SNS COLLEGE OF TECHNOLOGY
Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++'(III Cycle) Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

23ECB101 – CIRCUIT ANALYSIS AND DEVICES

I YEAR/ II SEMESTER

UNIT 2 – NETWORK THEOREMS AND SOURCE TRANSFORMATION

TOPIC - Star-delta conversion Problems

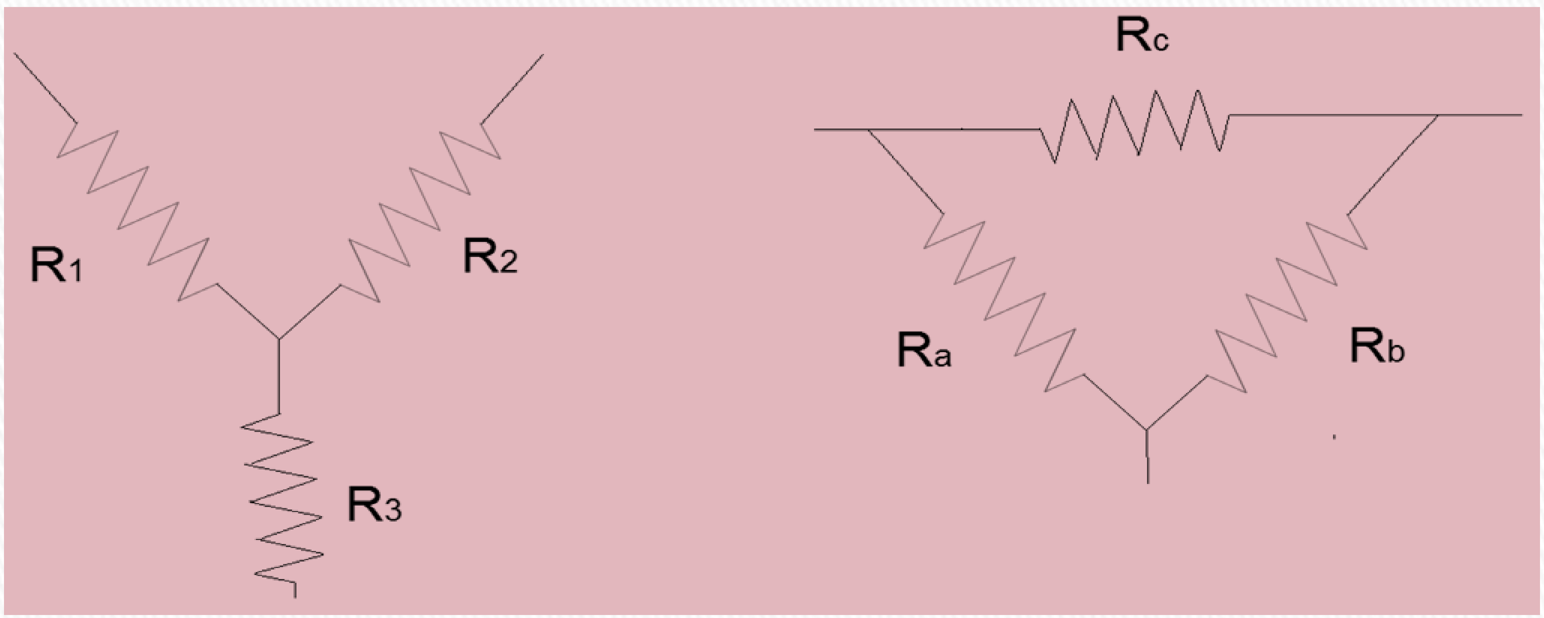
Introduction

- Some resistor networks cannot be simplified using the usual series and parallel combinations. This situation can often be handled by trying the Δ−Y\Delta - Wye Y-Δ\Wye - delta transformation.

- The transformation allows us to replace three resistors in a Δ\Delta configuration by three resistors in a Y\Wye configuration, and the other way around.

