

# task\_tb6pi8dgh0m2e2pw\_with\_calculation

## Student Group

First Name	Surname	Matrikel Nr.

## Table of Contents

Exercise E1 Charging Capacitors (written test, approx. 16 % of a 60-minute written test, WS2022) .....	2
--	---

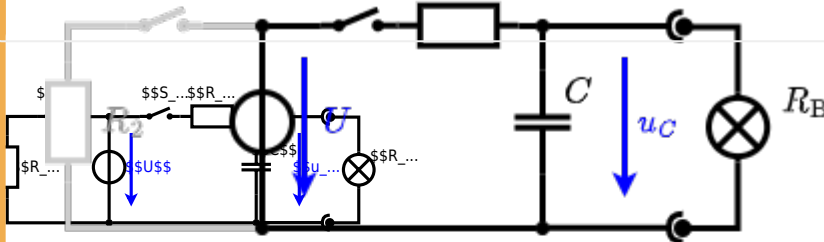
Charging Capacitors, dc network analysis, pure resistor network simplification, delta wye transformation, exam ee1 WS2022

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

The circuit (with the real solution) is in the picture of the RC circuit. The capacitor is initially uncharged. At the moment  $t_0 = 0 \text{ s}$  when the switch  $S_1$  is closed. Calculate the voltage  $u_c(t_2)$  across the capacitor at  $t_2 = 1 \text{ ms}$  after closing the switch.

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

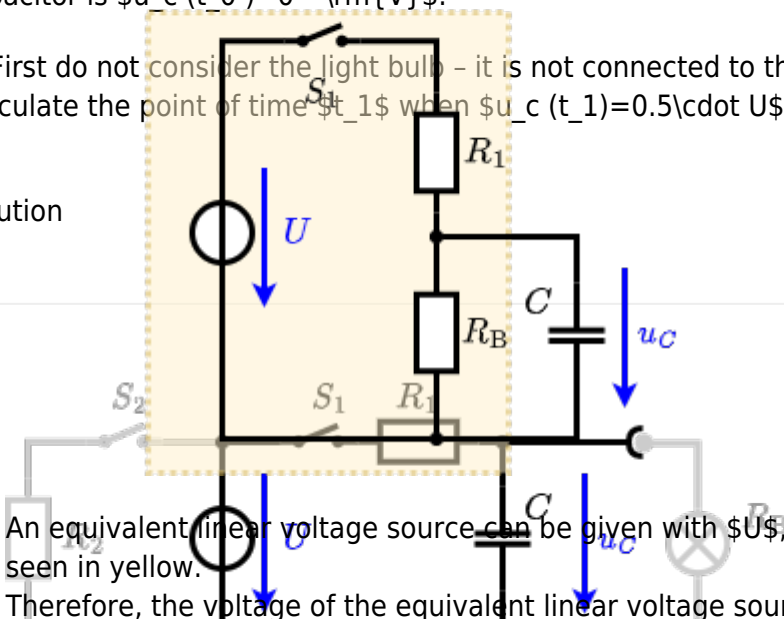
The equivalent circuit is shown in the picture. The voltage source is  $U_s = U \cdot \frac{R_B}{R_1 + R_B} = 12 \text{ V} \cdot \frac{10 \Omega}{20 \Omega + 10 \Omega} = 4 \text{ V}$ . The internal resistance is  $R_{int} = R_1 \parallel R_B = 20 \Omega \parallel 10 \Omega = 6.67 \Omega$ . On an alternative 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  $U = 12 \text{ V}$ , a switch  $S_1$ , a resistor of  $R_1 = 20 \Omega$  and a capacitor of  $C = 100 \mu\text{F}$ . The switch  $S_2$  to an additional consumer  $R_2$  will be considered to be open for the first asks. At the moment  $t_0 = 0 \text{ s}$  the switch  $S_1$  is closed, the voltage across the capacitor is  $u_c(t_0) = 0 \text{ V}$ .

... 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  $U_s$ ,  $R_1$ , and  $R_B$  as seen in yellow.

Therefore, the voltage of the equivalent linear voltage source is:  $U_s = U \cdot \frac{R_B}{R_1 + R_B} = 1/2 \cdot U$ . The internal resistance is given by substituting the ideal voltage source with its resistance ( $R_{int} = R_1 \parallel R_B = 6.67 \Omega$ , short-circuit).

$\begin{aligned} R_1 &= R_2 \\ \tau &= R_1 C \end{aligned}$

The following formula describes the current  $i(t)$  in a circuit with a resistor  $R$  and a capacitor  $C$  in series. It has to be rearranged to  $(1 - e^{-t/\tau}) = 0.5$   $\Rightarrow t/\tau = \ln(0.5)$   $\Rightarrow t = \tau \cdot \ln(0.5)$   $\Rightarrow t = R_1 \cdot C \cdot \ln(0.5)$

From: <https://mexle.te.hs-heilbronn.de/> - MEXLE Wiki

Permanent link: [https://mexle.te.hs-heilbronn.de/electrical\\_engineering\\_1/task\\_tb6pi8dgh0m2e2pw\\_with\\_calculation?rev=1680388598](https://mexle.te.hs-heilbronn.de/electrical_engineering_1/task_tb6pi8dgh0m2e2pw_with_calculation?rev=1680388598)

Last update: 2023/04/02 00:36

