# THEVENIN'S THEOREM

## BASIC CIRCUIT ANALYSIS METHOD


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# TOPIC OUTLINE

## Thevenin's Theorem

# THEVENIN'S THEOREM

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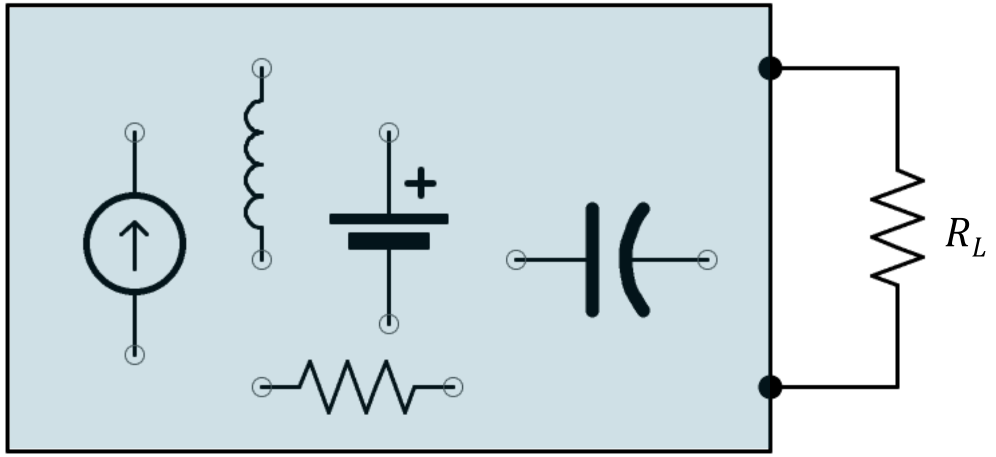
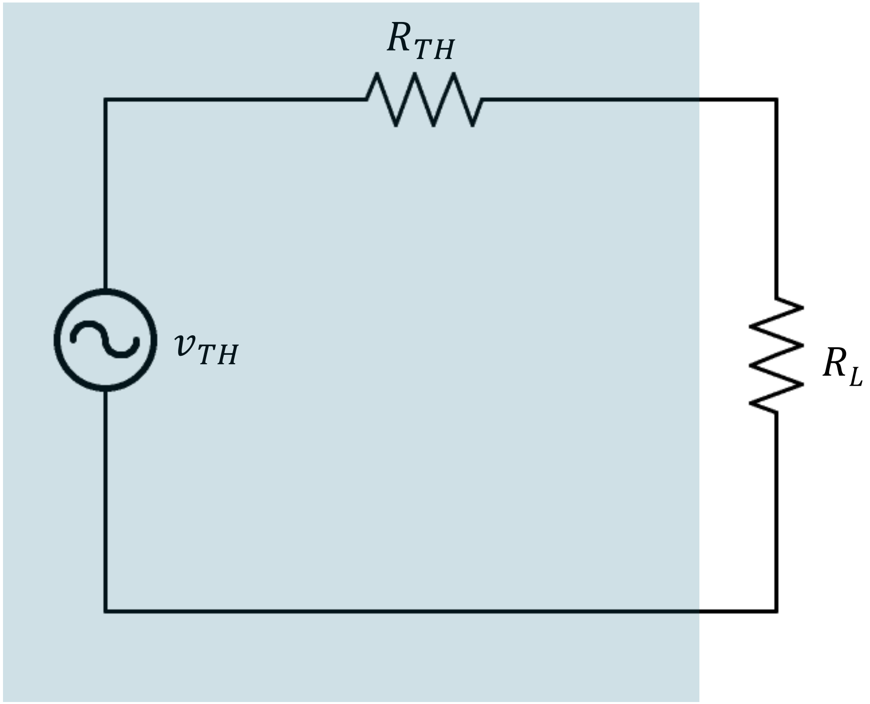
Arbitrary Network



