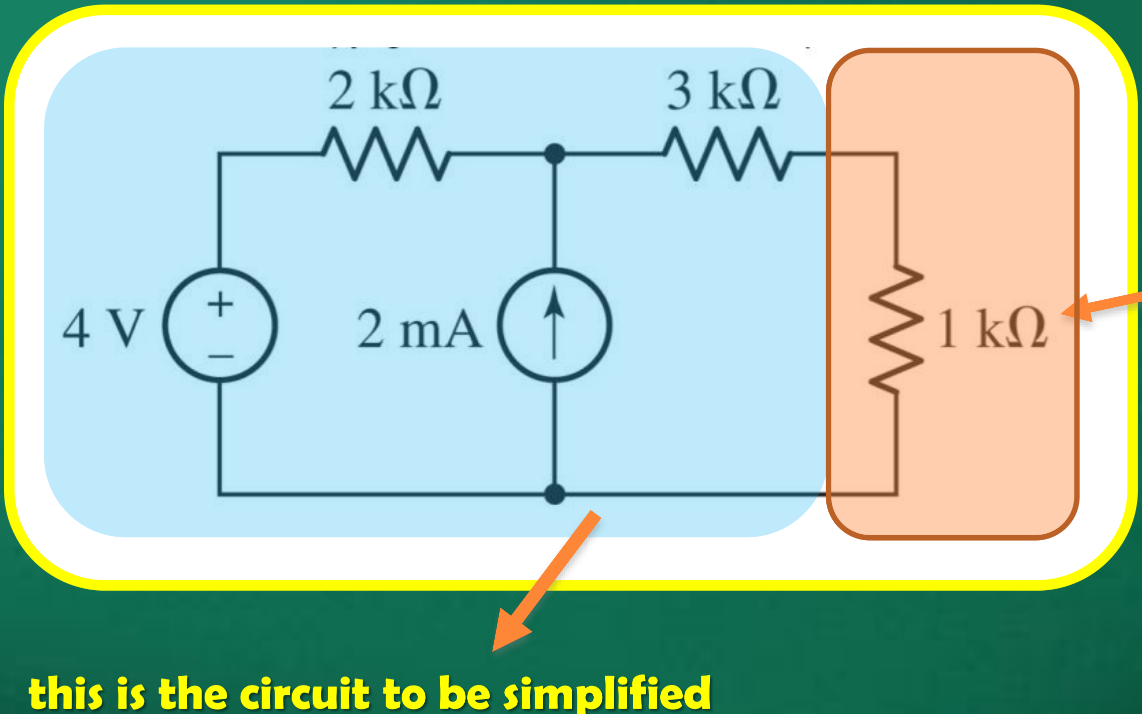
Electrical Science - I
(IEC-102)

Lecture-05

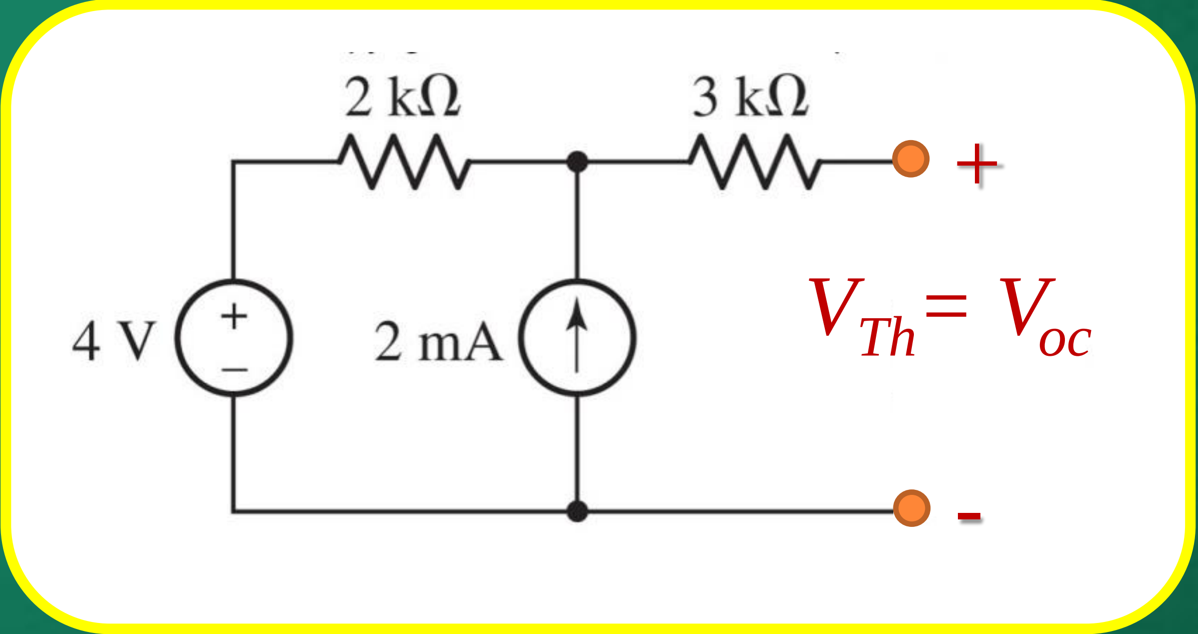
Example: Norton and Thévenin

Find the Thévenin and Norton equivalents for the network faced by the $1\ \text{k}\Omega$ resistor.



Example: Thévenin Equivalent

Finding the Thévenin voltage (V_{Th})



