Al-Anbar University
College of engineering
Electrical Engineering Department

fundamental of Electric Circuit 1
Assist. Lect. Yasameen Kamil
Stage 1
2021-2022

LECTURE 07
WYE-DELTA TRANSFORMATION

Topics

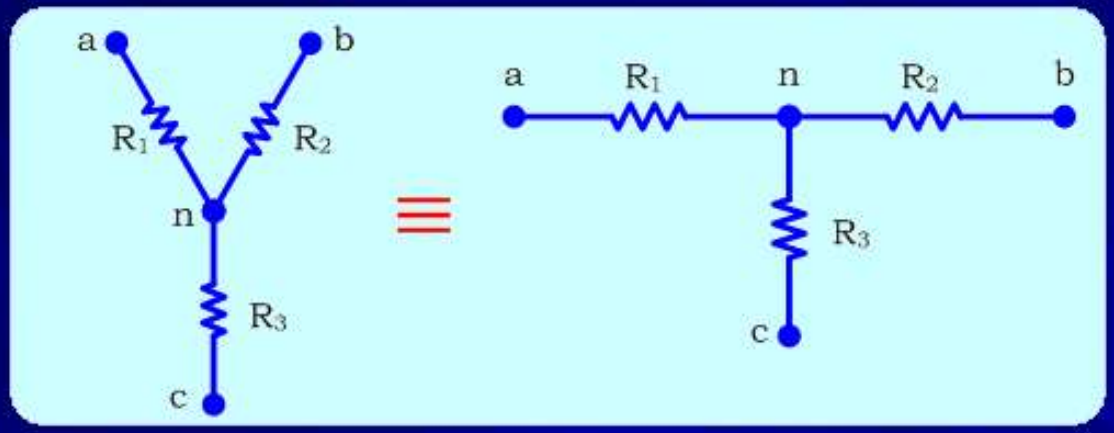
- △ - Connection
- Y - Connection
- △-Y Transformation

Objectives

- Recognize Y and △ connections
- Redraw the circuit to make it easier to identify Y and △ connections
- Use the transformation relations to perform Y-△ transformations
- Use Y-△ transformation to simplify analysis of certain circuits

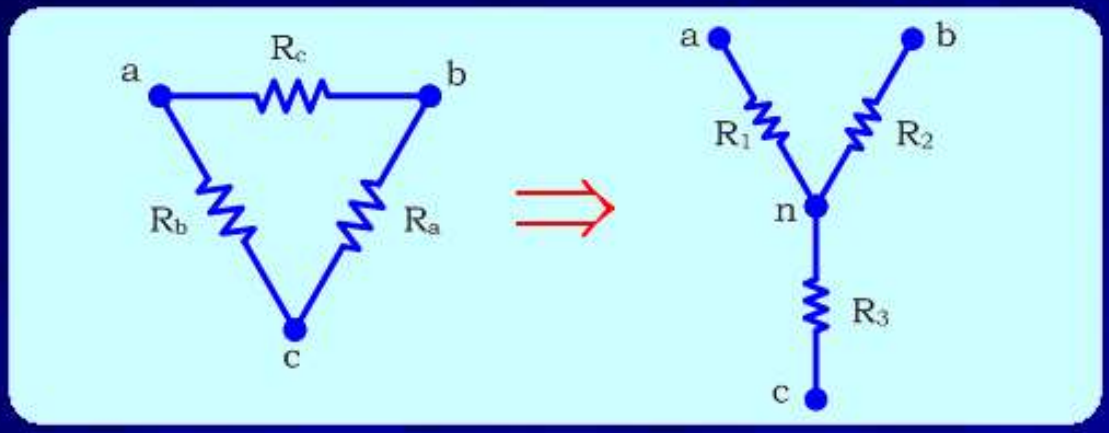
Y - Connection

R_1, R_2 and R_3 form a Y connection



The *terminals* of the Y connection are also labeled as ***a***, ***b*** and ***c***.

△-Y Transformation



Relations for △-Y Transformation

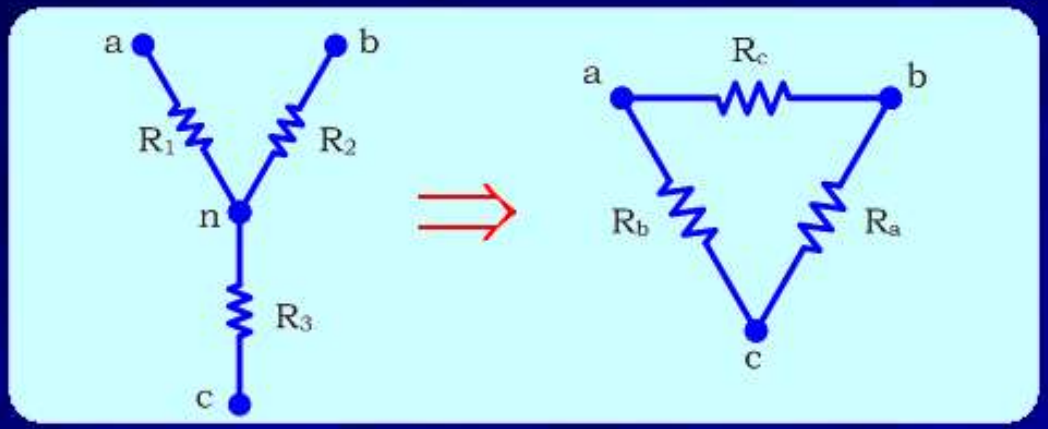
$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