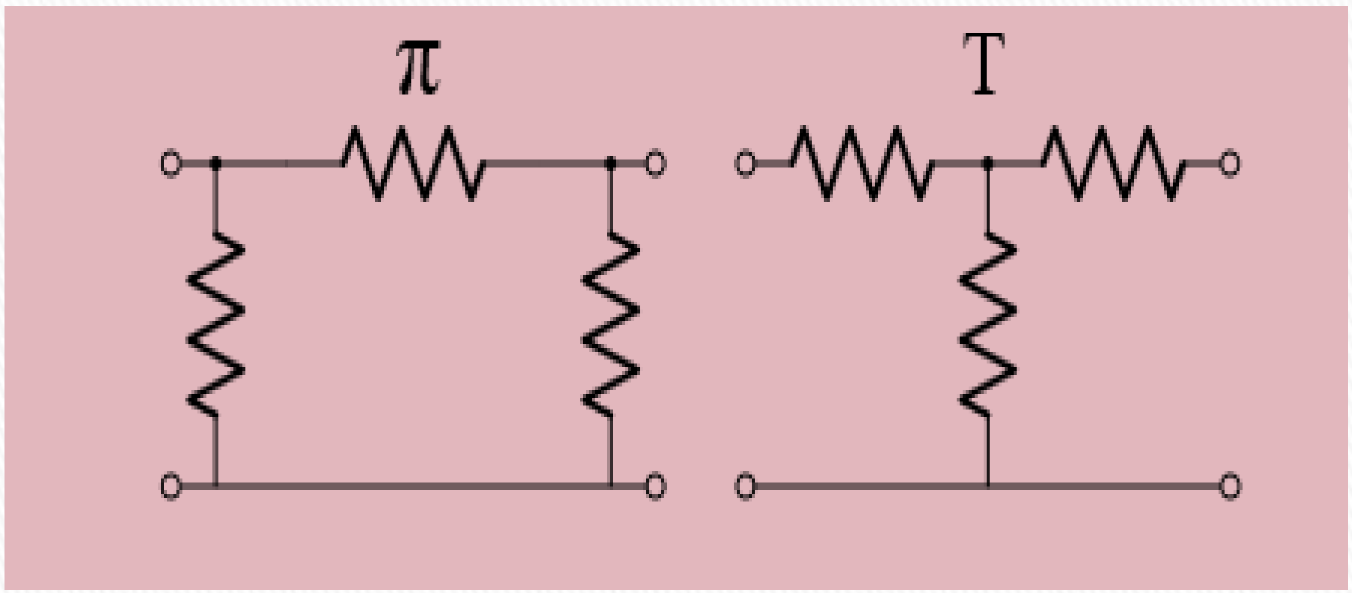
Delta Wye Conversion

- 3 terminal arrangements – commonly used in power systems



Wye (Y)　　　　　　　　Delta (D)

- delta has three nodes, while Y\Wye has four nodes (one extra in the center).
- *The configurations can be redrawn to square up the resistors. This is called a π−T*



To transform a Delta into a Wye

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

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

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

To transform a Wye into a Delta

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

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

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

Simplification

- If Ra = Rb = Rc = R’, then R1 = R2 = R3 = R/3
- If R1 = R2 = R3 = R, then Ra = Rb =Rc = 3R

