task_erlctd760zmvox0t_with_calculation

Student Group

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[network simplification](), [exam ee1 SS2023]()

Exercise E2 Pure Resistor Network Simplification I
(written test, approx. 14 % of a 60-minute written test, SS2023)

Now the input voltage shall be given as $U_{\rm AB} = 60 ~\rm V$. What is the value for U in the circuit?

Solution

The current through the circuit is given as $I_{\rm AB} = U_{\rm AB} \cdot R_{\rm eq}$.
This current has to flow in summary through parallel branches. The voltage U in question in the upper right branch given by $(4R\|4R)+2R+2R$. Its resistance is just the same as the upper left branch $6R$.
Therefore, half of the current flows to the left half to the right side.
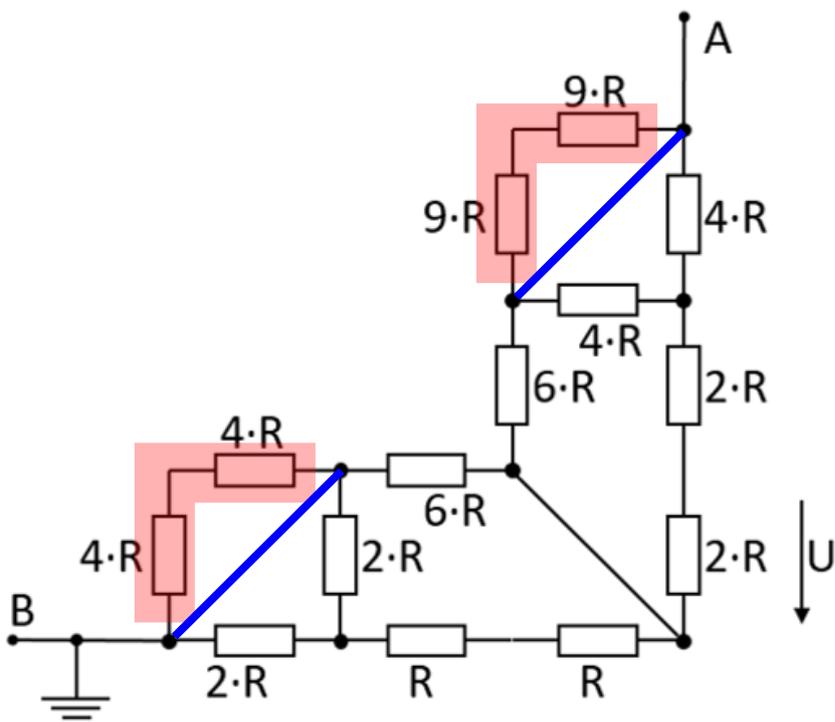The voltage U is consequently: \begin{align*} U &= {{I_{\rm AB} }\over{ 2\cdot R_{\rm eq} }} \\ &= {{U_{\rm AB} \cdot 2R }\over{ 2\cdot R_{\rm eq} }} \\ &= {{60 ~\rm V }\over{ 5 }} \end{align*}
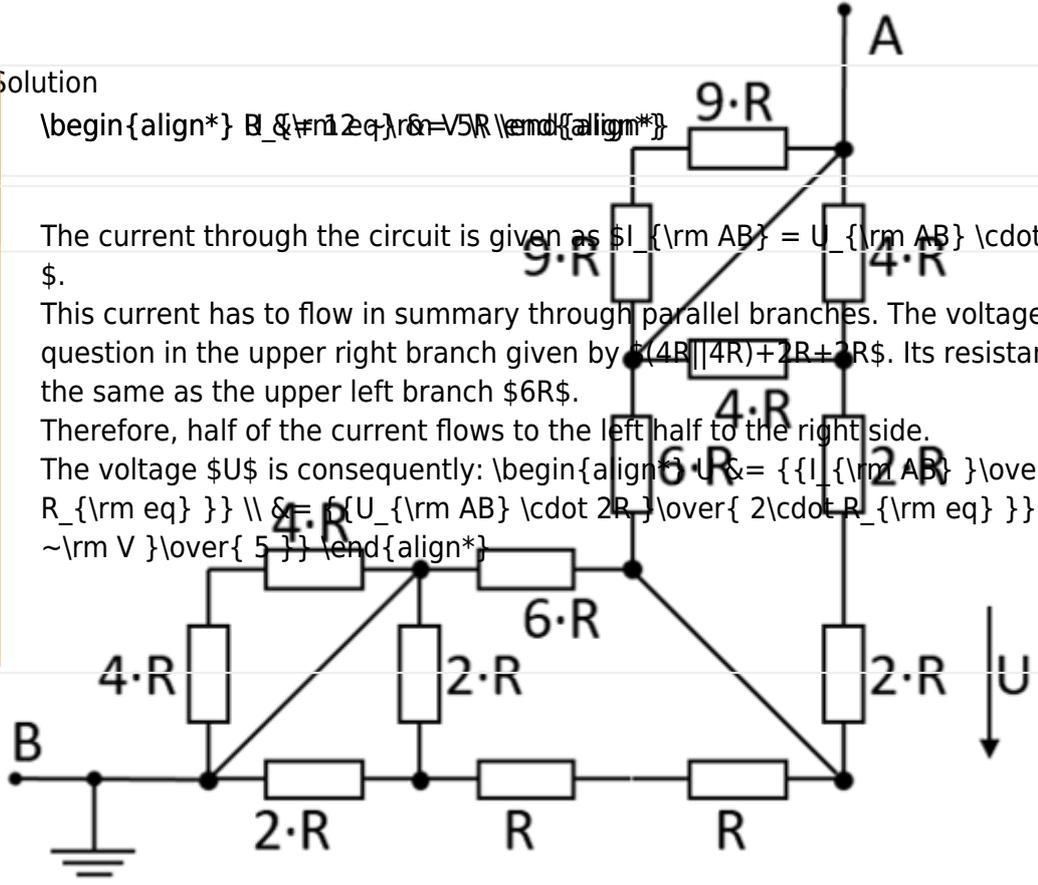
1. What is the equivalent resistance $R_{\rm eq}$?

Solution

Part of the circuit is shorted. Here the resistors (marked in red) are shorted by the connections marked in blue:

The circuit can then be rearranged for better interpretation:

Therefore, $R_{\rm eq}$ is given as: \begin{align*} R_{\rm eq} &= (2R||2R + R +

R)||6R &&+ 6R ||(2R + 2R + 4R||4R) \\ &= (R + R + R)||6R &&+ 6R ||(2R + 2R + 2R) \\ &= 3R||6R &&+ 6R ||6R \\ &= {{3R\cdot 6R}\over{3R+6R}} &&+3R \\ \end{align*}