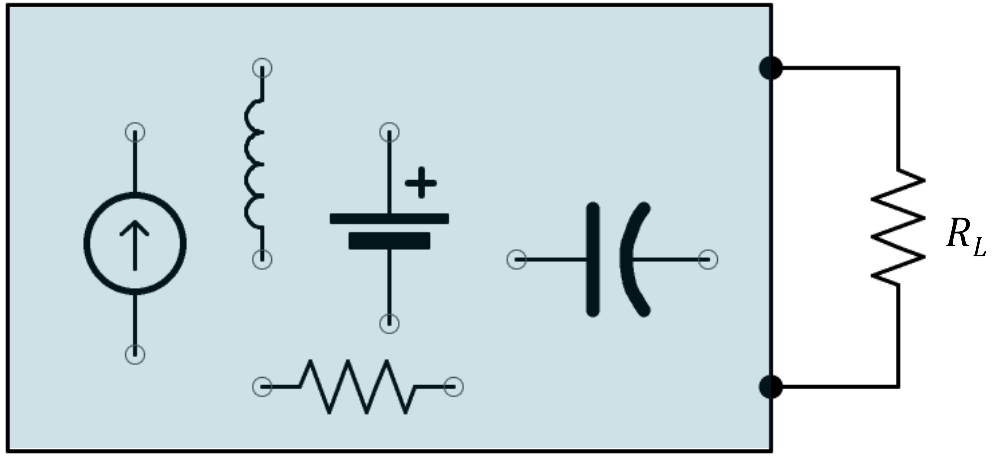

**Thevenin's theorem** states that it is possible to simplify any **linear circuit**, irrespective of how complex it is, to an equivalent circuit with a single voltage source ($\boldsymbol{v_{TH}}$) and a series resistance ($\boldsymbol{R_{TH}}$).

