# task_tb6pi8dgh0m2e2pw_with_calculation

## Student Group

| First Name | Surname | Matrikel Nr. |
|---|---|---|
| | | |
| | | |
| | | |

## Table of Contents

Charging Capacitors, dc network analysis, pure resistor network simplification, delta wye transformation, exam ee1 WS2022

**Exercise E1 Charging Capacitors**
**(written test, approx. 16 % of a 60-minute written test, WS2022)**

[illegible] the switch $S_2$ is closed [illegible] voltage across the capacitor is again $0 ~\rm{V}$ at the moment $t_0=0 ~\rm{s}$ when the switch $S_1$ is closed. Calculate the voltage $u_c (t_2)$ across the capacitor at $t_2=1 ~\rm{ms}$ after closing the switch.

Hint: To solve this, first create an equivalent linear voltage source from $U$, $R_1$, and $R_B$.

Result

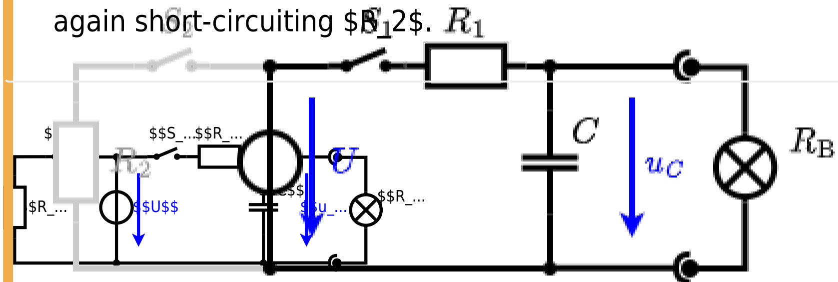
\begin{align*} [illegible] = 3.792 ~\rm{V} [illegible] \end{align*}

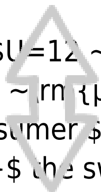
Solution

\begin{align*} \Delta W_C &= {{1}\over{2}} \cdot C \cdot U^2 \\ &= {{1}\over{2}} \cdot 100 ~\rm{µF} \cdot (12 ~\rm{V})^2 \end{align*}

[illegible] independent of this resistor.

On an alternative view, one can try to create an equivalent linear voltage source again. Then, the internal resistance is given by substituting the ideal voltage source is again short-circuiting $R_2$.

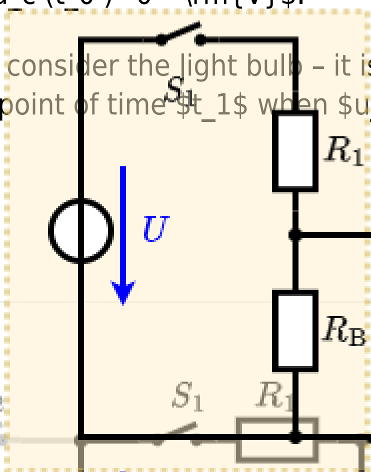


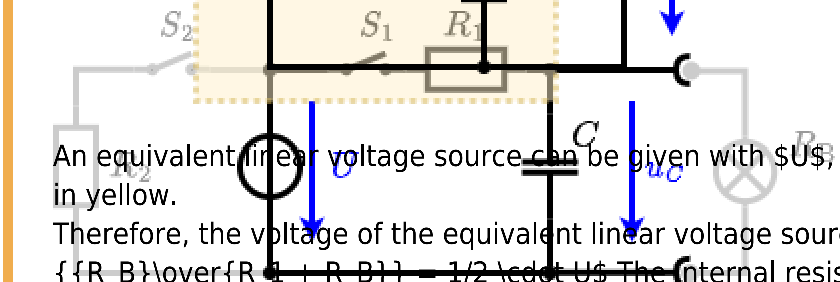



The circuit contains a voltage source $U=12 ~\rm{V}$, a switch $S_1$, a resistor of $R_1=20 ~\Omega$ and a capacitor of $C=100 ~\rm{µF}$.
The switch $S_2$ to an additional consumer $R_2$ will be considered to be open for the first tasks. At the moment $t_0=0 ~\rm{s}$ the switch $S_1$ is closed, the voltage across the capacitor is $u_c (t_0 )=0 ~\rm{V}$.

1. First do not consider the light bulb – it is not connected to the RC circuit.
Calculate the point of time $t_1$ when $u_c (t_1)=0.5\cdot U$.

Solution



An equivalent linear voltage source can be given with $U$, $R_1$, and $R_B$ as seen in yellow.
Therefore, the voltage of the equivalent linear voltage source is: $U_s = U \cdot {{R_B}\over{R_1 + R_B}} = 1/2 \cdot U$ The internal resistance is given by substituting the ideal voltage source with its resistance ($=0 ~\Omega$, short-circuit).

So, here only R_1 and C give the time constant: $\tau = R_1 \cdot C$

\begin{align*} R_i &= R_1 || R_B \\ &= 10~\Omega \end{align*}

The following formula describes the time course of $u_C(t)$, which has to be $u_C (t_1)=0.5\cdot U_s$: \begin{align*} u_C(t) = U_s \cdot (1- e^{t/\tau}) = 0.5 \cdot U_s \end{align*}

\begin{align*} u_{C2}(t) &= U_s \cdot (1- e^{-t/(R_i \cdot C)}) \\ &= {{1}\over{2}} \cdot U_0 \cdot (1- e^{-t/(10~\Omega \cdot 100~\mu F)}) \end{align*}

\end{align*} It has to be rearranged to $t$ \begin{align*} (1- e^{t/\tau}) &= 0.5 \\ e^{t/\tau} &= 0.5 \\ t/\tau &= ln(0.5) \\ t &= \tau \cdot ln(0.5) \\ t &= R_1 \cdot C \cdot ln(0.5) \end{align*}