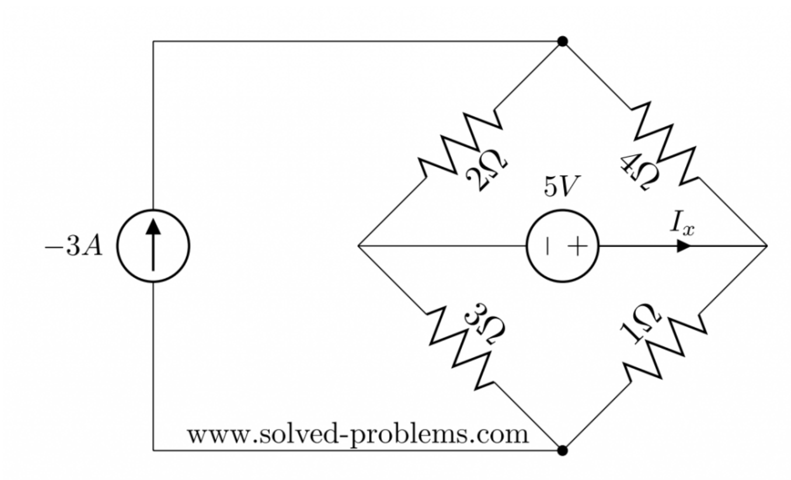
Superposition method - Circuit with two sources

Notes

Find I_x using superposition rule:



Solution

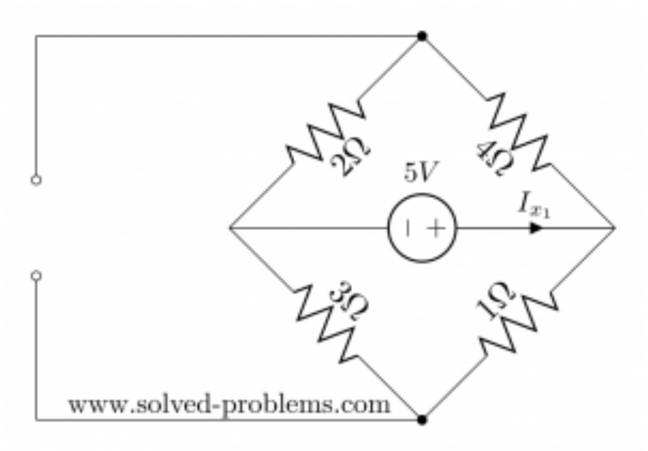
Superposition

The superposition theorem states that the response (voltage or current) in any branch of a linear circuit which has more than one independent source equals the algebraic sum of the responses caused by each independent source acting alone, while all other independent sources are turned off (made zero).

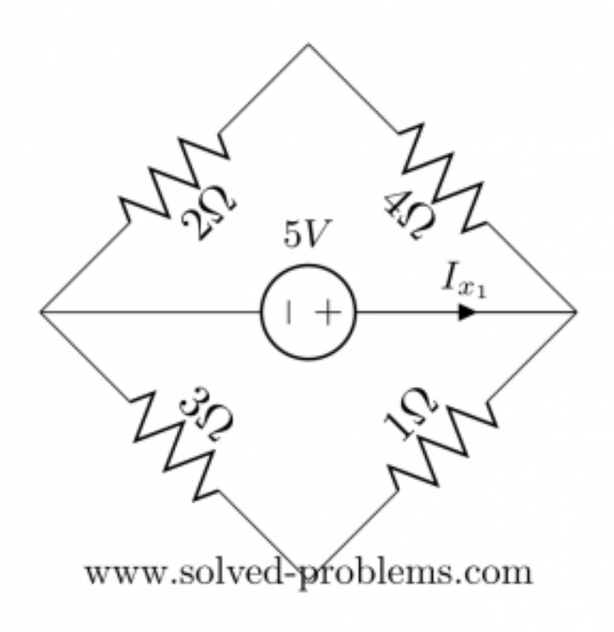
There are two sources, so we need to turn them off one by one and calculate associated I_x values.

