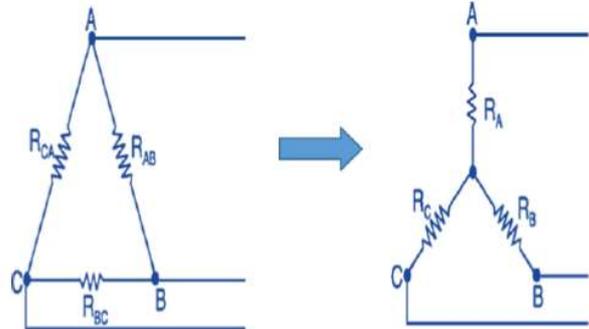


- Similarly for resistance between two terminals B-C and C-A,

$$\Rightarrow R_B + R_C = \frac{R_{BC}(R_{CA} + R_{AB})}{R_{AB} + R_{BC} + R_{CA}} \quad (3)$$

$$\Rightarrow R_C + R_A = \frac{R_{CA}(R_{AB} + R_{BC})}{R_{AB} + R_{BC} + R_{CA}} \quad (4)$$

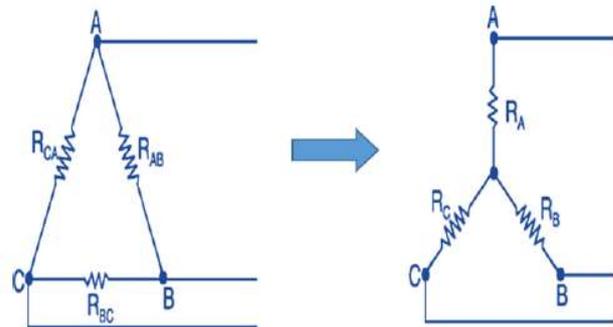


- The objective is to find R_A, R_B and R_C in terms of R_{AB}, R_{BC} and R_{CA} .
- Subtracting (3) from (2) and adding to (4) we obtain,

$$\Rightarrow R_A = \frac{R_{AB}R_{CA}}{R_{AB} + R_{BC} + R_{CA}} \quad (5)$$

$$\Rightarrow R_B = \frac{R_{BC}R_{AB}}{R_{AB} + R_{BC} + R_{CA}} \quad (6)$$

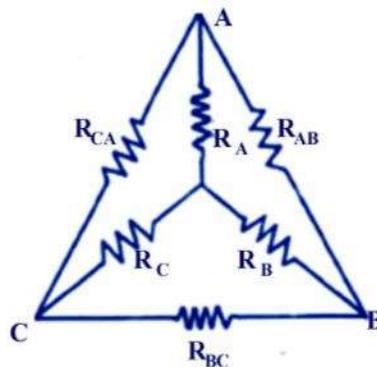
$$\Rightarrow R_C = \frac{R_{CA}R_{BC}}{R_{AB} + R_{BC} + R_{CA}} \quad (7)$$



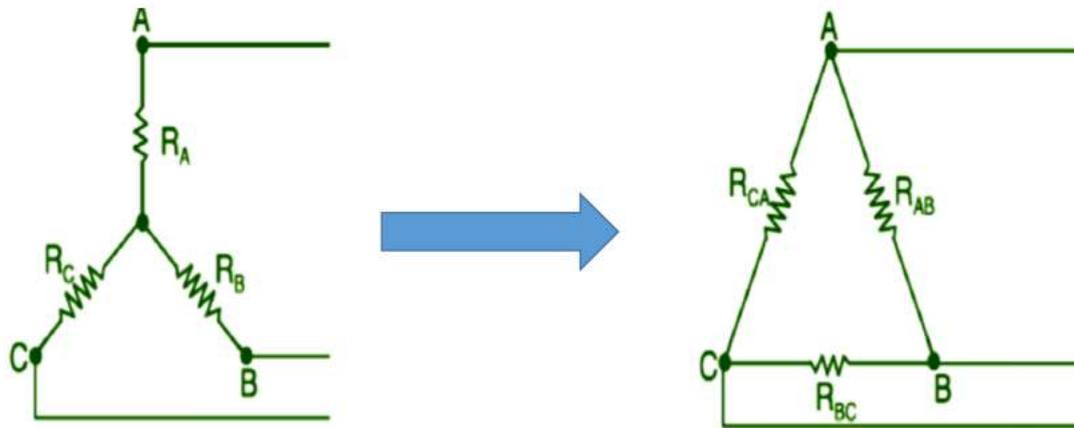
DELTA TO STAR TRANSFORMATION

- Easy way to remember delta to star transformation is,

$$\text{Any arm of star connection} = \frac{\text{Product of two adjacent arms of } \Delta}{\text{Sum of arms of } \Delta}$$



