1. Objective

The objective for conducting this experiment, is to perform Delta-Wye Conversion as well as To verify the results with measured data and Solve a complex circuit using Delta-Wye Conversion

2. List of Equipment

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

3. Theory

Δ -Y transformation

The Δ -Y transform, also written as delta-wye and also known by many other names is a mathematical technique to simplify the analysis of three phase electric power circuits. The Δ -Y transform can be considered as a special case of the star mesh transform for three resistors. It plays an important role in the theory of circular plane graphs. This is also referred to as a Pi - T transformation

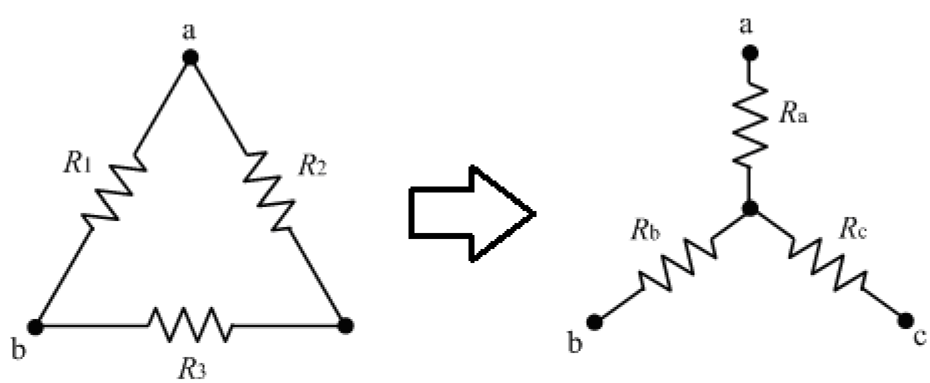


Fig (a): Delta to Wye transform

$$R_1 = \frac{R_B R_C}{R_A + R_B + R_C}$$

$$R_2 = \frac{R_A R_C}{R_A + R_B + R_C}$$

$$R_3 = \frac{R_A R_B}{R_A + R_B + R_C}$$

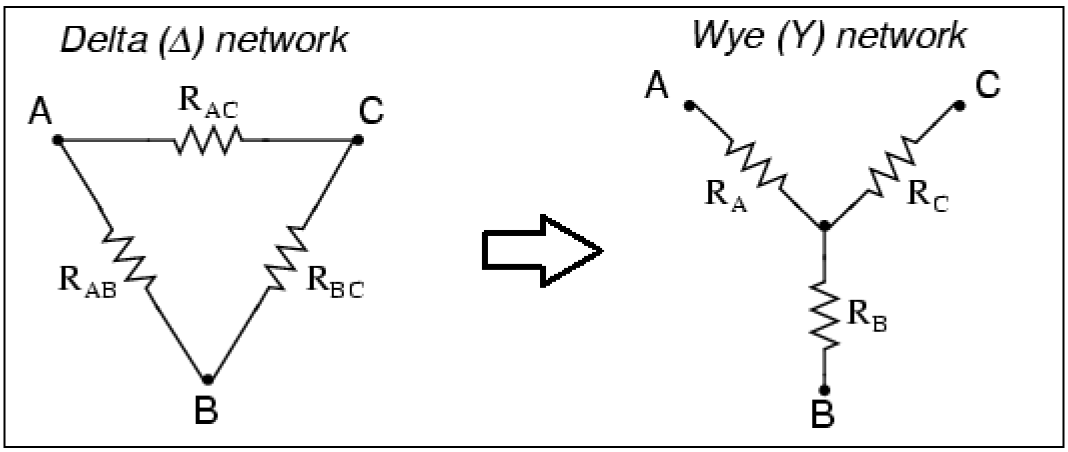
Importance of delta – wye transformation

Delta-Wye Transformation is very important in Circuits, sometimes we are not sure in electric circuits that the resistors are neither parallel nor series. In many circuit applications, we encounter components connected together in one of two ways to form a three-terminal network: the "Delta," or Δ (also known as the "Pi," or π) configuration, and the "Y" (also known as the "T") configuration.

- "Delta" (Δ) networks are also known as "Pi" (π) networks.
- "Y" networks are also known as "T" networks
- Δ and Y networks can be converted with the proper resistance equations. By "equivalent," I mean that the two networks will be electrically identical as measured from the three terminals (A, B, and C).