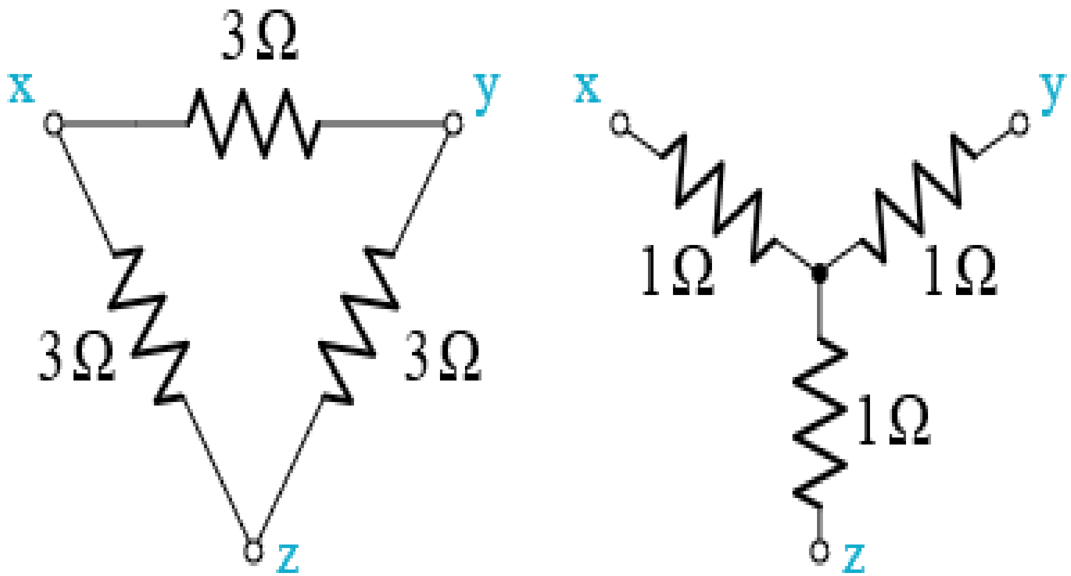
Example

- Assume we have a Δ\Delta 3 Ω resistors. Derive the Y equivalent by using the Δ→Y equations.

$$R1 = \frac{Rb\,Rc}{Ra + Rb + Rc} = \frac{3 \cdot 3}{3 + 3 + 3} = 1\,\Omega$$

$$R2 = \frac{Ra\,Rc}{Ra + Rb + Rc} = \frac{3 \cdot 3}{3 + 3 + 3} = 1\,\Omega$$

$$R3 = \frac{Ra\,Rb}{Ra + Rb + Rc} = \frac{3 \cdot 3}{3 + 3 + 3} = 1\,\Omega$$



All the 3Ω resistors in delta connected network has been replaced By 1Ω resistor in Star connected network.

Going in the other direction, from $Y \rightarrow \Delta$,

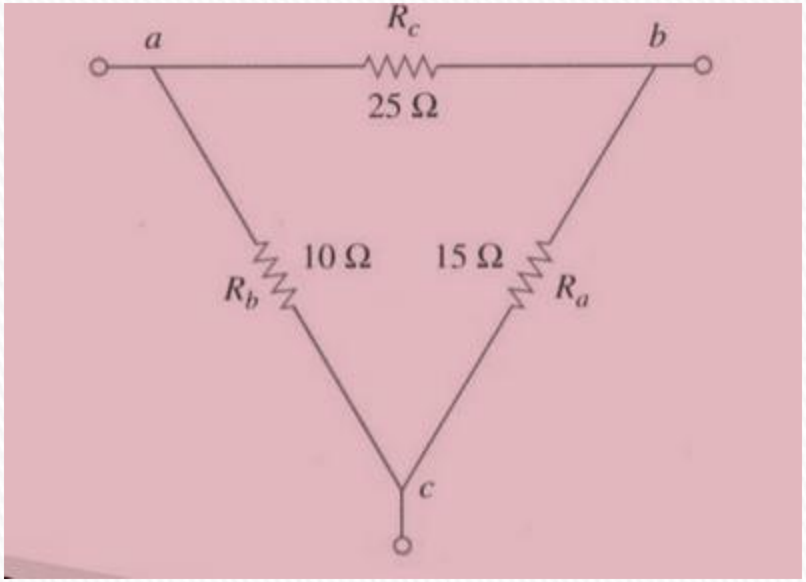
$$Ra = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R1} = \frac{1 \cdot 1 + 1 \cdot 1 + 1 \cdot 1}{1} = 3\,\Omega$$

$$Rb = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R2} = \frac{1 \cdot 1 + 1 \cdot 1 + 1 \cdot 1}{1} = 3\,\Omega$$

$$Rc = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R3} = \frac{1 \cdot 1 + 1 \cdot 1 + 1 \cdot 1}{1} = 3\,\Omega$$