Three resistors R_A, R_B and R_C connected in star formation and its equivalent delta connection is shown below



Star and its Equivalent Delta

- Dividing (5) by (6) we obtain,

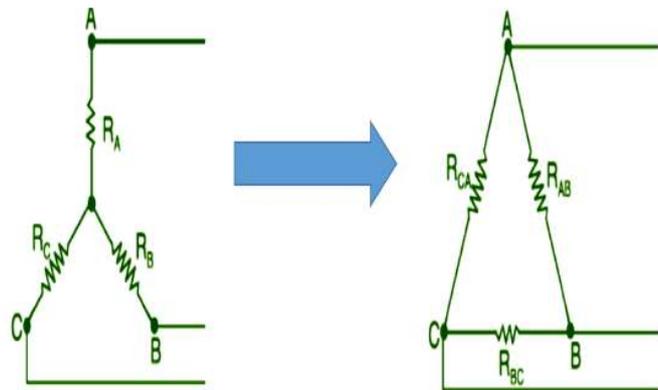
$$\frac{R_A}{R_B} = \frac{R_{CA}}{R_{BC}} \quad (8)$$

$$\Rightarrow R_{CA} = \frac{R_A R_{BC}}{R_B} \quad (9)$$

- Dividing (5) by (7) we obtain,

$$\frac{R_A}{R_C} = \frac{R_{AB}}{R_{BC}} \quad (10)$$

$$\Rightarrow R_{AB} = \frac{R_A R_{BC}}{R_C} \quad (11)$$



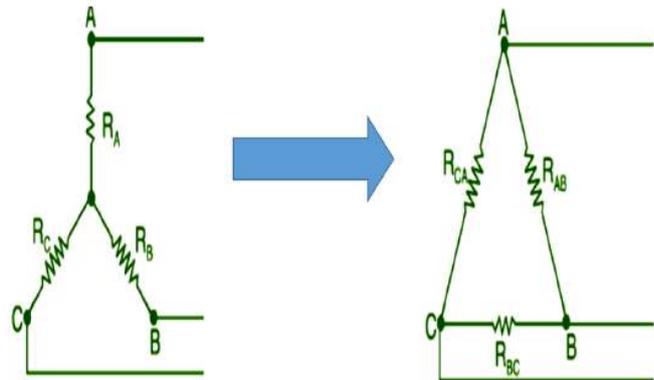
- Substituting (9) and (11) into (5),

$$R_{BC} = R_B + R_C + \frac{R_B R_C}{R_A} \quad (12)$$

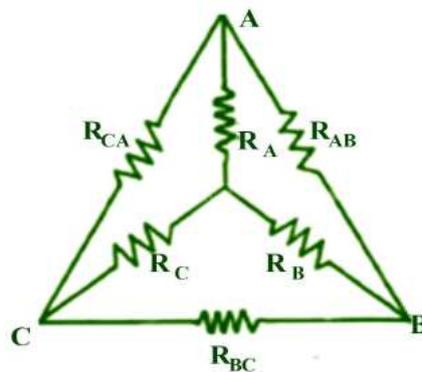
- Similarly,

$$R_{AB} = R_A + R_B + \frac{R_A R_B}{R_C} \quad (13)$$

