NORTH SOUTH UNIVERSITY

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

EEE41L/ETE141L

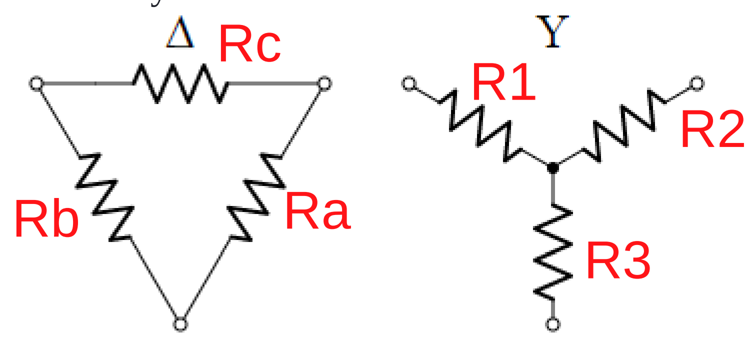
Lab 4: Delta-Wye Conversion

Objectives:
1. To perform Delta-Wye Conversion
2. To verify the results with measured data.
3. Solve a complex circuit using Delta-Wye Conversion.

The Delta-Wye transformation is an extra technique for transforming certain resistor combinations that cannot be handled by the series and parallel equations. This is also referred to as a Pi - T transformation

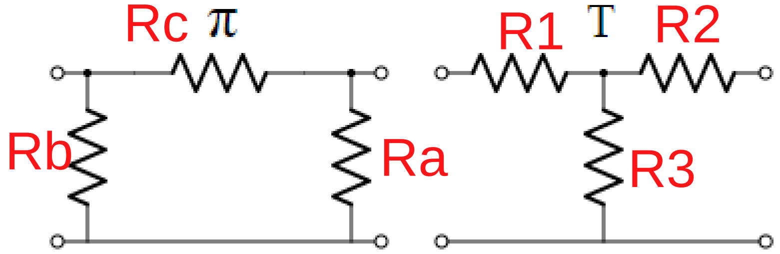
Sometimes when you are simplifying a resistor network, you get stuck. Some resistor networks cannot be simplified using the usual series and parallel combinations. This situation can often be handled by trying $\Delta - Y$ transformation, or 'Delta-Wye' transformation.

The names Delta and Wye come from the shape of the schematics, which resemble letters. The transformation allows you to replace three resistors in a Δ configuration by three resistors in a Y configuration, and the other way around.



The$\Delta - Y$drawing style emphasizes these are 3-terminal configurations. Something to notice is the different number of nodes in the two configurations. Δ has three nodes, while Y has four nodes (one extra in the center).

The configurations can be redrawn to square up the resistors. This is called π–T configuration,



The π−T style is a more conventional drawing you would find in a typical schematic. The transformation equations developed next apply to π−T as well.

$\Delta \rightarrow \mathrm{Y}$ transformation

Equations for transforming a Δ network into a Y network:

$$R1 = \frac{Rb\,Rc}{Ra + Rb + Rc}$$

$$R2 = \frac{Ra\,Rc}{Ra + Rb + Rc}$$

$$R3 = \frac{Ra\,Rb}{Ra + Rb + Rc}$$

Transforming from Δ to Y introduces one additional node.

$\mathrm{Y} \rightarrow \Delta$ transformation

Equations for transforming a Y network into a Δ network:

$$Ra = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R1}$$

$$Rb = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R2}$$

$$Rc = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R3}$$

Transforming from Y to Δ removes one node.

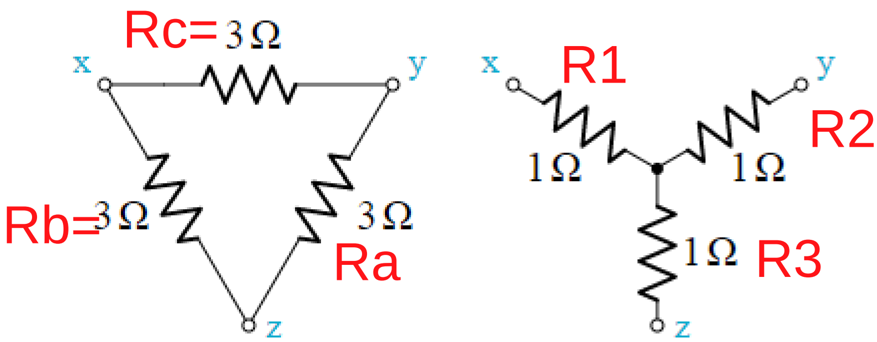
Example

Let's do a symmetric example. Assume we have a Δ circuit with $3\,\Omega$ resistors. Derive the Y equivalent by using the $\Delta \rightarrow \mathrm{Y}$ equations.