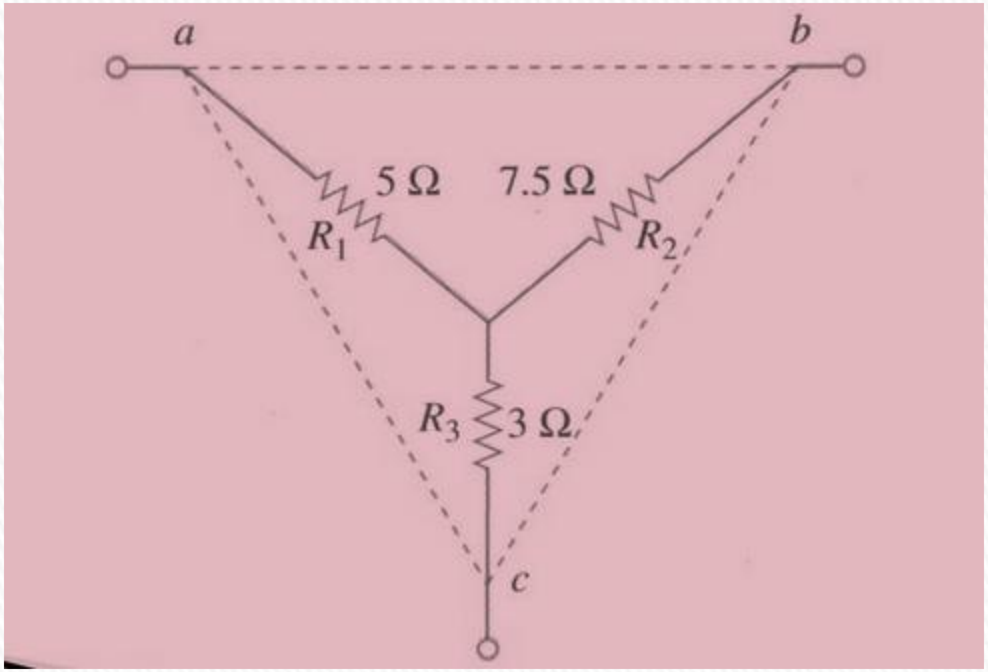
Example

- Transform the delta network into its equivalent Wye network



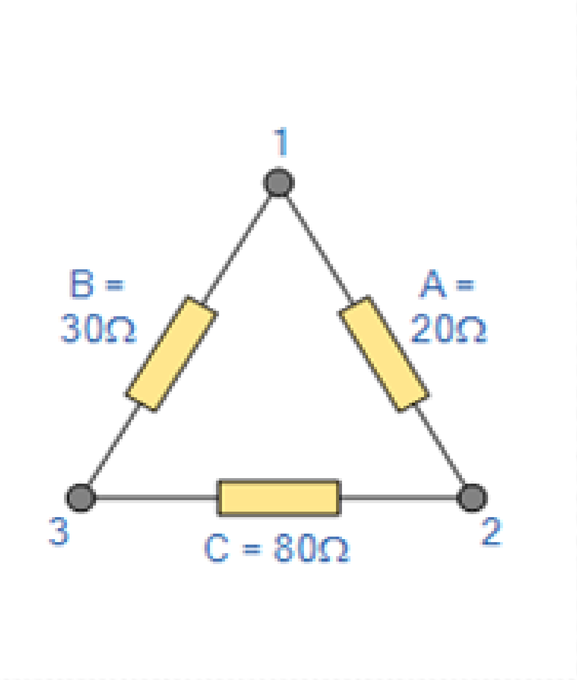
Procedure

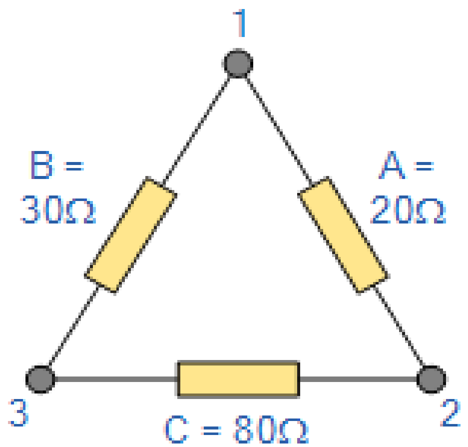
- First transform your network into opposite network.
- Calculate the values of the new network.
- Erase the old network.


a
b
5 Ω
7.5 Ω
R_1
R_2
R_3
3 Ω
c

Example

- Convert the following Delta Resistive Network into an equivalent Star Network.





