

# task\_p8yrdjr60k6bvc4n\_with\_calculation

## Student Group

First Name	Surname	Matrikel Nr.

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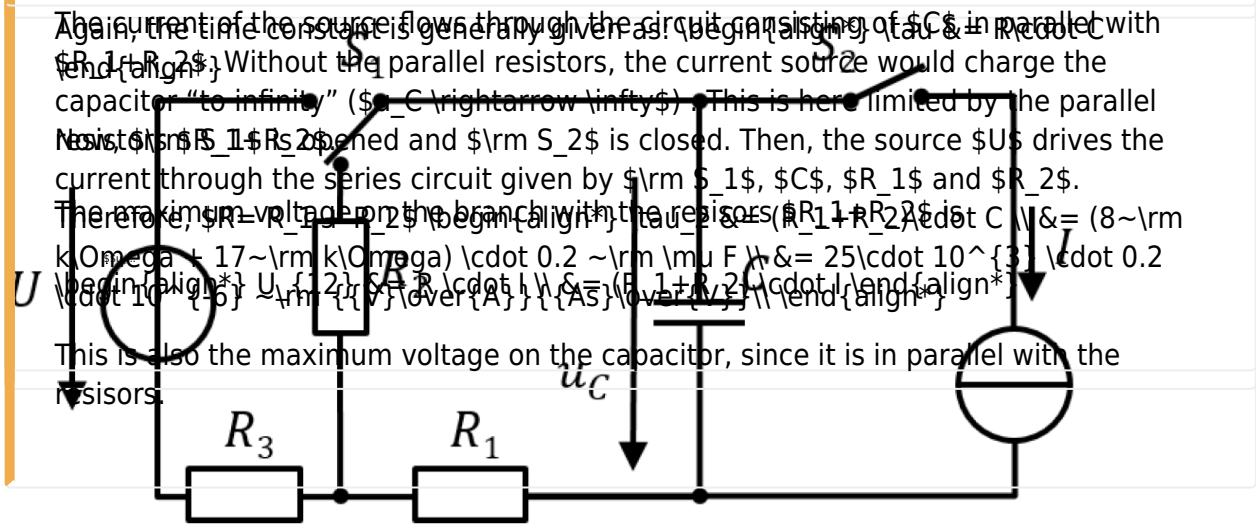
charging, capacities, exam ee1 SS2023

**Exercise E7 (Dis)Charging Capacities  
(written test, approx. 14 % of a 60-minute written test, SS2023)**

The circuit below is initially closed with both switches  $S_1$  and  $S_2$  in the position shown. At  $t = 0$  s, switch  $S_1$  switches to the situation shown in the drawing. What is the time constant  $\tau$ ?

- $C = 200 \text{ nF}$

**Solution:**  
 $R = 8.0 \text{ k}\Omega$   
 $\tau = R \cdot C = 8.0 \text{ k}\Omega \cdot 200 \text{ nF} = 1.6 \text{ ms}$



Before  $t = 0$  s all switches are switched as shown and the capacitor is fully discharged. At  $t = 0$  s the switch  $S_1$  shall switch to the voltage source.

1. Calculate the time constant for charging the capacitor.

Solution

The time constant is generally given as:  $\tau = R \cdot C$

Once  $S_1$  is closed and  $S_2$  is open at  $t = 0$  s, the source  $U$  drives the current through the series circuit given by  $S_1$ ,  $C$ ,  $R_1$  and  $R_3$ .  
 Therefore,  $R = R_1 + R_3$   
 $\tau = (R_1 + R_3) \cdot C = (8 \text{ k}\Omega + 7 \text{ k}\Omega) \cdot 0.2 \text{ }\mu\text{F} = 15 \cdot 10^3 \cdot 0.2 \cdot 10^{-6} \text{ s} = 3 \text{ ms}$

Both courses of the voltage for charging and discharging are described with an exponential function. However, the curve for charging increases first steep and flattens out for longer time scales ( $\propto (1 - e^{-x})$ ).

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Last update: **2023/08/17 06:45**