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

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

You need only to remember one of the above relations, since the other two are similar

Y-△ Transformation



Relations for Y-△ Transformation

$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

The numerator is the same making the above relations easy to recall

Notice that the nodes *a*, *b* and *c are kept the same in both circuits*

Example 1

Use △→Y transformation to calculate

(a) R_{eq} seen by the voltage source (b) i_s

Solution

(a) We cannot calculate R_{eq} using the series parallel approach

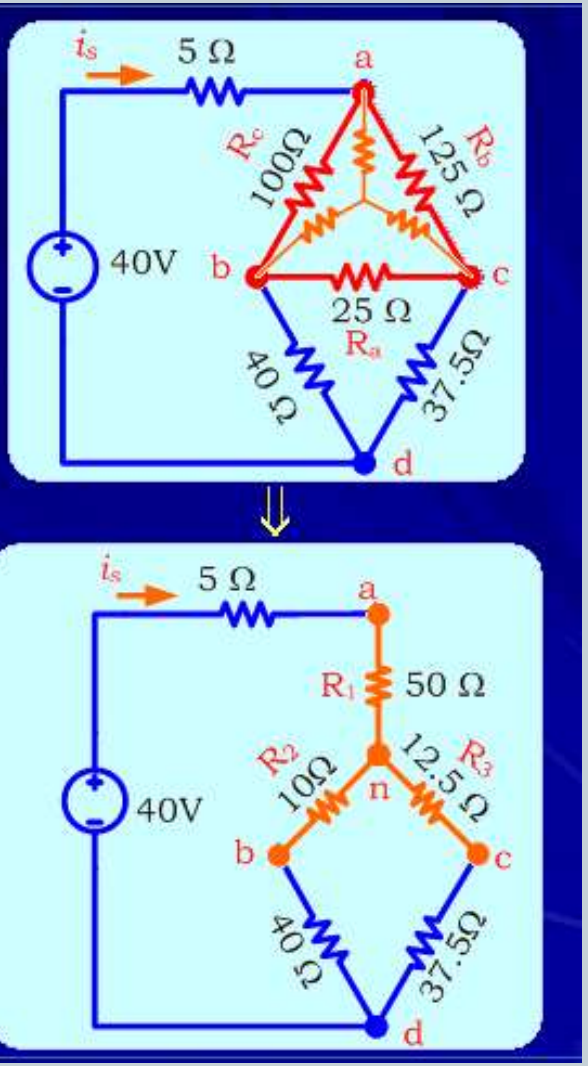
We can transform the (upper or lower) △ to Y

Transforming the upper △ to Y

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{125 \times 100}{25 + 125 + 100} = \frac{125 \times 100}{250} = 50\Omega$$

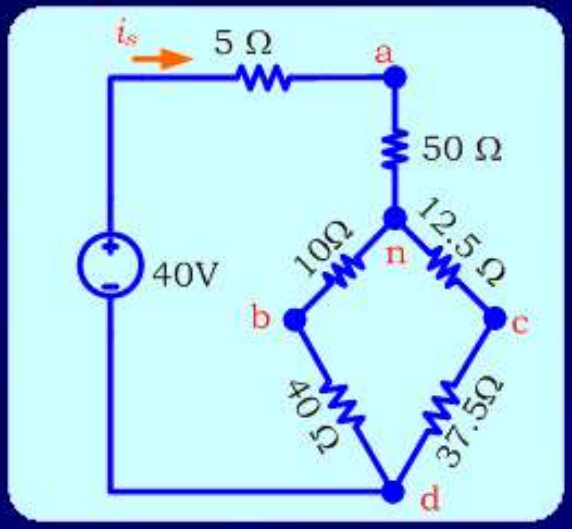
$$R_2 = \frac{R_a R_c}{R_a + R_b + R_c} = \frac{25 \times 100}{250} = 10\Omega$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c} = \frac{25 \times 125}{250} = 12.5\Omega$$



Example 1 (Contd...)