Example: Thévenin Equivalent

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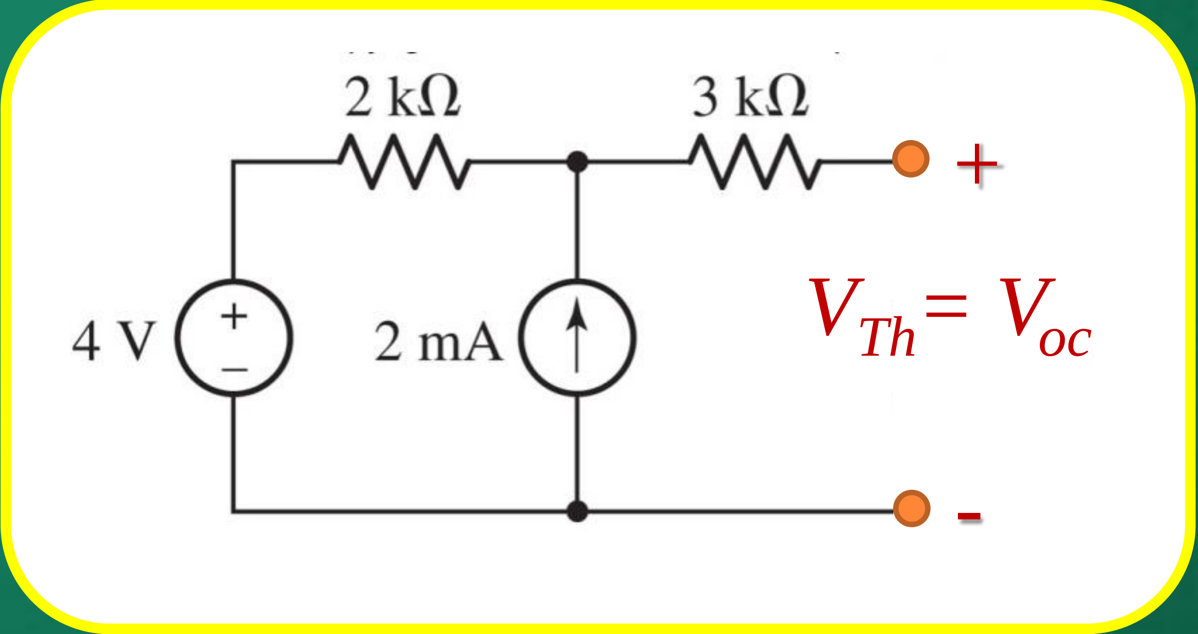
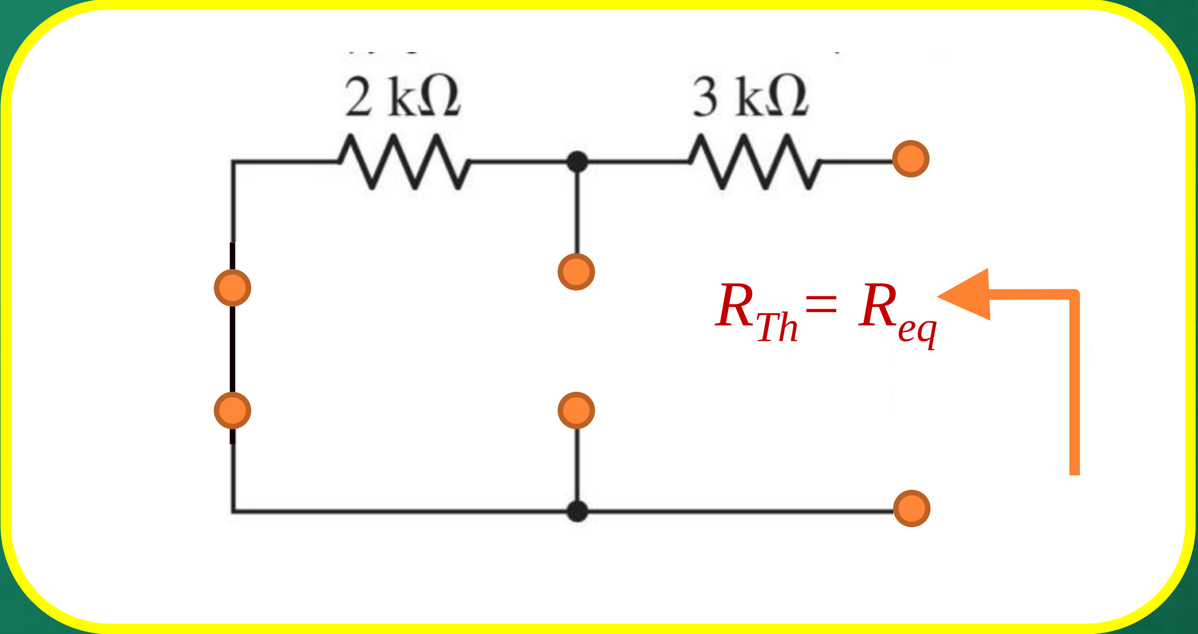


$$V_{Th} = Voc = 8\ \mathrm{V}$$

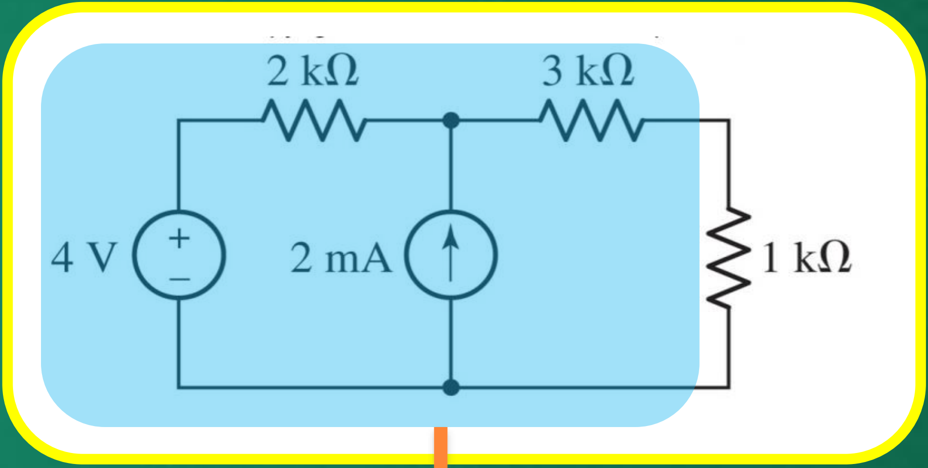
Example: Thévenin Equivalent

Finding the Thévenin resistance (R_{Th})

