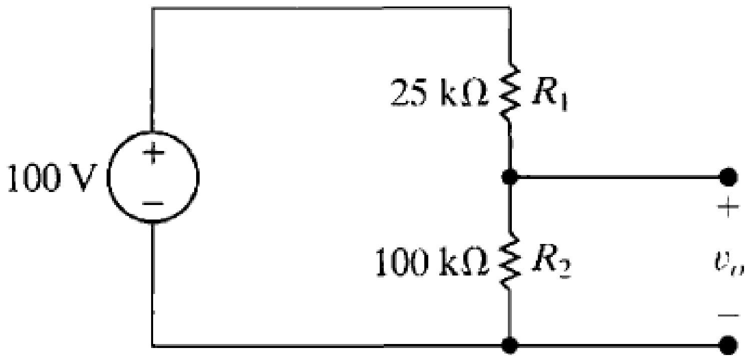
CET 141: Day 2

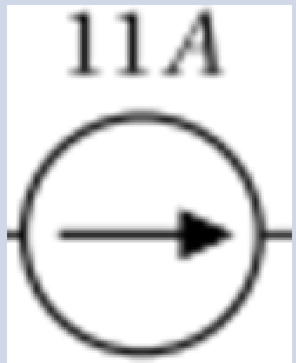
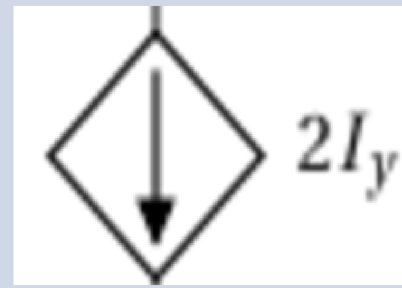
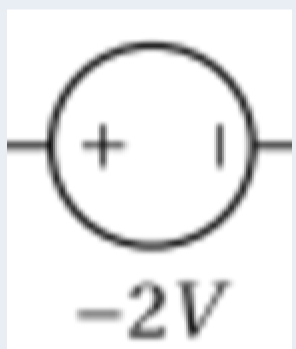
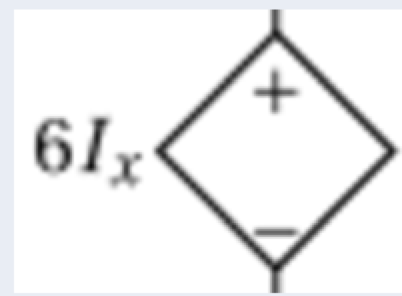
Dr. Noori KIM

- The resistors used in the voltage-divider circuits have a tolerance of ±10%. Find the maximum and minimum value of v_0



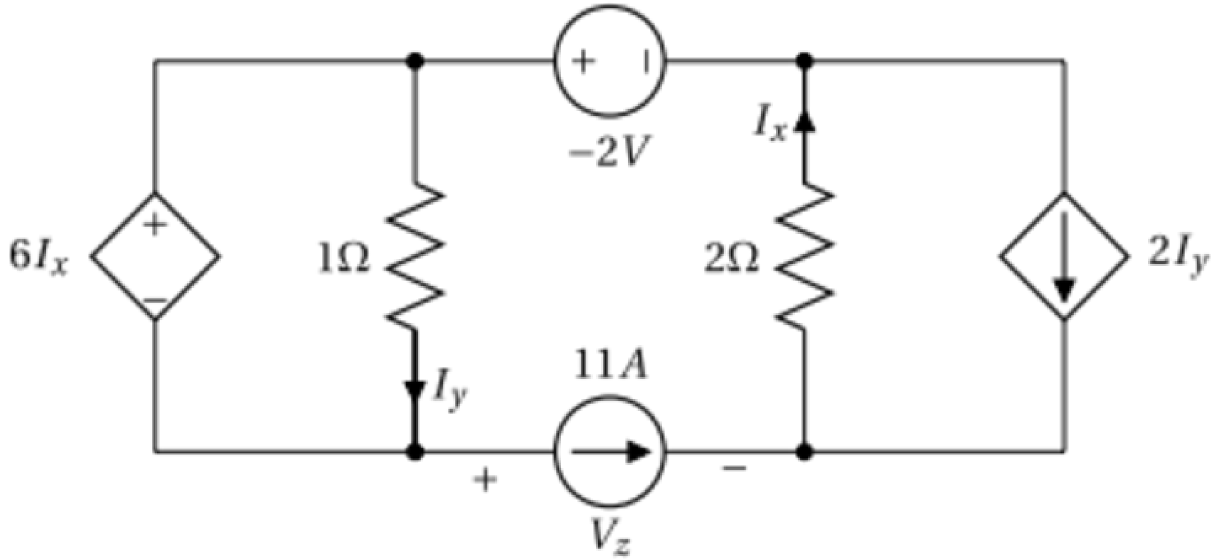
- The maximum value of v_0 occurs when *R2* is 10% high and *R1* is 10% low
- The minimum value of v_0 occurs when *R2* is 10% low and *R1* is 10% high