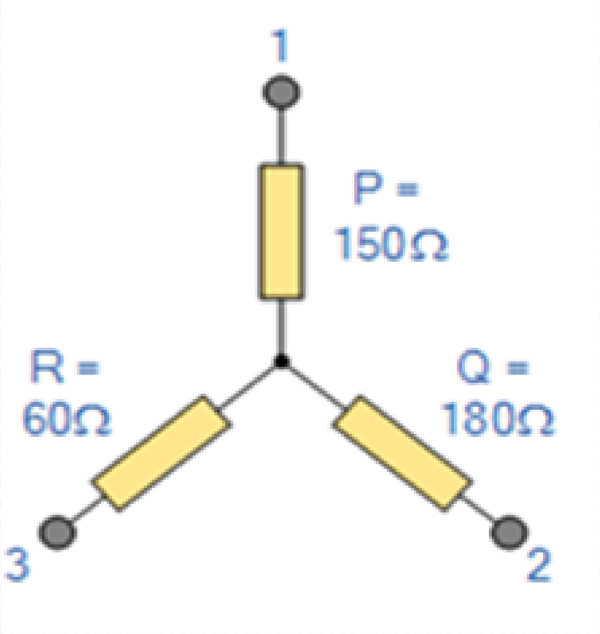
$$Q = \frac{AC}{A+B+C} = \frac{20\times 80}{130} = 12.31\Omega$$

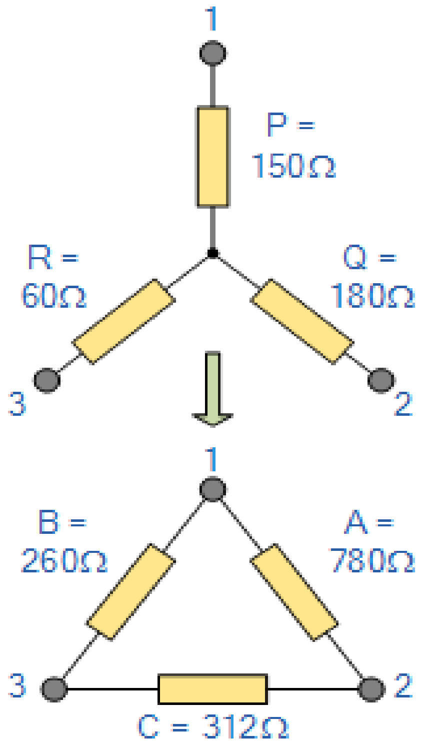
$$P = \frac{AB}{A+B+C} = \frac{20\times 30}{130} = 4.61\Omega$$

$$R = \frac{BC}{A+B+C} = \frac{30\times 80}{130} = 18.46\Omega$$

Example

- Convert the following Star Resistive Network into an equivalent Delta Network.





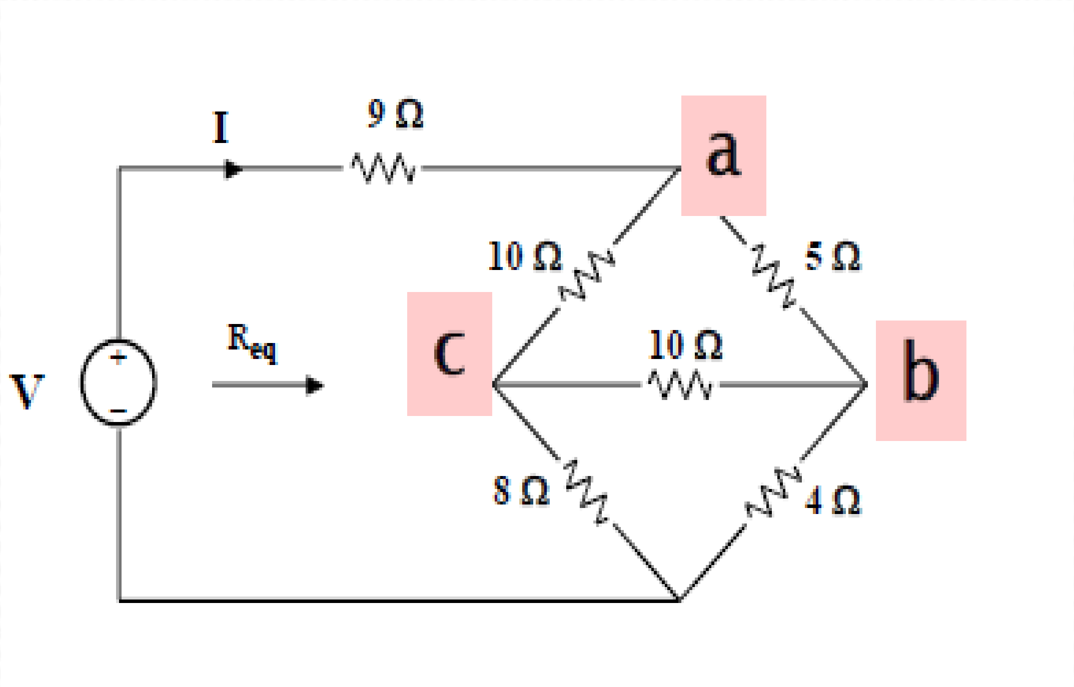
$$A = \frac{QP}{R} + Q + P = \frac{180 \times 150}{60} + 180 + 150 = 780\Omega$$