# THEVENIN'S THEOREM

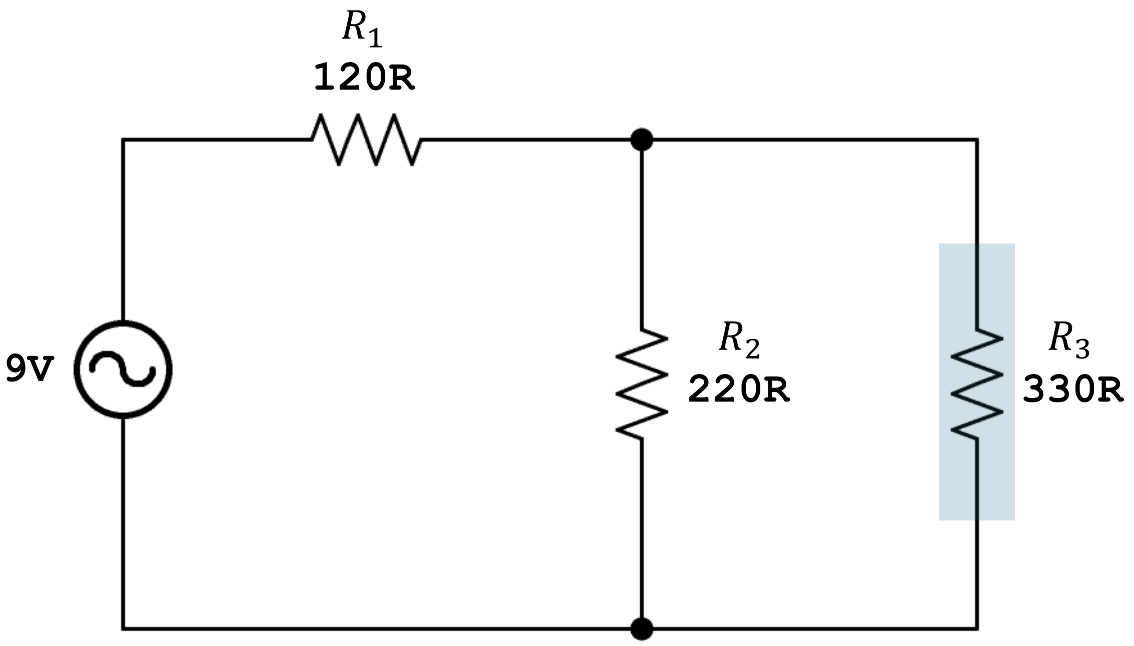
Thevenin's Equivalent Circuit




Arbitrary Network

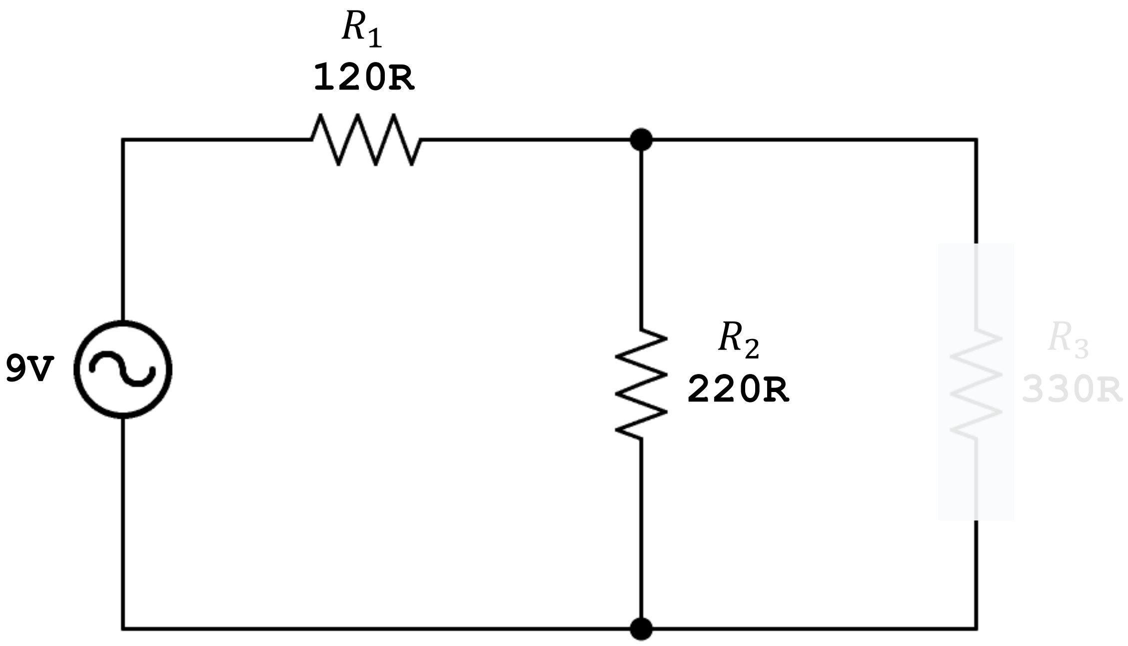


# STEPS TO APPLY THEVENIN'S THEOREM




1. Identify the load.

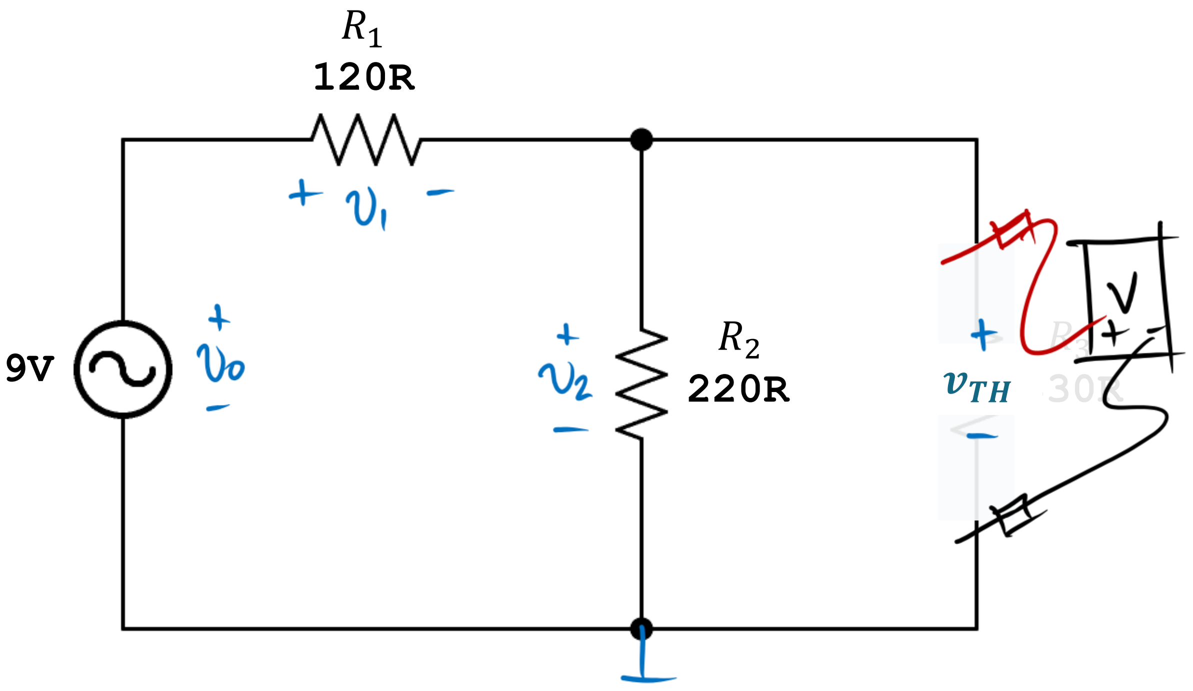
# STEPS TO APPLY THEVENIN'S THEOREM




1. Identify the load.

2. Remove the load.

# STEPS TO APPLY THEVENIN'S THEOREM




1. Identify the load.

2. Remove the load.

3. Determine the Thevenin voltage ($v_{th}$):

Calculate the open-circuit voltage across the terminals where the load was connected.

