

task_tb6pi8dgh0m2e2pw_with_calculation

Student Group

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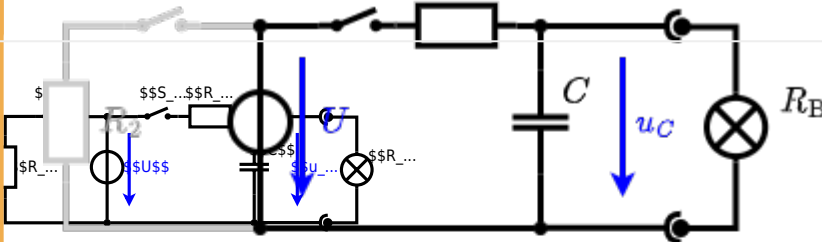
Charging Capacitors, dc network analysis, pure resistor network simplification, delta wye transformation, exam ee1 WS2022

Exercise E5 Charging Capacitors
(written test, approx. 16 % of a 60-minute written test, WS2022)

The circuit (with the real solution) is in the picture. At $t_0 = 0$ s the switch S_1 is closed. Calculate the voltage $u_c(t_2)$ across the capacitor at $t_2 = 1$ ms after closing the switch.

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

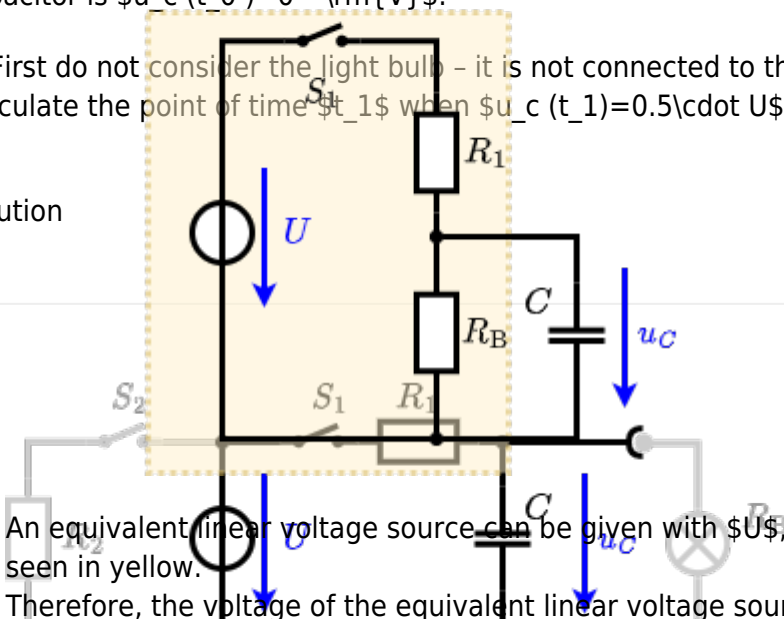
The internal resistance is given by substituting the ideal voltage source is again short-circuiting R_1 .



The circuit contains a voltage source $U = 12$ V, a switch S_1 , a resistor of $R_1 = 20$ Ω and a capacitor of $C = 100$ μ F. The switch S_2 to an additional consumer R_2 will be considered to be open for the first asks. At the moment $t_0 = 0$ s the switch S_1 is closed, the voltage across the capacitor is $u_c(t_0) = 0$ 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 ($= 0$ Ω , short-circuit).

$$R_1 = \frac{C}{\tau} \ln\left(\frac{1}{1 - 0.5 e^{-t/\tau}}\right)$$

The following formula describes the time course of a substance with a half-life of $t_{1/2} = 0.5 \tau$. It has to be rearranged to $(1 - e^{-t/\tau}) = 0.5$ $\implies e^{-t/\tau} = 0.5$ $\implies -t/\tau = \ln(0.5)$ $\implies t = -\tau \ln(0.5)$

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