$$R_{CA} = R_C + R_A + \frac{R_C R_A}{R_B} \quad (14)$$



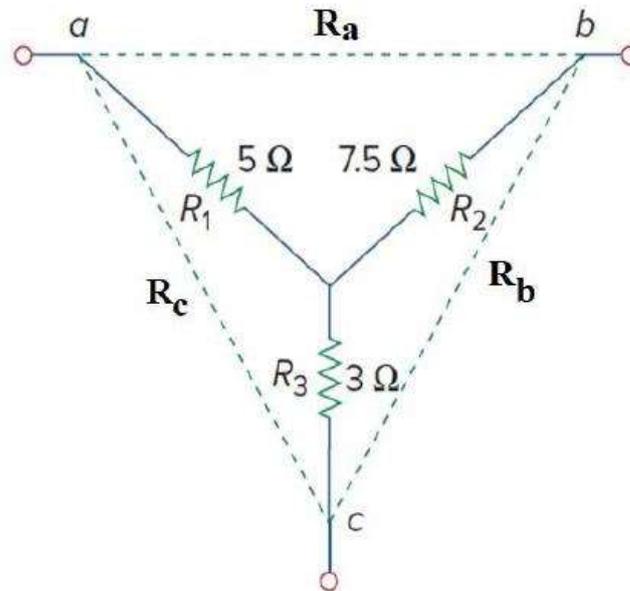
- Easy way to remember star to delta transformation is,
Resistance between two terminals of Δ =
Sum of star resistances connected to those terminals +
product of same two resistances divided by the third



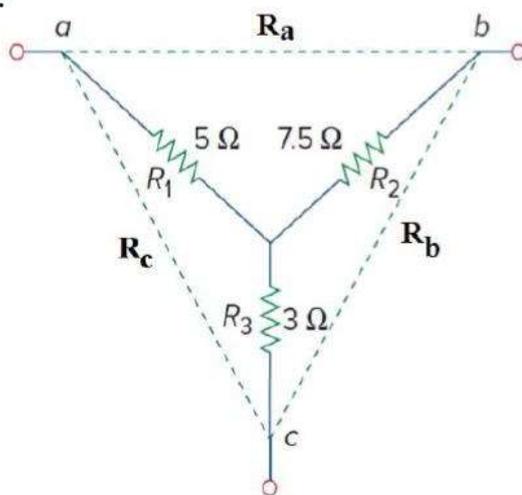
- If a star network has all resistances equal to R, its equivalent delta has all resistances equal to ?
- If a delta network has all resistances equal to R, its equivalent star has all resistances equal to ?

Example :-

Q. Convert the Y network to an equivalent Δ network.



Soln:



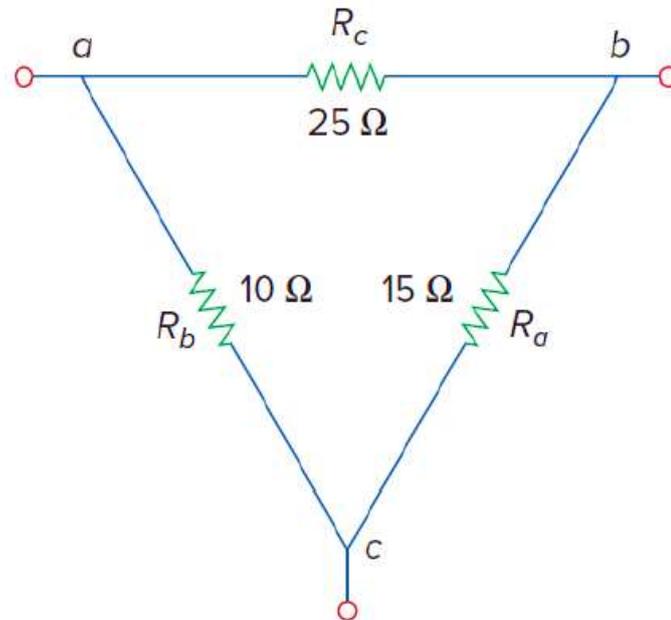
$$R_a = 7.5 + 5 + \frac{7.5 \times 5}{3} = 25 \text{ ohms}$$