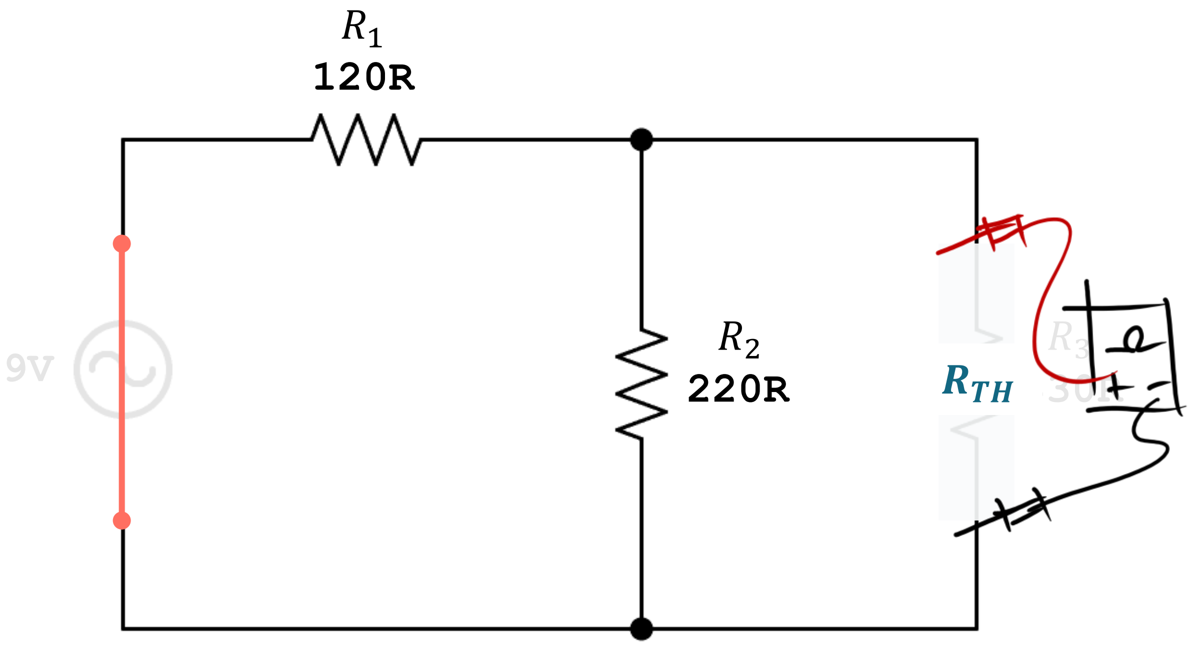
by VDT

$$v_{TH} = v_0 \frac{R_2}{R_1 + R_2}$$

$$v_{TH} = 9 \frac{220}{120 + 220}$$

$$v_{TH} = 5.82\ V$$

# STEPS TO APPLY THEVENIN'S THEOREM




1. Identify the load.

2. Remove the load.

3. Determine the Thevenin voltage ($v_{th}$):

Calculate the **open-circuit voltage** across the terminals where the load was connected.

4. Determine the Thevenin Resistance ($R_{TH}$):

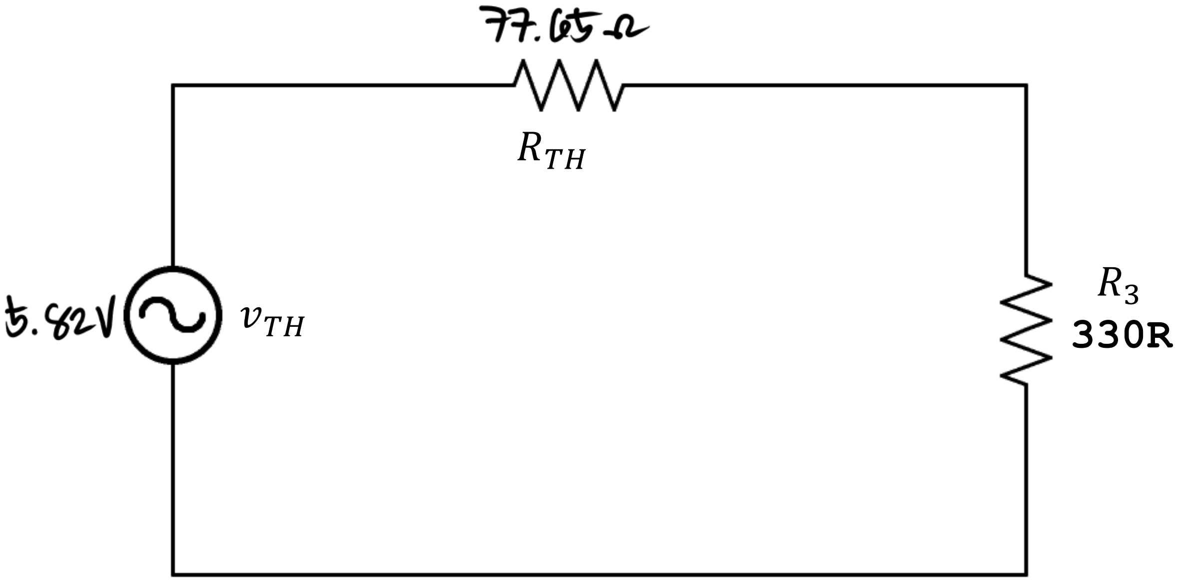
Set all independent **sources to zero** and calculate the equivalent resistance looking into the terminals where the load was connected.