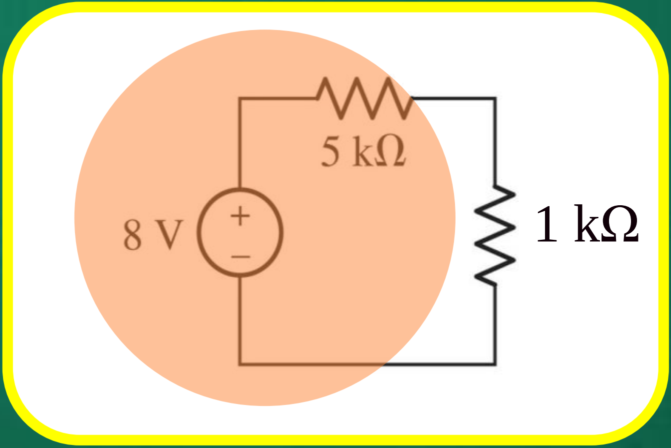


$$R_{Th} = Req = 5\ \text{k}\Omega$$

Example: Thévenin Equivalent



Thévenin Equivalent



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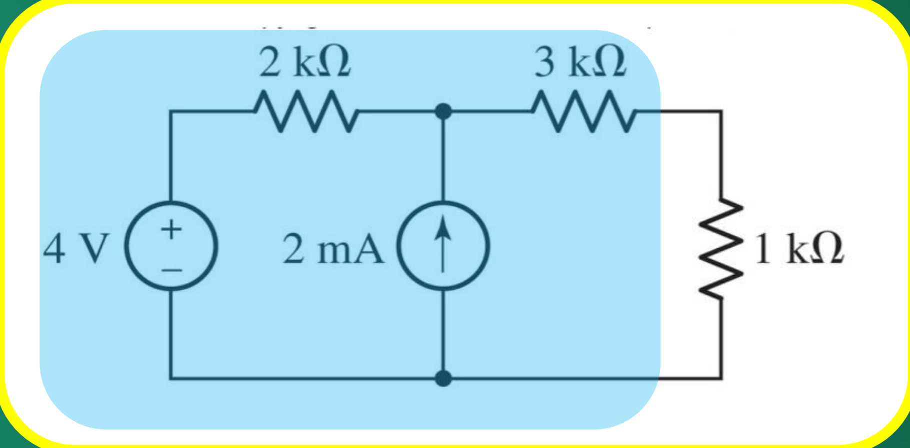
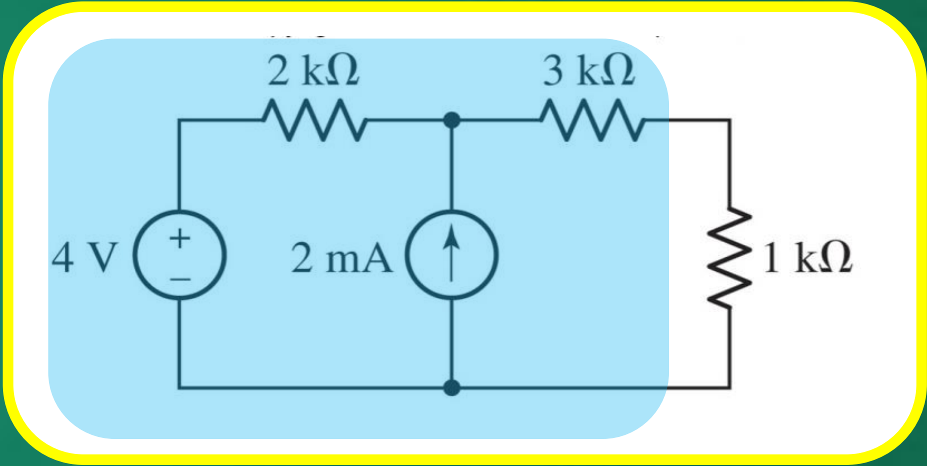
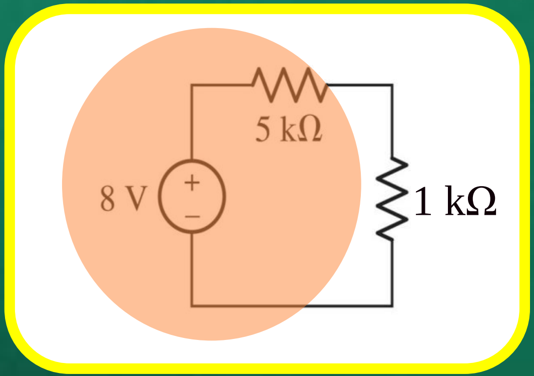


