K. J. SOMAIYA COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRONICS ENGINEERING
ELECTRONIC CIRCUITS
DC CIRCUITS

Numerical 1: Calculate V_o and I_o for the circuit shown in Figure 1.

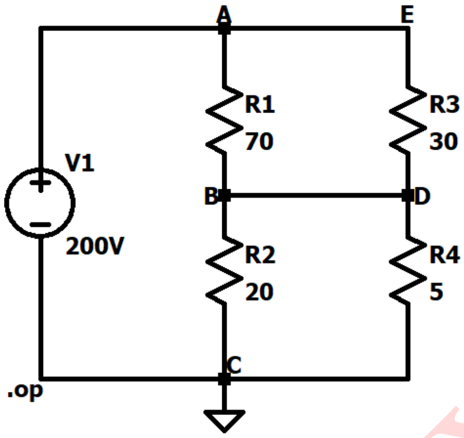

Figure 1: Circuit 1

Solution:

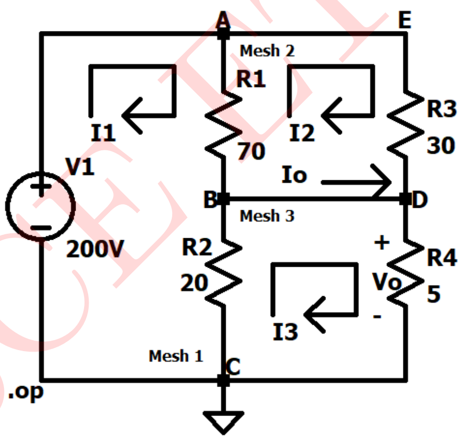

Figure 2: Simplified circuit

Consider I_1, I_2 and I_3 flowing through mesh 1, 2 and 3 clockwise.

Applying KVL to mesh 1,

$200 - 70(I_1 - I_2) - 20(I_1 - I_3) = 0$

$90I_1 - 70I_2 - 20I_3 = 200$ —(i)

Applying KVL to mesh 2,

$-70(I_2 - I_1) - 30I_2 = 0$

$70I_1 - 100I_2 = 0$ —(ii)

Applying KVL to mesh 3,

$-20(I_3 - I_1) - 5I_3 = 0$

$20I_1 - 25I_3 = 0$ —(iii)

From Eqs. (i), (ii) and (iii) we get,
$I_1 = 8\text{A}$
$I_2 = 5.6\text{A}$
$I_3 = 6.4\text{A}$

Hence, $I_o = -I_2 = -5.6\text{A}$

$$V_o = V_{R4} = I_{R4} \times R4$$
$$= 6.4A \times 5\Omega$$
$$= 32\text{V}$$

$\mathbf{V_o = 32V \ I_o = -5.6 \ A}$

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

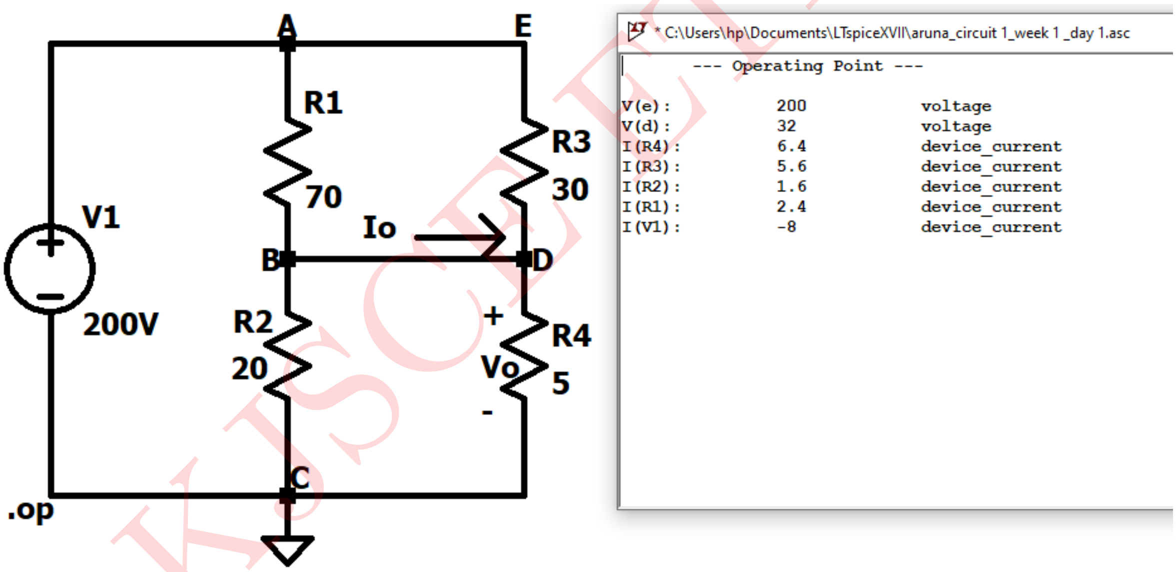

Figure 3: Circuit Schematic and Simulated Results

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_o	32 V	32 V
I_o	−5.6 A	−5.6 A

Table 1: Numerical 1

Numerical 2: Calculate equivalent resistance R_{ab} at terminals a-b for each of the following circuits in Figure 4 and Figure 5.

(a)

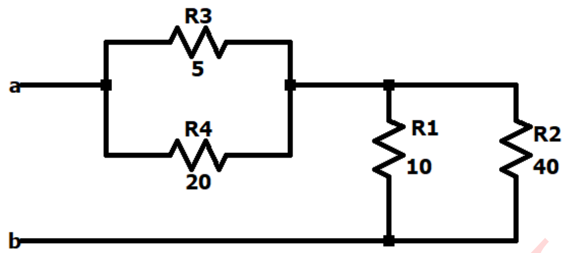

Figure 4: Circuit 2

(b)

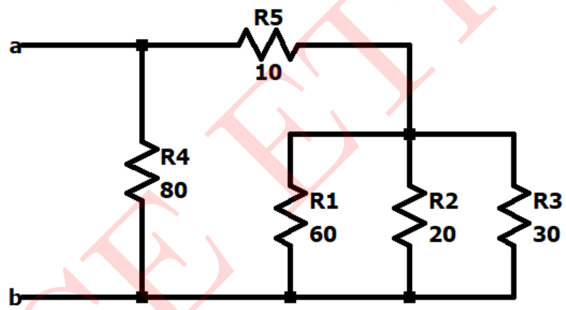

Figure 5: Circuit 3

Solution:

(a)

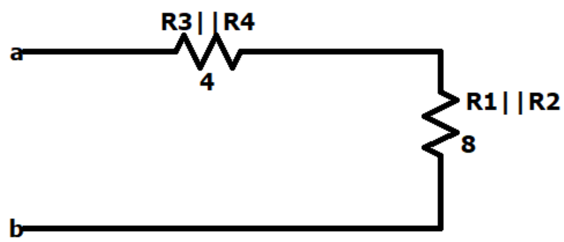

Figure 6: Circuit 2 Simplified Circuit (1)

$$\begin{aligned} \text{R1}||\text{R2} &= 10\ \Omega \ ||\ 40\ \Omega \\ &= 8\ \Omega \end{aligned}$$

$$\begin{aligned} \text{R3}||\text{R4} &= 5\ \Omega \ ||\ 20\ \Omega \\ &= 4\ \Omega \end{aligned}$$

$$\begin{aligned} \text{R1}||\text{R2} + \text{R3}||\text{R4} &= 10\ \Omega \ ||\ 40\ \Omega + 5\ \Omega \ ||\ 20\ \Omega \\ &= 12\ \Omega \end{aligned}$$

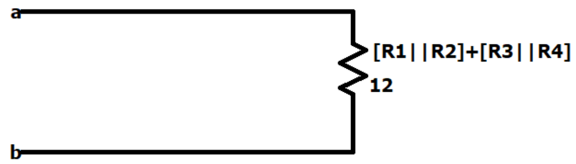

Figure 7: Circuit 2 Simplified Circuit (2)

$\mathbf{R_{ab}} = \mathbf{12}\ \Omega$

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

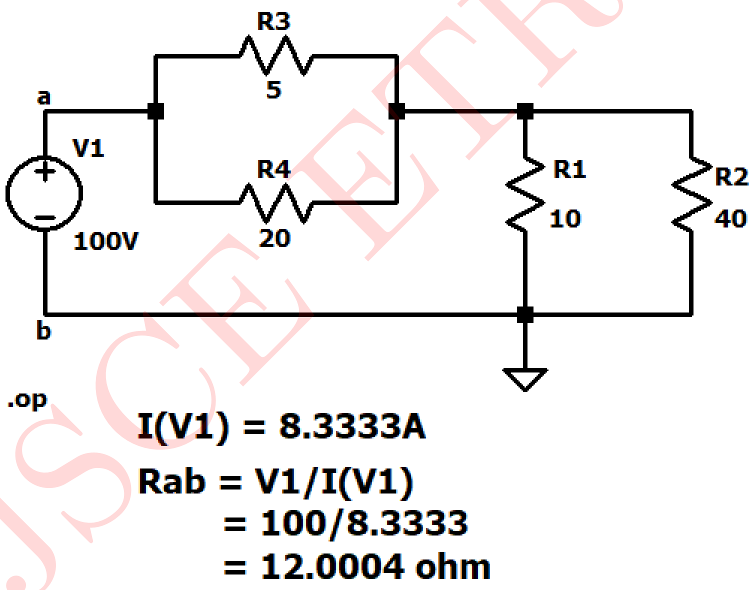

Figure 8: Circuit Schematic

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
R_{ab}	12 Ω	12.0004 Ω

Table 2: Numerical 2 (a)

(b)

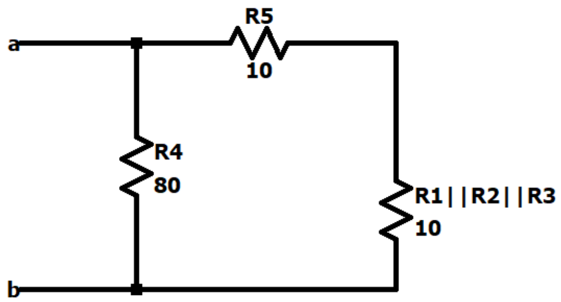

Figure 9: Circuit 3 Simplified Circuit (1)

R1||R2||R3 = 60 Ω || 20 Ω || 30 Ω
= 10 Ω

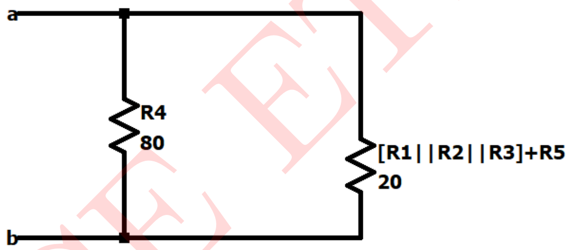

Figure 10: Circuit 3 Simplified Circuit (2)