Two announcements before we start! First, a PDF sheet of this problem with the solution and side space for notes can be downloaded below. Second, you may watch solving this problem on the video posted below. My suggestion is that you print the solution sheet and make notes on it while watching the video. Please subscribe to my YouTube channel for more videos!

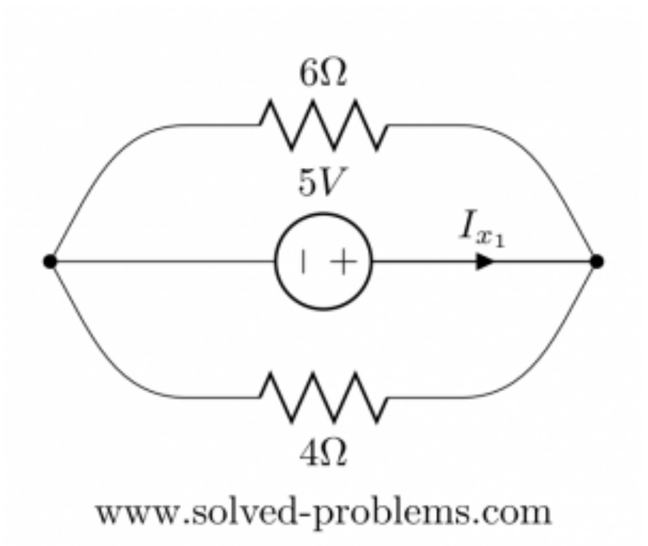
Let's start with the current source. To turn a current source off we need to replace it with an open circuit. Easiest way to remember this is that to turn off a source we must make its value zero and for a current source we need to make its current zero. Zero current means no way for current to pass and that is possible with an open circuit.



Or simply

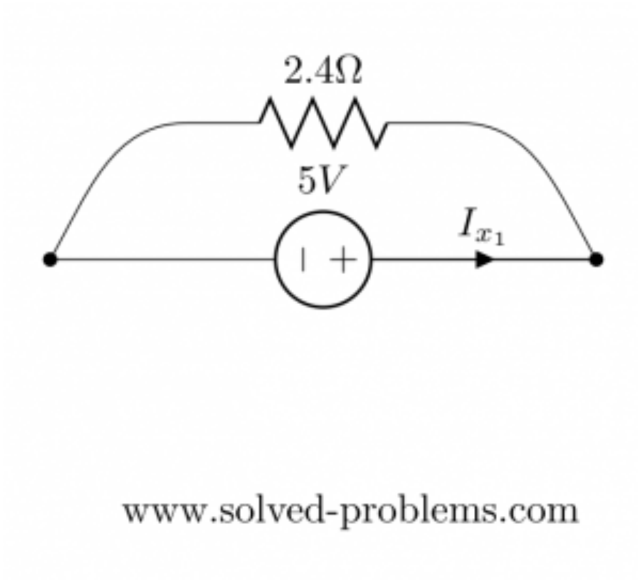


4Ω and 2Ω are in series and also 3Ω and 1Ω:



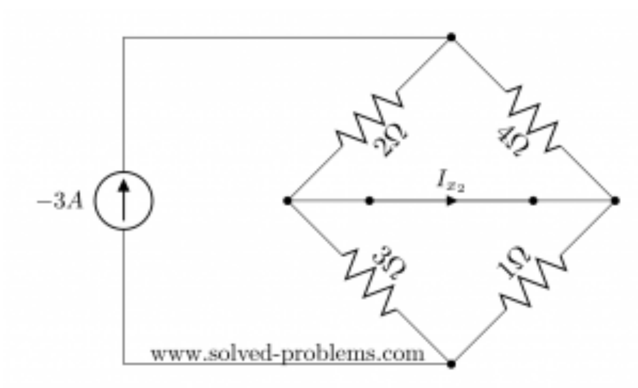
Now 4Ω and 6Ω are parallel:

$4\Omega||6\Omega = \frac{4\times6}{4+6} = 2.4\Omega$

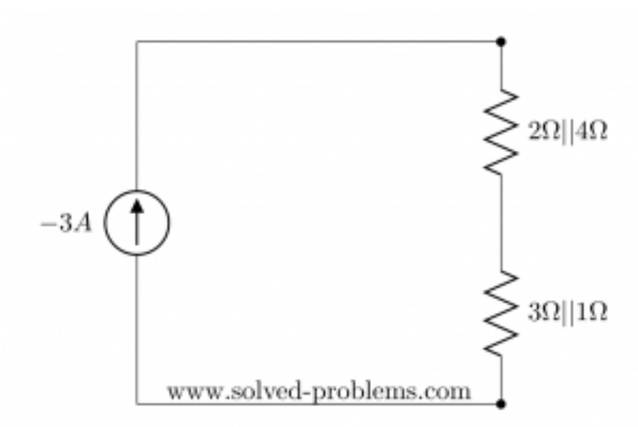


So using Ohm's law:
$I_{x_1} = \frac{5V}{2.4\Omega} = 2.083A$

To continue solving the circuit with the Superposition method, we should make the voltage source zero and find the contribution of the current source on I_x. Making voltage source means replacing it with a short circuit. Similar to the current source, you may memorize this by remembering that you need to make the source value (here: voltage) equal to zero and to force zero voltage drop between two points you need to connect them.

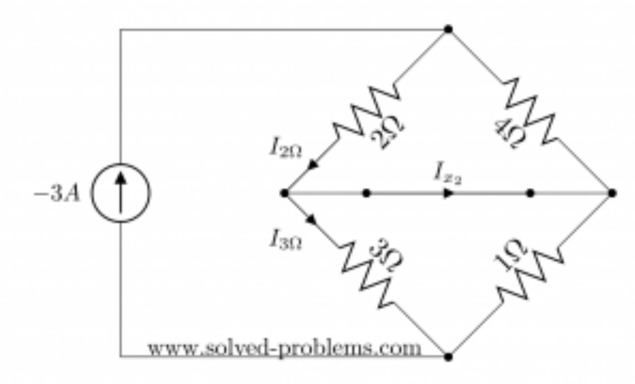


For a moment forget I_x and concentrate on finding current of resistors. If we have the current of resistors, we can easily apply KCL and find I_{x_2}. So, 4Ω and 2Ω are parallel and also 3Ω and 1Ω are parallel:



$4\Omega||2\Omega = \frac{4\times2}{4+2} = \frac{4}{3}\Omega$
$3\Omega||1\Omega = \frac{3\times1}{3+1} = \frac{3}{4}\Omega$

Now, we can find their voltage drops:
$V_{4\Omega||2\Omega} = \frac{4}{3} \times -3A = -4V$
$V_{3\Omega||1\Omega} = \frac{3}{4} \times -3A = -2.25V$
Please note that the voltage drop on $4\Omega||2\Omega$ is the same as 4Ω and 2Ω voltage drops, because the circuits are equivalent and all are connected to the same nodes. The same statement is correct for $3\Omega||1\Omega$ voltage drop and 3Ω and 1Ω voltage drops. So
$V_{4\Omega} = V_{2\Omega} = V_{4\Omega||2\Omega} = -4V$
$V_{3\Omega} = V_{1\Omega} = V_{3\Omega||1\Omega} = -2.25V$
To find I_{x_2} all we need is to write KCL at one of the nodes:



$-I_{2\Omega} + I_{x_2} + I_{3\Omega} = 0$
$\rightarrow I_{x_2} = I_{2\Omega} - I_{3\Omega}$

$I_{2\Omega}$ and $I_{3\Omega}$ can be found using Ohm's law:
$I_{2\Omega} = \frac{V_{2\Omega}}{2\Omega} = \frac{-4}{2} = -2A$
$I_{3\Omega} = \frac{V_{3\Omega}}{3\Omega} = \frac{-2.25}{3} = -0.75A$
Therefore,
$I_{x_2} = -1.25A$
And
$I_x = I_{x_1} + I_{x_2} = 2.083 - 1.25 = 0.8333A$
Now, replace 1Ω resistor with a 6Ω one and solve the circuit using superposition method. Let me now your answer below in the comments section.

Solution sheet

Superposition-method-Circuit-with-two-sources-Solved-Problems Download