

# task\_tb6pi8dgh0m2e2pw\_with\_calculation

## Student Group

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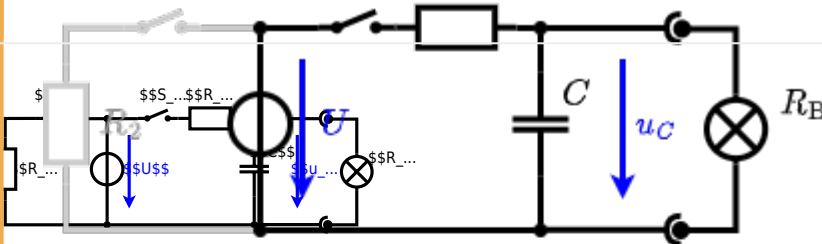
**Exercise E1.1 Charging Capacitors**  
**(written test, approx. 16 % of a 60-minute written test, WS2022)**

The circuit (with the real solution) is in the picture of  $R_1 = 20 \Omega$  and  $C = 100 \mu F$ . The voltage across the capacitor is again  $0 \text{ V}$  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 voltage source is  $U_s = U \cdot \frac{R_B}{R_1 + R_B} = 12 \text{ V} \cdot \frac{20 \Omega}{20 \Omega + 20 \Omega} = 6 \text{ V}$ .

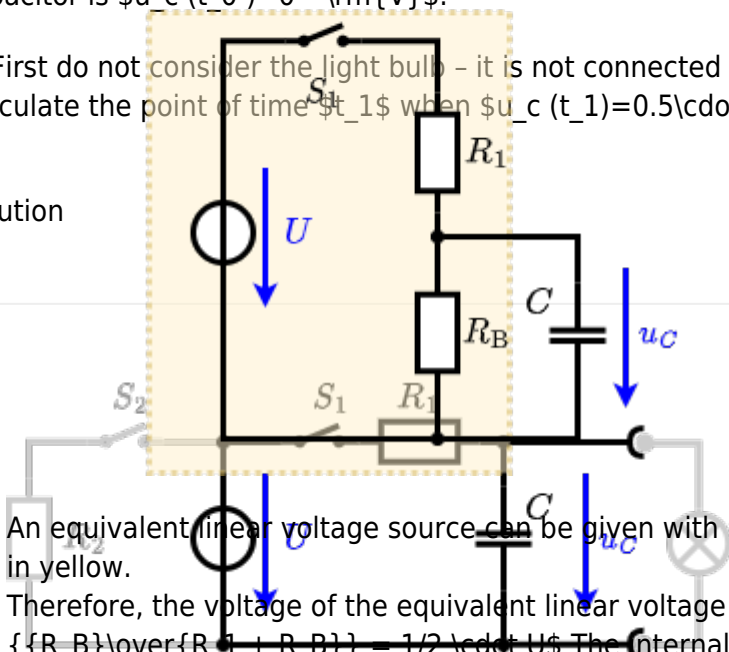
On an alternative view, one can try to create an equivalent linear voltage source again. Then, the internal resistance is given by substituting the ideal voltage source is again short-circuiting  $R_1$ .



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  $C = 100 \mu F$ . 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  $U$ ,  $R_1$ , 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 ( $= 0 \Omega$ , short-circuit).

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  $t = R \cdot C \cdot \ln(0.5) \cdot \ln(0.5)$ .

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Last update: 2023/03/31 07:55

