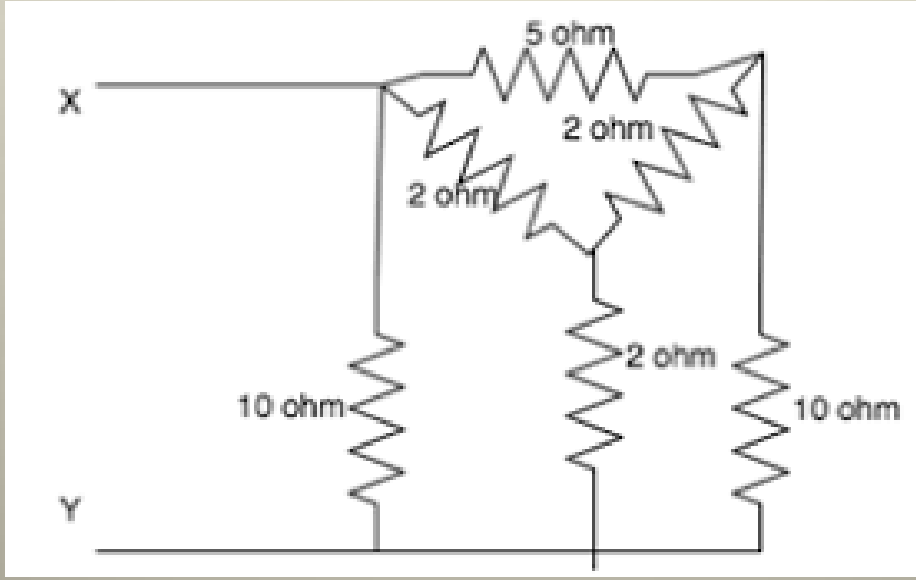
$$B = \frac{PQ + QR + RP}{Q}$$

$$C = \frac{PQ + QR + RP}{P}$$

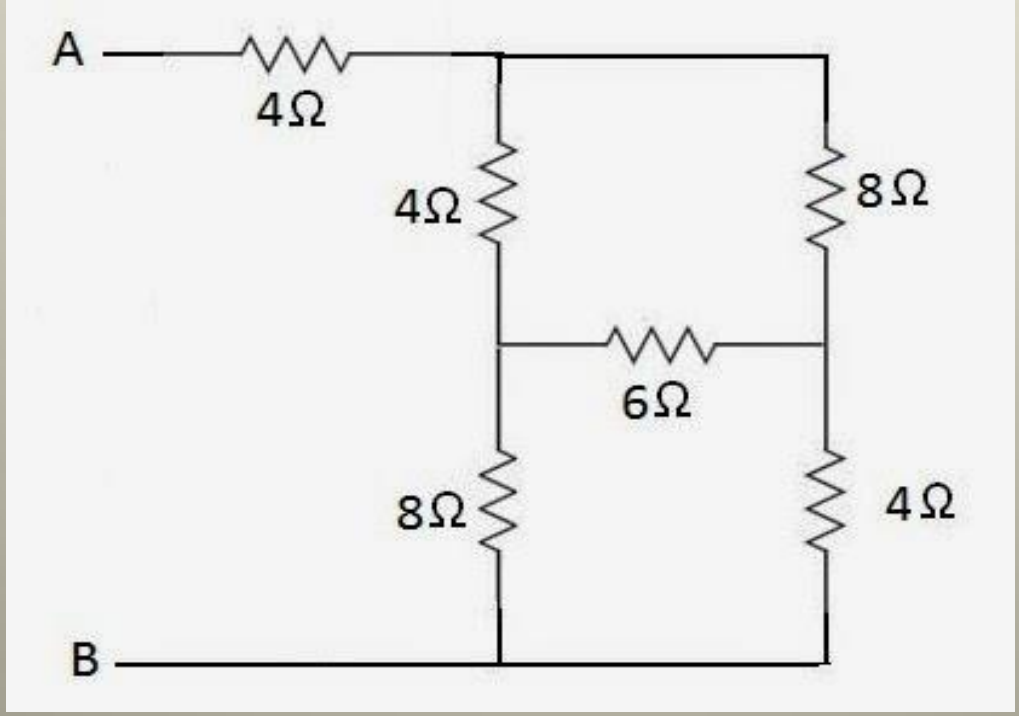
Example: Obtain (Rt) for the circuit below



