Fall 2021
EEE/ETE 141L
Electrical Circuits-I Lab(Sec-5)
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Lab No. : 04

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Lab 4: Delta-Wye Conversion

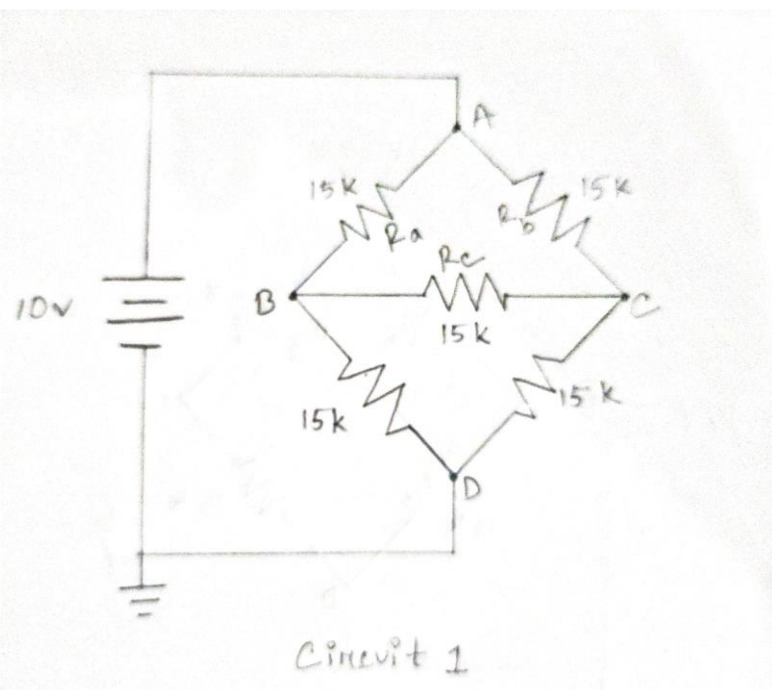
Objectives:

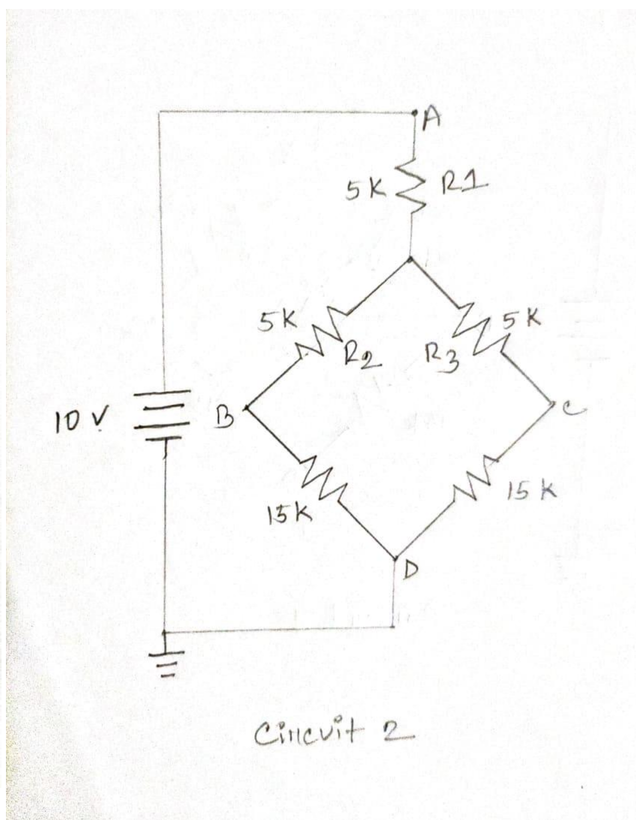
1. We have to perform Delta-Wye Conversion
2. We have to verify the results with measured data.
3. We have to solve a complex circuit using Delta-Wye Conversion.

List of Equipment

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

Circuit Diagram:





Data Table:

Table 1:

Theoretical R	Measured R	% Error
15k	Brown, Green, Orange, Gold	0%
5k	Green, Black, Red, Gold	0%

Table 2:

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

Results:

All the results of the tables are shown in the Question/Answer section.

Question/Answer:

1. **The resistors in Circuit 1 are in series or in parallel combination?**
   Ans:
   The resistors in Circuit 1 are neither in series or in parallel combination. They are in a complex combination.
2. **What technique would you use to find the equivalent resistance?**
   Ans:
   I would use Delta-Wye conversion technique 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.**
   Ans:
   Here, R_a = 15kOhm, R_b = 15kOhm, R_c = 15kOhm

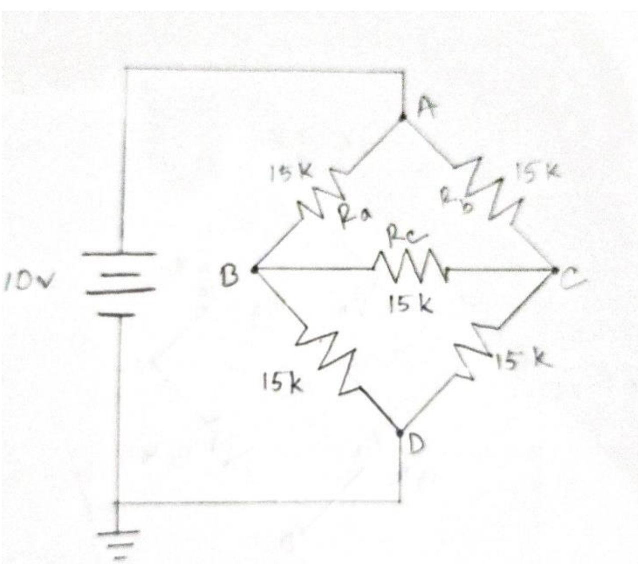
According to Delta-Wye conversion formula,