$$R_b = 7.5 + 3 + \frac{7.5 \times 3}{5} = 15 \text{ ohms}$$

$$R_c = 5 + 3 + \frac{5 \times 3}{7.5} = 10 \text{ ohms}$$

Example

Q. Convert the Δ network to an equivalent Y network.

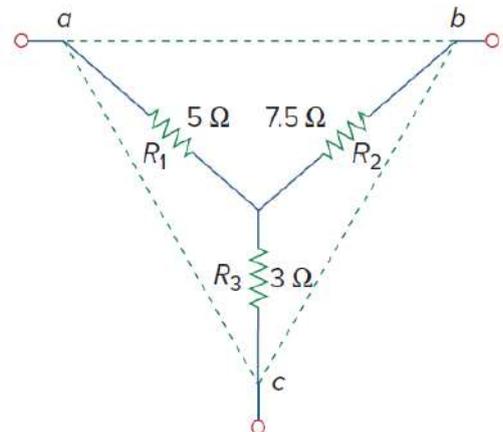


Soln:

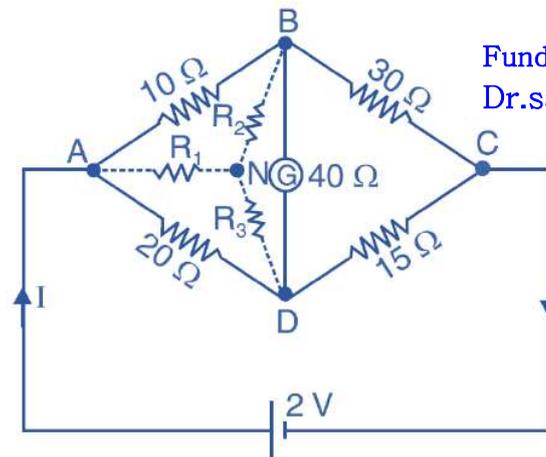
$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{10 \times 25}{15 + 10 + 25} = 5 \text{ ohms}$$

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

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



Q. Using delta/star transformation, find equivalent resistance across AC.



Soln: Delta can be replaced by equivalent star-connected resistances,

$$R_1 = \frac{R_{AB}R_{DA}}{R_{AB} + R_{DA} + R_{BD}} = \frac{10 \times 20}{10 + 40 + 20} = 2.86 \text{ ohms}$$

$$R_2 = \frac{R_{AB}R_{BD}}{R_{AB} + R_{DA} + R_{BD}} = \frac{10 \times 40}{10 + 40 + 20} = 5.72 \text{ ohms}$$

$$R_3 = \frac{R_{DA}R_{BD}}{R_{AB} + R_{DA} + R_{BD}} = \frac{20 \times 40}{10 + 40 + 20} = 11.4 \text{ ohms}$$

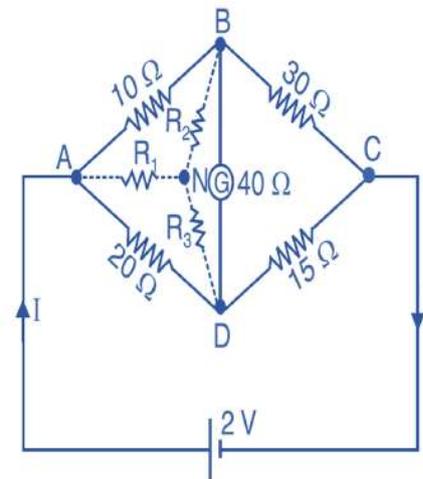
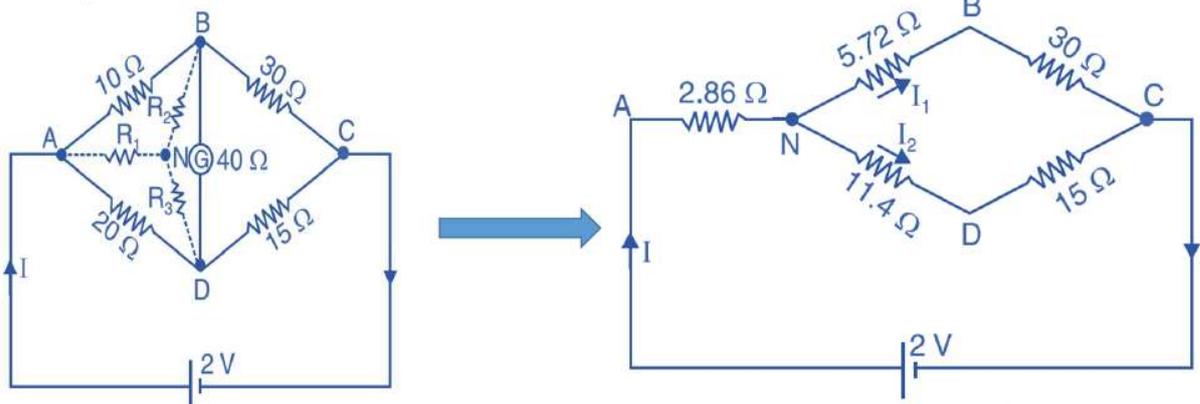
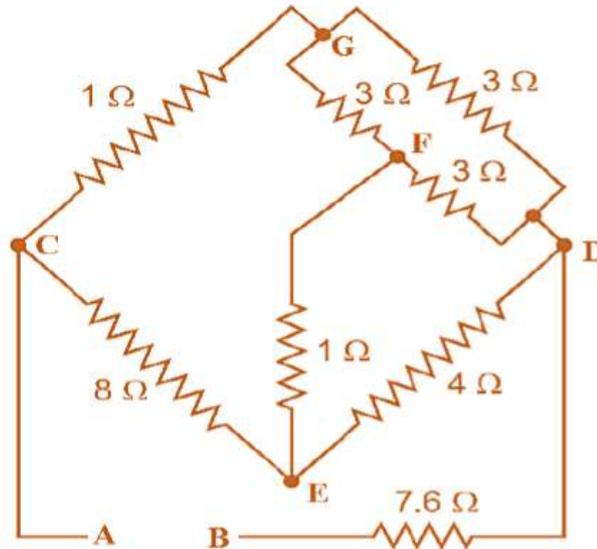