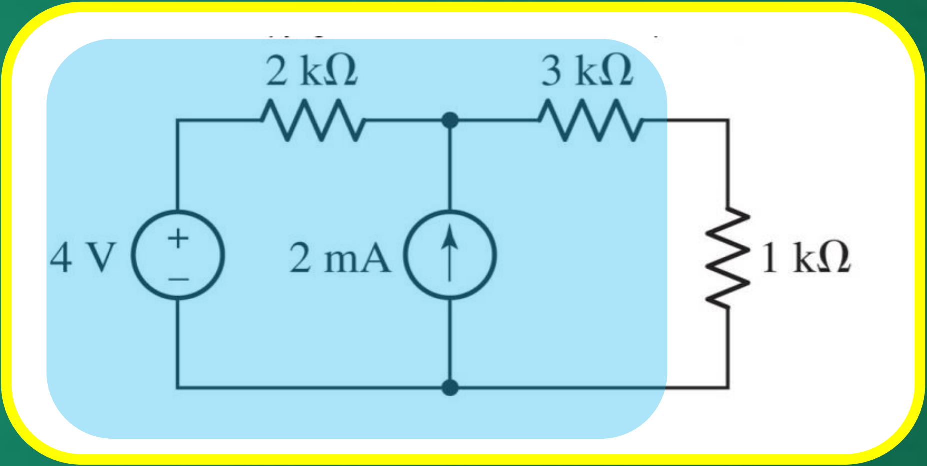
Example: Norton and Thévenin



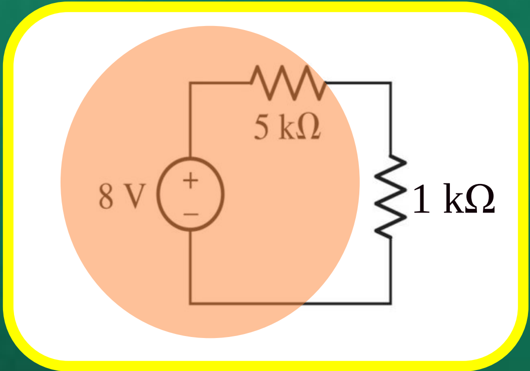
Thévenin Equivalent



Example: Norton and Thévenin

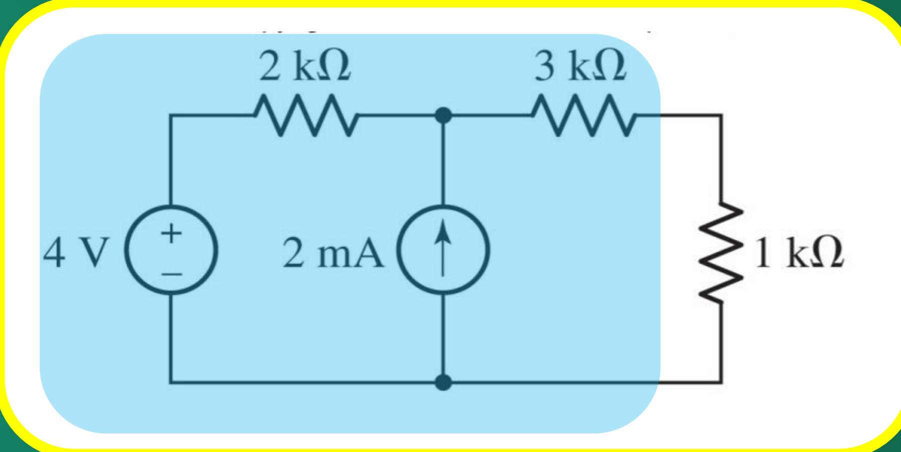


Thévenin Equivalent

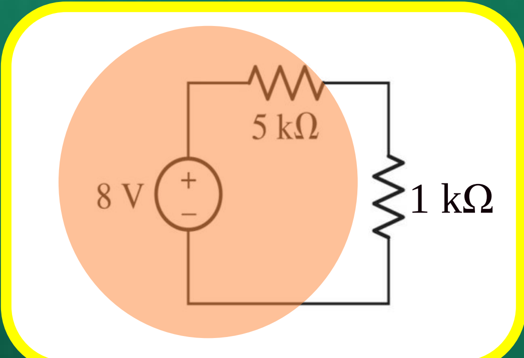


Source Transformation

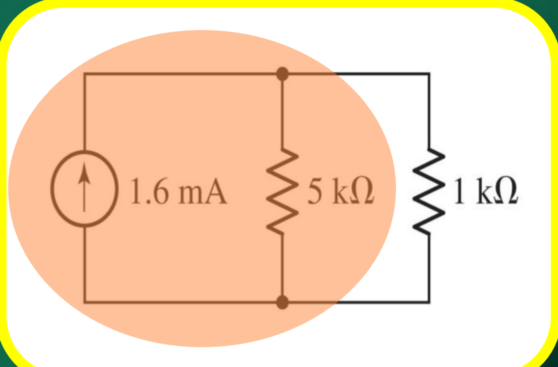
Example: Norton and Thévenin



Thévenin Equivalent

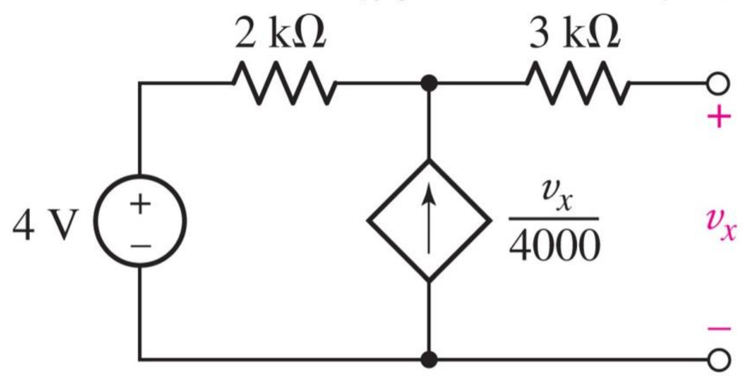


Norton Equivalent

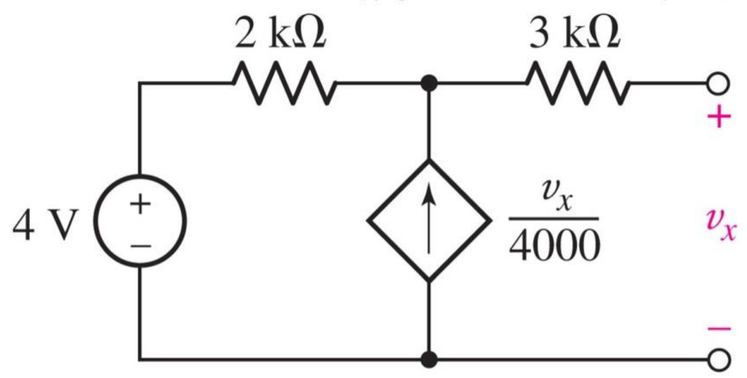


Source Transformation

Thévenin Example: Handling Dependent Sources

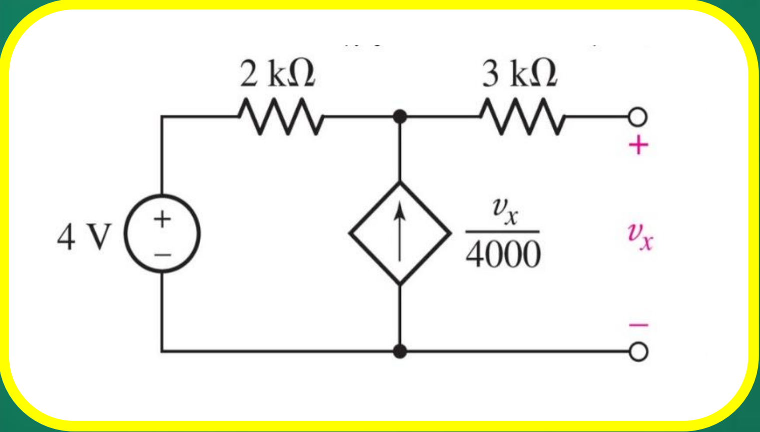


Thévenin Example: Handling Dependent Sources



One method to find the Thévenin equivalent of a circuit with a dependent source: find V_{TH} and I_N and solve for $R_{TH} = V_{TH} / I_N$

Thévenin Example: Handling Dependent Sources



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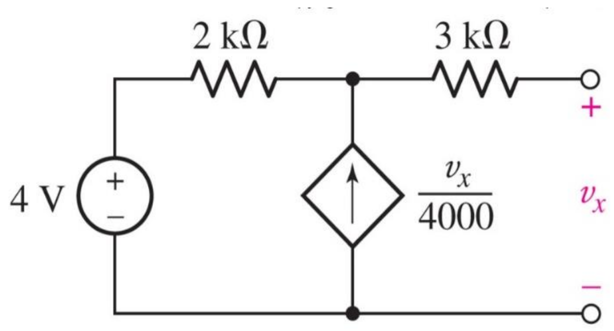

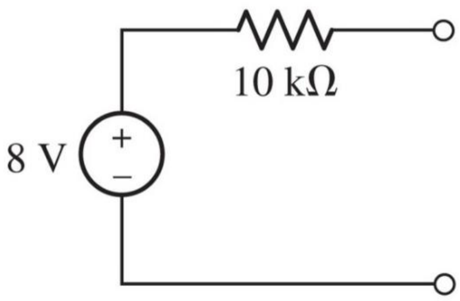

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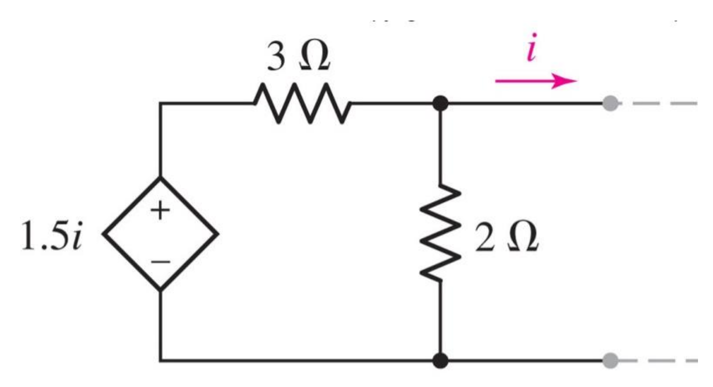
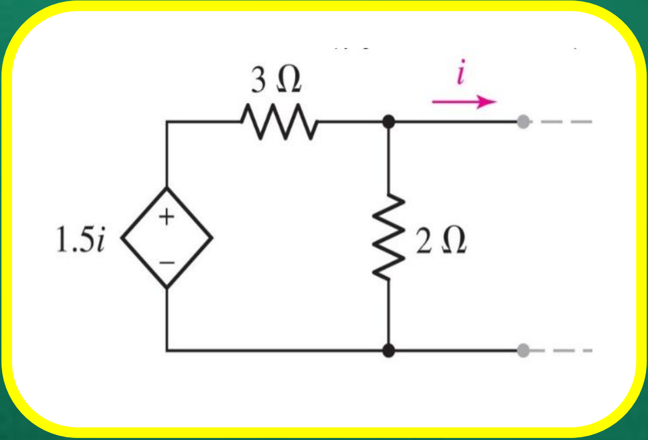


$V_{TH} = ?$ $I_N = ?$

Thévenin Example: Handling Dependent Sources

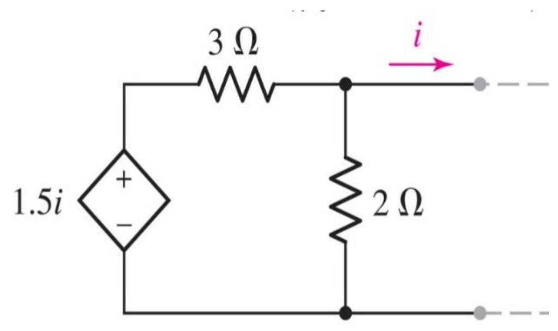
Finding the ratio V_{TH} / I_N fails when both quantities are zero!