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

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

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



Going in the other direction, from $\mathrm{Y} \rightarrow \Delta$, looks like this,

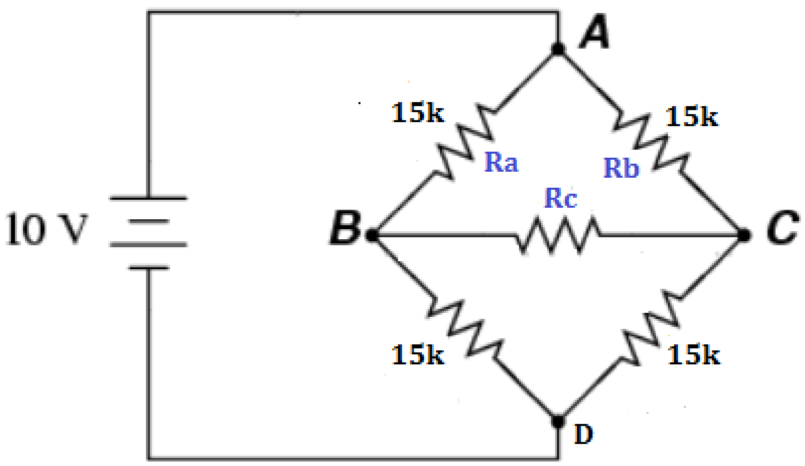
$$Ra = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R1} = \frac{1 \cdot 1 + 1 \cdot 1 + 1 \cdot 1}{1} = 3\,\Omega$$

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

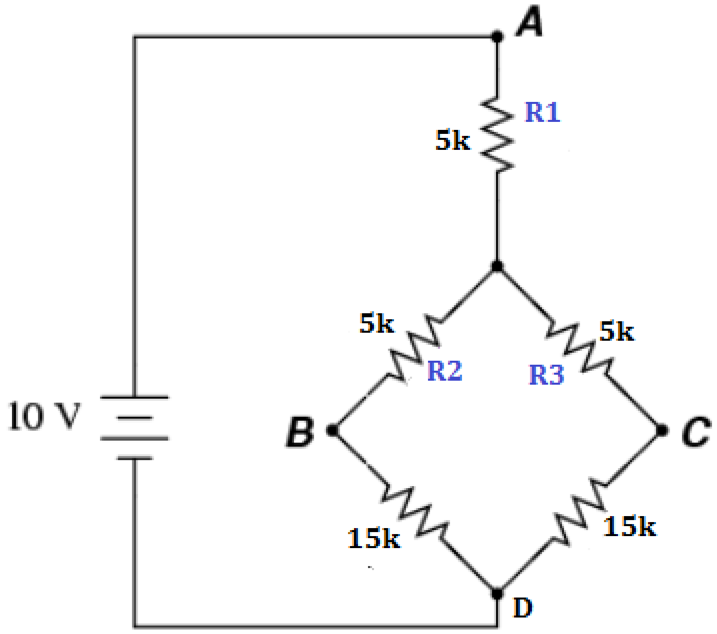
$$Rc = \frac{R1\,R2 + R2\,R3 + R3\,R1}{R3} = \frac{1 \cdot 1 + 1 \cdot 1 + 1 \cdot 1}{1} = 3\,\Omega$$

The transformed network and the original network has the same equivalent resistance (although the individual resistors between the nodes are different).The two networks will be electrically identical as measured from the three terminals (A, B, and C), i.e. the node voltages of both the circuits would be equal.

Circuit Diagram:



Circuit 1



Circuit 2

List of Equipment

- Trainer Board
- DMM
- 5 x 15kΩ resistor
- 3 x 5 kΩ resistor

Procedure

1. Measure the resistor values with DMM and note down in Table 1.
2. Setup the circuit as shown in the circuit 1
3. Measure the voltage V_{AD} , V_{BD}, V_{CD}(D is the reference node) and note down in Table 2
4. Measure the voltage V_{AB} , V_{BC}, V_{AC} and note down in Table 2
5. Setup Circuit 2.
6. Measure the voltage V_{AD} , V_{BD}, V_{CD} (D is the reference node) and note down in Table 2
7. Measure the voltage V_{AB} , V_{BC}, V_{AC} and note down in Table 2

Data Collection for Lab4:

Group No. ________

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Instructor's Signature __________

Table 1:

Theoretical R	Measured R	% Error
15k		
5k		

Table 2:

Rt= 15 K Rt= 15 K

Readings	Circuit 1	Circuit 2	% Error
V_{AD}	10 V	10 V	
V_{BD}	5 V	5 V	
V_{CD}	5 V	5 V	
V_{AB}	5 V	5 V	
V_{BC}	0 V	0 V	
V_{AC}	5 V	5 V	

Report:

1. The resistors in Circuit 1 are in series or in parallel combination?
2. What technique would you use to find the equivalent resistance?
3. Perform Delta-Wye conversion for ΔABC $(upper\ portion)$ of circuit 1. Show all your steps to find the equivalent resistance R1, R2, R3 from Ra, Rb, Rc.

4. Redraw the equivalent the circuit after applying the Delta-Wye conversion for ΔABC. Is it same as circuit 2?

5. Calculate Req.

6. Calculate the voltage of R1, R2, R3.

7. Calculate V_{AB} , V_{BC}, V_{AC} and V_{AD} , V_{BD}, V_{CD}. Do your calculated values match the measured values for circuit 2? Find the % Error.

8. Using Table 2, analyze whether Circuit 2 is equivalent to Circuit 1? Was Delta-Wye conversion successful?