$$\frac{1}{R_{TH}} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \frac{1}{R_{TH}} = \frac{17}{1320}$$

$$\frac{1}{R_{TH}} = \frac{1}{120} + \frac{1}{220} \qquad R_{TH} = 77.65\,\Omega$$

# STEPS TO APPLY THEVENIN'S THEOREM

Thevenin Equivalent Circuit




1. Identify the load.

2. Remove the load.

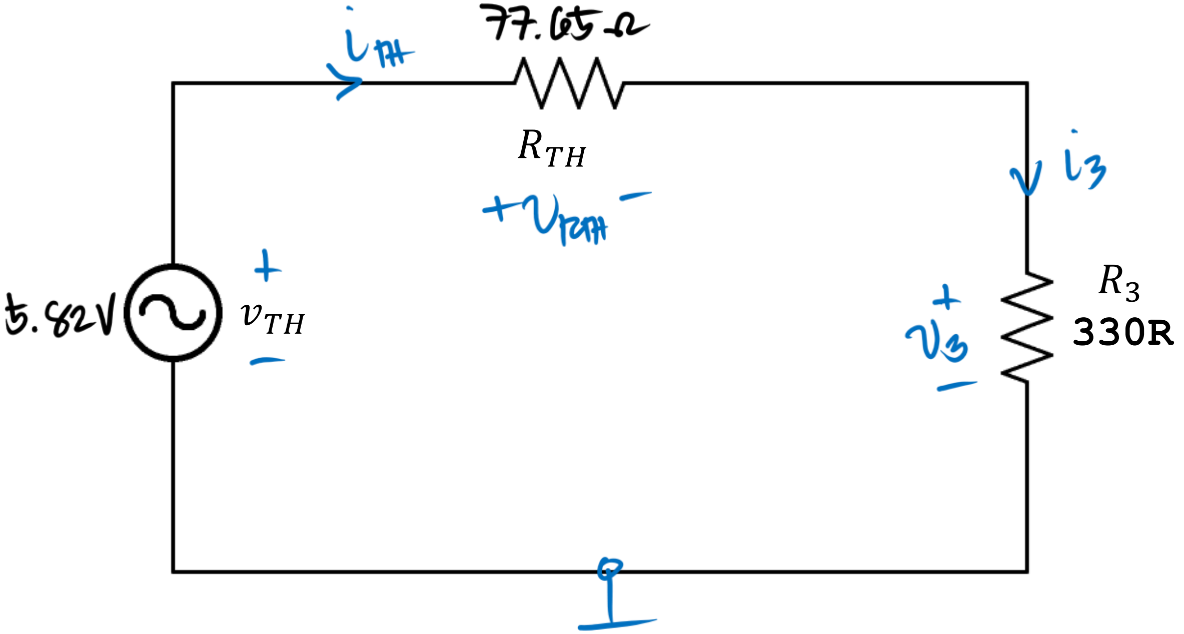
3. Determine the Thevenin voltage ($\boldsymbol{v_{th}}$):
Calculate the **open-circuit voltage** across the terminals where the load was connected.

4. Determine the Thevenin Resistance ($\boldsymbol{R_{TH}}$):
Set all independent **sources to zero** and calculate the equivalent resistance looking into the terminals where the load was connected.