Figure now becomes,

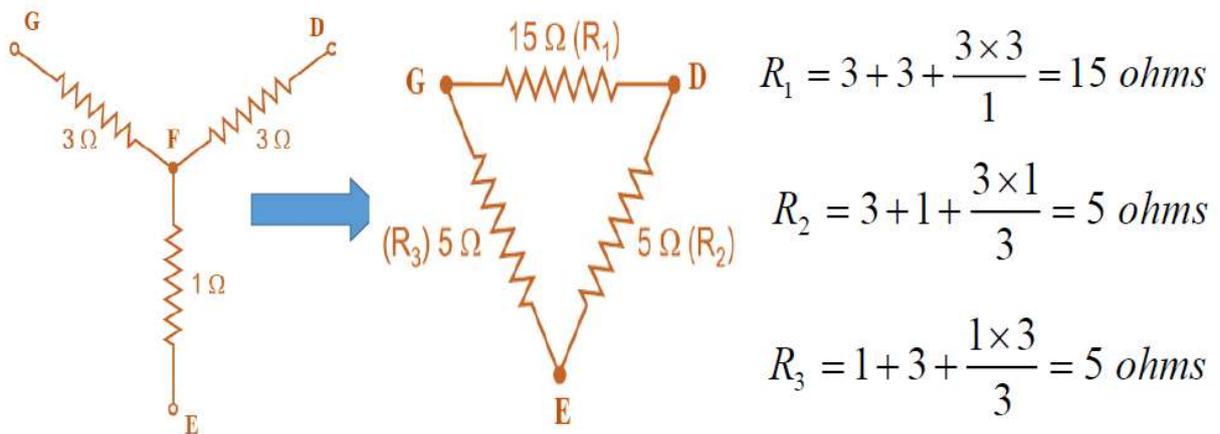


$$R_{AC} = 2.86 + \frac{(30 + 5.72) \times (15 + 11.4)}{(30 + 5.72) + (15 + 11.4)} = 18.04 \text{ ohms}$$