Electrical Sources

	Independent (Circle)	Dependent (Diamond)
Current (Arrow)		
Voltage (Polarity)		

Dependent sources

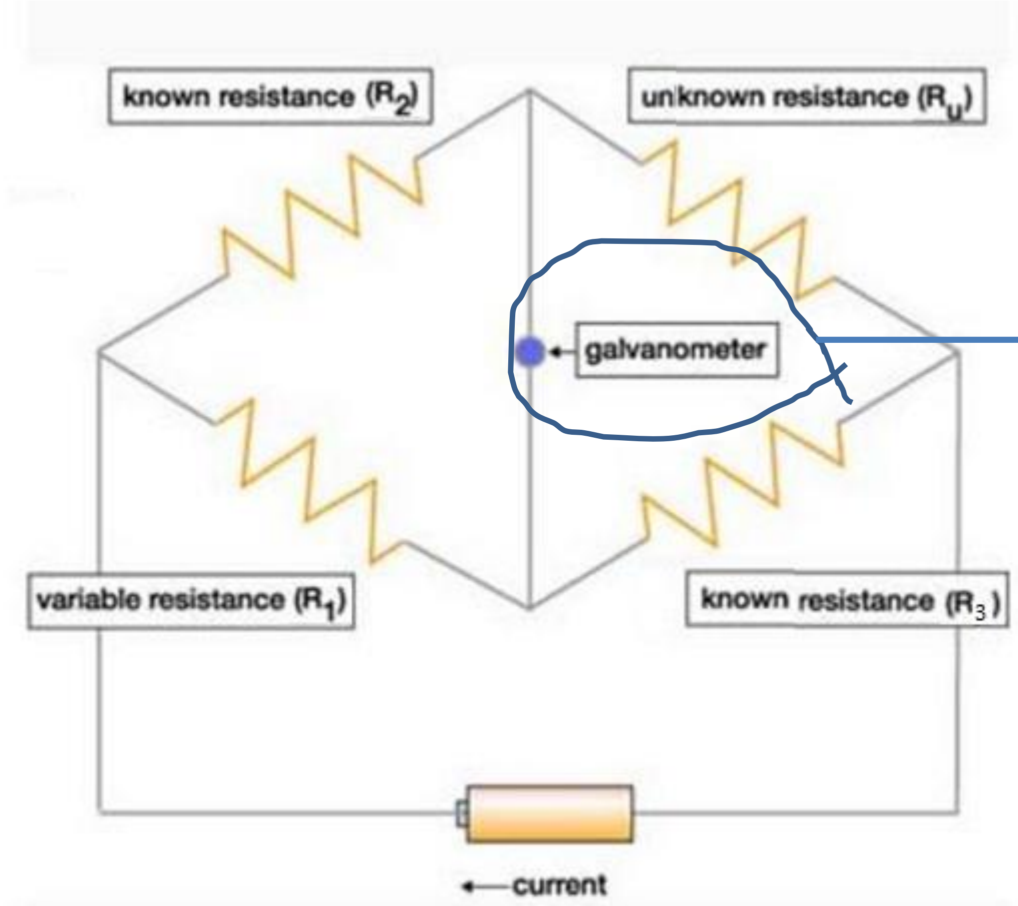
- A **dependent source**
  - a voltage **source** or a current **source**
  - whose value depends on a voltage or current **somewhere** else in the network.