$R1 = (R_b*R_c)/R_a+R_b+R_c$
$= (15k*15k)/(15k+15k+15k)$
$= 5k$

$R2 = (R_a*R_c)/R_a+R_b+R_c$
$= (15k*15k)/(15k+15k+15k)$
$= 5k$

$R3 = (R_a*R_b)/R_a+R_b+R_c$
$= (15k*15k)/(15k+15k+15k)$
$= 5k$

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



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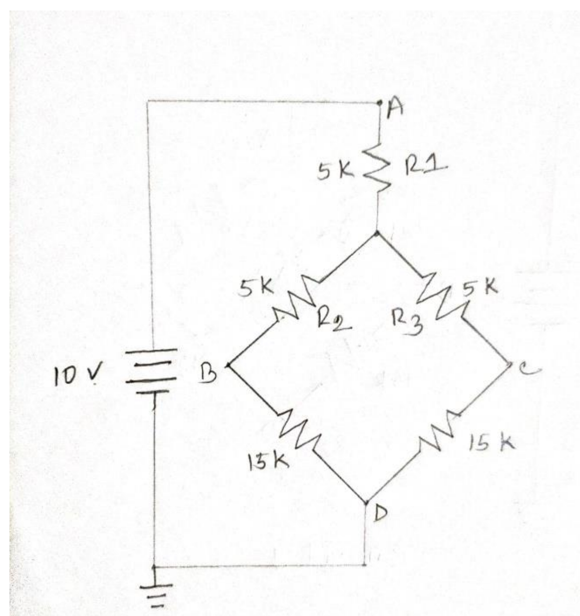

After redrawing the equivalent circuit after applying the Delta-Wye conversion for ΔABC. Everything is exactly same except the values of individual resistances of the Delta and Wye schematics.

5. **Calculate Req.**
   Ans:

   We are calculating R_{eq} from circuit 2,
   R2 and R_{BD} are in series, so, R2' = 5k + 15k = 20kOhm
   R3 and R_{CD} are in series, so, R3' = 5k + 15k = 20kOhm
   R2' and R3' are in parallel, so, 1/Rp = (1/20k) + (1/20k) = 1/10kOhm
   Rp = 10 Kohm
   R1 and Rp are in series, So, R_{eq} = 5k + 10k = 15 kOhm

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

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.

   Ans:

   R1 = 5kOhm
   V_{R1} = (5*10)/(5+10) = 3.33 V
   Voltage across 10kOhm in circuit 2 and the 20kOhm resistors being parallel in circuit 1 = (10-3.33) = 6.67 V
   V_{R2} = V_{R3} = (5/(5+15))*6.67 = 1.67 V
   V_{AB} = V_{R1}+V_{R2} = 3.33 + 1.67 = 5V
   V_{AC} = V_{R1}+V_{R3} = 3.33 + 1.67 = 5V
   V_{BD} = V_{CD} = 6.67*(15/(15+5)) = 5V
   V_{AD} = V_{AB} + V_{BD} = 5+5 = 10V

   Is = V/Req = 10/15k = 0.67mA
   Using CDR, I_{R2} = ((R3+R5)/(R2+R3+R4+R5))*Is
   = (20/40)*0.67 = 0.335 mA
   V2 = I2*R2 = $0.335*10^{-3}$ * 5k
   =1.675V
   I3 = Is – I2
   = 0.67 – 0.335
   = 0.335 mA

$V3 = I3*R3 = 0.335*10^{-3} * 5k$

$=1.675V$

Using KVL,

$V2-V3-V_{bc} = 0$

$\rightarrow V_{bc} = V2 - V3$

$\rightarrow 1.675V - 1.675V = 0V$

The measured values of V_{AB} , V_{BC}, V_{AC} and V_{AD} , V_{BD}, V_{CD} from multisim are 5V, 0V, 5V and 10V, 5V, 5V. So, the calculated and measured values are Exactly the same. And the error% for V_{AB} , V_{BC}, V_{AC} and V_{AD} , V_{BD}, V_{CD} are all 0%

7. **Using Table 2, analyze whether Circuit 2 is equivalent to Circuit 1? Was Delta-Wye conversion successful?**
   Ans:
   If we analyze Table 2, we are able to see that the terminal voltages are absolutely same for each circuit. For example, V_{AB} is 5V, V_{BC} is 0V, V_{AC} is 5V and V_{AD} is 10V , V_{BD} is 5V, V_{CD} is 5V for each circuit. So, the error is 0%. As a result, we can that Delta-Wye conversion is successful.

Discussion:

From the lab 4, we learned how to solve a complex circuit using Delta-Wye conversion method.

As, it was an online lab, we had to use multisim to do the experiments. So, we didn't have to face many errors or faults. We could find the theoretical values easily. But when evaluating V_{BC}, I faced some technical error in multisim and got unusual value. Restarting multisim solved the problem.

If we would have done the lab offline, we could have faced many errors such as human errors, environmental errors or mechanical errors. Also, we could have faced errors using DMM, cables, breadboard connection etc.