$$B = \frac{RP}{Q} + R + P = \frac{60 \times 150}{180} + 60 + 150 = 260\Omega$$

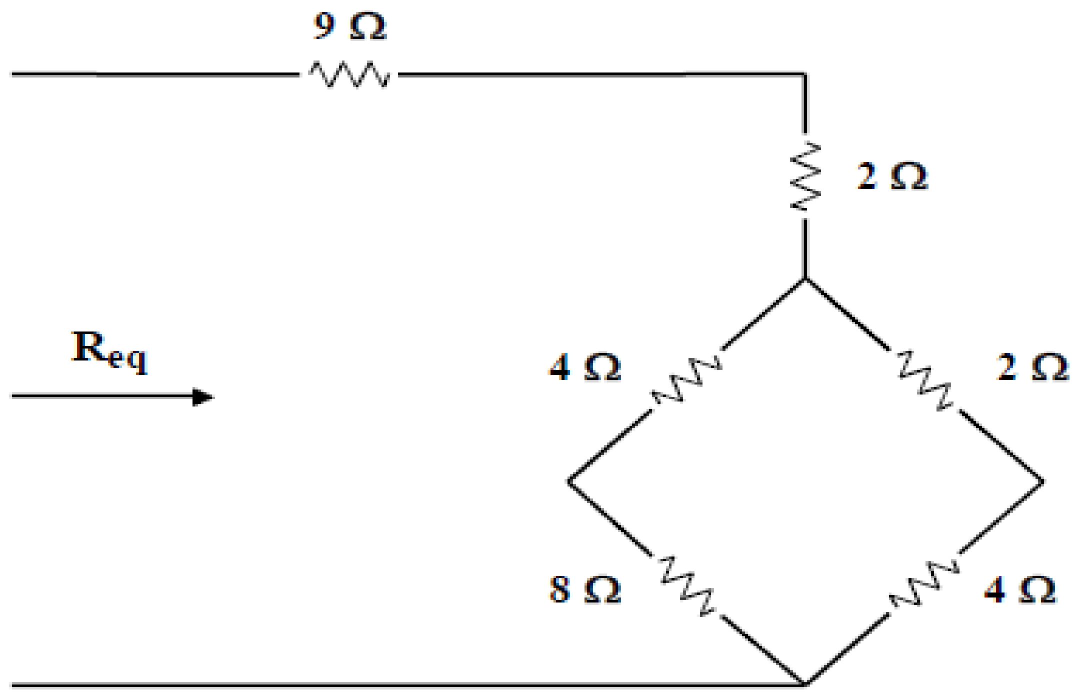
$$C = \frac{QR}{P} + Q + R = \frac{180 \times 60}{150} + 180 + 60 = 312\Omega$$

Example

- Using the following circuit. Find Req.



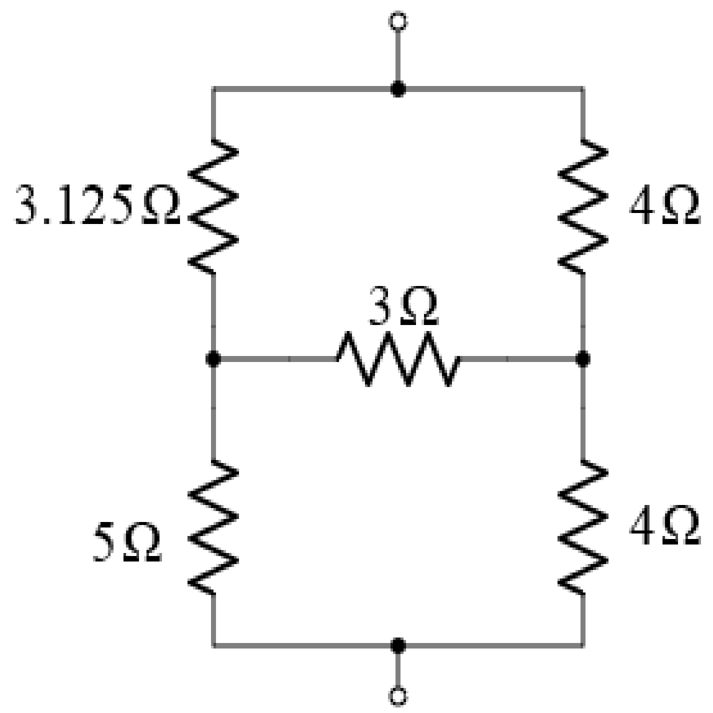
Convert the delta around a – b – c to a wye.