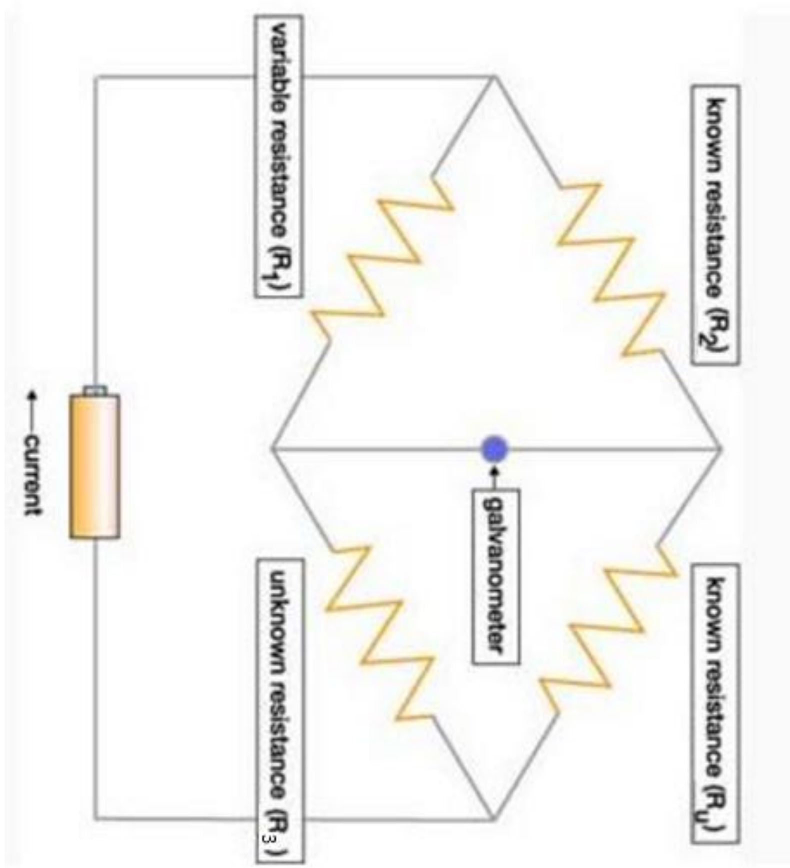
Wheatstone bridge

- A device which is used to measure the electrical resistance by comparison method
- To measure an unknown resistance by passing current through the unknown resistor
- Brief History:
  - First founded by Samuel Hunter Christie in 1833
  - Sir Charles **Wheatstone** claimed the various applications of the device and showed its importance to the people (the device name after him)

- R1, R2, R3 and Ru
- Ru is the resistor whose resistance is to be found and R1 is the only adjustable resistor (in this setting)

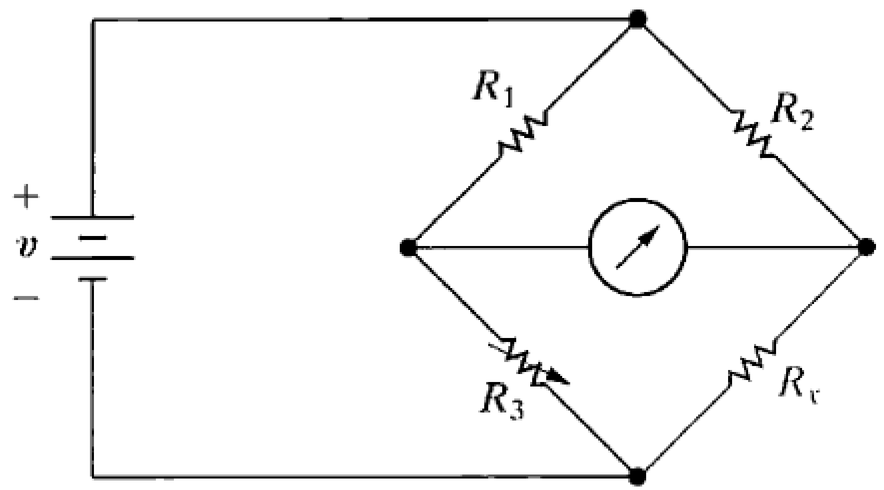


When does it read zero?