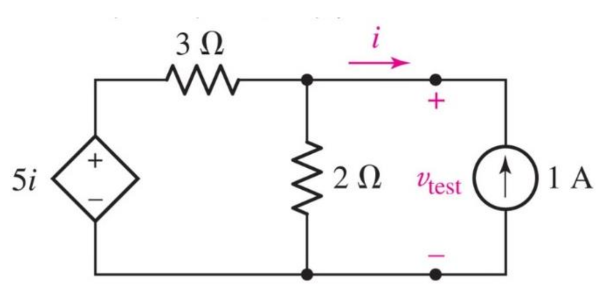


Thévenin Example: Handling Dependent Sources

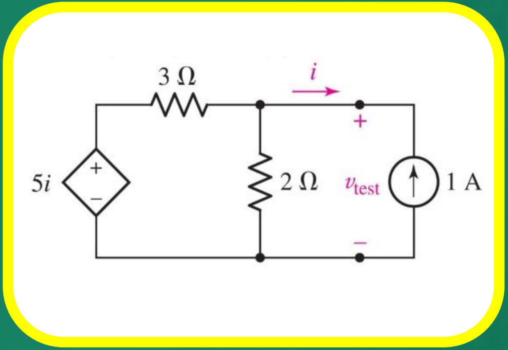
Finding the ratio V_{TH} / I_N fails when both quantities are zero!

Solution: apply a test independent source.





Thévenin Example: Handling Dependent Sources



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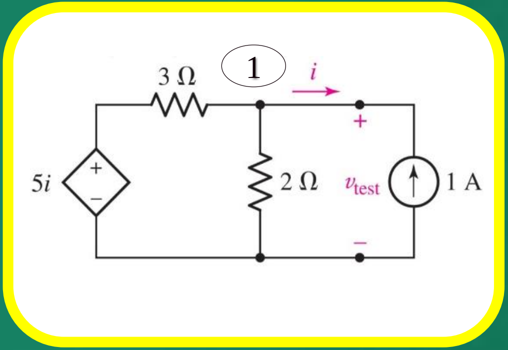

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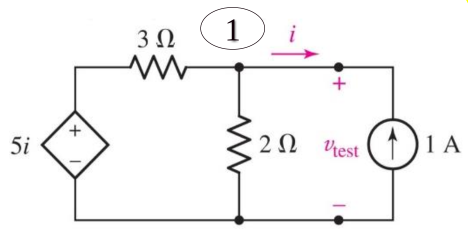
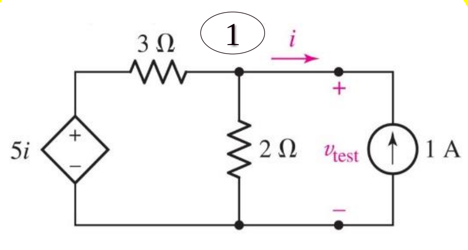


Applying KCL at node 1

$$\frac{v_{test}}{2} + \frac{v_{test} - (1.5i)}{3} = 1$$

$$i = -1$$

Thévenin Example: Handling Dependent Sources



Applying KCL at node 1

$$\frac{v_{test}}{2} + \frac{v_{test} - (1.5i)}{3} = 1$$
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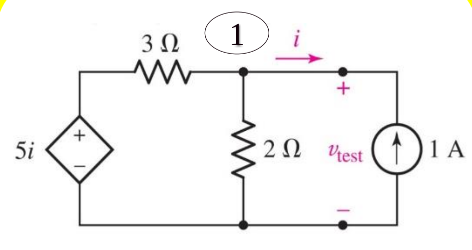
Answer: $v_{test} = 0.6$ V, **and so** $R_{TH} = 0.6\ \Omega$

Thévenin Example: Handling Dependent Sources



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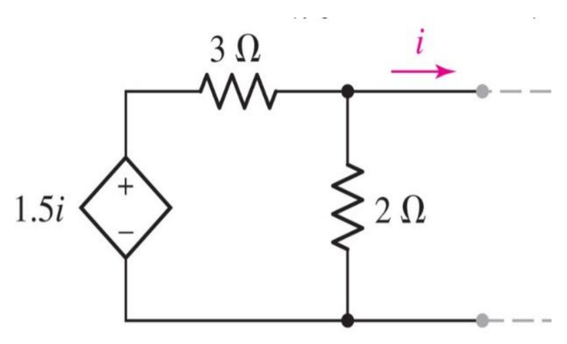

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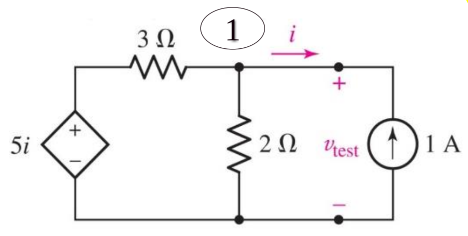

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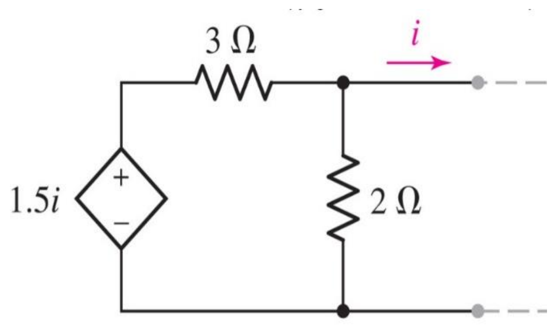
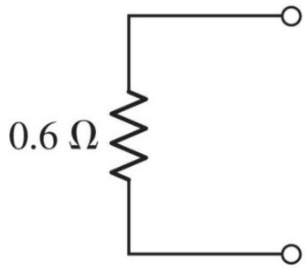
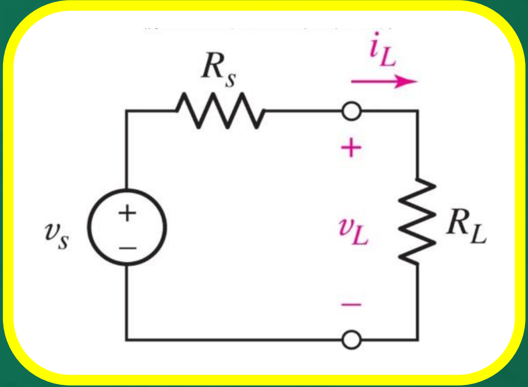




Maximum Power Transfer Theorem

Maximum Power Transfer

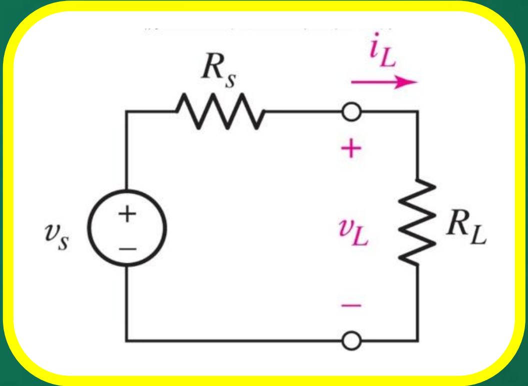
What load resistor will allow the practical source to deliver the maximum power to the load?



