

task_tb6pi8dgh0m2e2pw_with_calculation

Student Group

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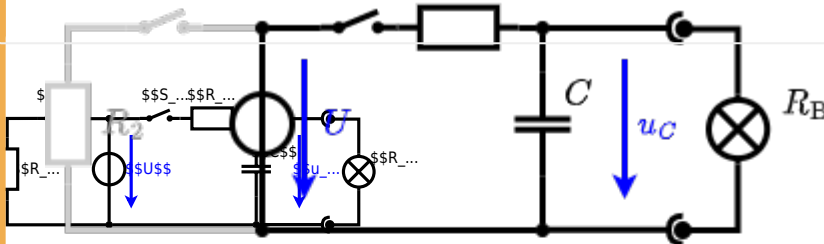
Exercise E8 Charging Capacitors
(written test, approx. 16 % of a 60-minute written test, WS2022)

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 voltage across the capacitor is again 0 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.

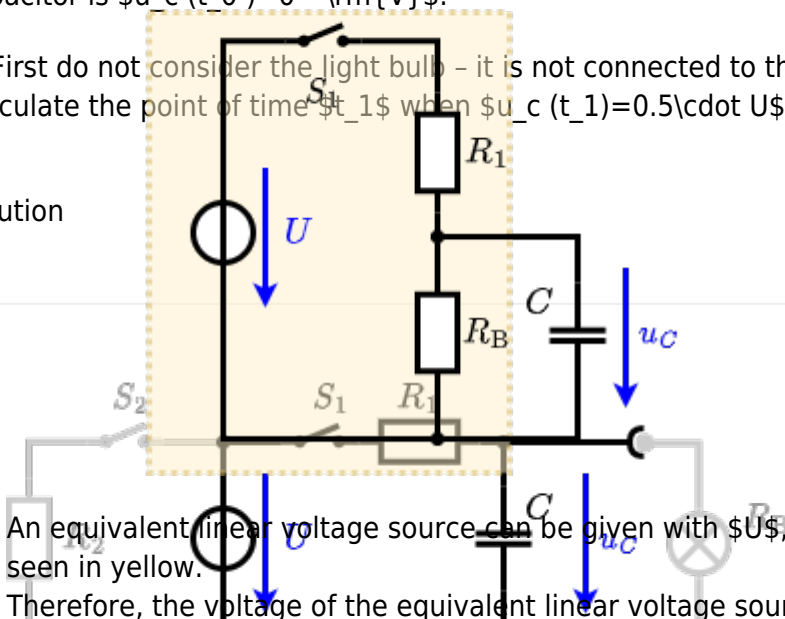
On an alternative view, one can try to create an equivalent linear voltage source again. Then, the internal resistance is given by substituting the ideal voltage source is again short-circuiting R_1 .



The circuit contains a voltage source $U = 12 \text{ V}$, a switch S_1 , a resistor of $R_1 = 20 \text{ }\Omega$ and a capacitor of $C = 100 \text{ }\mu\text{F}$. 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 , 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 ($= 0 \text{ }\Omega$, short-circuit).

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

$$\tau = R_1 C$$

$$I_{max} = \frac{U}{R_1}$$

The following formula describes the current $i(t)$ in a circuit with a resistor R_1 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 $t = R_1 C \cdot \ln(0.5)$

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