

task_x357drkaqv84jnc_with_calculation

Student Group

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Exercise 1 : Pure Resistor Network Simplification

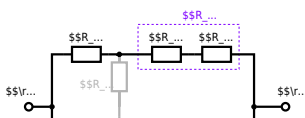
(written test, approx. 13 % of a 60-minute written test, WS2022)

The following circuit with $R_1=200\ \Omega$, $R_2=R_3=100\ \Omega$ and the switch S is given.

1. The switch shall now be open. Calculate the equivalent resistance R_{eq} between A and B .

Solution

With the switch open the resistor R_3 does not take part into the resulting resistor.



The equivalent resistor is given by a parallel configuration of resistors in series:

$$\begin{aligned} R_{eq} &= (R_2 + R_1 + R_1) \parallel (R_2 + R_2) \\ R_{eq} &= (100 \, \Omega + 200 \, \Omega + 200 \, \Omega) \parallel (100 \, \Omega + 100 \, \Omega) \\ R_{eq} &= (500 \, \Omega) \parallel (200 \, \Omega) \\ R_{eq} &= \frac{500 \, \Omega \cdot 200 \, \Omega}{500 \, \Omega + 200 \, \Omega} \end{aligned}$$

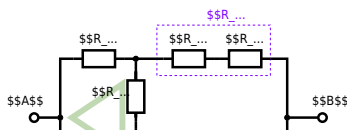
Final result

$$R_{eq} = 142.8 \, \Omega$$

2. The switch shall now be closed. Calculate the equivalent resistance R_{eq} between A and B.

Solution

Now a wye-delta transformation is necessary.



Since $R_2 = R_3$ and based on the equations for the transformation, the transformed R_Y is given as:
$$R_Y = \frac{R_2 \cdot R_2}{R_2 + R_2 + R_2} = \frac{(100 \, \Omega)^2}{3 \cdot 100 \, \Omega} = \frac{1}{3} \cdot 100 \, \Omega = 33.33 \, \Omega$$

The equivalent resistor is given by a parallel configuration of resistors in series:
$$R_{eq} = R_Y + (R_Y + R_1 + R_1) \parallel (R_Y + R_2) \parallel R_{eq} = 33.33 \, \Omega + (33.33 \, \Omega + 400 \, \Omega) \parallel (33.33 \, \Omega + 100 \, \Omega) \parallel$$

Final result

$$R_{eq} = 135.3 \, \Omega$$

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