Maximum Power Transfer

What load resistor will allow the practical source to deliver the maximum power to the load?

[Solve $dp_L/dR_L = 0$**]**



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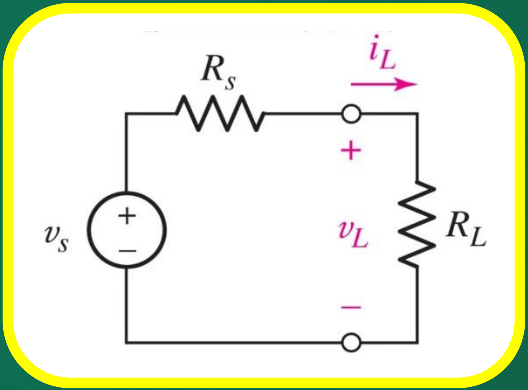
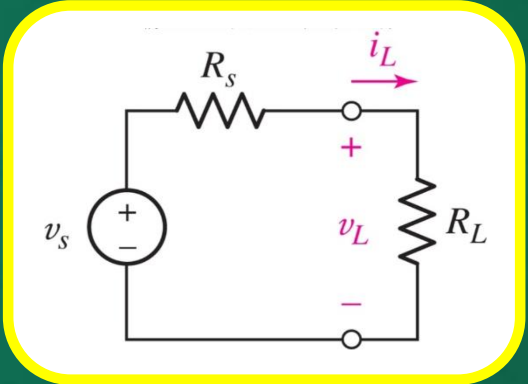


[Solve $dp_L/dR_L = 0$**]**

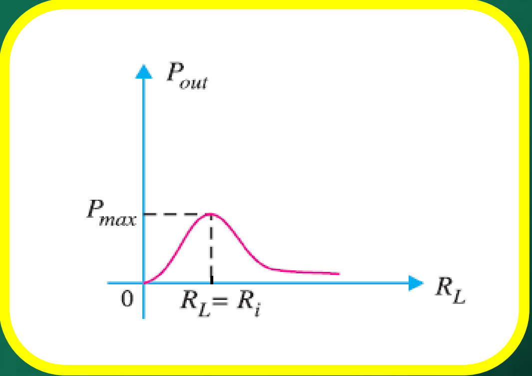
Answer: $R_L = R_s$

Maximum Power Transfer

What load resistor will allow the practical source to deliver the maximum power to the load?



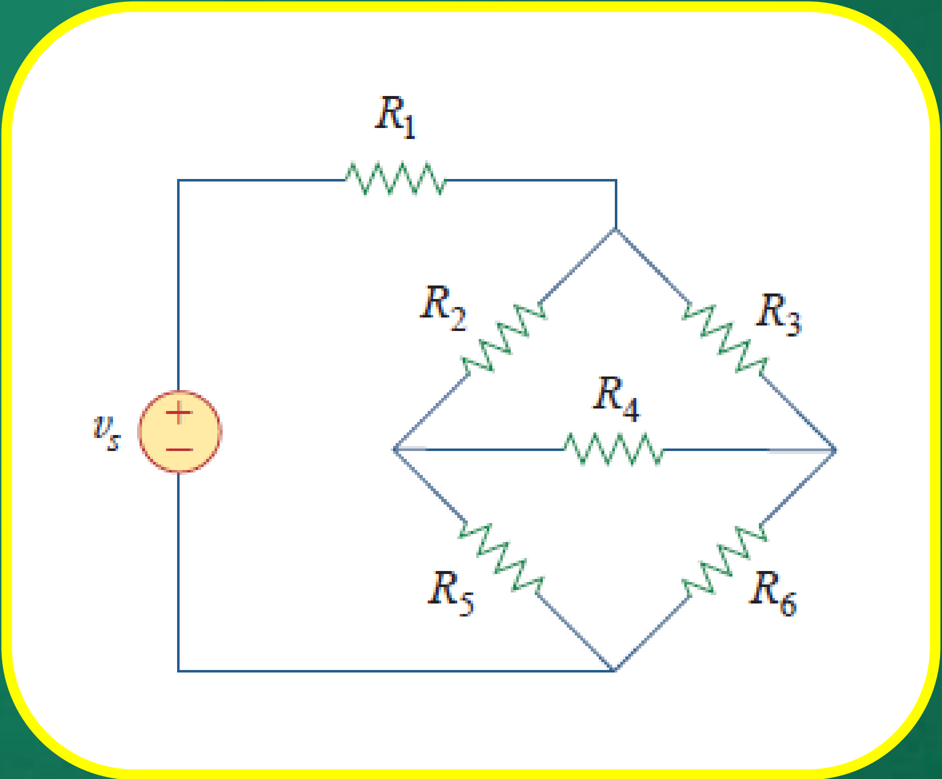
[Solve $dp_L/dR_L = 0$**]**



Answer: $R_L = R_s$

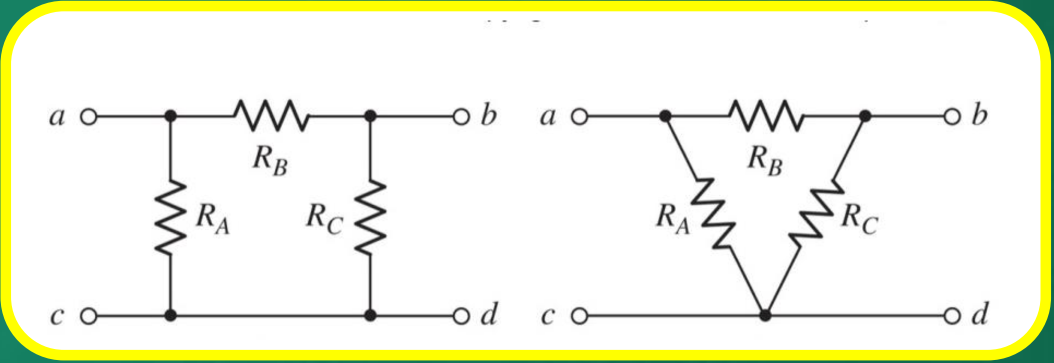
Δ-Y or Y-Δ Conversion

Δ-Y (delta - wye) Conversion



Δ-Y (delta - wye) Conversion

The following resistors form a Δ (or π)