5. Replace the original circuit with **Thevenin equivalent** and reconnect the load.

# STEPS TO APPLY THEVENIN'S THEOREM

Thevenin Equivalent Circuit




by VDT

$$v_3 = v_{TH} \frac{R_3}{R_{TH} + R_3}$$

$$v_3 = 5.82 \frac{330}{77.65 + 330}$$

$$\boxed{v_3 = 4.71\ V}$$

ans

$$i_3 = \frac{v_3}{R_3}$$

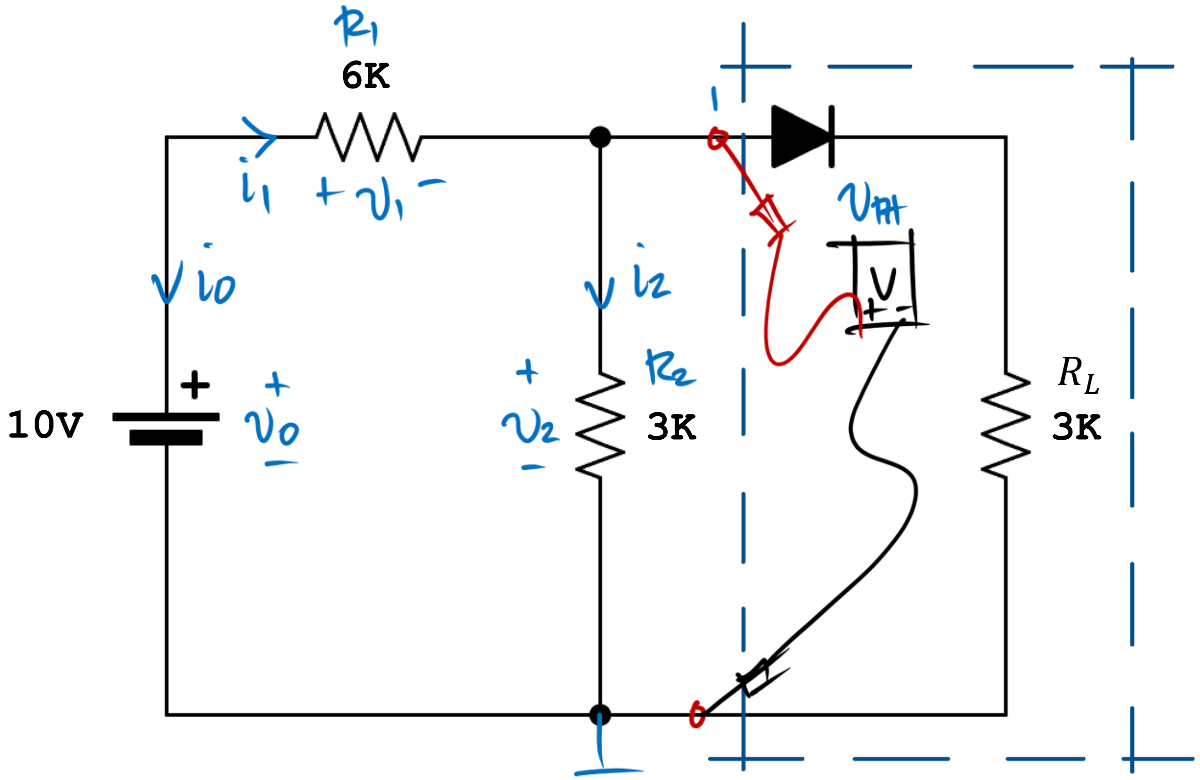
$$i_3 = \frac{4.71}{330}$$

$$\boxed{i_3 = 14.27\ mA}$$

ans

## EXERCISE

Use the 2nd approximation diode to calculate the load voltage and load current of the given network.