R1||R2||R3 +R5 = 10 Ω+ 10 Ω
= 20 Ω

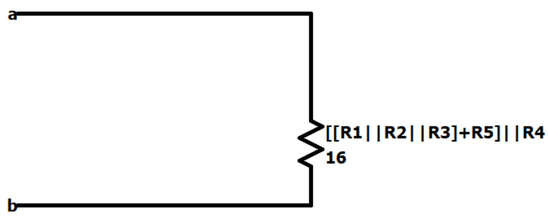

Figure 11: Circuit 3 Simplified Circuit (3)

R1||R2||R3 +R5 || R4 = 20Ω || 80 Ω
= 16 Ω

$\mathbf{R_{ab} = 16}\ \Omega$

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

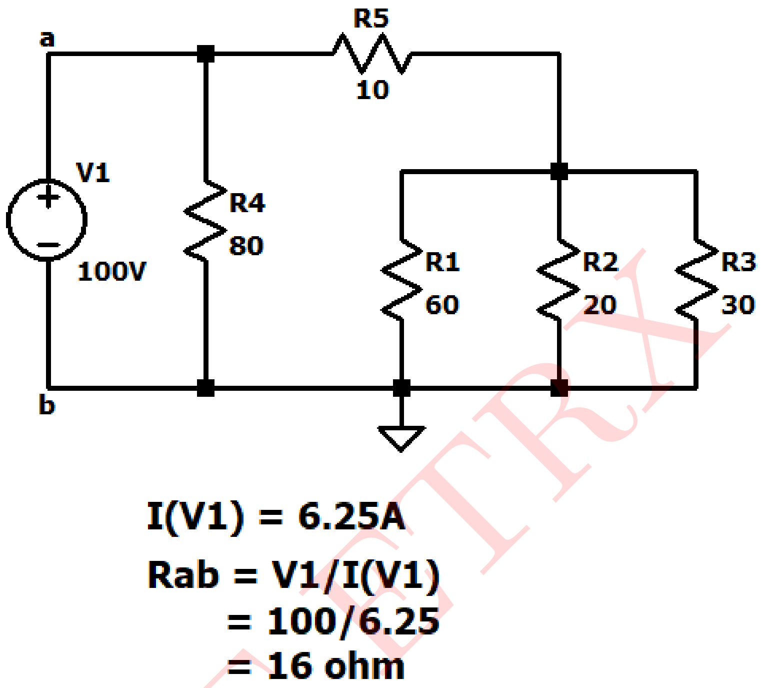

Figure 12: Circuit Schematic

Comparison of theoretical and Simulated Results

Parameters	Theoretical Values	Simulated Values
R_{ab}	16 Ω	16 Ω

Table 3: Numerical 2 (b)

Numerical 3: Apply Superposition theorem to compute current across 2Ω resistor in figure 13

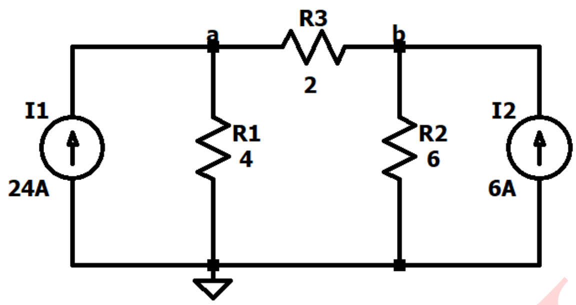

Figure 13: Circuit 4

Solution:

Case 1:
Taking I_1 as the source, I_2 will be open circuited, figure 14

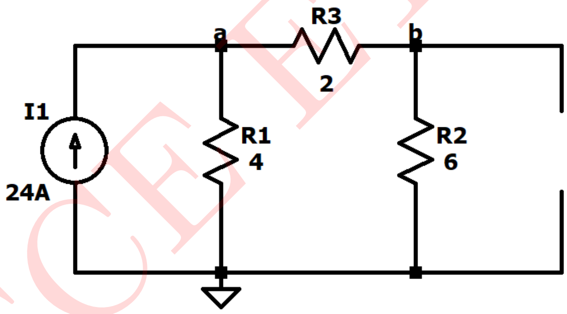

Figure 14: Circuit 4 keeping I_1 as source

Current through 2Ω resistor = i_1

Total current through the circuit I_T = 24A

$$
\begin{aligned}
R_{eq} &= R_2 + R_3 \\
&= 2\Omega + 6\Omega \\
&= 8\Omega \\
i_1 &= I_T \frac{R_1}{R_1 + R_{eq}} \\
&= 24 \times \frac{4}{4+8} \\
&= 8A
\end{aligned}
$$

i_1 = 8A (clockwise)

Case 2:
Taking I_2 as the source, I_1 will be open circuited, figure 15

Current through 2Ω resistor = i_2

Total current through the circuit I_T = 6A

$R_{eq} = R_1 + R_2$

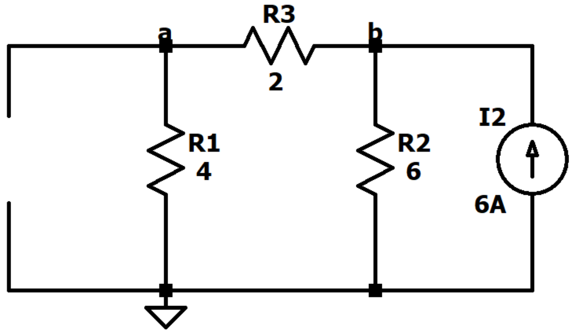

Figure 15: Circuit 4 keeping I_2 as source

$$
\begin{aligned}
&= 4\Omega + 2\Omega \\
&= 6\Omega \\
i_2 &= I_T \frac{R_1}{R_1 + R_{eq}} \\
&= 6 \times \frac{6}{6+6} \\
&= 3A
\end{aligned}
$$

$i_2 = 3A$ (anticlockwise)

From Case 1 and Case 2,

$$
\begin{aligned}
I_{2\Omega} &= i_1 + i_2 \\
&= 8A - 3A \\
&= 5A \text{ (clockwise)}
\end{aligned}
$$

$\mathbf{I_{2\Omega} = 5A}$ **(clockwise)**

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

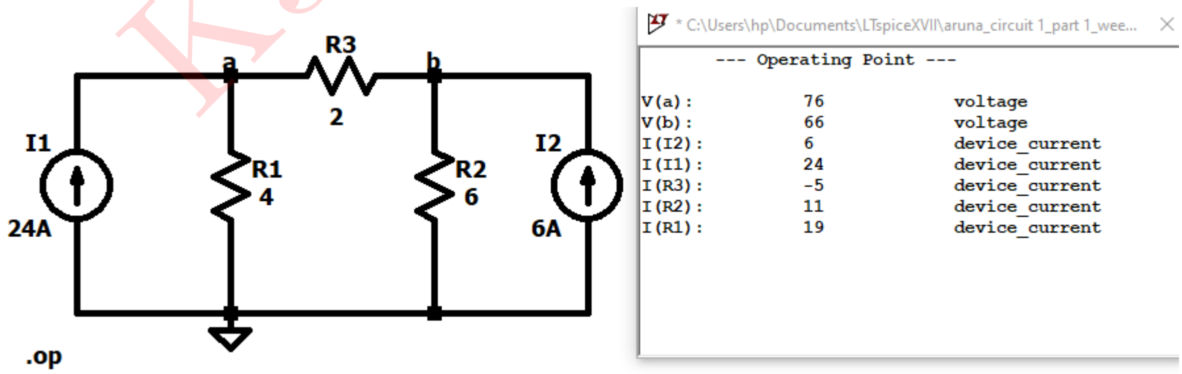

Figure 16: Circuit Schematic and Simulated Results

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
$I_{2\Omega}$	5A	5A

Table 4: Numerical 3

Numerical 4: Use Superposition theorem to calculate voltage across 3Ω resistor in figure 17

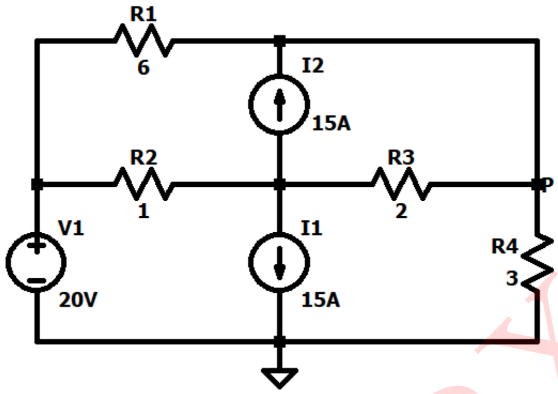

Figure 17: Circuit 5

Solution:

Case 1:
Taking V_1 as the source, I_1 and I_2 will be open circuited, figure 18

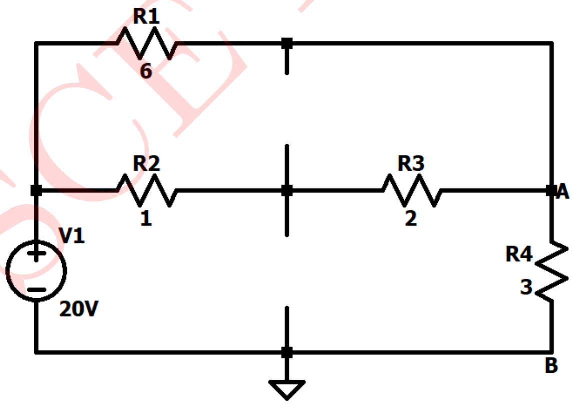

Figure 18: Circuit 5 keeping V_1 as source

$$
\begin{aligned}
R_{eq} &= (R_1 \,||\, (R_2 + R_3)\ ) + R_4 \\
&= (6 \,||\, (1+2) + 3) \\
&= 5\Omega
\end{aligned}
$$

$$
\mathrm{I_T} = \frac{V_1}{R_{\mathrm{eq}}} = \frac{20}{5} = 4\mathrm{A}
$$

$$
\begin{aligned}
V_{A1} &= I_T \times R_4 \\
&= 4 \times 3 \\
&= 12\mathrm{V}
\end{aligned}
$$

Case 2:
Taking I_1 as the source, V_1 will be short circuited and I_2 will be open circuited, figure 19

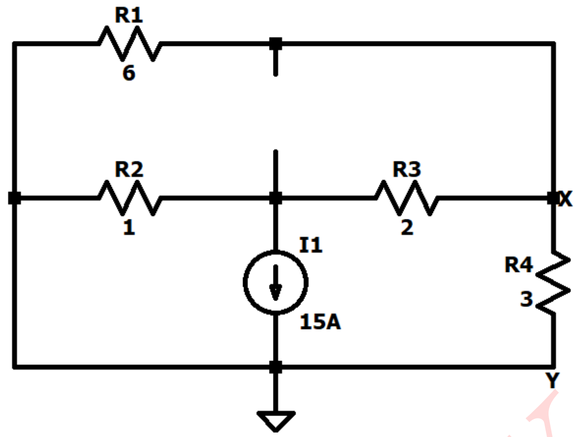

Figure 19: Circuit 5 keeping I_1 as source

Using Mesh analysis in Mesh 1, 2 and 3 we get,

Applying KVL in Mesh 1,

$-6I_1\ -2(I_1 - I_2)\ -1(I_1 - I_3) = 0$

$-9I_1 + 3I_2 + I_3 = 0$ —(i)