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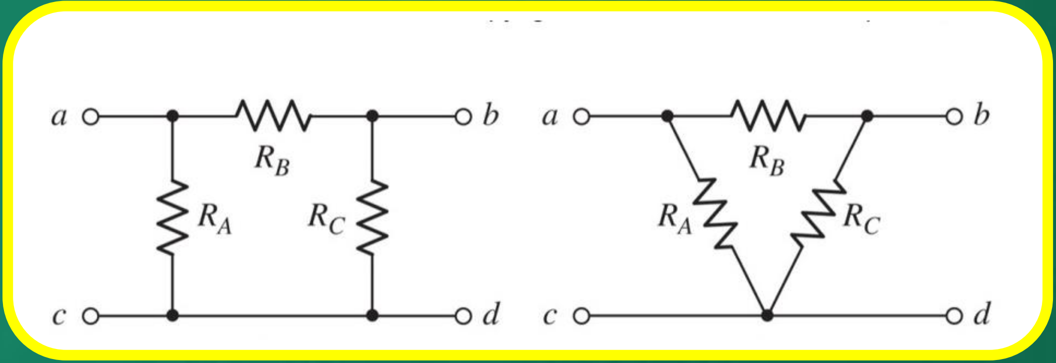
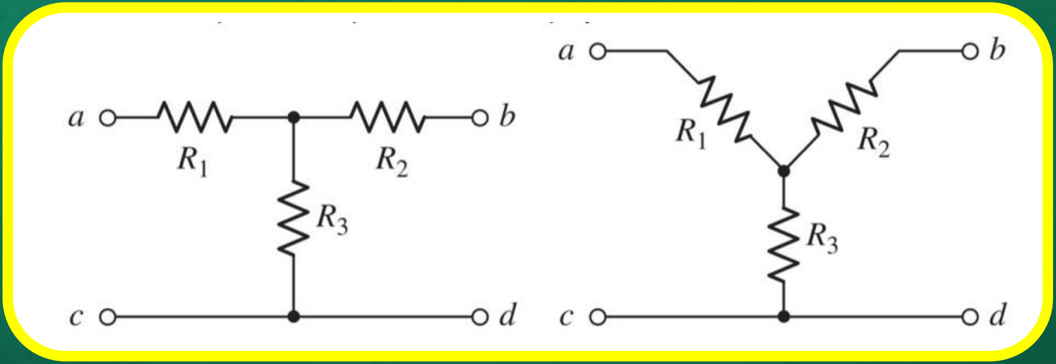


The following resistors form a Y (or T)



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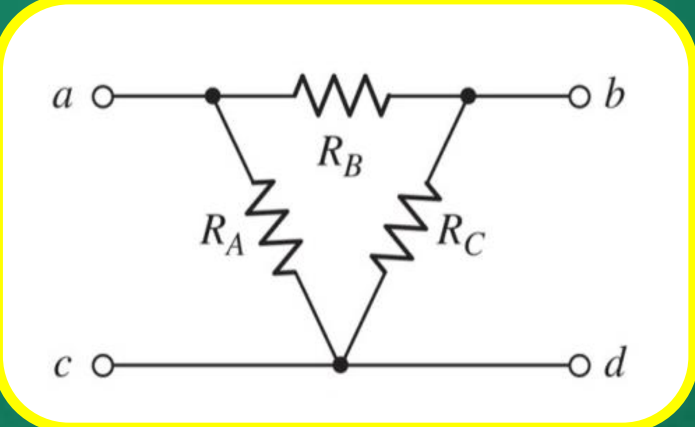

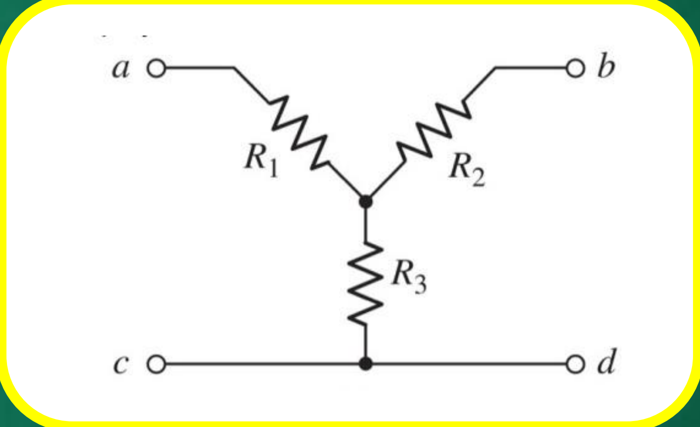

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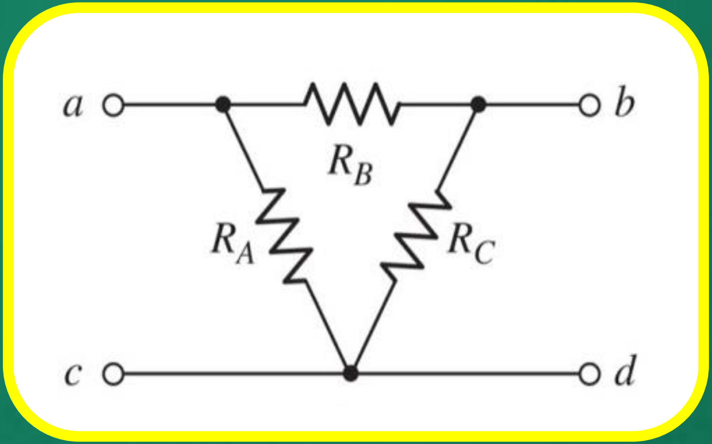

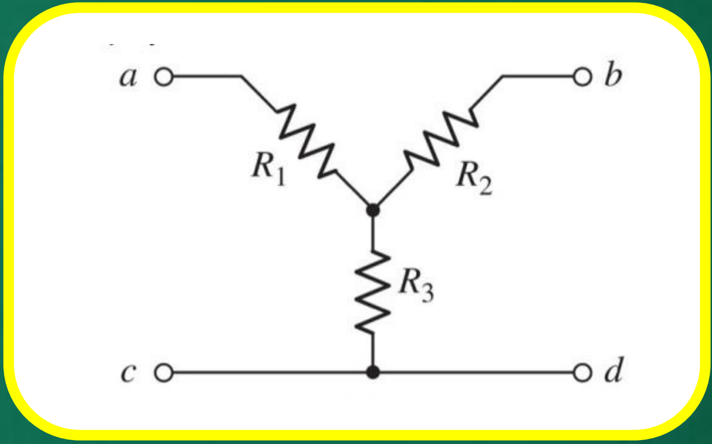

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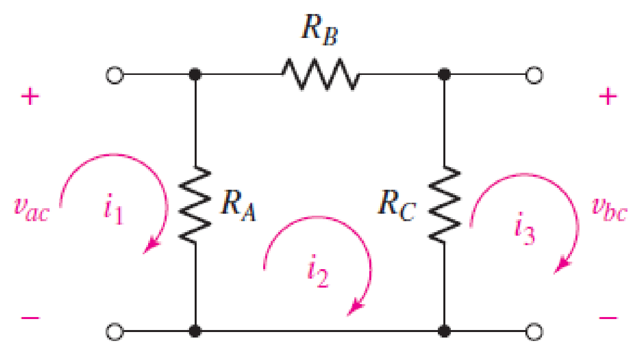