- Known path: R2, R1 = Unknown path: Ru, R3
  - The reading current at the galvanometer=0
  - Varying R1 to find Ru: **Ru = (R3*R2)/R1**
  - **Or varying one of variable resistors among R1, R2, or R3**

- The bridge circuit shown is balanced when R1= 100Ω, R2 = 1000 Ω, and R3 = 150 Ω. The bridge is energized from a 5 V dc source. What is the value of *Rx*?

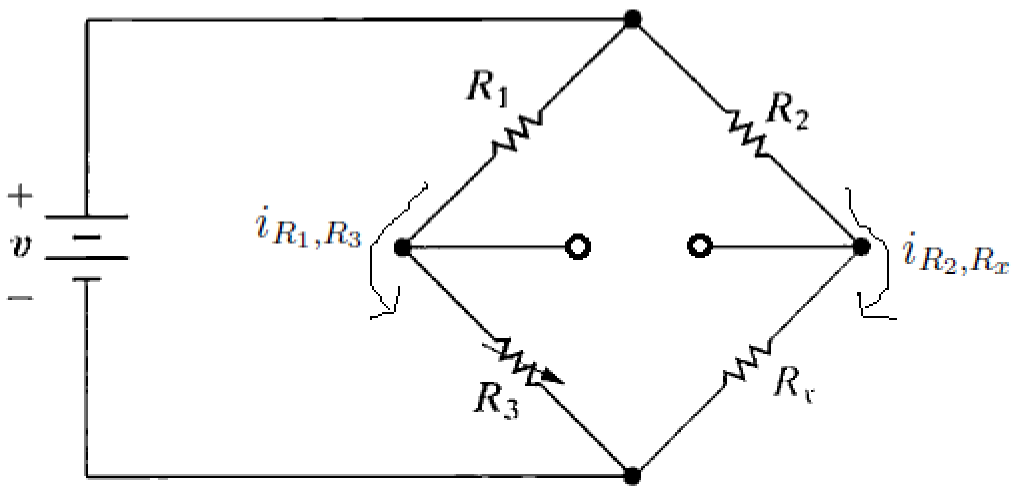


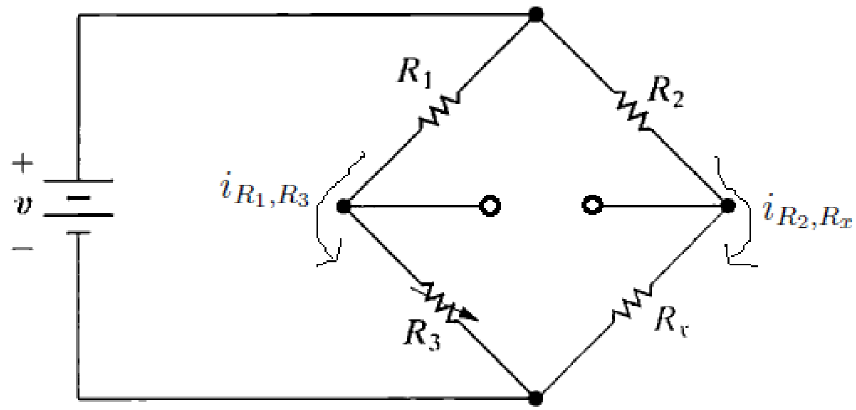
- Suppose each bridge resistor is capable of dissipating 250 mW. Can the bridge be left in the balanced state without exceeding the power-dissipating capacity of the resistors (without damaging the bridge)?