Applying KVL in Supermesh,

$-2(I_2 - I_1)\ -3I_2\ -1(I_3 - I_1) = 0$

$3I_1\ -5I_2\ -I_3 = 0$ —(ii)

From the figure 7,

$-I_1 + I_2 = -15$ —(iii)

From Eqs. (i), (ii) and (iii) we get,
$I_1 = 1$A
$I_2 = -2$A
$I_3 = 17$A

Current through 3Ω resistor $= -2A$
Voltage across 3Ω resistor $V_{A2} = -2 \times 3 = -6V$

Case 3:
Taking I_2 as the source, V_1 will be short circuited and I_1 will be open circuited, figure 20

Using Mesh analysis in Mesh 1, 2 and 3 we get,

Applying KVL in Mesh 3,

$-3I_3\ -1(I_3 - I_1)\ -2(I_3 - I_2) = 0$

$I_1 + 2I_2\ -6I_3 = 0$ —(i)

Applying KVL in Supermesh,

$-1(I_1 - I_3)\ -6I_1\ -2(I_2 - I_3) = 0$

$-7I_1\ -2I_2\ +3I_3 = 0$ —(ii)

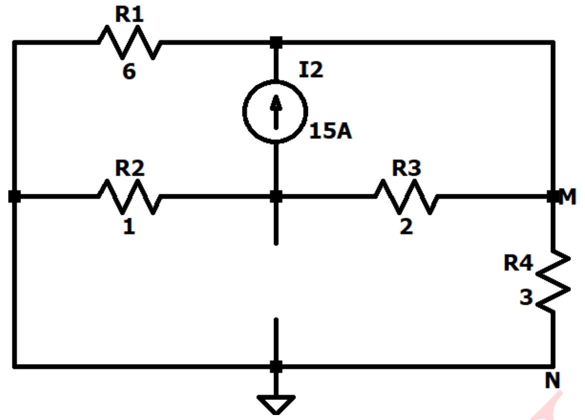

Figure 20: Circuit 5 keeping I_2 as source

From the figure 20,
$-I_1 + I_2 = -15$ —(iii)

From Eqs. (i), (ii) and (iii) we get,
$I_1 = 2\text{A}$
$I_2 = -13\text{A}$
$I_3 = 4\text{A}$

Current through 3Ω resistor = 4A
Voltage across 3Ω resistor $V_{A3} = 4 \times 3 = 12\text{V}$

From Case 1, Case 2 and Case 3,
Net voltage across $R_4 = V_{A1} + V_{A2} + V_{A3}$
$= 12\text{V} - 6\text{V} - 12\text{V}$
$= 18\text{V}$ (clockwise)

$\mathbf{V_{3\Omega} = 18V(clockwise)}$

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

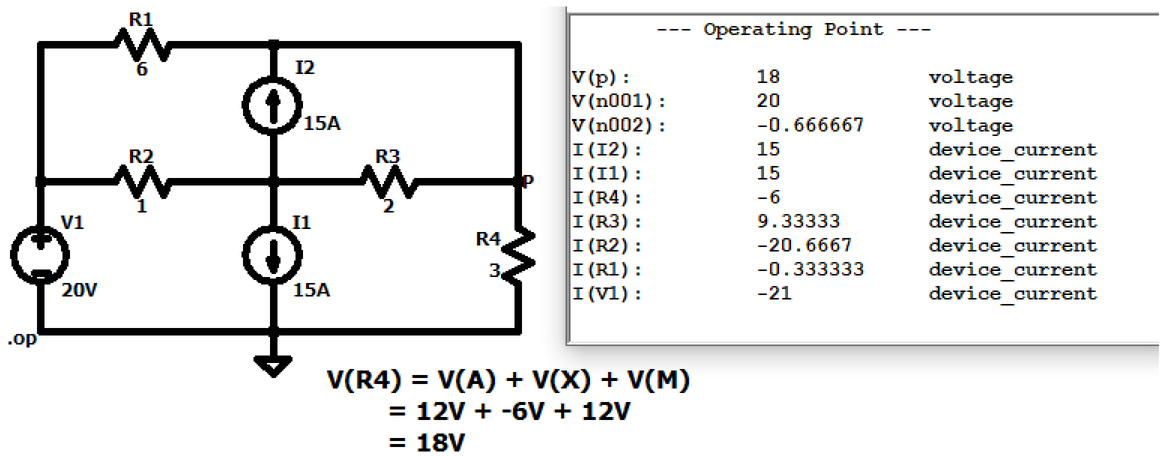

Figure 21: Circuit Schematic and Simulated Results

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
$V_{3\Omega}$	18V	18V

Table 5: Numerical 4

Numerical 5: Find the Thevenin's equivalent of the circuit as seen by looking into terminals A-B in figure 22.

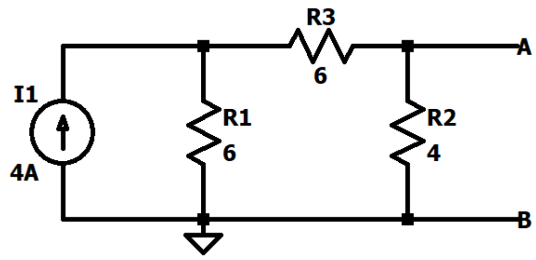

Figure 22: Circuit 6

Solution:

Step 1: Calculation of V_{th}

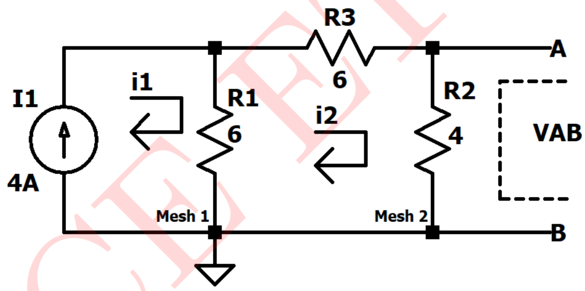

Figure 23: Finding V_{th}

Apply KVL to mesh 1,

$i_1 = 4\text{A (anticlockwise)}$ —(i)

Apply KVL to mesh 2,

$-6i_2 - 4i_2 - 6(i_2 - i_1) = 0$

$-16i_2 - 6i_1 = 0$ —(ii)

Solving (i) and (ii),

$i_2 = 1.5\text{A (anticlockwise)}$

$V_{AB} = i_2 \times R_2 = 6\text{V}$

$V_{th} = V_{AB} = 6\text{V}$

$V_{th} = \mathbf{6V}$

Step 2: Calculation of R_{th}

For finding R_{th}, deactivate all the independent sources,

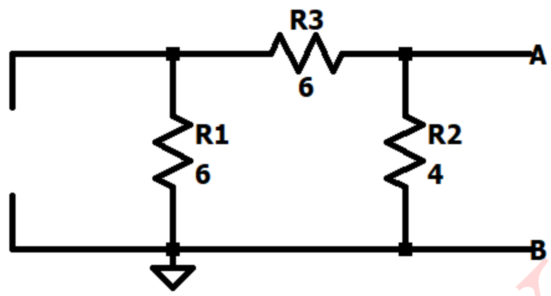

Figure 24: Finding R_{th}

$$
\begin{aligned}
\text{Equivalent resistance across AB} = R_{th} &= (R_1 + R_3)||R_2 \\
&= (6 + 6)||4 \\
&= 3\Omega
\end{aligned}
$$

$\boldsymbol{R_{th} = 3\Omega}$

Thevenin's Equivalent Circuit

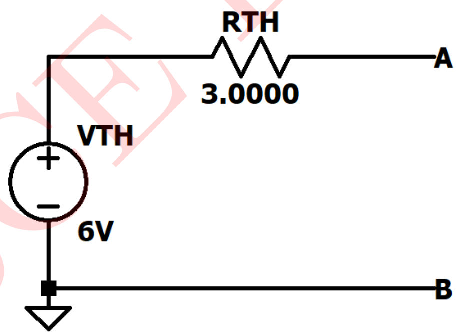

Figure 25: Thevenin's equivalent circuit

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

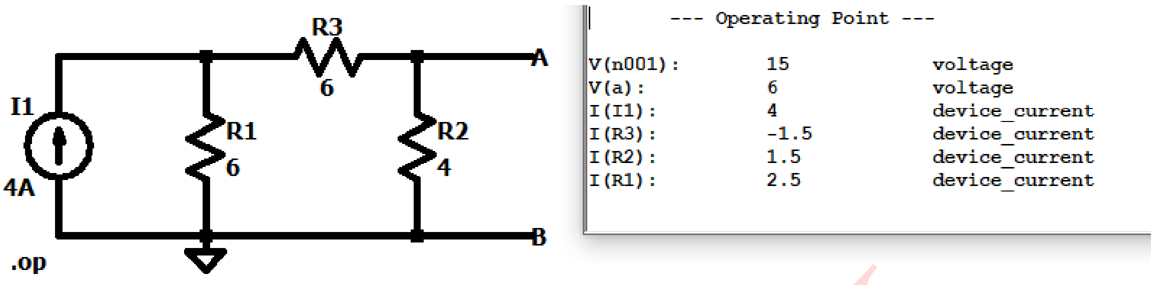

Figure 26: Circuit Schematic and Simulated Results for V_{th}

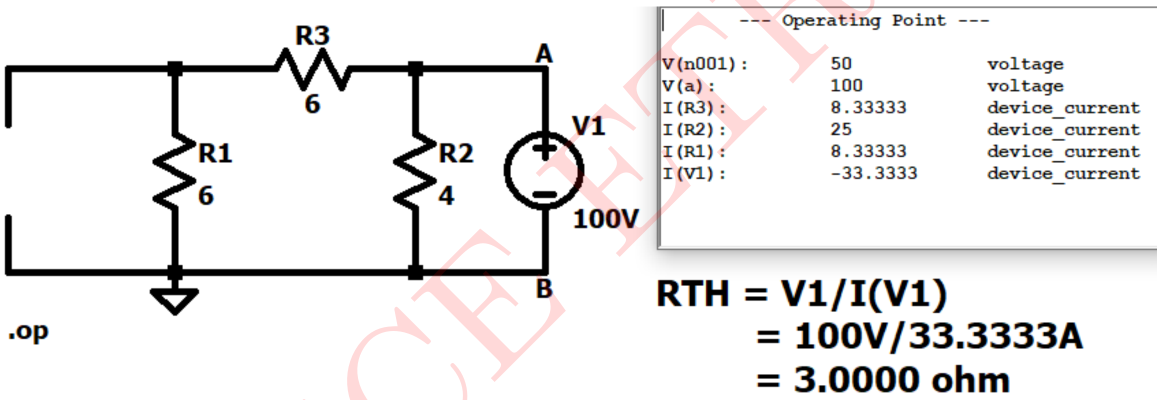

Figure 27: Circuit Schematic and Simulated Results for R_{th}

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_{th}	6V	6V
R_{th}	3Ω	3.00Ω

Table 6: Numerical 5

Numerical 6: For the circuit in figure 28, find the Thevenin's equivalent of the circuit across terminals A-B.

