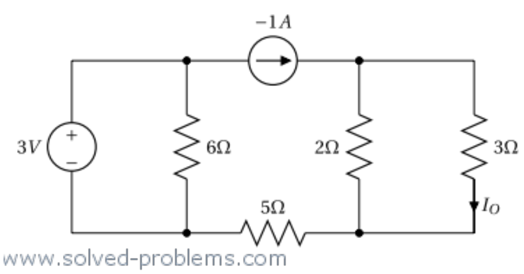
Thévenin's Theorem - Circuit with Two Independent Sources

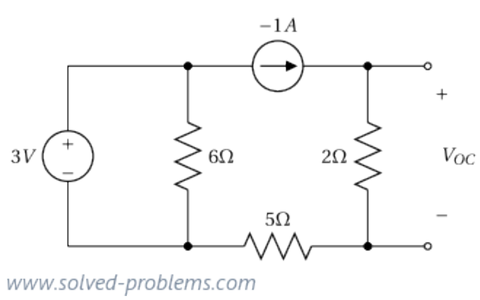
Notes

Use Thévenin's theorem to determine I_O.

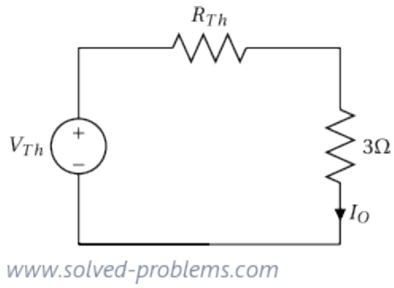


Solution

Lets break the circuit at the 3Ω load as shown in Fig. (1-27-2).

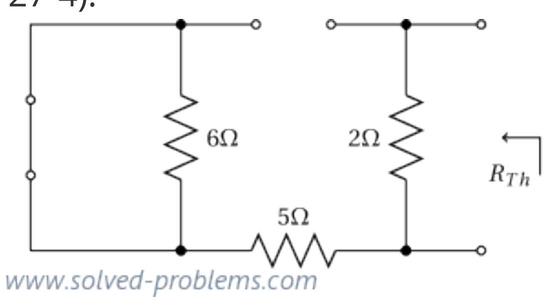


Now, we should find an equivalent circuit that contains only an independent voltage source in series with a resistor, as shown in Fig. (1-27-3).



Unknowns are V_{Th} and R_{Th}. V_{Th} is the open circuit voltage V_{OC} shown in Fig. (1-27-2).
It is trivial that the current of 2Ω resistor is equal to the current of the current source, i.e. $I_{2\Omega} = -1A$. Therefore, $V_{OC} = V_{2\Omega} = 2\Omega \times I_{2\Omega} = -2V$. The Thévenin theorem says that $V_{Th} = V_{OC} = -2V$. Please note that it is not saying that V_{OC} is the voltage across the load in the original circuit (Fig. (1-27-1)).

To find the other unknown, R_{Th}, we turn off independent sources and find the equivalent resistance seen from the port, as this is an easy way to find R_{Th} for circuits without dependent sources. Recall that in turning independent sources off, voltage sources should be replace with short circuits and current sources with open circuits. By turning sources off, we reach at the circuit shown in Fig. (1-27-4).



The 6Ω resistor is short circuited and the 5Ω one is open. Therefore, their currents are zero and

$R_{Th} = 2\Omega.$

Now that we have found V_{Th} and R_{Th}, we can calculate I_O in the original circuit shown in Fig. (1-27-1) using the Thévenin equivalent circuit depicted in Fig. (1-27-3). It is trivial that

$$I_O = \frac{V_{th}}{R_{Th}+3\Omega} = \frac{-2V}{2\Omega+3\Omega} = -\frac{2}{5}A.$$

We used the Thévenin Theorem to solve this circuit. A much more easier way to find I_O here is to use the current devision rule. The current of the current source is divided between 2Ω and 3Ω resistors. Therefore,

$$I_O = \frac{2\Omega}{2\Omega+3\Omega} \times (-1A) = -\frac{2}{5}A$$

Now, replace the current source with a $-1V$ voltage source as shown below and solve the problem. The answers are $V_{th} = \frac{4}{7}V$, $R_{th} = \frac{10}{7}\Omega$ and $I_O = \frac{4}{31}A$. Please let me know how it goes and leave me a comment if you need help 🙂