

# task\_tb6pi8dgh0m2e2pw\_with\_calculation

## Student Group

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**Exercise E1 Charging Capacitors**

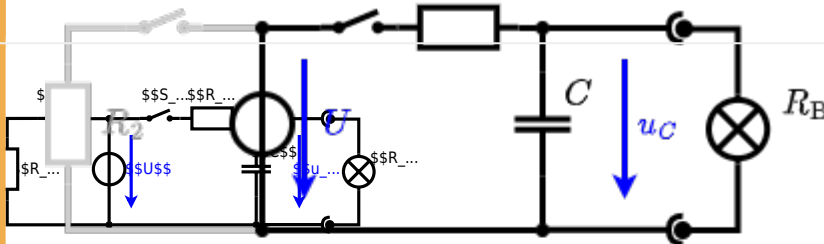
(written test, approx. 16 % of a 60-minute written test, WS2022)

The circuit (with the real solution) is in the picture of  $R_1 = 20 \Omega$  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  $R_B$ .

**Solution**  
 The ideal 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  $R_1$ .



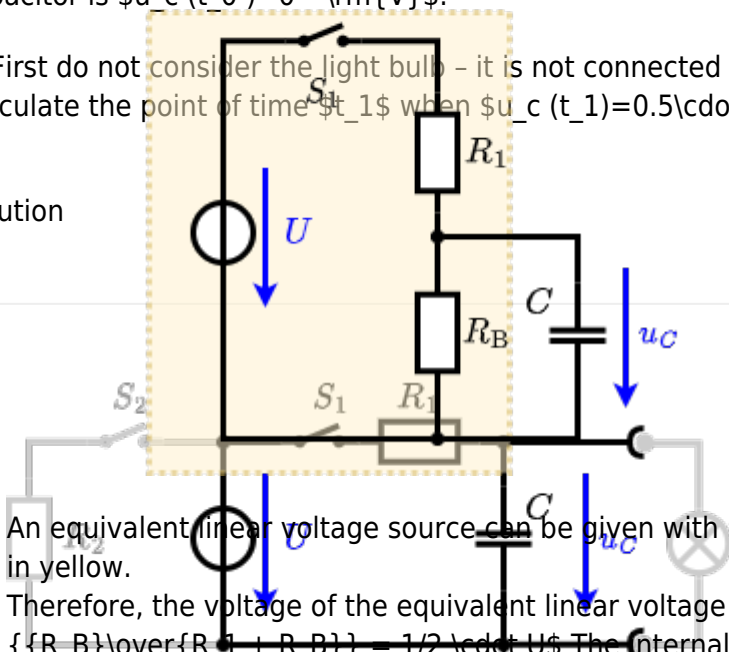
The circuit contains a voltage source  $U = 12 \text{ V}$ , a switch  $S_1$ , a resistor of  $R_1 = 20 \Omega$  and a capacitor of  $C = 100 \mu F$ .

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  $U_s$ ,  $R_1$ , 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 ( $= 0 \Omega$ , short-circuit).

$$i(t) = I_{max} (1 - e^{-t/\tau})$$

The following formula describes the current  $i(t)$  in an RL circuit with a DC voltage source  $U_0$  and a resistor  $R$  and inductor  $L$  in series. It has to be rearranged to  $(1 - e^{-t/\tau}) = 0.5$   $\Rightarrow t/\tau = \ln(0.5)$   $\Rightarrow t = \tau \cdot \ln(0.5)$   $\Rightarrow t = R \cdot C \cdot \ln(0.5)$

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