Hint>>

➢ Calculate dissipating power for each resistor and compare it to 250mW

➢ When the bridge is balanced, there is no current flowing through the meter, so the meter acts like an open circuit.





$$i_{R_1,R_3} = \frac{5\text{ V}}{100\,\Omega + 150\,\Omega} = 20\text{ mA} \quad i_{R_2,R_x} = \frac{5\text{ V}}{1000 + 1500} = 2\text{ mA}$$

$p = Ri^2$:

$p_{100\Omega} =$

$p_{150\,\Omega} =$

$p_{1000\Omega} =$

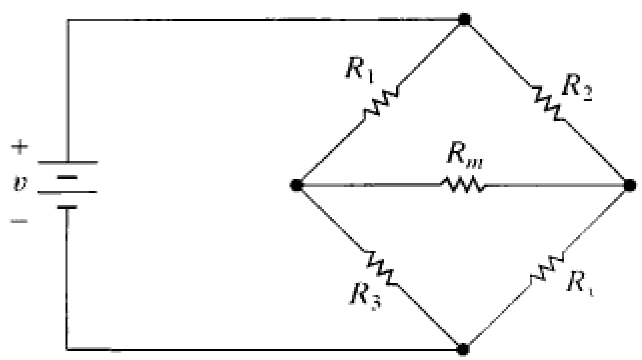
$p_{1500\,\Omega} =$

$\Big\}$ << 250 mW

<u>The bridge can be left in the balanced state without exceeding the power-dissipating capacity of the resistors</u>

Delta-to-Wye Equivalent Circuits

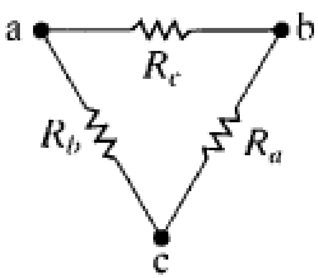
- From the Wheatstone bridge, we replace the galvanometer with its equivalent resistance *Rm*,

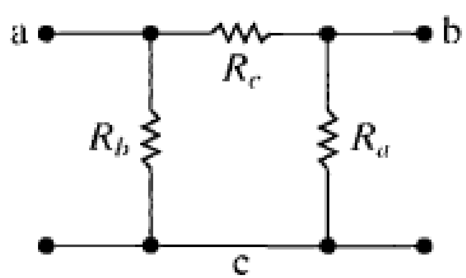


delta (Δ) interconnection

or

Pi (π) interconnection





as the Δ can be shaped into a π without disturbing the electrical equivalence of each node

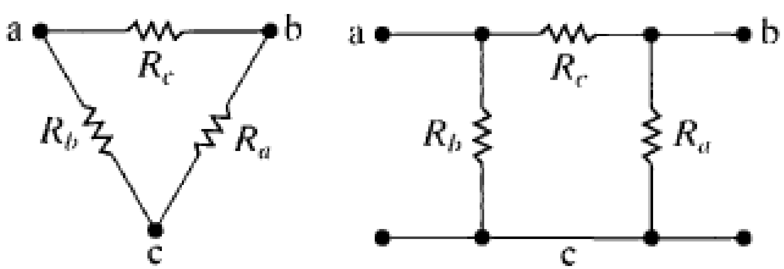


Figure 3.29 ▲ A Δ configuration viewed as a π configuration.

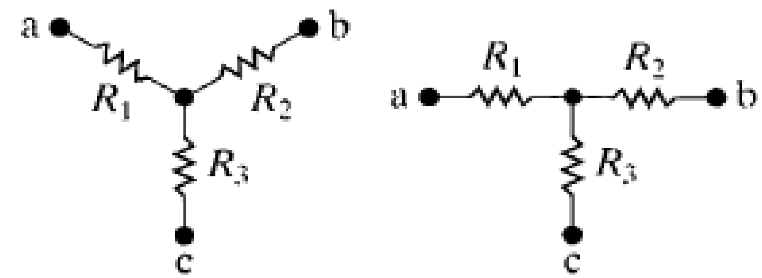


Figure 3.30 ▲ A Y structure viewed as a T structure.

Transformations without disturbing the electrical equivalence

Then, how about this?

