

task_p8yrdjr60k6bvc4n_with_calculation

Student Group

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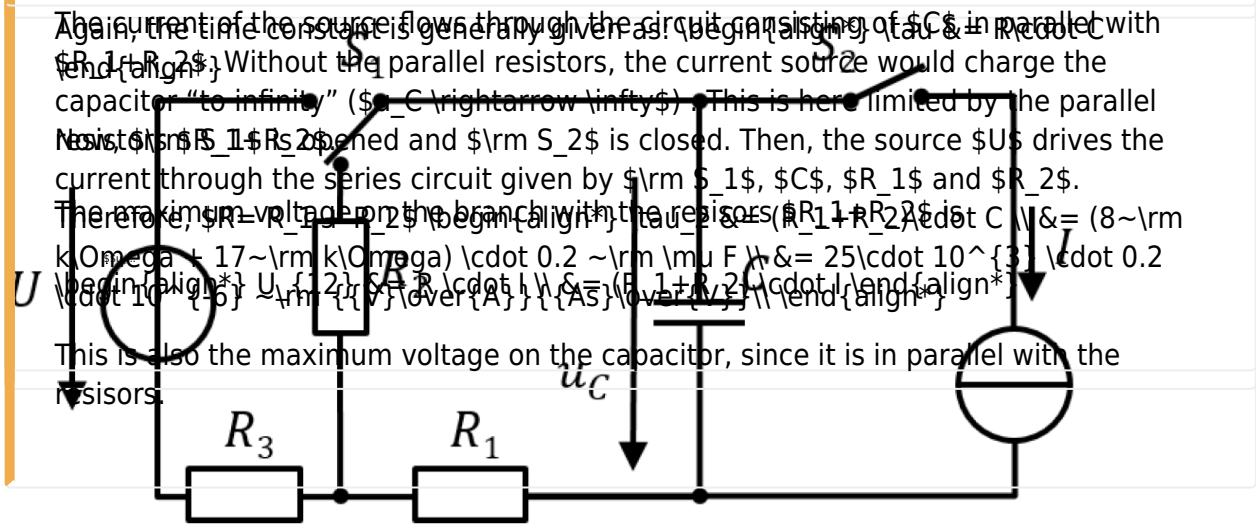
charging, capacities, exam ee1 SS2023

**Exercise E4 (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 τ ?

- $C = 200 \text{ nF}$

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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