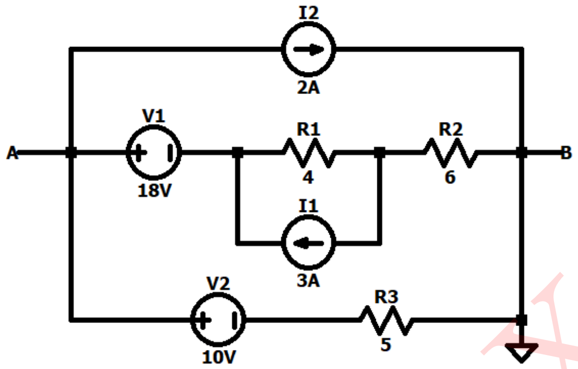

Figure 28: Circuit 7

Solution:

Step 1: Calculation of V_{th}

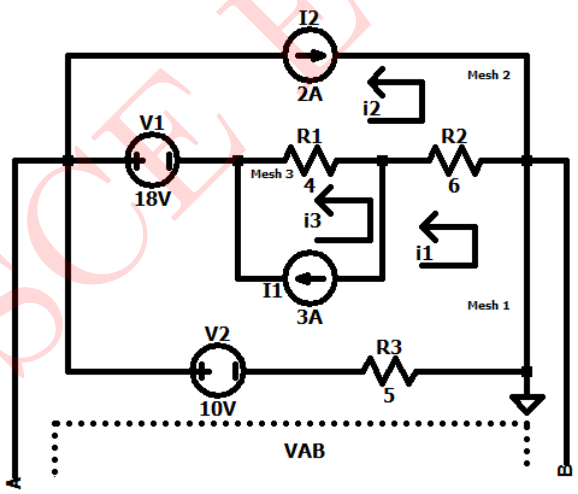

Figure 29: Finding V_{th}

From figure 29,

$i_1 - i_3 = 3\text{A}$ —(i)

$i_2 = -2\text{A}$ —(ii)

Applying KVL in Supermesh,

$-10 - 5i_1 - 6(i_1 - i_2) - 4(i_3 - i_2) + 18 = 0$

$11i_1 - 10 - i_2 + 4i_3 = 8$ —(iii)

Solving (i), (ii) and (iii),

$i_1 = 0\text{A}, \ i_3 = -3\text{A}$

$$\begin{aligned} V_{th} &= V_2 + i_1 \times R_2 \\ &= 10 + 0 \times 5 \\ &= 10\text{V} \end{aligned}$$

Step 2: Calculation of R_{th}

For finding R_{th}, deactivate all the independent sources,

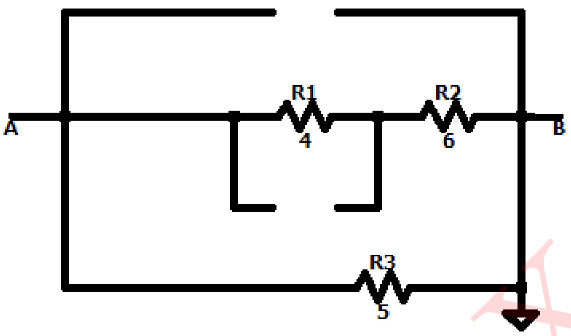

Figure 30: Finding R_{th}

$$\begin{aligned}\text{Equivalent resistance across AB} = R_{th} &= (R_1 + R_2)||R_3 \\ &= (4+6)||\ 5 \\ &= 3.3333\Omega\end{aligned}$$

R_{th} **= 3.3333**Ω

Thevenin's Equivalent Circuit

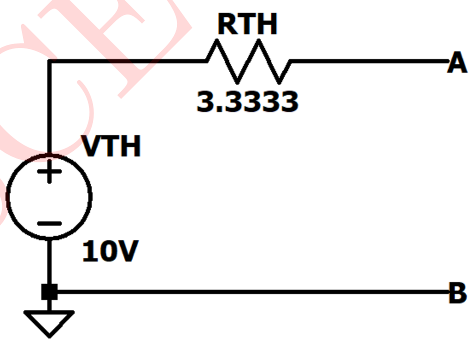

Figure 31: Thevenin's equivalent circuit

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

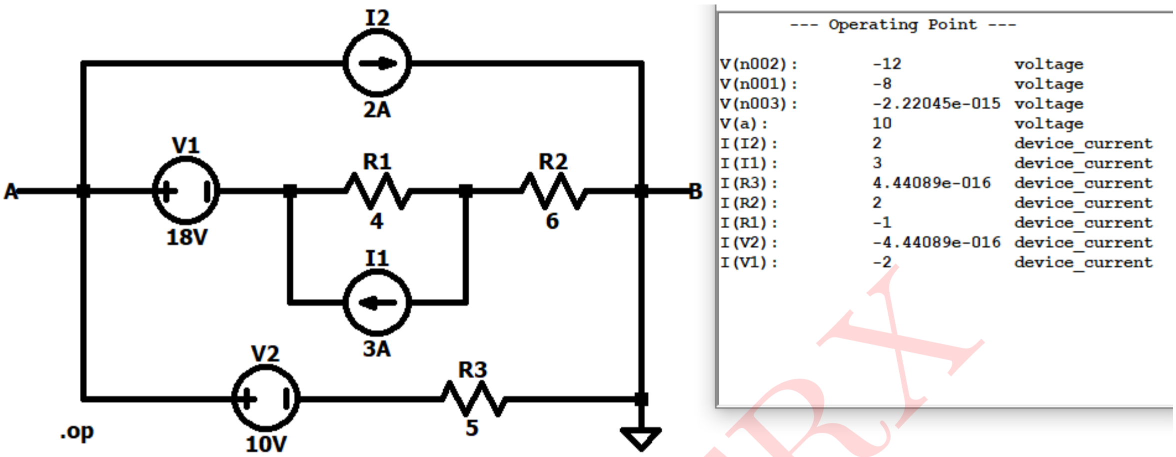

Figure 32: Circuit Schematic and Simulated Results for V_{th}

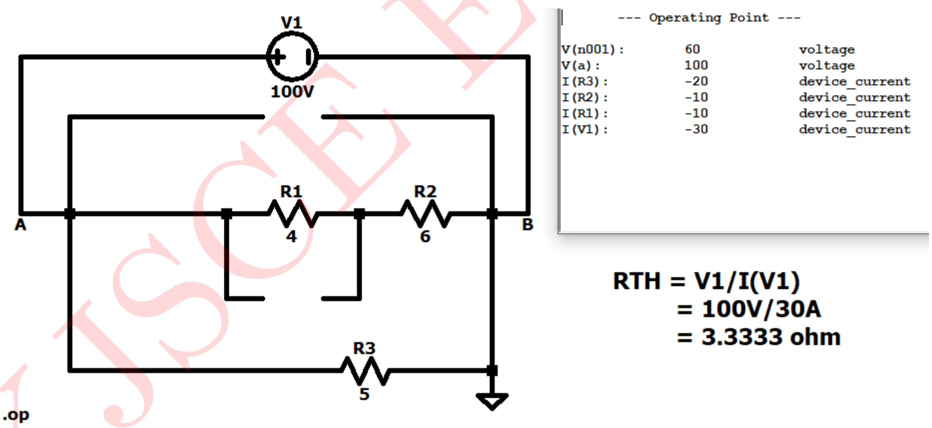

Figure 33: Circuit Schematic and Simulated Results for R_{th}

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_{th}	10V	10V
R_{th}	3.3333Ω	3.3333Ω

Table 7: Numerical 6

Numerical 7: Using Norton's theorem, find the current which would flow in a 25Ω resistor connected between points N and O in figure 34.

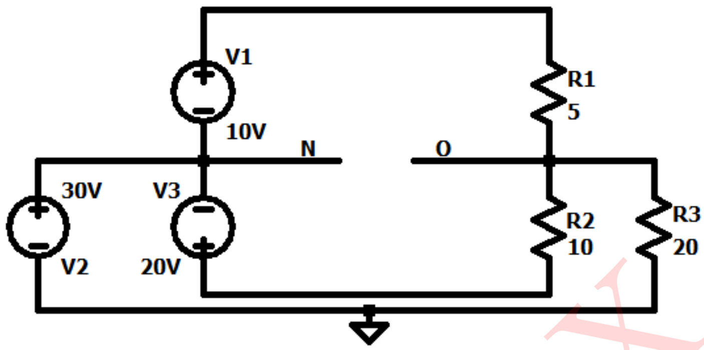

Figure 34: Circuit 8

Solution:

Step 1: Calculation of I_{sc}

Short Circuit NO to find I_{sc}

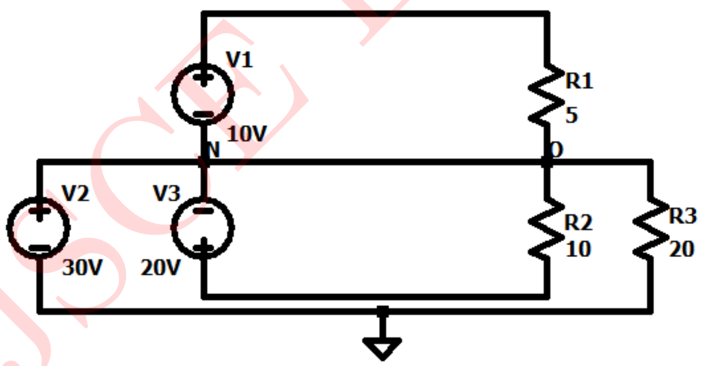

Figure 35: Finding I_{sc}

$$
\begin{aligned}
I_{sc} &= \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \\
&= \frac{10}{3} + \frac{20}{10} - \frac{30}{20} \\
&= 2.5\text{A}
\end{aligned}
$$

I_{sc} = **2.5A**

Step 2: Calculation of R_N

Deactivate all independent sources to find R_N

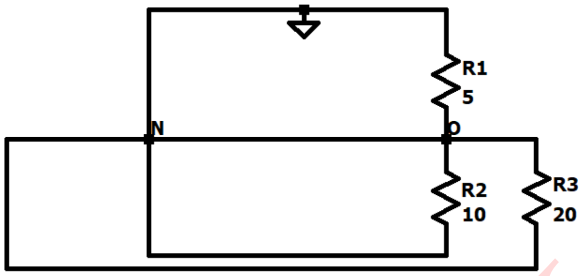

Figure 36: Finding R_N

$$\frac{1}{R_\mathrm{N}} = \frac{1}{R_1} + \frac{1}{R_\mathrm{N}} + \frac{1}{R_3}$$
$$= \frac{1}{5} + \frac{1}{10} + \frac{1}{20}$$
$$= \frac{7}{20}$$

R_N = **2.857**Ω

Norton's Equivalent Circuit

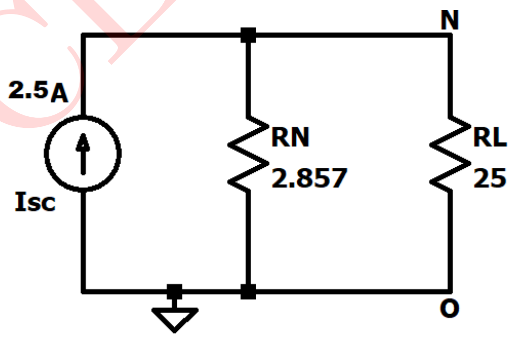

Figure 37: Norton's equivalent circuit

For finding current across 25Ω resistor

Open circuit voltage through NO

$$V_{NO} = I_{SC} \times R_N$$
$$= 2.5 \times 2.857$$
$$= 7.1425\mathrm{V}$$

Current through 25Ω resistor across NO

$$I_{RL} = \frac{V_\mathrm{NO}}{R_\mathrm{L}}$$
$$= \frac{7.4125}{25}$$
$$= 0.2857\mathrm{A}$$