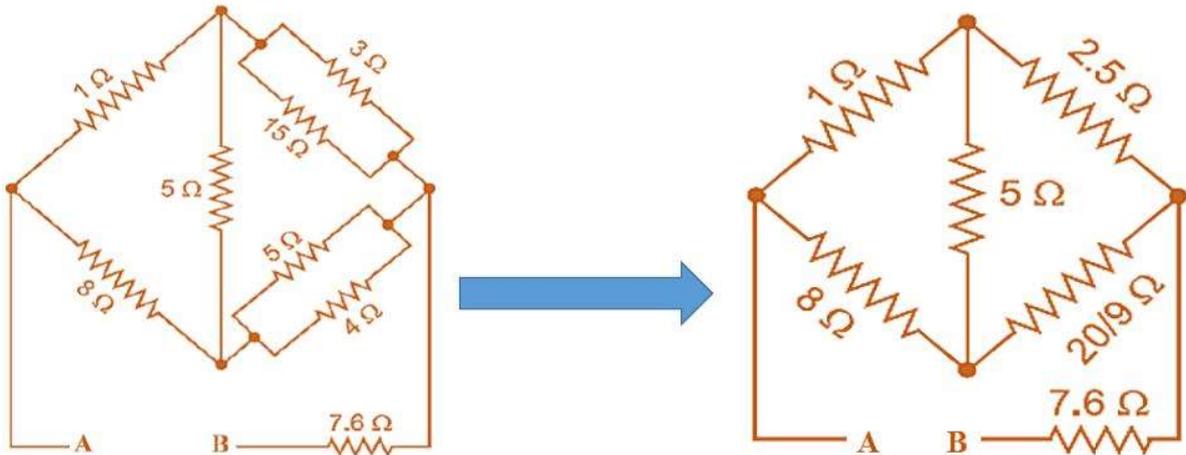
Q. Calculate equivalent resistance across terminals A and B.



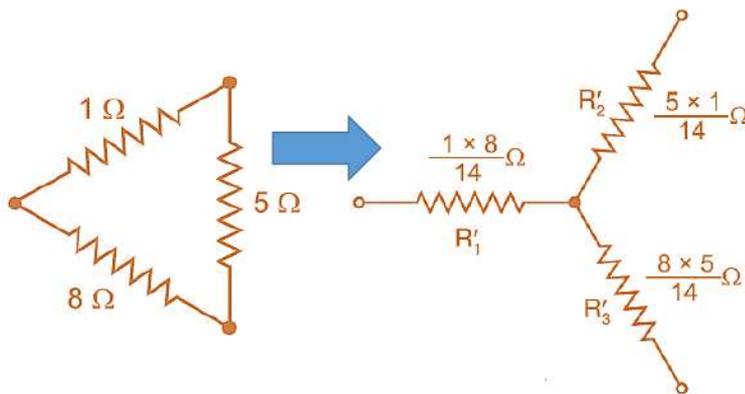
Soln: Converting inner STAR (3 ohms, 3 ohms and 1 ohms) into Delta.



Circuit now becomes,



Delta-connected resistances 1 Ω, 5 Ω and 8 are converted in star,

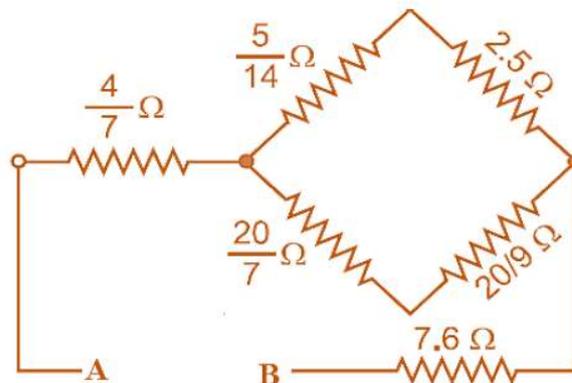


$$R_1' = \frac{1 \times 8}{1 + 5 + 8} = \frac{4}{7} \text{ ohms}$$

$$R_2' = \frac{5 \times 1}{1 + 5 + 8} = \frac{5}{14} \text{ ohms}$$

$$R_3' = \frac{8 \times 5}{1 + 5 + 8} = \frac{20}{7} \text{ ohms}$$

Circuit now becomes,



$$R_{AB} = \frac{4}{7} + \left[\left(\frac{5}{14} + 2.5 \right) \parallel \left(\frac{20}{7} + \frac{20}{9} \right) \right] + 7.6 = 10 \text{ ohms}$$

Q. Calculate equivalent resistance across terminals A and B.