Solution

Thevenin Voltage

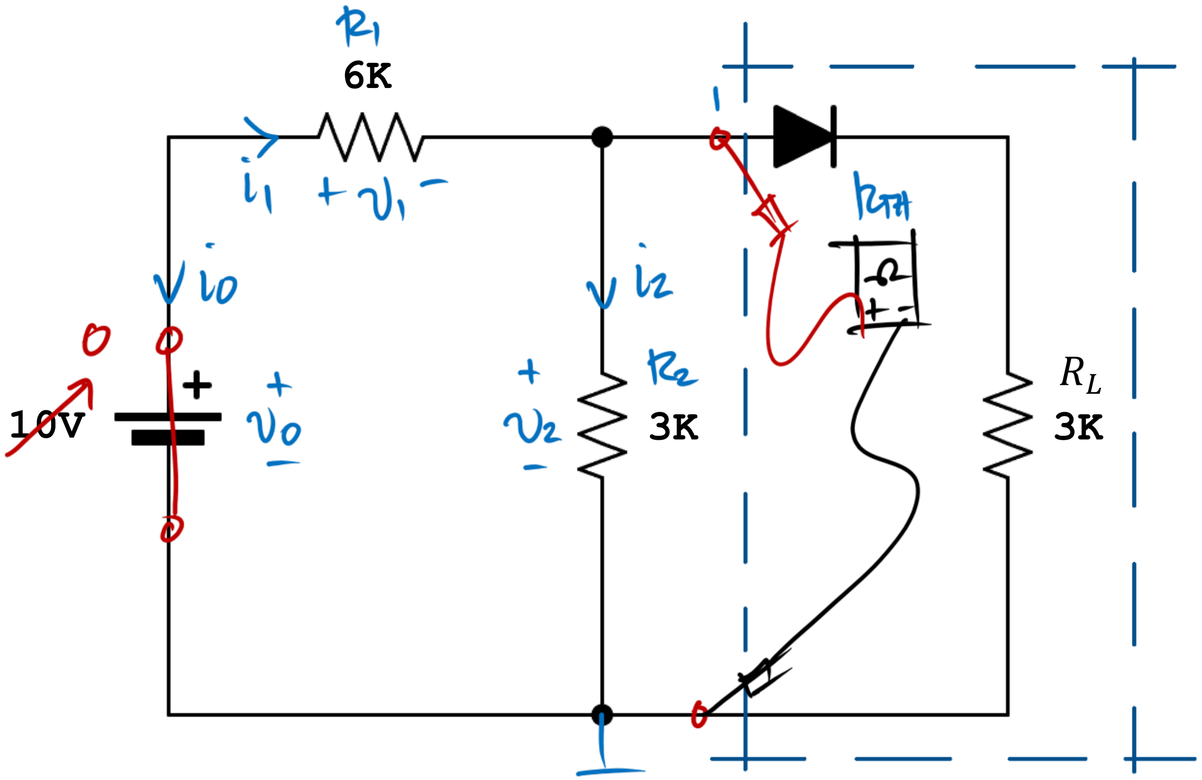
$$v_{TH} = v_0 \frac{R_2}{R_1 + R_2}$$

$$v_{TH} = 10 \frac{3k}{6k + 3k}$$

$$v_{TH} = 3.33V$$

# EXERCISE

Use the 2nd approximation diode to calculate the load voltage and load current of the given network.




Solution

**Thevenin Resistance**

$$\frac{1}{R_{TH}} = \frac{1}{R_1} + \frac{1}{R_2}$$

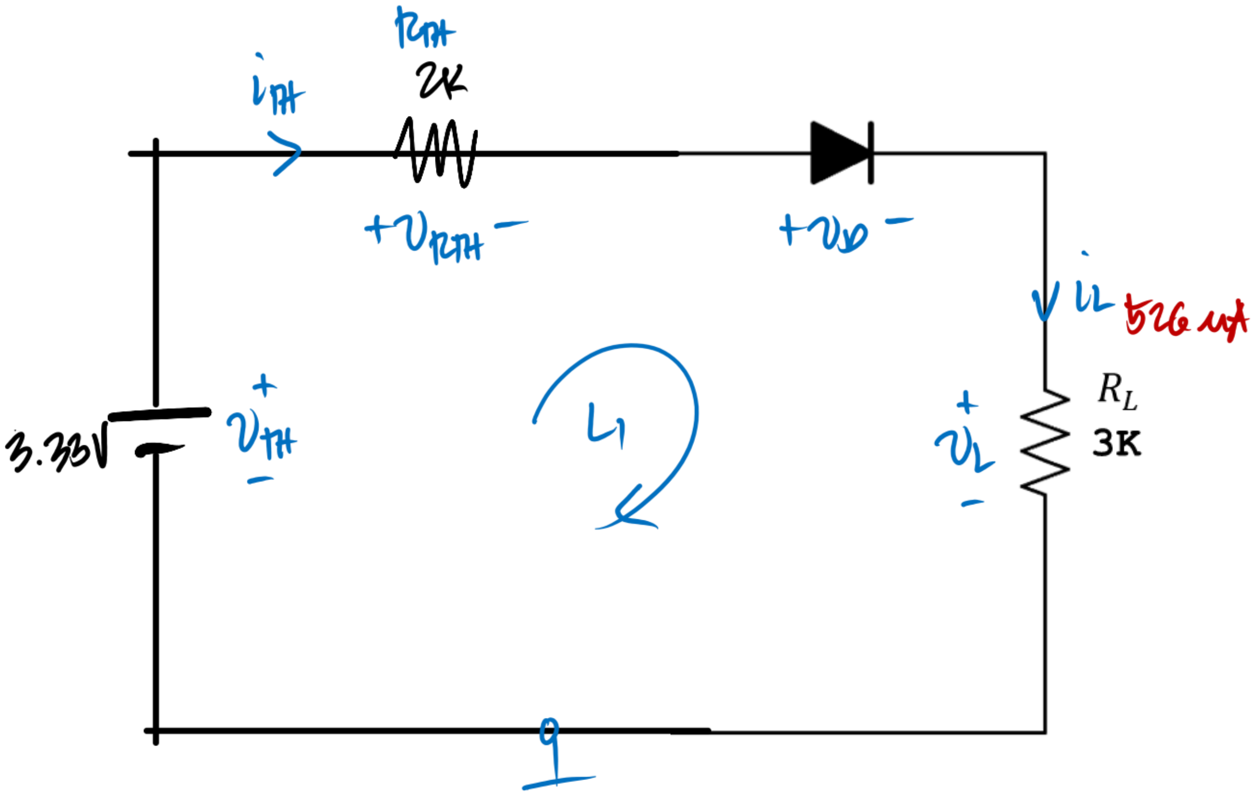
$$\frac{1}{R_{TH}} = \frac{1}{6K} + \frac{1}{3K}$$

$$\frac{1}{R_{TH}} = \frac{1}{2K}$$

$$R_{TH} = 2K$$

# EXERCISE

Use the 2nd approximation diode to calculate the load voltage and load current of the given network.