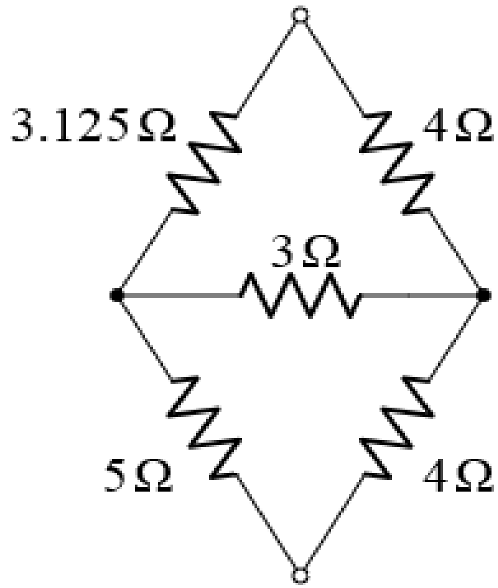
Req = 15 Ω

Example

- find the equivalent resistance between the top and bottom terminals.



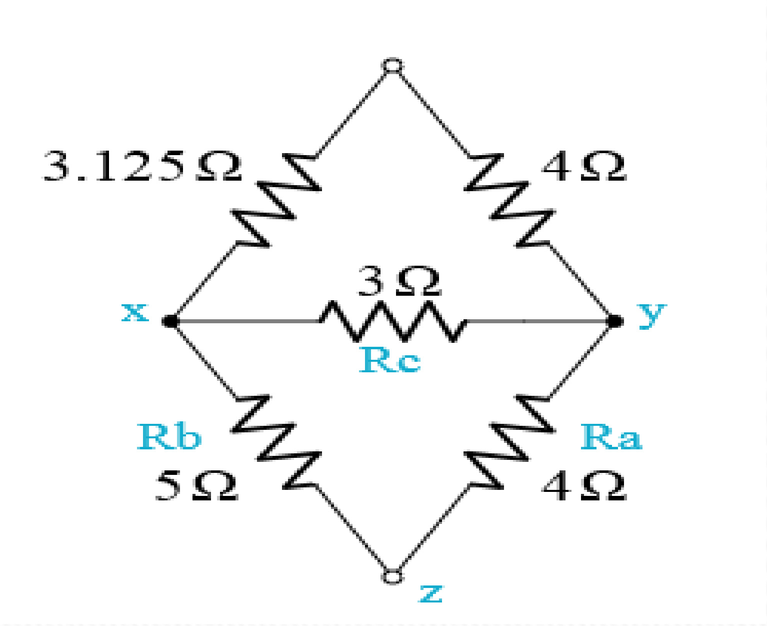
rst, let's redraw the schematic to emphasize
have two Δ\Delta connections stacked o
on the other.



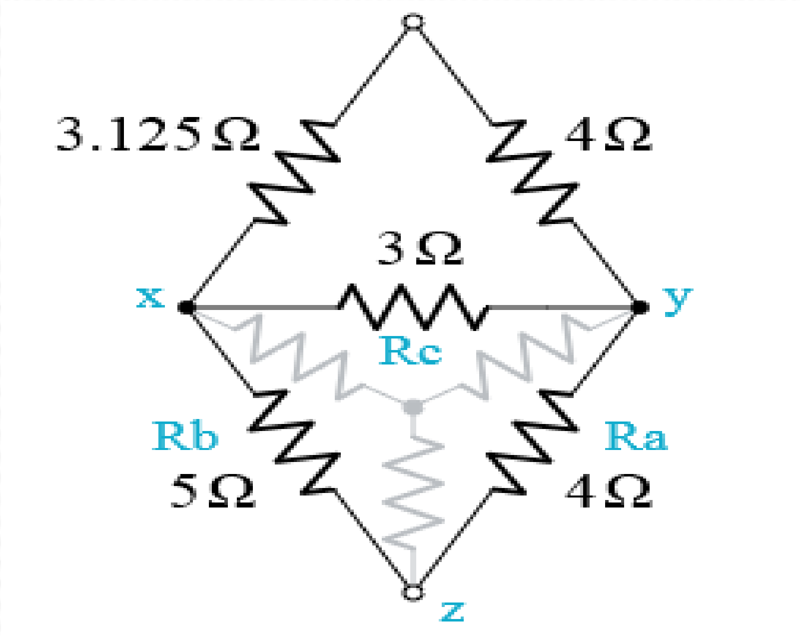
Now select one of the Δ\Delta to convert to Y. We will perform a Δ→Y transformation.