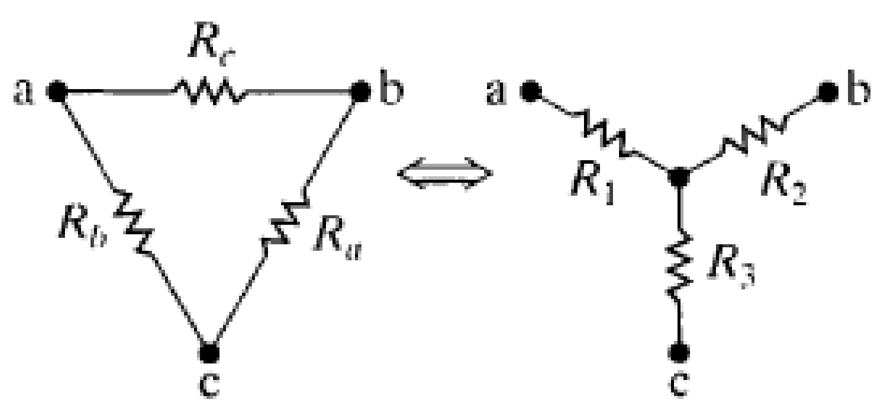
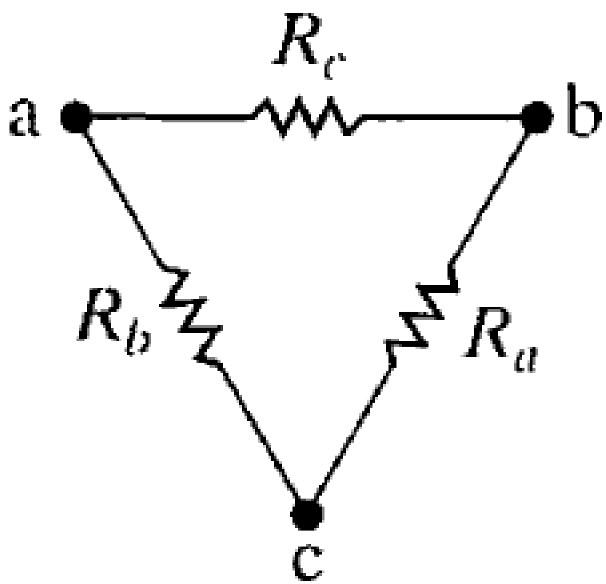
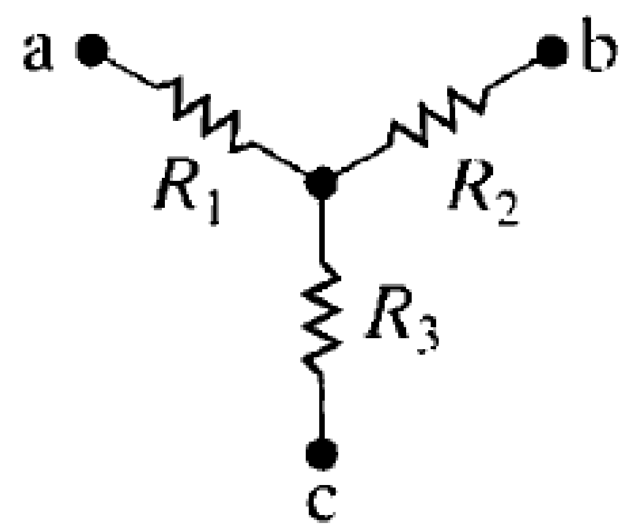


Figure 3.31 ▲ The Δ-to-Y transformation.

