

task_tb6pi8dgh0m2e2pw_with_calculation

Student Group

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

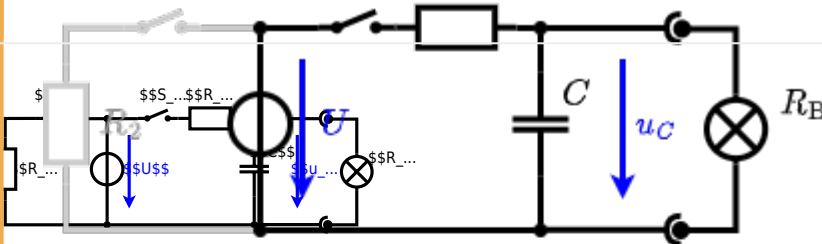
Exercise E1 Charging Capacitors
(written test, approx. 16 % of a 60-minute written test, WS2022)

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 $U_s = U \cdot \frac{R_B}{R_1 + R_B} = 12 \text{ V} \cdot \frac{20 \text{ } \Omega}{20 \text{ } \Omega + 20 \text{ } \Omega} = 6 \text{ V}$.

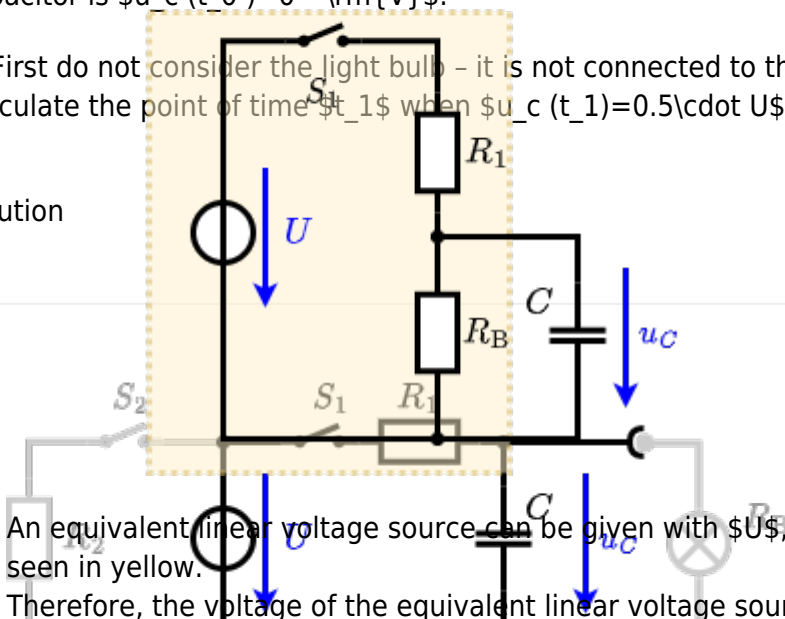
On an alternative view, one can try to create an equivalent linear voltage source again. Then, the internal resistance is given by substituting the ideal voltage source is again short-circuiting R_1 .



The circuit contains a voltage source $U = 12 \text{ V}$, a switch S_1 , a resistor of $R_1 = 20 \text{ } \Omega$ 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_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 ($R = 0 \text{ } \Omega$, short-circuit).

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

$$\tau = R_1 C$$

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

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

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