Converting delta-wye connection

In delta to star conversion, the delta connected elements will be converted to star connection in order to simplify the network analysis. Transforming from delta to star introduces one additional node.



$$R_A = \frac{R_{AB} R_{AC}}{R_{AB} + R_{AC} + R_{BC}}$$

$$R_B = \frac{R_{AB} R_{BC}}{R_{AB} + R_{AC} + R_{BC}}$$

$$R_C = \frac{R_{AC} R_{BC}}{R_{AB} + R_{AC} + R_{BC}}$$

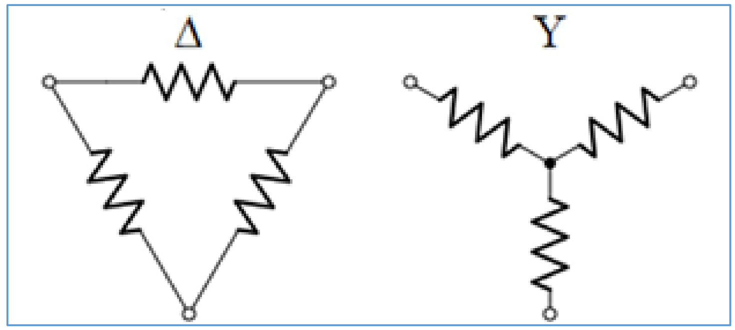
For Example

Let's do a symmetric example. Assume we have a Δ circuit with 6Ω resistors.

$$R_1 = \frac{R_B R_C}{R_A + R_B + R_C} = \frac{6.6}{6+6+6} = 2$$

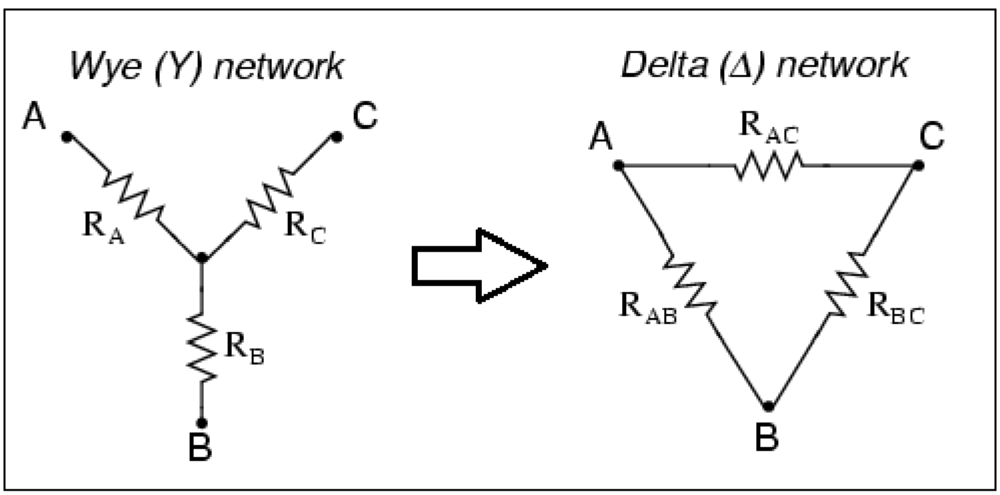
$$R_2 = \frac{R_A R_C}{R_A + R_B + R_C} = \frac{6.6}{6+6+6} = 2$$

$$R_3 = \frac{R_A R_B}{R_A + R_B + R_C} = \frac{6.6}{6+6+6} = 2$$



wye (Y) to Delta (Δ) Conversion

In wye to delta conversion, the wye connected elements will be converted to delta connection in order to simplify the network analysis. Transforming from star to delta removes one node.



$$R_{AB} = \frac{R_A R_B + R_A R_C + R_B R_C}{R_C}$$

$$R_{BC} = \frac{R_A R_B + R_A R_C + R_B R_C}{R_A}$$

$$R_{AC} = \frac{R_A R_B + R_A R_C + R_B R_C}{R_B}$$

Application of delta connection

Star-Delta connection in three phase circuits is used to vary voltage and current. If you use star connection then voltage is reduced to 60% of supply voltage and current remains same while in Delta connection current is reduced to 60% of the value of current in star connection. Its major application is in starting induction motor where it need starting at low voltage to keep starting current low, it is started in star ie its three windings are connected in star but induction motor needs to be operated at high voltage at steady state or normal state to deliver rated power, after starting in star its three windings are switched to delta.