$I_{25\Omega}$ = **0.2857A**

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

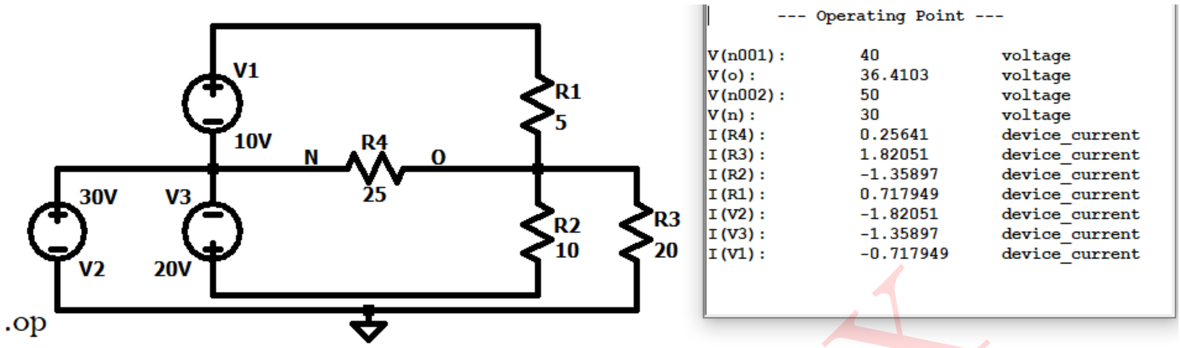

Figure 38: Circuit Schematic and Simulated Results for $I_{25\Omega}$

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
$I_{25\Omega}$	0.2857A	0.2564A

Table 8: Numerical 7

Numerical 8 : Find the Norton's equivalent and Thevenins's equivalent of the circuit across terminals A-B of the circuit in figure 39.

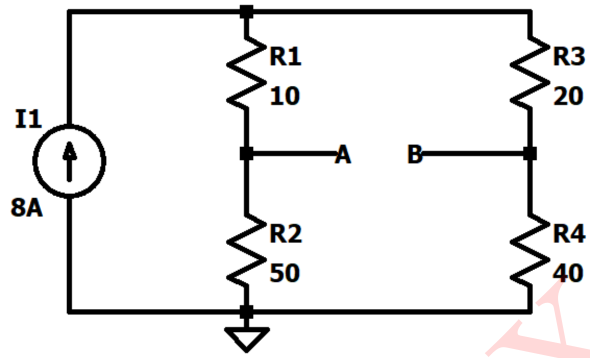

Figure 39: Circuit 9

Solution:

Step 1: Calculation of I_{sc}

Short Circuit AB to find I_{sc}

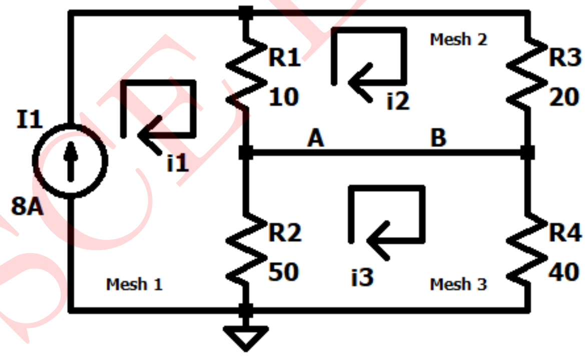

Figure 40: Finding I_{sc}

Apply KVL to mesh 1,

$i_1 = 8\text{A}$ (clockwise) —(i)

Apply KVL to mesh 2,

$-20i_2 - 10(i_2 - i_1) = 0$

$i_2 = 2.667\text{A}$ (clockwise) —(ii)

Apply KVL to mesh 3,

$-40i_3 - 50(i_3 - i_1) = 0$

$i_3 = 4.444\text{A}$ (clockwise) —(iii)

From (ii) and (iii),

$$\begin{aligned} I_{sc} &= i_3 - i_2 \\ &= 4.444 - 2.667 \\ &= 1.777\text{A (clockwise)} \end{aligned}$$

I_{sc} **= 1.777A (clockwise)**

Step 2: Calculation of R_N

Deactivate all independent sources to find R_N

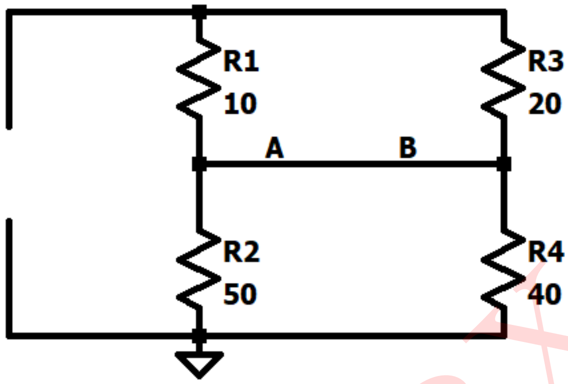

Figure 41: Finding R_N

$$
\begin{aligned}
R_N &= (R_1 + R_3) \,||\, (R_2 + R_4) \\
&= (10 + 20) \,||\, (50 + 40) \\
&= 22.5\Omega
\end{aligned}
$$

R_N $=$ **22.5**Ω

Norton's Equivalent Circuit

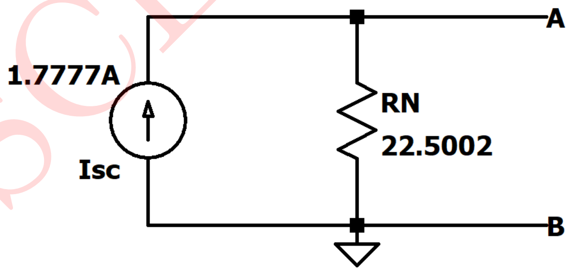

Figure 42: Norton's equivalent circuit

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

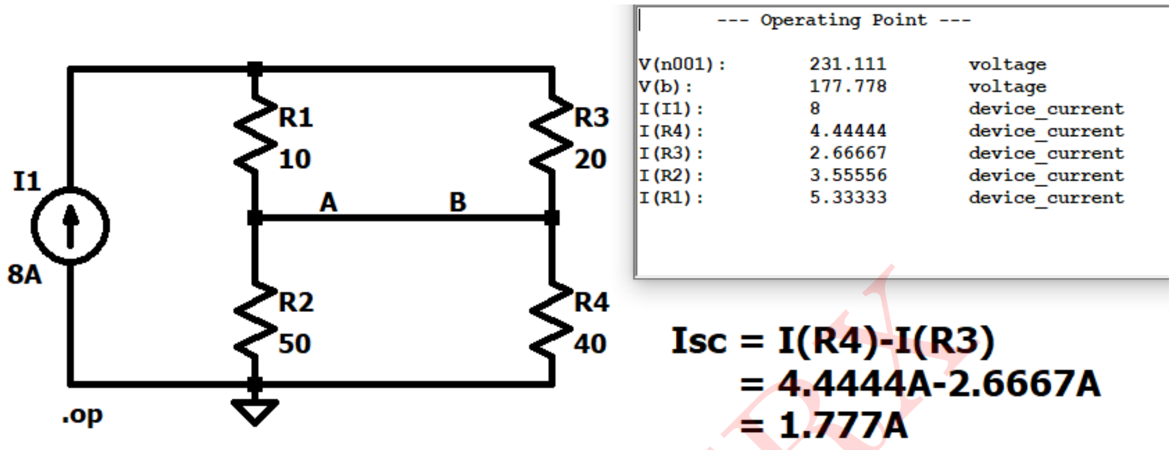

Figure 43: Circuit Schematic and Simulated Results for I_{sc}

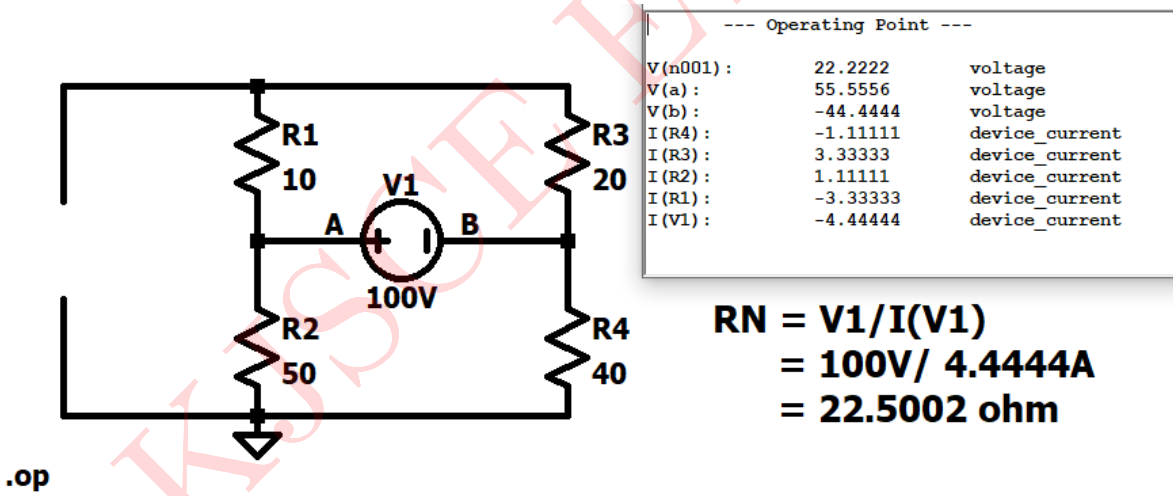

Figure 44: Circuit Schematic and Simulated Results for R_N

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
I_{sc}	1.777A	1.7777A
R_N	22.5Ω	22.5002Ω

Table 9: Numerical 8 Norton's Theorem

Thevenin's Theorem

Step 1: Calculation of V_{th}

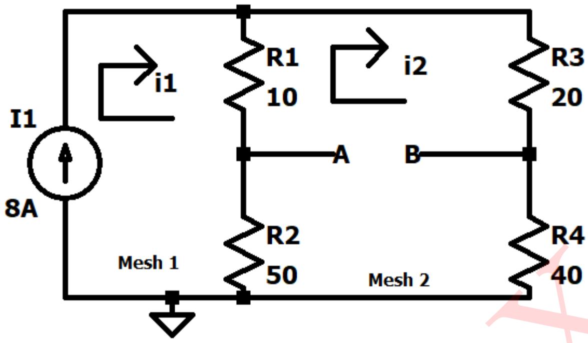

Figure 45: Finding V_{th}

Apply KVL to mesh 1,

$i_1 = 8\text{A}$ (clockwise) —(i)