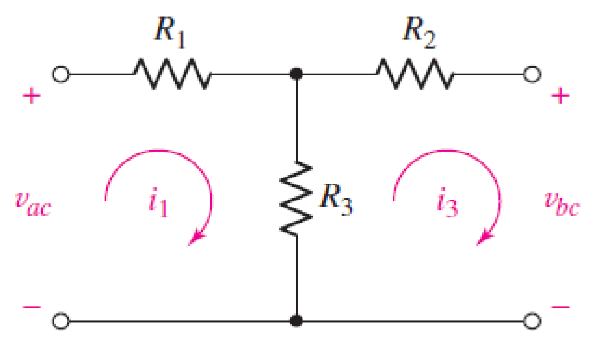

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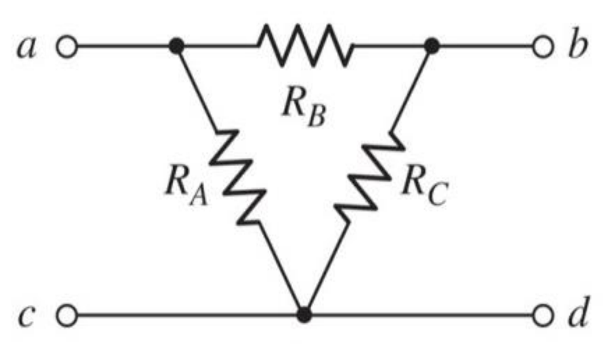
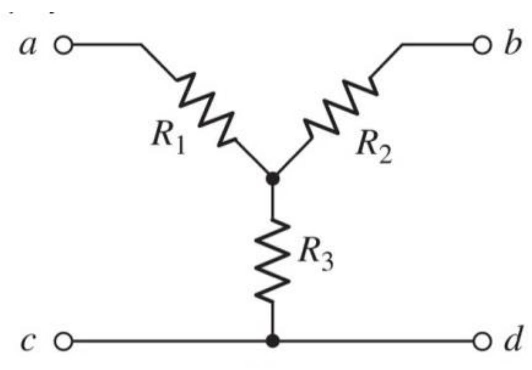




this Δ is equivalent to the Y if

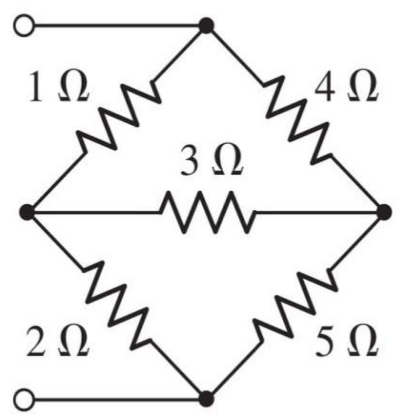
$$R_A = \frac{R_1R_2+R_2R_3+R_3R_1}{R_2}$$
$$R_B = \frac{R_1R_2+R_2R_3+R_3R_1}{R_3}$$
$$R_B = \frac{R_1R_2+R_2R_3+R_3R_1}{R_1}$$

this Y is equivalent to the Δ if

$$R_1 = \frac{R_AR_B}{R_A+R_B+R_C}$$
$$R_2 = \frac{R_BR_C}{R_A+R_B+R_C}$$
$$R_3 = \frac{R_CR_A}{R_A+R_B+R_C}$$

Example: Δ-Y Conversion

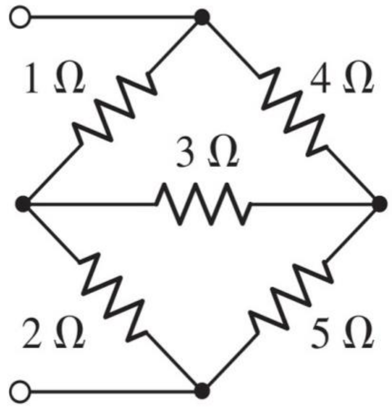
Find the equivalent resistance of the following network?

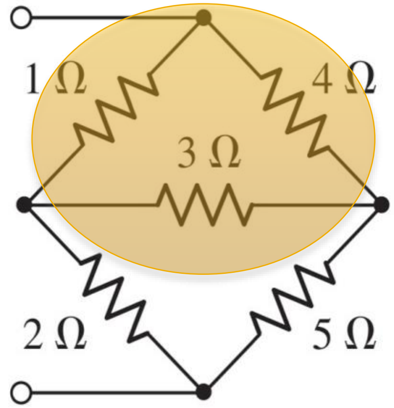


Example: Δ-Y Conversion

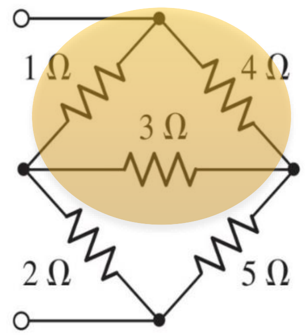
Find the equivalent resistance of the following network?

Convert a Δ to Y

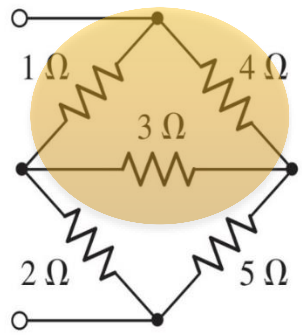




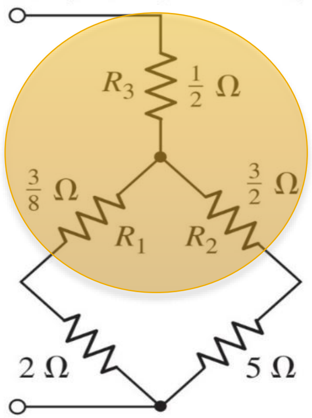
Example: Δ-Y Conversion



Example: Δ-Y Conversion



use the Δ to Y transformation



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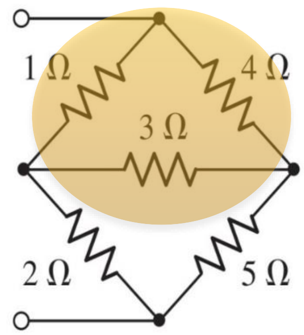

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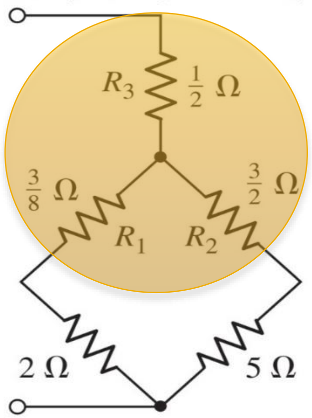

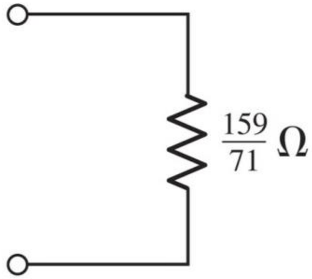

use standard serial and parallel combinations