4. Results/Data/Readings

Table 1:

Theoretical R	Measured R	% Error
15k	15k	0%
5k	4.91k	1.8%

Table 2:

Readings	Circuit 1	Circuit 2	% Error
V_{AD}	9.97mV	9.97mv	0%
V_{BD}	4.96mV	5mV	-0.81%
V_{CD}	4.99mV	4.99mV	0%
V_{AB}	5mV	4.97mV	0.6%
V_{BC}	0.02mV	0.0mV	100%
V_{AC}	4.98mV	4.97mV	0.2%

$$\text{Percentage Error} = \frac{\text{practical} - \text{Theoretical}}{\text{Theoretical}} * 100$$

5. Circuit Diagram

6. Q&A

1. The resistors in Circuit 1 are in series or in parallel combination?

Answer: The circuit is neither Series nor Parallel combination.

2. What technique would you use to find the equivalent resistance?

Answer: Circuit of this type can be simplified by using the delta (Δ)- wye(Y) Conversion.

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.
Answer:

$R_A = 15k$

$R_B = 15k$

$R_C = 15k$

$$R_1 = \frac{R_B R_C}{R_A + R_B + R_C}$$

$$R_1 = \frac{15.15}{15 + 15 + 15}$$

$R_1 = 5k$

$$R_2 = \frac{R_A R_C}{R_A + R_B + R_C}$$

$$R_2 = \frac{15.15}{15 + 15 + 15}$$

$R_2 = 5k$

$$R_3 = \frac{R_A R_B}{R_A + R_B + R_C}$$

$$R_3 = \frac{15.15}{15 + 15 + 15}$$

$R_3 = 5k$

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

- Calculate R_{eq}

$$R_{eq} = (5 + 10)k$$

$$R_{eq} = 15k$$

- Calculate the voltage of R1, R2, R3

For R1

$$V_{r1} = \frac{10}{15} * 5$$
$$V_{r1} = 3.33V$$

For R2

$$V_{r2=}V_{ab} - V_{r1}$$
$$V_{r2=}1.67V$$

For R3

$$V_{r3=}1.67V$$

- Calculate V_{ab}, V_{bc}, V_{ac} and V_{ad}, V_{bd}, V_{cd}.
- Find the % Error

$$V_{ab} = 5V$$

$$V_{bc} = 0V$$

$$V_{ac} = 5V$$

$$V_{ad} = 10V$$

$$V_{bd} = 5V$$

$$V_{cd} = 5V$$

Error

$$V_{ab} = 0.6\%$$
$$V_{ac} = 0.6\%$$
$$V_{bc} = 0\%$$
$$V_{ad} = 0.1\%$$
$$V_{bd} = 0.6\%$$
$$V_{cd} = 0.6\%$$

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

After analyze the Circuit. Circuit 2 was almost equivalent to Circuit 1 .and yes the Delta-Wye conversion was successful

7. Result Analysis & Discussion

During this Experiment, our main aim was to understand to perform Delta-Wye conversion and to solve a complex circuit using Delta-Wye conversion.

At first, to understand and become familiarized with the analysis of Delta-Wye Conversion, we have gone through the theory portion of the conversion. From that part, we have learned about the Delta to Wye Conversion. After going through these parts, we have attained a brief understanding of the Delta-Wye conversion and started our experiment part.

In the practical portion, we used 15 kilo-Ohm (5 x 15k.Ohm),5 kilo-Ohm (3 x 5K.Ohm).By using DMM, we measured 15k.Ohm and 5K.Ohm for circuit-1 and circuit-2 from 10 volt input source.

From result analysis, we saw error between circuit-1 and circuit-2. More specially the conversion between Delta-Wye is almost same. The results between the circuits for some cases were small, but at some point the error was greater than we expected specially for V_{bc} where for circuit-1 we got 0.02V but for circuit-2 there was no connection. So, we don't get any value of V_{bc} and the error is 100 percent.

Though we faced some problems the result was satisfactory.

8. Conclusion

For circuit-1 and circuit-2 the percentage of error between theoretical and practical are almost zero. Moreover, we can saw that our Delta-Wye conversion was successful and it was proved that Delta-Wye conversion can be converted to Wye-Delta conversion.