- To get the right answers from the transformation equations, it is critical to keep the resistor names and node names straight.

- Rc must connect between nodes X and Y, and so on for the other resistors.

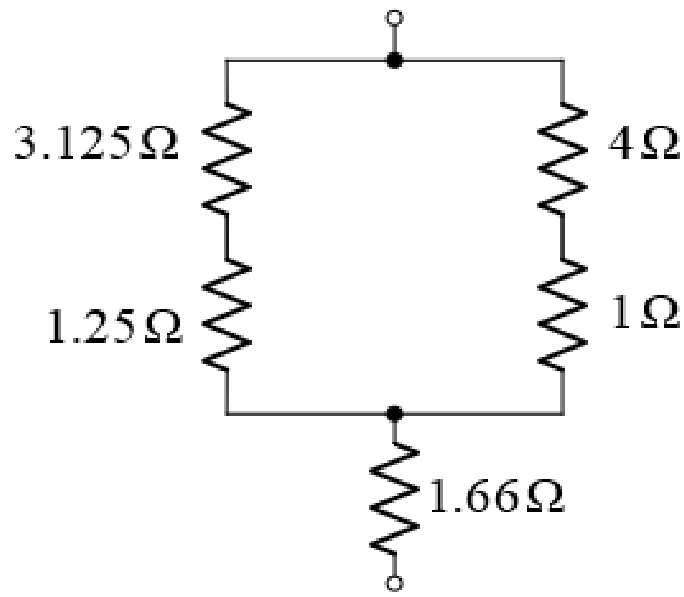


hen we perform the transform on the lower Δ\delta,
e Δ\Delta resistors will be replaced by the new
resistors,



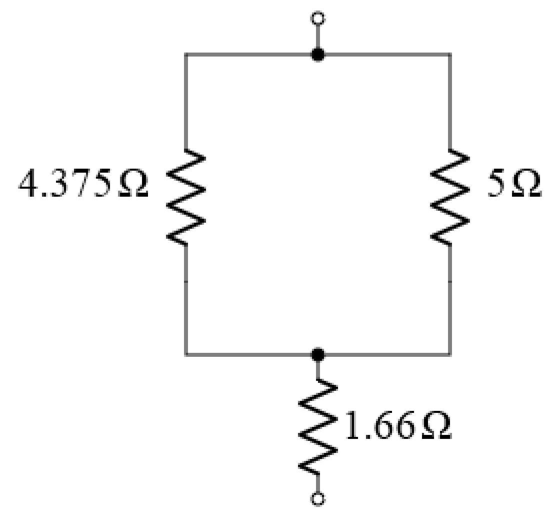
Compute three new resistor values to convert the Δ\Delta to a Y, and draw the complete circuit.

Continue simplification with series and parallel combinations until we get down to a single resistor between the terminals.

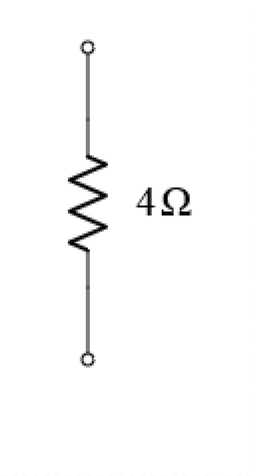


We proceed through the remaining simplification steps.

- On the left branch, 3.125+1.25=4.375 Ω
- On the right branch, 4+1=5 Ω



- *The two parallel resistors combine as 2.33Ω.*
- *Requivalent=2.33+1.66=4Ω*



THANK YOU