

# task\_x357drkaqv84jnsc\_with\_calculation

## Student Group

First Name	Surname	Matrikel Nr.

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exam ee1 WS2022

## Exercise 1.1 : Pure Resistor Network Simplification

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

The following circuit with  $R_1=200 \text{ }\Omega$ ,  $R_2=R_3=100 \text{ }\Omega$  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:

$$R_{eq} = (R_2 + R_1 + R_1) \parallel (R_2 + R_2) \parallel R_{eq} = (100 \Omega + 200 \Omega + 200 \Omega) \parallel (100 \Omega + 100 \Omega) \parallel R_{eq} = (500 \Omega) \parallel (200 \Omega) \parallel R_{eq} = \frac{\{500 \Omega \cdot 200 \Omega\}}{500 \Omega + 200 \Omega}$$

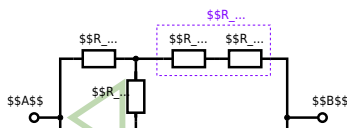
Final result

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

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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