Apply KVL to mesh 2,

$-20i_2 - 40i_2 - 4i_2 - 10(i_2 - i_1) - 50(i_2 - i_1) = 0$

$60i_1 - 120i_2 = 0$ —(ii)

Solving (i) and (ii),

$i_2 = 4\text{A}$ (anticlockwise)

$V_B = i_2 \times R_3$

$= 4 \times 20$

$= 80$

$V_A = i_2 \times R_1$

$= 4 \times 10$

$= 40$

$V_{AB} = V_B - V_A$

$= 80 - 40$

$= 40$

$V_{th} = V_{AB} = 40\text{V}$

$V_{th} = \mathbf{40V}$

Step 2: Calculation of R_{th}

For finding R_{th}, deactivate all the independent sources,

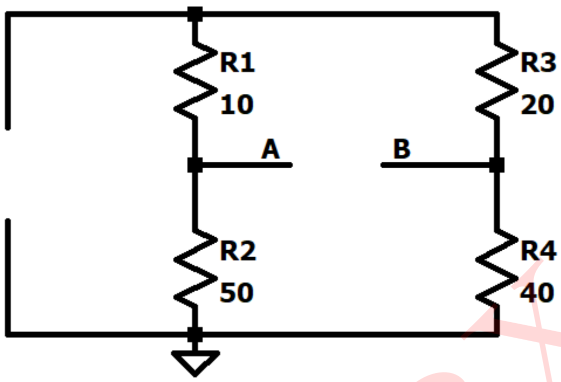

Figure 46: Finding R_{th}

$$
\begin{aligned}
R_{th} &= (R_1 + R_3) \mid\mid (R_2 + R_4) \\
&= (10 + 20) \mid\mid (50 + 40) \\
&= 22.5\Omega
\end{aligned}
$$

R_{th} **= 22.5Ω**

Thevenin's Equivalent Circuit

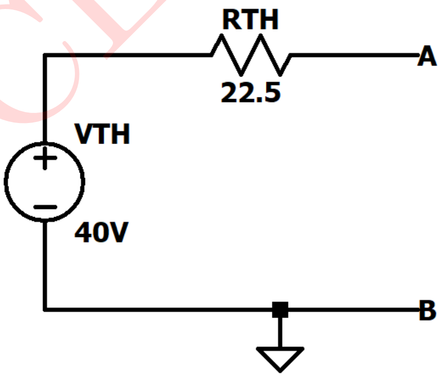

Figure 47: Thevenin's equivalent circuit

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

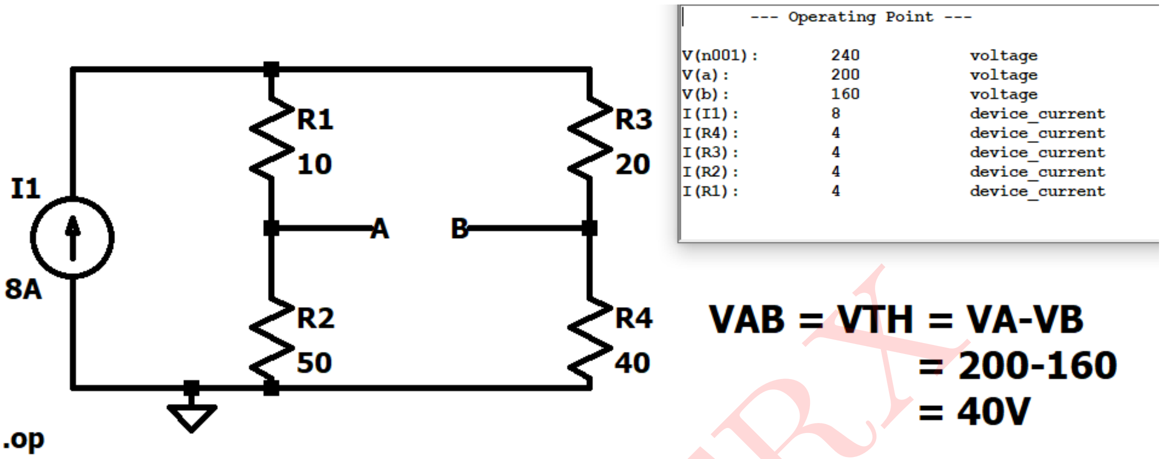

Figure 48: Circuit Schematic and Simulated Results for V_{th}

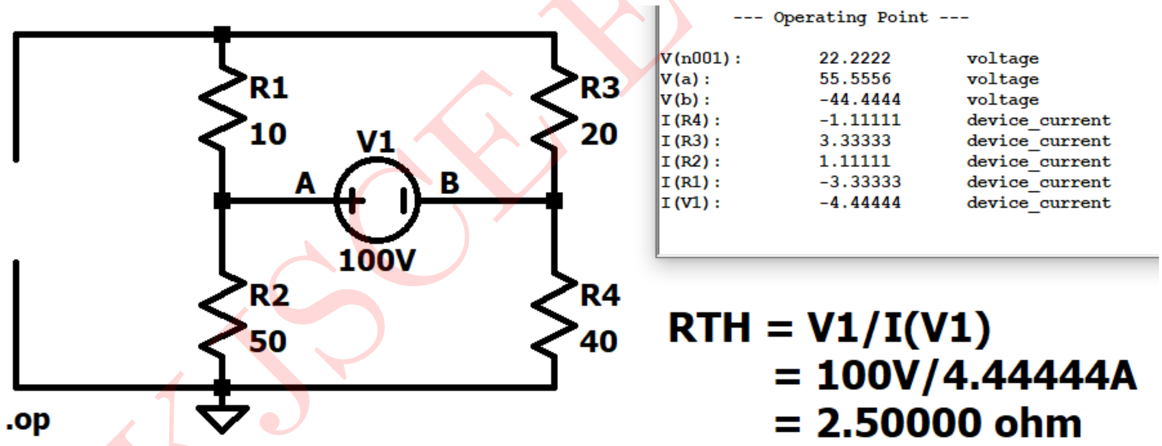

Figure 49: Circuit Schematic and Simulated Results for R_{th}

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_{th}	40V	40V
R_{th}	22.5Ω	22.500Ω

Table 10: Numerical 8 Thevenin's theorem

Numerical 9: For the circuit in figure 50, find the Norton's equivalent circuit at terminals A-B.

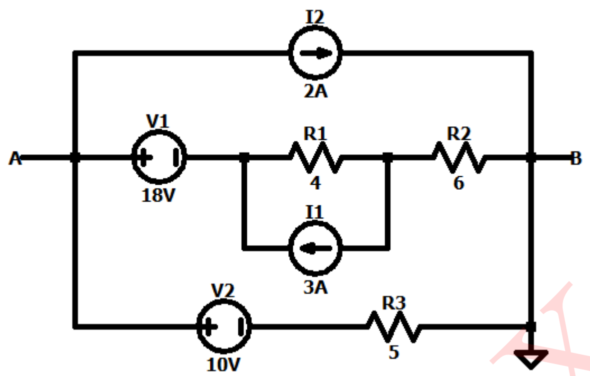

Figure 50: Circuit 10

Solution:

Step 1: Calculation of I_{sc}

Short Circuit AB to find I_{sc}

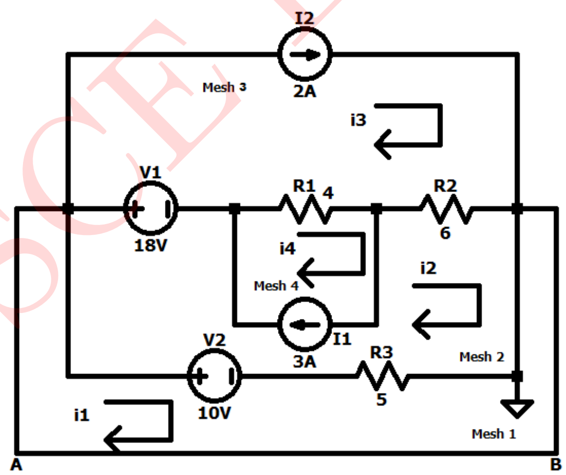

Figure 51: Finding I_{sc}

From figure 51,

$i_3 = 2\text{A}$ —(i)

$i_4 - i_3 = 3\text{A}$ —(ii)

Applying KVL in Mesh 1,

$-10 - 5(i_1 - i_2) = 0$
$-5i_1 + 5i_2 = 10$ —(iii)

Applying KVL in Supermesh,

$-18 - 4(i_4 - i_3) - 6(i_2 - i_3) - 5(i_2 - i_1) + 10 = 0$
$5i_1 - 11i_2 + 10i_3 - 4i_4 = 10$ —(iv)