Use △→Y transformation to calculate (a) R_{eq} seen by the voltage source (b) i_s

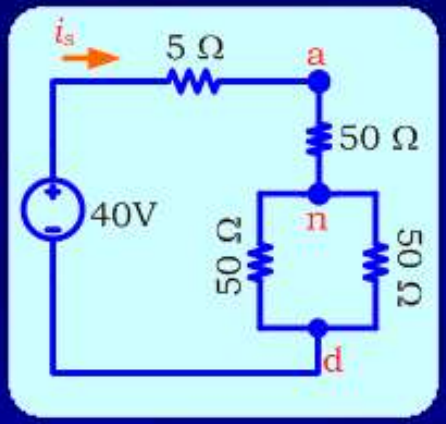


12.5Ω & 37.5Ω (in series)

$\Rightarrow 12.5+37.5=50\Omega$

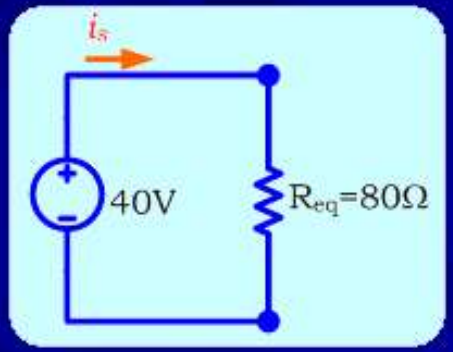
10Ω & 40Ω (in series)

$\Rightarrow 10+40=50\Omega$



$\therefore R_{eq} = 5+50+(50/2)$

$\Rightarrow R_{eq} = 80\Omega$



(b) $i_s = \frac{40}{R_{eq}} = \frac{40}{80} = 0.5A$

Example 2

Let us explore some other possibilities for solving the previous problem. Repeat the previous example using Y→△ transformation

(a) R_{eq} seen by the voltage source (b) i_s

Solution

(a) Redraw the circuit

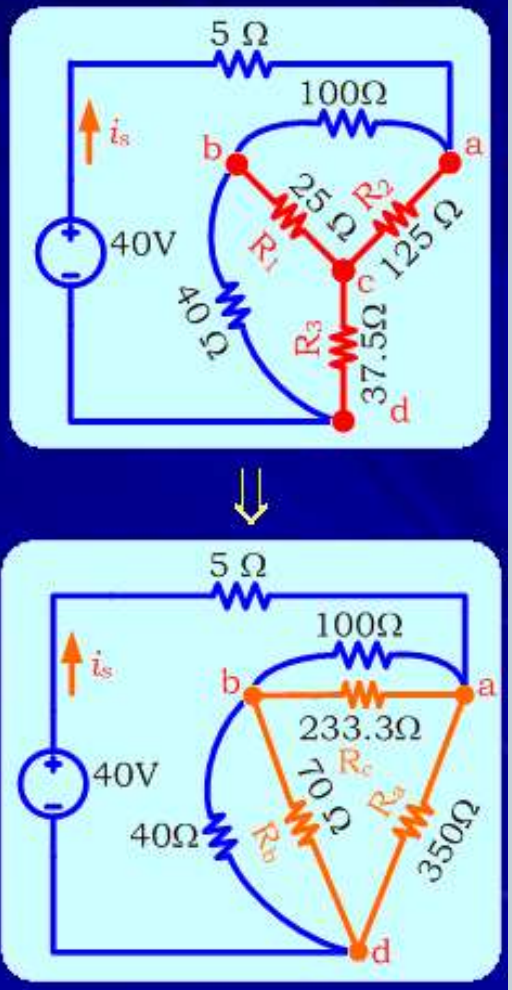
25Ω, 125Ω and 37.5Ω form a Y connection

Using Y to △ transformation

$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1} = \frac{25\times125 + 125\times37.5 + 37.5\times25}{25} = 350\Omega$$