Basic idea of the transformation



Two parallel resistors viewed as two series resistors



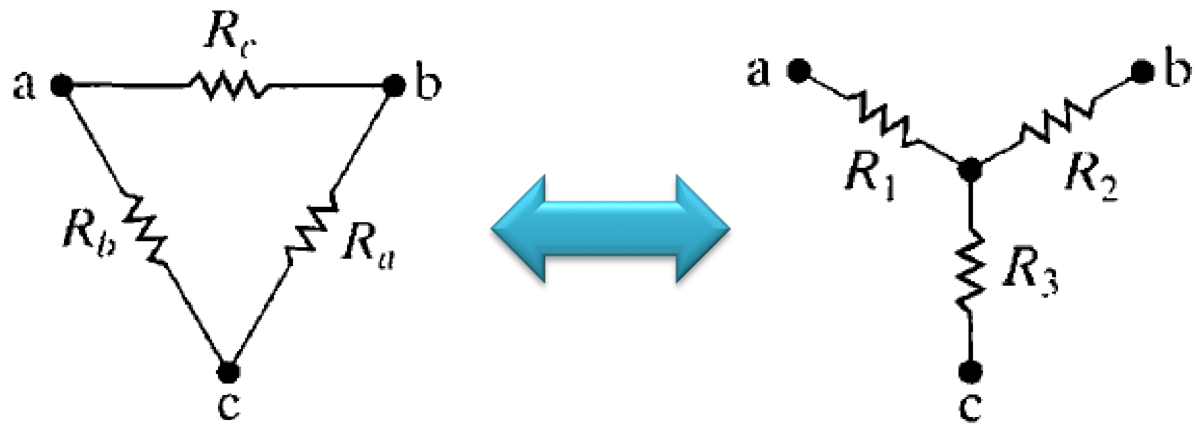
$$R_{ab} = \frac{R_c(R_a + R_b)}{R_a + R_b + R_c} = R_1 + R_2$$

$$R_{bc} = \frac{R_a(R_b + R_c)}{R_a + R_b + R_c} = R_2 + R_3$$

$$R_{ca} = \frac{R_b(R_c + R_a)}{R_a + R_b + R_c} = R_1 + R_3$$

Preserve node a, b, c voltages

Solve for R1, R2, and R3 in terms of Ra, Rb, and Rc



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

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

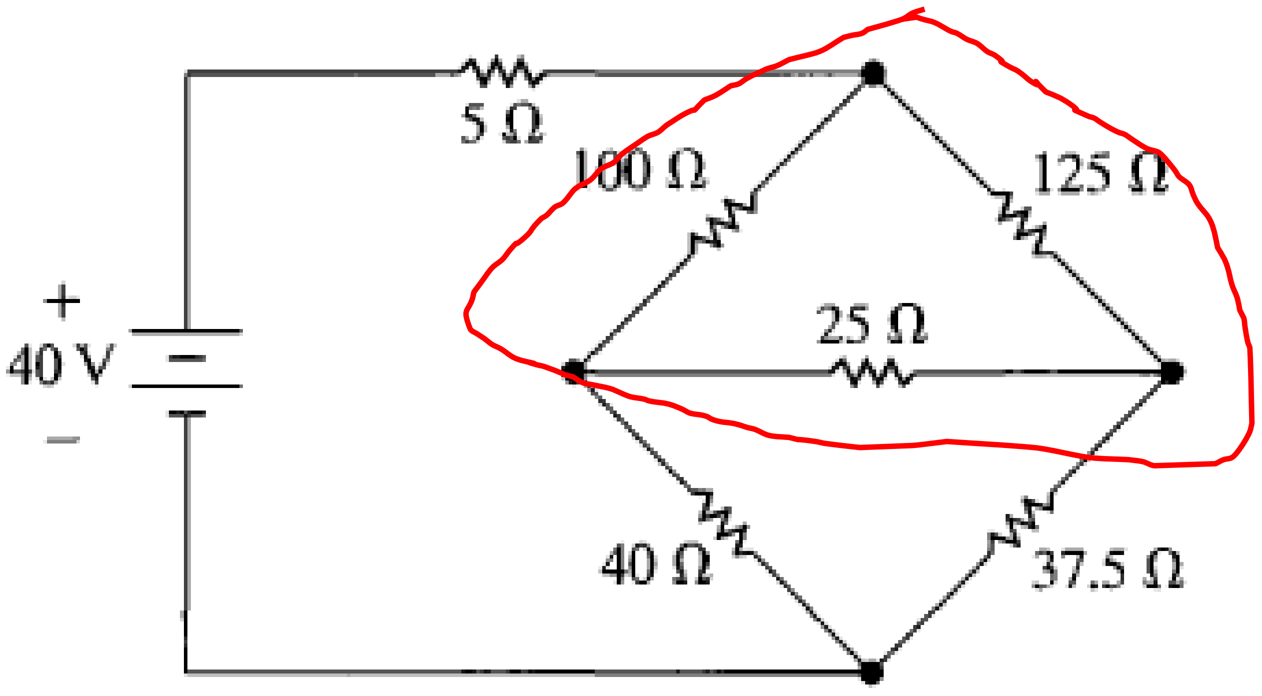
$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}.$$