Solving (i), (ii), (iii) and (iv),

$i_1 = 3\text{A}$, $i_2 = -1\text{A}$

$I_{sc} = i_1 = 3\text{A}$

$\boldsymbol{I_{sc} = 3\text{A}}$

Step 2: Calculation of R_N

Deactivate all independent sources to find R_N

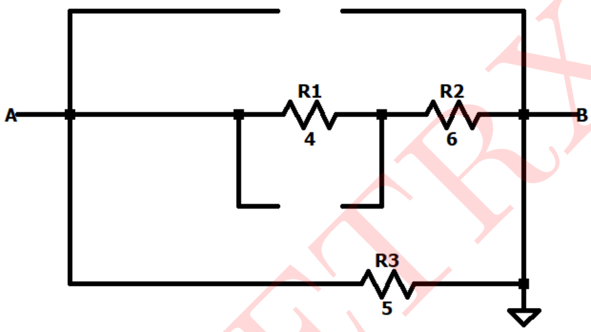

Figure 52: Finding R_N

Equivalent resistance across AB $= R_N = (R_1 + R_2)||R_3$

$= (4+6)||\ 5$

$= 3.3333\Omega$

$\boldsymbol{R_N = 3.3333\Omega}$

Norton's Equivalent Circuit

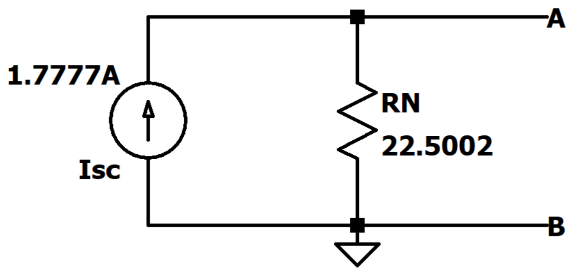

Figure 53: Norton's equivalent circuit

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

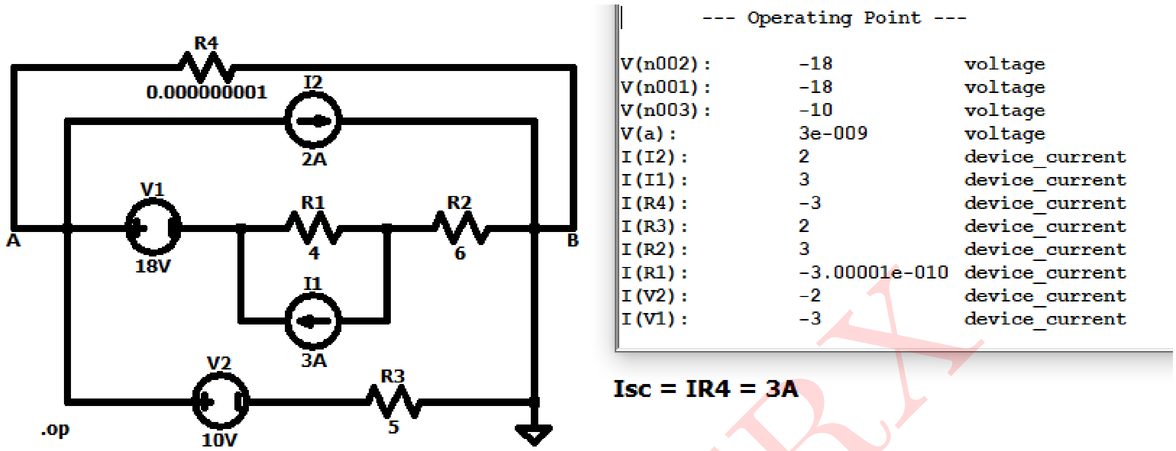

Figure 54: Circuit Schematic and Simulated Results for I_{sc}

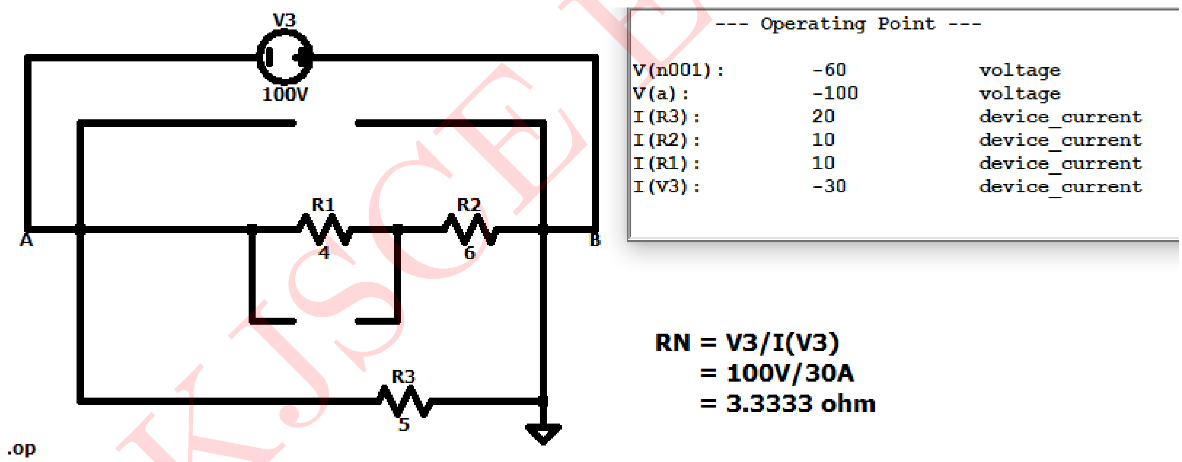

Figure 55: Circuit Schematic and Simulated Results for R_N

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
I_{sc}	3A	3A
R_N	3.33Ω	3.33Ω

Table 11: Numerical 9

Numerical 10: Calculate the value of R_L whcich will absorb maximum power from the circuit in figure 56. Also compute the value of maximum power.

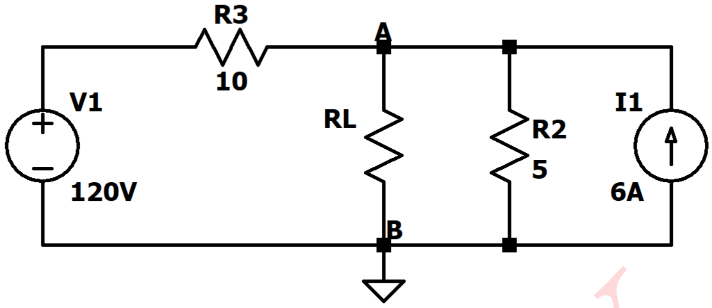

Figure 56: Circuit 11

Solution:

Step 1: Calculation of V_{th}

For finding V_{th} , remove resistor R_L and find voltage across AB.

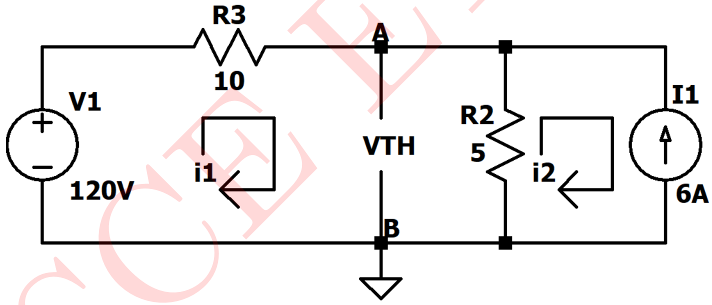

Figure 57: Finding V_{th}

Apply KVL to loop 1,

$120 - 10i_1 - 5(i_1 - i_2) = 0$
$15i_1 - 5i_2 = 120$ —(i)

Apply KVL to loop 2,

$i_2 = -6\text{A}$ —(ii)

From (i) and (ii),

$i_1 = 6\text{A}$

$V_{th} = V_{AB} = 120 - 6{\times}10 - 5(6{-}6) = 60$

V_{th} **= 60V**

Step 2: Calculation of R_{th}

For finding R_{th}, deactivate all the independent sources,

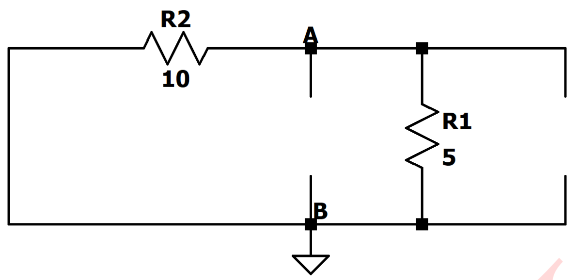

Figure 58: Finding R_{th}

$$\text{Equivalent resistance across AB} = R_{th} = R_1 || \; R_2$$
$$= 5||10$$
$$= 3.333\Omega$$

$\boldsymbol{R_{th} = 3.333\Omega}$

Thevenin's Equivalent Circuit

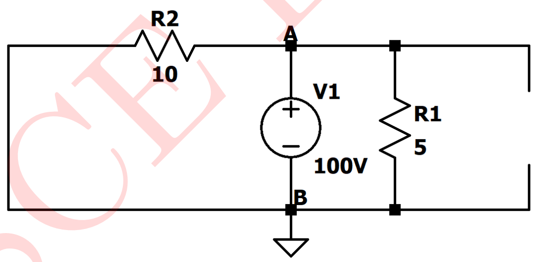

Figure 59: Thevenin's equivalent circuit

For maximum power transfer $R_L = R_{th} = 3.333\Omega$

$\boldsymbol{R_L = 3.333\Omega}$

Maximum power can be calculated as

$$P_{max} = \frac{V_{\text{th}}{}^2}{4R_{\text{th}}}$$
$$= \frac{60^2}{4 \times 3.333}$$
$$= 270.0027\text{W}$$

Maximum Power = 270.0027W

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

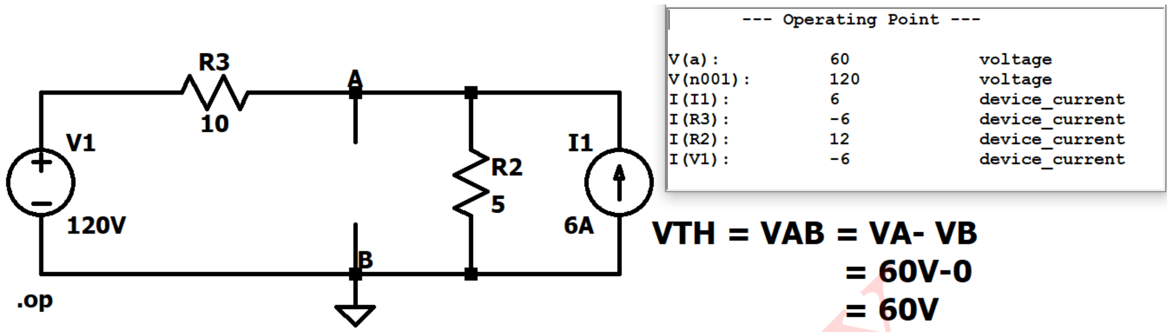

Figure 60: Circuit Schematic and Simulated Results for V_{th}

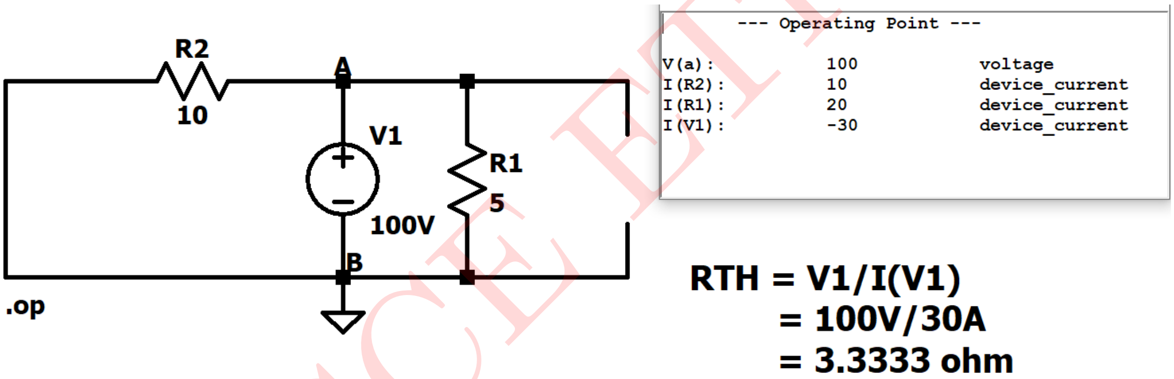

Figure 61: Circuit Schematic and Simulated Results for R_{th}

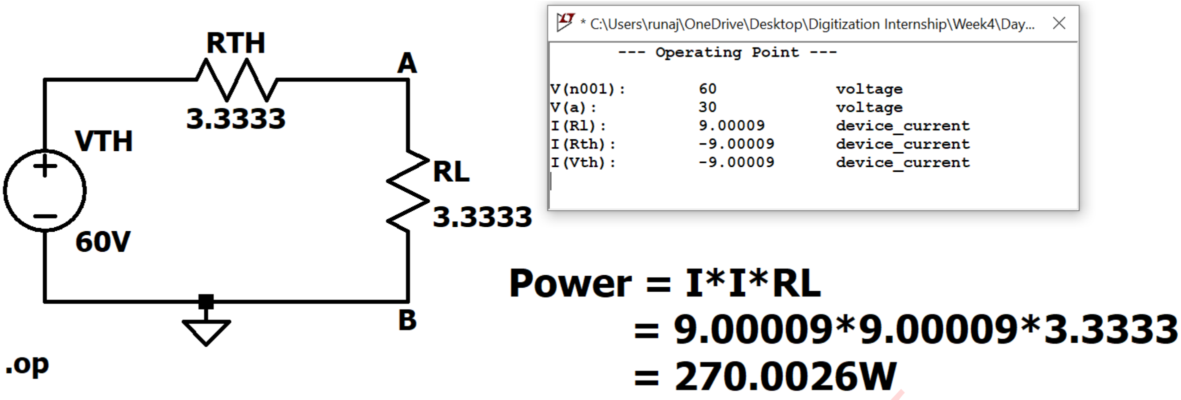

Figure 62: Circuit Schematic and Simulated Results for Maximum Power

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_{th}	60V	60V
R_{th}	3.333Ω	3.333Ω
Maximium Power	270.0027W	270.0026W

Table 12: Numerical 10

Numerical 11: Calculate the value of R_L which will absorb maximum power from the circuit in figure 63. Also compute the value of maximum power.