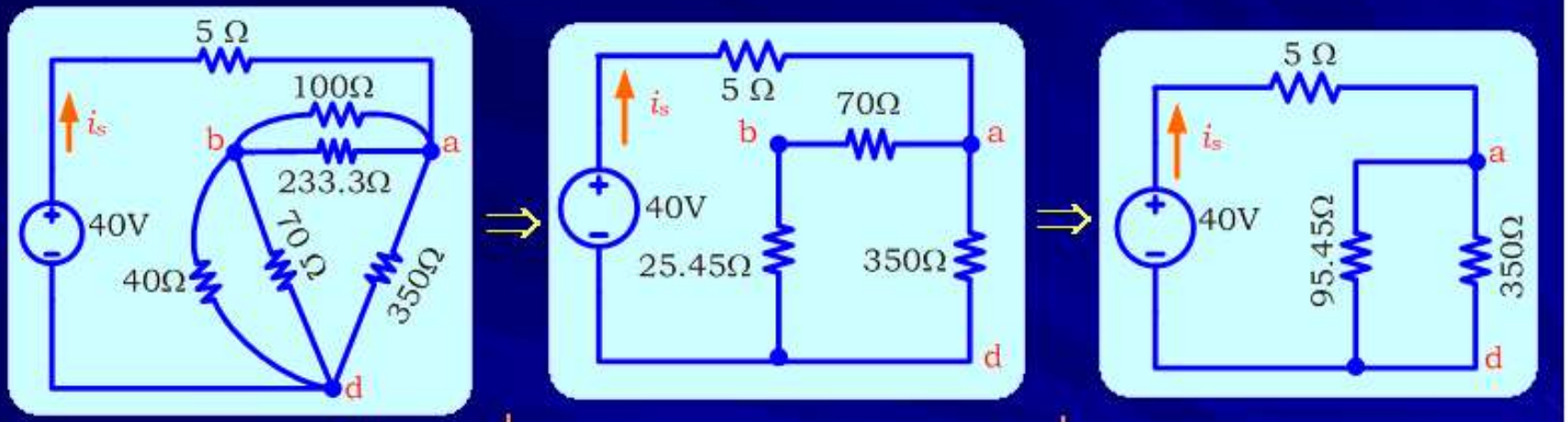
$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2} = \frac{8750}{125} = 70\Omega$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3} = \frac{8750}{37.5} = 233.33\Omega$$



Example 2 (Contd...)

Use Y→△ transformation to calculate (a) R_{eq} seen by the voltage source (b) i_s



$40\Omega \| 70\Omega$

$\Rightarrow \frac{40\times 70}{40+70} = 25.455\Omega$

$100\Omega \| 233.33\Omega$

$\Rightarrow \frac{100\times 233.33}{100+233.33} = 70\Omega$

70Ω & 25.45Ω (in series)

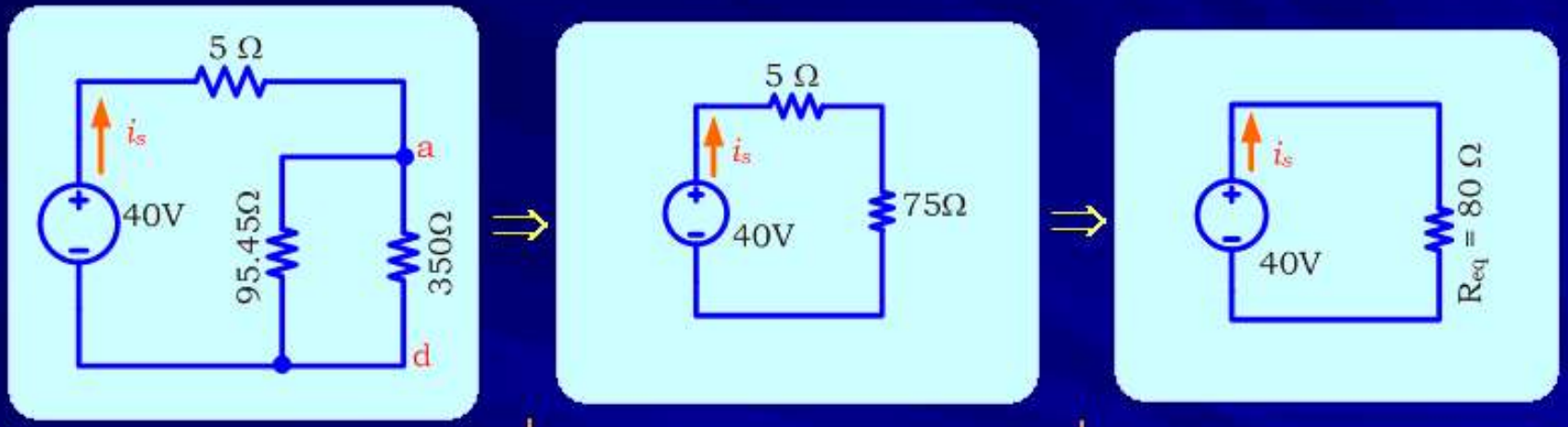
$\Rightarrow 70+25.45 = 95.45\Omega$

$95.45\Omega \| 350\Omega$

$\Rightarrow \frac{95.45\times 350}{95.45+350} = 75\Omega$

Example 2 (Contd...)

Use Y→△ transformation to calculate (a) R_{eq} seen by the voltage source (b) i_s



$95.45\Omega \| 350\Omega$

$\Rightarrow \dfrac{95.45 \times 350}{95.45 + 350} = 75\Omega$

5Ω & 75Ω (in series)

$\Rightarrow 5 + 75 = 80\Omega$

$\therefore R_{eq} = 80\Omega$

same answer as before

(b) $i_s = \dfrac{40}{R_{eq}} = \dfrac{40}{80} = 0.5\text{A}$