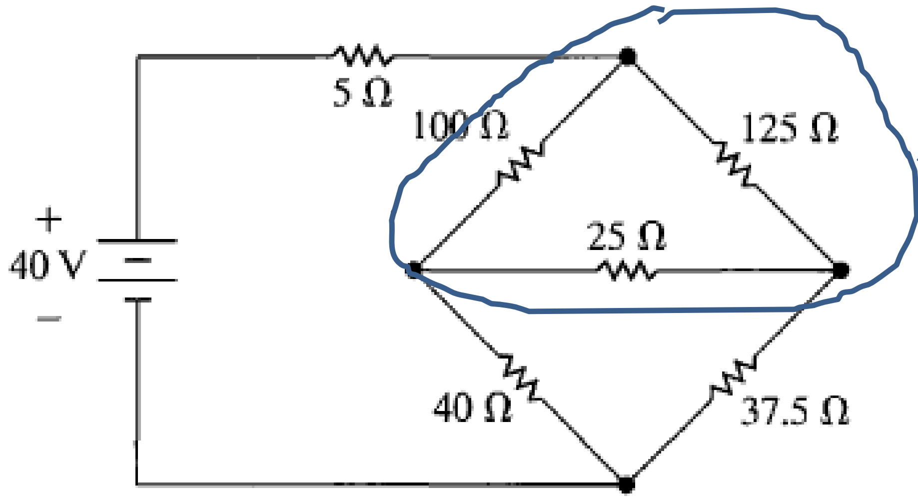
$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c},$$

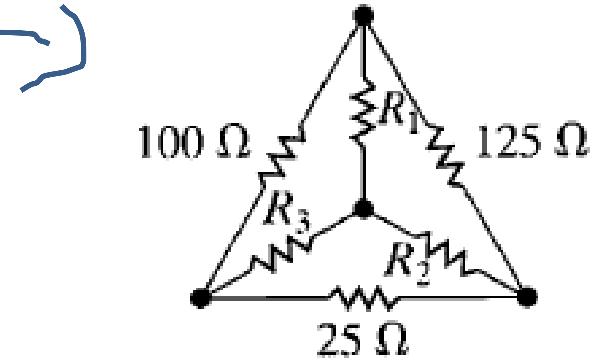
$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c},$$

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

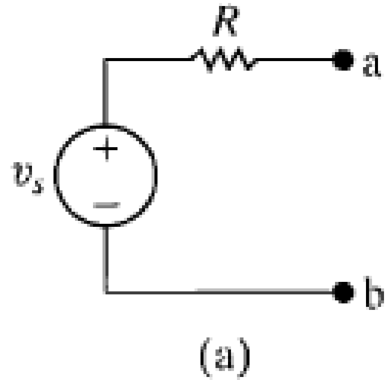
- Find the current and power supplied by the 40V source




5 Ω
100 Ω
125 Ω
+
40 V
−
25 Ω
40 Ω
37.5 Ω

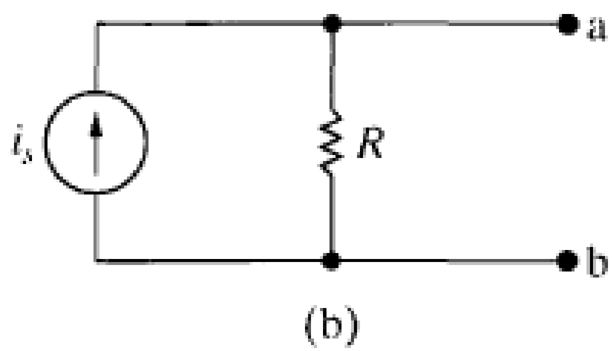

R_1
100 Ω
125 Ω
R_3
R_2
25 Ω

Source transformation



$V_{ab}=V_s*R_L/(R+R_L)$

Where $i_s=v_s/R$ $\Updownarrow$



$V_{ab}=I_s*(R_L*R)/(R+R_L)$

Figure 4.36 ▲ Source transformations.

- Find the power associated with the 6 V source.