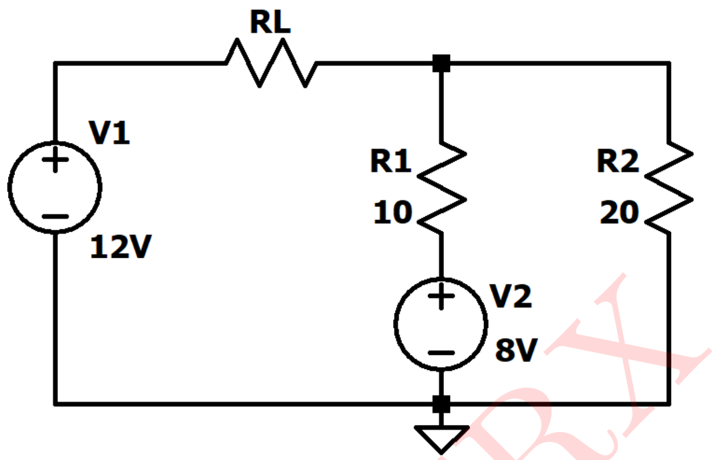

Figure 63: Circuit 12

Solution:

Step 1: Calculation of V_{th}

For finding V_{th} , remove resistor R_L and find voltage across AB.

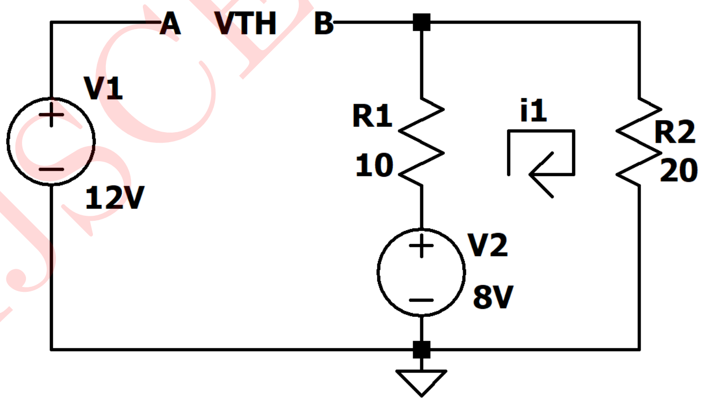

Figure 64: Finding V_{th}

Applying Mesh analysis,

$8 - 10i_1 - 20i_1 = 0$
$i_1 = 0.2667\text{A}$

$$V_{th} = V_{AB} = 12 - 8 + 10 \times i_1$$
$$= 12 - 8 + 10 \times 0.2667$$
$$= 6.6667\text{V}$$

V_{th} = **6.6667V**

Step 2: Calculation of R_{th}

For finding R_{th}, deactivate all the independent sources,

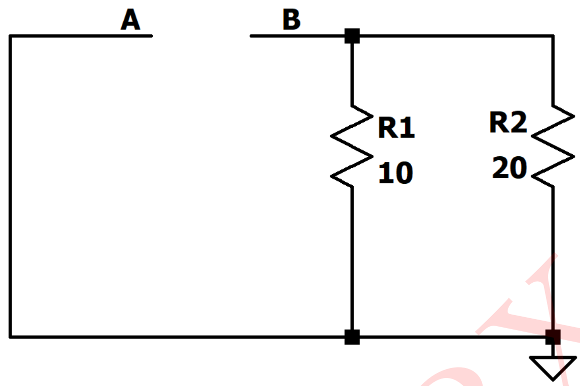

Figure 65: Finding R_{th}

$$\text{Equivalent resistance across AB} = R_{th} = R_1 || R_2$$
$$= 10||20$$
$$= 6.6667\Omega$$

R_{th} = $\mathbf{6.6667\Omega}$

Thevenin's Equivalent Circuit

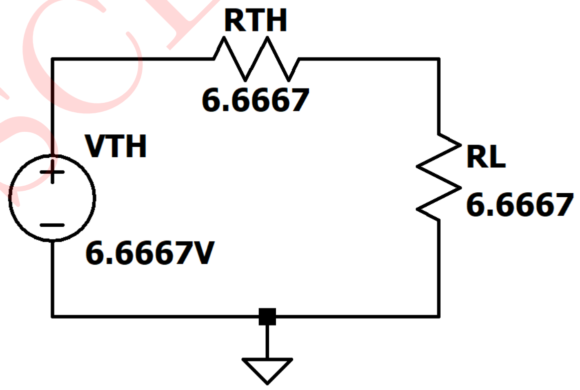

Figure 66: Thevenin's equivalent circuit

For maximum power transfer $R_L = R_{th} = 6.6667\Omega$

R_L = $\mathbf{6.6667\Omega}$

Maximum power can be calculated as

$$P_{max} = \frac{V_{\text{th}}{}^2}{4R_{\text{th}}}$$
$$= \frac{6.6667^2}{4 \times 6.6667}$$
$$= 1.666675\text{W}$$

Maximum Power = 1.666675W

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

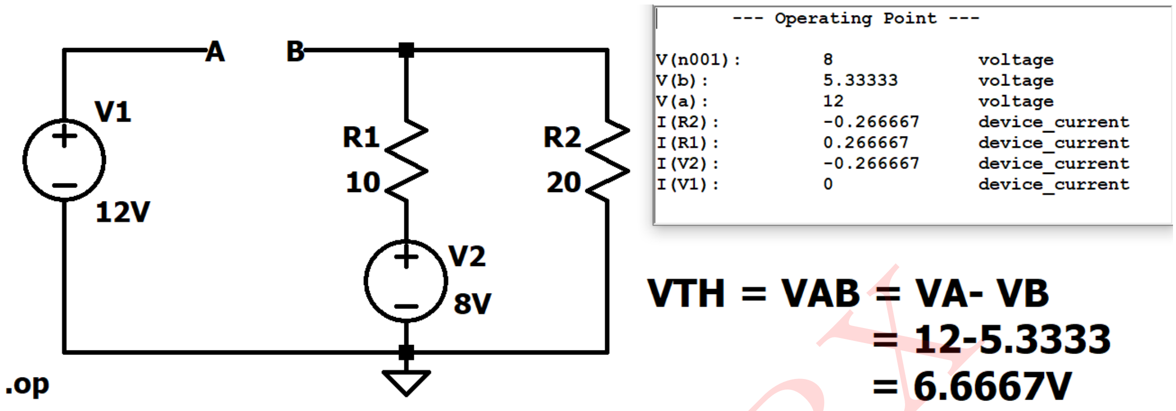

Figure 67: Circuit Schematic and Simulated Results for V_{th}

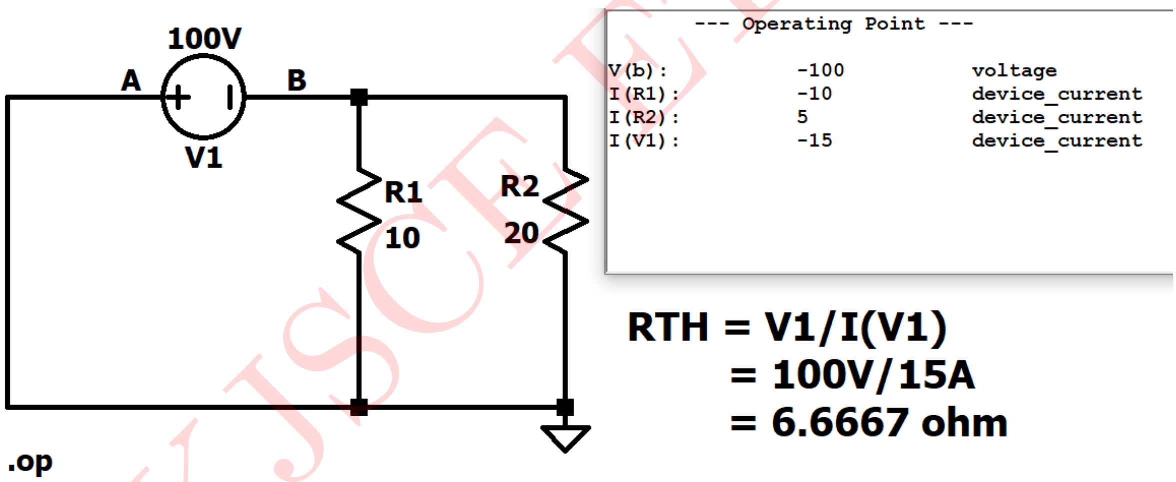

Figure 68: Circuit Schematic and Simulated Results for R_{th}

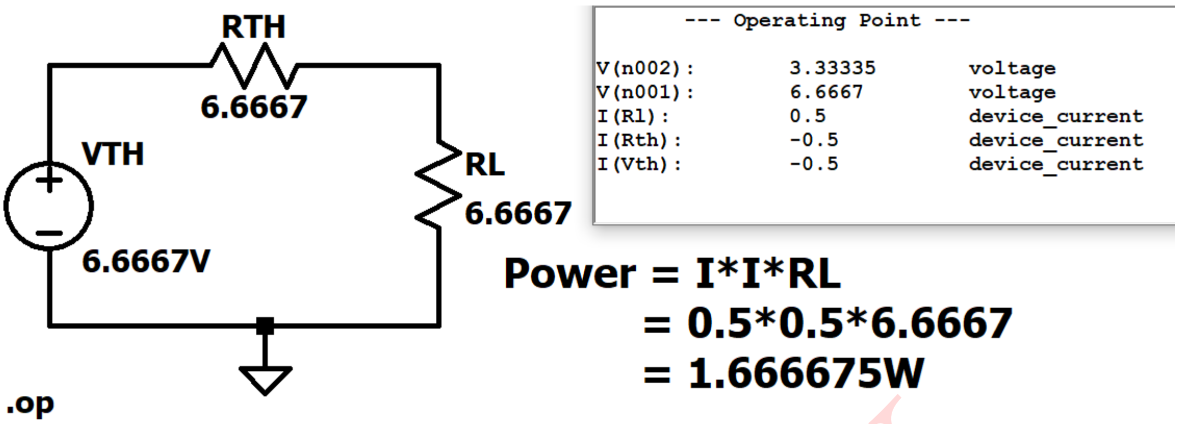

Figure 69: Circuit Schematic and Simulated Results for Maximum Power

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_{th}	6.6667V	6.6667V
R_{th}	6.6667Ω	6.6667Ω
Maximium Power	1.666675W	1.666675W

Table 13: Numerical 11