Solution

KVL @ $L_1$

$$-v_{TH} + v_{RTH} + v_D + v_L = 0$$

$$v_{RTH} + v_L = v_{TH} - v_D$$

$$\xcancel{i_{TH}}^{\,i_L}R_{TH} + i_L R_L = v_{TH} - v_D$$

$$i_L(R_{TH} + R_L) = v_{TH} - \cancel{v_D}^{\,0.7}$$

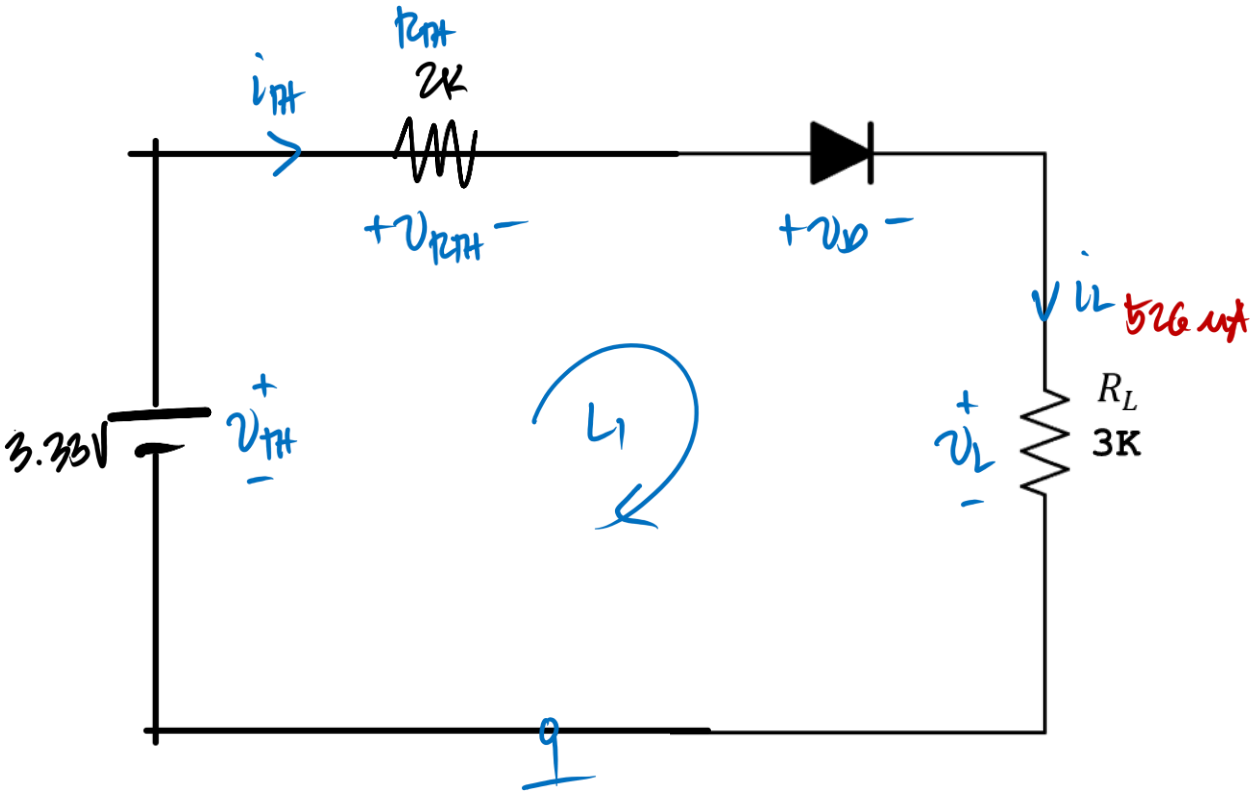
$$i_L = \frac{3.33 - 0.7}{2k + 3k}$$

$$\boxed{i_L = 526\ \mu A}$$

ans

# EXERCISE

Use the 2nd approximation diode to calculate the load voltage and load current of the given network.




Solution

$v_L = i_L R_L$

$v_L = 526\mu(3k)$

$\boxed{v_L = 1.58\,V}$ ans

# LABORATORY