task_cgeyprm6oboukcci_with_calculation

Student Group

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Table of Contents

network simplification, exam ee1 SS2023

Exercise E1 Pure Resistor Network Simplification
(written test, approx. 12 % of a 60-minute written test, SS2023)

1. Calculate the voltage at node $\rm K$, when switch $\rm S$ is closed.
2. Calculate the voltage at node $\rm K$, when switch $\rm S$ is open.
It might be beneficial to redraw the circuit first.

Result

The values in the circuit are

- $R_1 = 60 ~\Omega$
- $R_2 = 40 ~\Omega$
- $R_3 = 40 ~\Omega$
- $R_4 = 100 ~\Omega$
- $U_{\rm AB} = 10 ~\rm V$

Solution

When switch $\rm S$ is closed, the equivalent resistance is $R_{\rm eq} = 150 ~\Omega$ in the circuit with closed switch. \begin{align*}
R_{\rm eq} &= 150 ~\Omega \end{align*}

The voltage divider for node $\rm K$ has the same proportionality as the voltage divider for node $\rm K'$. Therefore, the potential of $\rm K$ is the same as for $\rm K'$. There will be no current flow through R_3. The resistance does not create a voltage drop and therefore does not interfere with the circuit.

1. Calculate the voltage at node $\rm K$, when switch $\rm S$ is open.
It might be beneficial to redraw the circuit first.

Solution

Rearranging the circuit one can get:

Once the switch $\rm S$ is opened, the upper part is a parallel circuit. Therefore, $R_{\rm eq}$ is given as: \begin{align*} R_{\rm eq} &= (R_1+R_2)||(R_1+R_2)+R_4 \\ &= {{1}\over{2}}\cdot(R_1+R_2)+R_4 \\ &= {{1}\over{2}}\cdot(60~\Omega + 40~\Omega) + 100~\Omega \\ \end{align*}