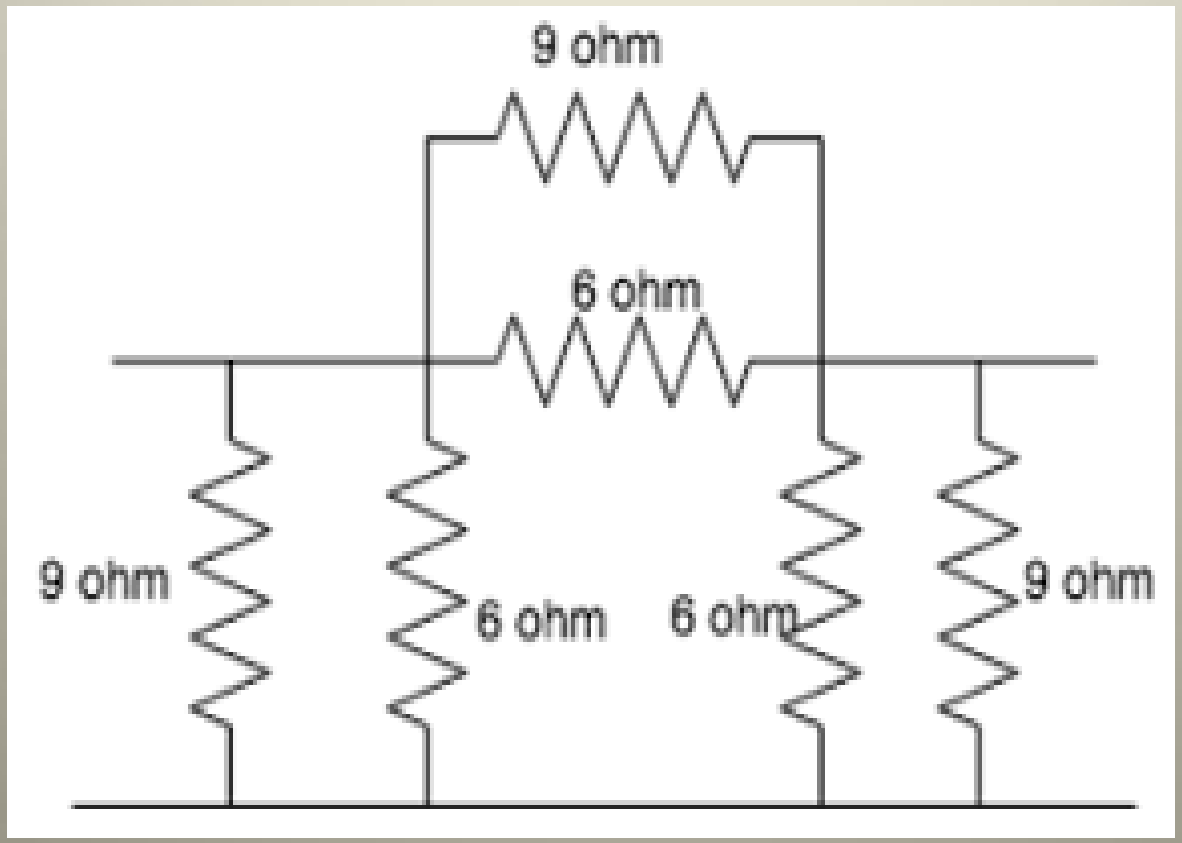
Example 3:



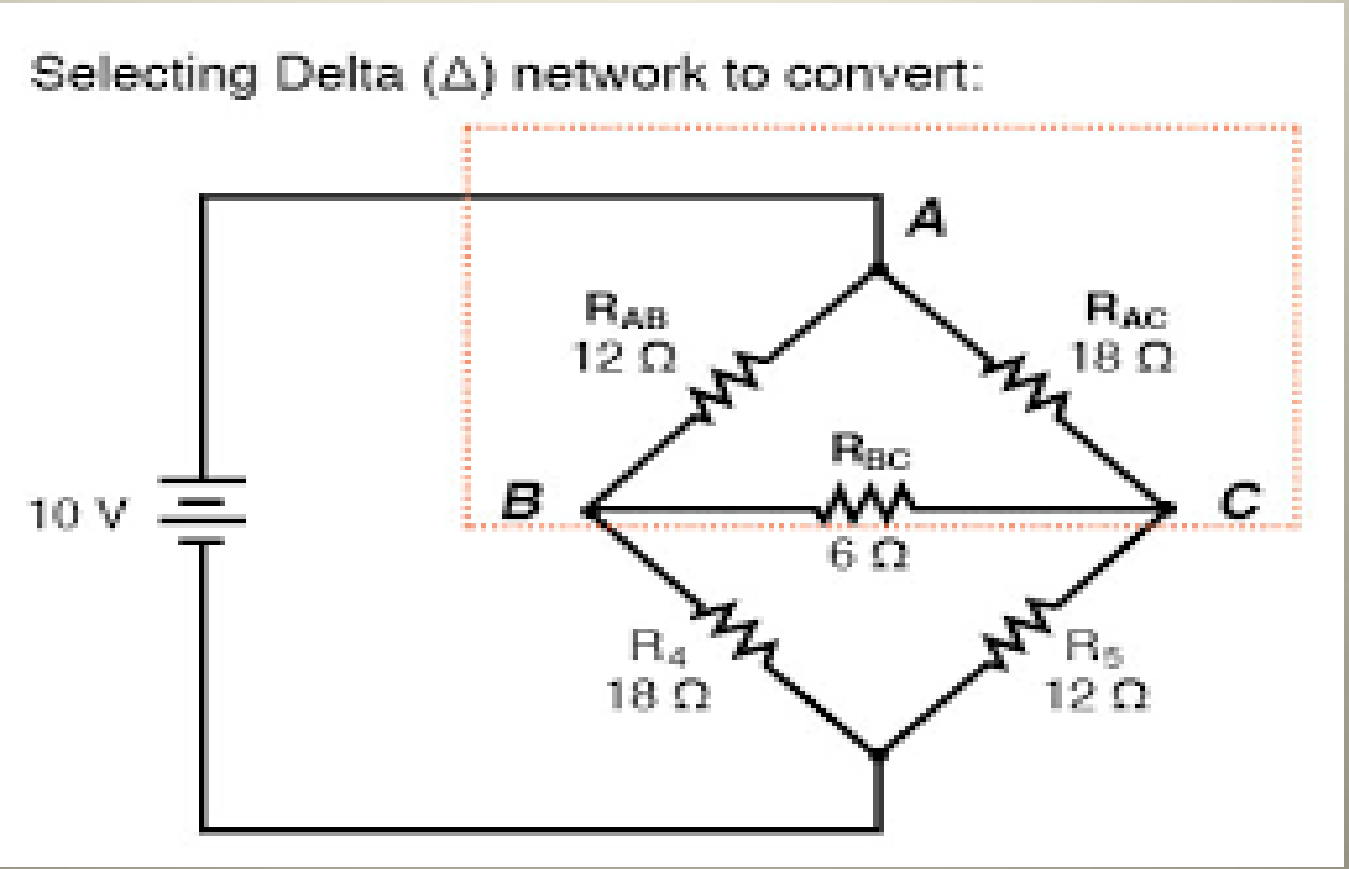
Example 4:



example 5:



Example 6:


Selecting Delta (Δ) network to convert:
A
B
C
R_{AB}
12 Ω
R_{AC}
18 Ω
R_{BC}
6 Ω
R_4
18 Ω
R_5
12 Ω
10 V

Example 7: