

Exam Winter Semester 2022

Student Group

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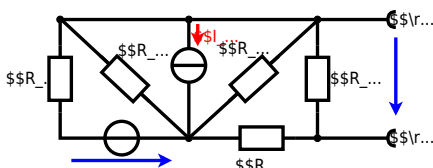
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Exercise E1 Equivalent linear Source (written test, approx. 14 % of a 60-minute written test, WS2022)

The circuit in the following has to be simplified.
Result

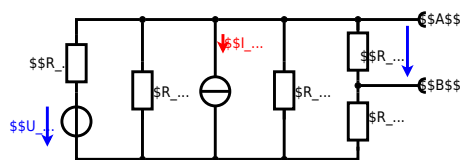
$$\begin{aligned} U_{\text{rs}} &= U_{\text{AB}} = 4.5 \text{ V} \\ R_{\text{ri}} &= R_{\text{AB}} = 6 \text{ } \Omega \end{aligned}$$



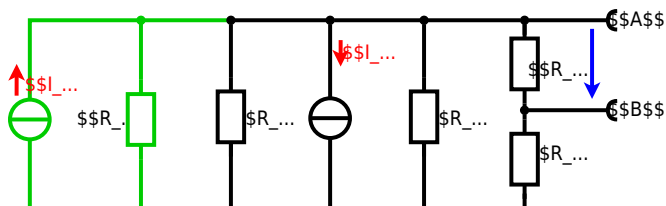
Calculated the internal resistance R_{ri} and the source voltage U_{rs} of an equivalent linear voltage source on the connectors A and B .
 $R_1 = 5.0 \text{ } \Omega$, $U_2 = 6.0 \text{ V}$, $R_3 = 10 \text{ } \Omega$, $I_4 = 4.2 \text{ A}$, $R_5 = 10 \text{ } \Omega$, $R_6 = 7.5 \text{ } \Omega$, $R_7 = 15 \text{ } \Omega$ Use equivalent sources in order to simplify the circuit!

Solution

The best thing is to re-think the wiring like rubber bands and adjust them:



The linear voltage source of U_2 and R_1 can be transformed into a current source $I_2 = \frac{U_2}{R_1}$ and R_1 :



Now a lot of them can be combined. The resistors R_1 , R_3 , R_5 are in parallel, like also I_2 and I_4 :

$$R_{135} = R_1 || R_3 || R_5$$

$$I_{24} = I_2 - I_4 = \frac{U_2}{R_1} - I_4$$

The resulting circuit can again be transformed:



Here, the U_{24} is calculated by I_{24} as the following:

$$U_{24} = I_{24} \cdot R_{135}$$

$$\&= R_{135} \cdot I_{24} \quad \&= \left(\frac{U_2}{R_1} - I_4 \right) \cdot R_1 \parallel R_3 \parallel R_5$$

$$\end{align*}$$

On the right side of the last circuit, there is a voltage divider given by R_{135} , R_6 , and R_7 .

Therefore the voltage between A and B is given as:
$$\begin{aligned} U_{AB} &= U_{24} \cdot \frac{R_7}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5} \\ &= \left(\frac{U_2}{R_1} - I_4 \right) \cdot \frac{R_7 \cdot R_1 \parallel R_3 \parallel R_5}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5} \end{aligned}$$

For the internal resistance R_i the ideal voltage source is substituted by its resistance ($=0\Omega$, so a short-circuit):
$$R_{AB} = R_7 \parallel (R_6 + R_1 \parallel R_3 \parallel R_5)$$

with $R_1 \parallel R_3 \parallel R_5 = 5\Omega \parallel 10\Omega \parallel 10\Omega = 5\Omega \parallel 5\Omega = 2.5\Omega$:

$$\begin{aligned} U_{AB} &= \frac{6.0\text{V}}{5.0\Omega} - 4.2\Omega \cdot \frac{15\Omega \cdot 2.5\Omega}{7.5\Omega + 15\Omega + 2.5\Omega} \\ R_{AB} &= 15\Omega \parallel (7.5\Omega + 2.5\Omega) \end{aligned}$$

$$\end{align*}$$

dc network analysis, pure resistor network simplification, delta wye transformation, exam ee1 ws2022

Exercise E1 Temperature-dependent Resistance

(written test, approx. 6 % of a 60-minute written test, WS2022)

2. The diagram below shows a thermistor with a resistance of $R_0 = 10\text{k}\Omega$ at $T_0 = 25^\circ\text{C}$. The thermistor has a resistance of $R_1 = 1\text{k}\Omega$ at $T_1 = -40^\circ\text{C}$. Calculate the resistance of the thermistor at $T_2 = -25^\circ\text{C}$. Your answer:

Its temperature coefficients are: $\alpha = 0.01 \frac{1}{\text{K}}$ and $\beta = 71 \cdot 10^{-6} \frac{1}{\text{K}^2}$.

Result The temperature inside the refrigeration system can reach down to -40°C .

$$\begin{aligned} R_0 &= 10\text{k}\Omega \end{aligned}$$

The power of the resistor P_R is given by $P_R = \frac{U^2}{R}$ and $P_R = I^2 R$. Therefore, a solution is to use a higher resistance up the refrigeration system.

Therefore, with constant U and increasing R the power decreases. Ten times more resistance decreases the heat flow to one-tenth.

$$\begin{aligned} R &= R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2) \\ \text{with } \Delta T &= T - T_0 \\ R &= 10\text{k}\Omega \cdot \left(1 + 0.01 \frac{1}{\text{K}} \cdot (-40^\circ\text{C} - 25^\circ\text{C}) + 71 \cdot 10^{-6} \frac{1}{\text{K}^2} \cdot (-40^\circ\text{C} - 25^\circ\text{C})^2 \right) \end{aligned}$$

$$\end{align*}$$

temperature dependent resistance, power, heat, exam ee1 ws2022

Exercise E1 Analyzing complex Impedances

(written test, approx. 14 % of a 60-minute written test, WS2022)

2. Calculate the phasor voltage $\underline{U}$ and the phasor current $\underline{I}$ in the circuit shown in the figure. The components R and X_L shall be given.

After analysis, the full bridge dimensioned circuit diagram shall be extracted and brought into the phase plane. The voltage $\underline{U}$ and the current $\underline{I}$ shall be given in the phase plane.

.. Calculate the physical values of the components.

Solution: $\underline{U} = 10 \angle 0^\circ \text{ V}$, $\underline{I} = 1 \angle 0^\circ \text{ A}$

Solution

```
\begin{align*} \underline{I} &= \frac{\underline{U}}{\underline{Z}} \quad \text{with } \underline{Z} = R + jX_L = 50 + j4.68 \Omega \\ \underline{I} &= \frac{10 \angle 0^\circ}{50 + j4.68} = 0.198 \angle -5.4^\circ \text{ A} \\ \underline{U} &= \underline{I} \cdot \underline{Z} = 0.198 \angle -5.4^\circ \cdot (50 + j4.68) = 9.9 \angle 0^\circ \text{ V} \end{align*}
```

The current and voltage are in phase and the voltage is purely real resulting in a power factor of 1. The voltage is 10 V and the current is 0.198 A. The power is 1.98 W.

With the complex part comes the physical values: $R = 50 \Omega$ and $X_L = 4.68 \Omega$. The inductance is $L = 0.03 \text{ mH}$ and the capacitance is $C = 0.01 \text{ F}$.

complex impedance, exam ee1 ws2022

Exercise E1 Complex Impedance Circuit

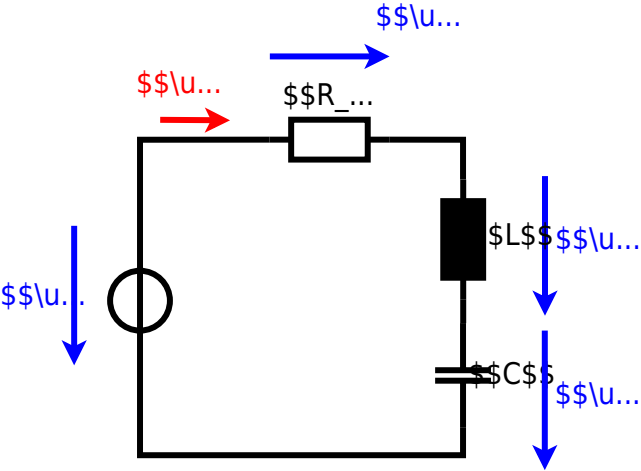
(written test, approx. 15 % of a 60-minute written test, WS2022)

2. Calculate the phasor voltage $\underline{U}$ and the phasor current $\underline{I}$ in the circuit shown in the figure. The components R and X_L shall be given. The voltage source $u(t) = 3.0 \sin(2\pi \cdot 15 \cdot t) \text{ V}$ and the current source $i(t) = 1.0 \sin(2\pi \cdot 15 \cdot t) \text{ A}$ are given.

Solution: This linear source is connected with an inductor of $330 \mu\text{H}$ and a capacitor of $30.22 \mu\text{F}$, all in series.

Result: $\underline{U} = 10 \angle 0^\circ \text{ V}$, $\underline{I} = 1 \angle 0^\circ \text{ A}$

[illegible]



complex impedance, exam ee1 ws2022

Exercise E1 Impedances at different Frequencies**(written test, approx. 18 % of a 60-minute written test, WS2022)**

2. A series circuit consists of a resistor with $R = 1.00 \text{ k}\Omega$, an inductor with $L = 4.7 \text{ }\mu\text{H}$, and a capacitor with $C = 40 \text{ nF}$. The voltage across the resistor is $U_R = 10.0 \text{ V}$. Calculate the absolute value of the impedance of the series circuit at $f = 4 \text{ MHz}$.

Solution

$$R_1 = 1.00 \text{ k}\Omega$$

$$R_2 = 10.0 \text{ V}$$

A series circuit means that the current is constant on every component.

The equivalent impedance for R and L combined is given by

$$Z_{RL} = R + j\omega L$$

$$|Z_{RL}| = \sqrt{R^2 + (\omega L)^2}$$

Therefore the resulting current of the parallel circuit is given as:

$$I_{\text{total}} = I_R + I_C$$

$$I_{\text{total}} = \frac{U_R}{R} + \frac{U_C}{X_C}$$

$$I_{\text{total}} = \frac{U_R}{R} + \frac{U_R}{X_C}$$

$$I_{\text{total}} = \frac{U_R}{R} \left(1 + \frac{R}{X_C} \right)$$

complex impedance, exam ee1 ws2022

Exercise E1 Resistance of a Wire by Resistivity**(written test, approx. 6 % of a 60-minute written test, WS2022)**

2. The heating element is used to heat the wire with a temperature of 1800 K . The power dissipation (= heat flow) of $P = 40 \text{ W}$ is necessary.

Calculate the current I needed to operate the heating element.

The Nichrome wire has a resistivity of $1.10 \cdot 10^{-6} \text{ }\Omega\text{m}$.

The heating element is 3 m long and has a diameter of 3.57 mm .

Calculate the resistance R of the heating element.

Solution

$$\begin{aligned} P &= U \cdot I = R \cdot I^2 \quad \rightarrow \quad I = \sqrt{\frac{P}{R}} = \sqrt{\frac{40 \text{ W}}{0.33 \text{ } \Omega}} \end{aligned}$$

$$\begin{aligned} R &= \rho \cdot \frac{l}{A} \quad \& \quad A = r^2 \cdot \pi = \frac{1}{4} d^2 \cdot \pi \quad \& \quad R = \rho \cdot \frac{4 \cdot l}{d^2 \cdot \pi} \quad \& \quad R = 1.10 \cdot 10^{-6} \text{ } \Omega \cdot \frac{4 \cdot 3 \text{ m}}{(3.57 \cdot 10^{-3} \text{ m})^2 \cdot \pi} \end{aligned}$$

resistivity, power, exam ee1 ws2022

Exercise E1 Charging Capacitors

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

The circuit (without the light bulb) also takes the form of an RC circuit. 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.

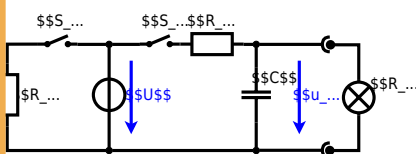
Solution

Hint: To solve this, first create an equivalent linear voltage source from U , R_1 , and R_2 .

$$\Delta U = U - \frac{R_2}{R_1 + R_2} U$$

Solution The voltage source ΔU is in series with the resistor R_1 . The voltage across the capacitor is $u_c(t) = \Delta U \cdot (1 - e^{-t/\tau})$, where $\tau = (R_1 + R_2)C$.

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_2 .



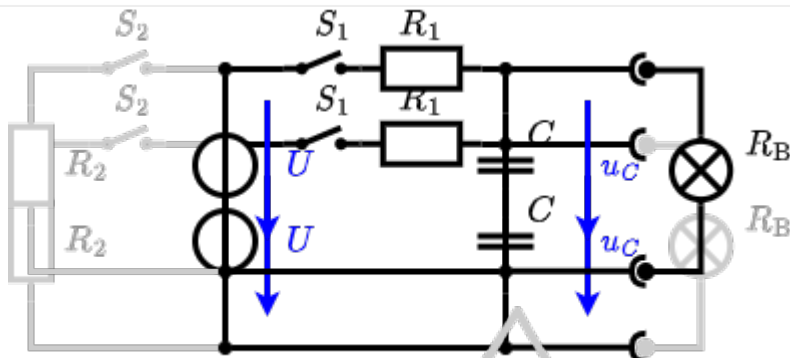
The circuit contains a voltage source $U = 12 \text{ V}$, a switch S_1 , a resistor of $R_1 = 20 \text{ } \Omega$ and a capacitor of $C = 100 \text{ } \mu\text{F}$.

The switch S_2 to an additional consumer R_2 will be considered to be open for the first tasks. At the moment $t_0 = 0 \text{ s}$ the switch S_1 is closed, the voltage across the capacitor is $u_c(t_0) = 0 \text{ V}$.

1. 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

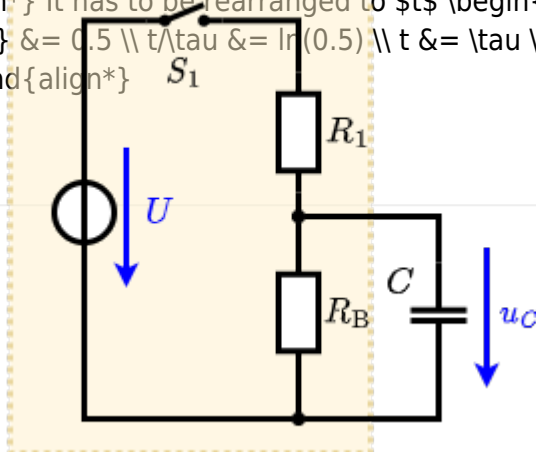


So, here only R_1 and C gives the time constant: $\tau = R_1 \cdot C$

The following formula describes the time course of $u_C(t)$ which has to be $u_C(t_1) = 0.5 \cdot U$:

$$u_C(t) = U \cdot (1 - e^{-t/\tau}) = 0.5 \cdot U$$

It has to be rearranged to $(1 - e^{-t/\tau}) = 0.5$

$$e^{-t/\tau} = 0.5 \quad \ln(0.5) = -t/\tau \quad t = \tau \cdot \ln(0.5) \quad t = R_1 \cdot C \cdot \ln(0.5)$$


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: $U_s = U \cdot \frac{R_B}{R_1 + R_B} = \frac{1}{2} \cdot U$ The internal resistance is given by substituting the ideal voltage source with its resistance ($= 0 \Omega$, short-circuit).

$$R_i = R_1 \parallel R_B = 10 \Omega$$

$$u_C(t_2) = U_s \cdot (1 - e^{-t_2/(R_i \cdot C)}) = \frac{1}{2} \cdot U \cdot (1 - e^{-1 \text{ ms} / (10 \Omega \cdot 100 \mu\text{F})})$$

charging capacitors, dc network analysis, pure resistor network simplification, delta wye transformation, exam ee1 ws2022

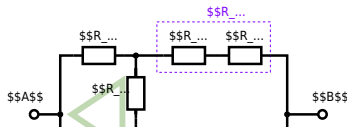
Exercise E1 Pure Resistor Network Simplification (written test, approx. 13 % of a 60-minute written test, WS2022)

The following shall be solved: A circuit with $R_1 = 200 \Omega$, $R_2 = 100 \Omega$, $R_3 = 150 \Omega$, $R_4 = 100 \Omega$, and the voltage source $U = 10 \text{ V}$ is given. R_B .

Solution

$$R_{\text{eq}} = 133.8 \, \Omega$$

Now a wye-delta transformation is necessary.



Since $R_2 = R_3$ and based on the equations for the transformation, the transformed R_Y is given as:

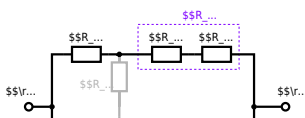
$$R_Y = \frac{R_2 \cdot R_2}{R_2 + R_2 + R_2} = \frac{(100 \, \Omega)^2}{3 \cdot 100 \, \Omega} = \frac{1}{3} \cdot 100 \, \Omega = 33.33 \, \Omega$$

The equivalent resistor is given by a parallel configuration of resistors in series:

$$R_{\text{eq}} = R_Y + (R_Y + R_1 + R_1) \parallel (R_Y + R_2) \parallel R_{\text{eq}} = 33.33 \, \Omega + (33.33 \, \Omega + 400 \, \Omega) \parallel (33.33 \, \Omega + 100 \, \Omega)$$

.. The switch shall now be open. Calculate the equivalent resistance R_{eq} between A and B .

Solution



The equivalent resistor is given by a parallel configuration of resistors in series:

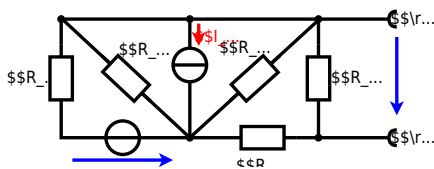
$$\begin{aligned} R_{\text{eq}} &= (R_2 + R_1 + R_1) \parallel (R_2 + R_2) \\ R_{\text{eq}} &= (100 \, \Omega + 200 \, \Omega + 200 \, \Omega) \parallel (100 \, \Omega + 100 \, \Omega) \\ R_{\text{eq}} &= (500 \, \Omega) \parallel (200 \, \Omega) \\ R_{\text{eq}} &= \frac{500 \, \Omega \cdot 200 \, \Omega}{500 \, \Omega + 200 \, \Omega} \end{aligned}$$

network simplification, exam ee1 ws2022

Exercise E4 Equivalent linear Source (written test, approx. 14 % of a 60-minute written test, WS2022)

The circuit in the following has to be simplified.
Result

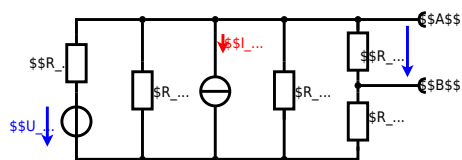
$$\begin{aligned} U_{\text{s}} &= U_{\text{AB}} = 4.5 \, \text{V} \\ R_{\text{i}} &= R_{\text{AB}} = 6 \, \Omega \end{aligned}$$



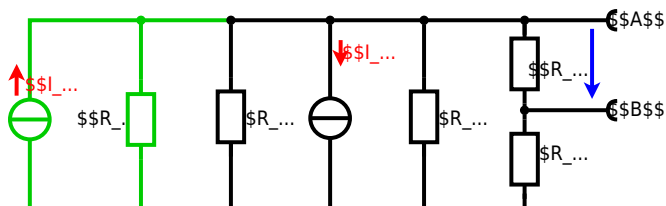
Calculate the internal resistance R_i and the source voltage U_s of an equivalent linear voltage source on the connectors A and B. $\begin{aligned} R_1 &= 5.0 \, \Omega, \quad U_2 = 6.0 \, \text{V}, \quad R_3 = 10 \, \Omega, \quad I_4 = 4.2 \, \text{A}, \\ R_5 &= 10 \, \Omega, \quad R_6 = 7.5 \, \Omega, \quad R_7 = 15 \, \Omega \end{aligned}$ Use equivalent sources in order to simplify the circuit!

Solution

The best thing is to re-think the wiring like rubber bands and adjust them:



The linear voltage source of U_2 and R_1 can be transformed into a current source $I_2 = \frac{U_2}{R_1}$ and R_1 :



Now a lot of them can be combined. The resistors R_1 , R_3 , R_5 are in parallel, like also I_2 and I_4 :

$$R_{135} = R_1 || R_3 || R_5$$

$$I_{24} = I_2 - I_4 = \frac{U_2}{R_1} - I_4$$

The resulting circuit can again be transformed:



Here, the U_{24} is calculated by I_{24} as the following:

$$U_{24} = I_{24} \cdot R_{135}$$

$$I_{24} = \frac{U_{24}}{R_6 + R_1 \parallel R_3 \parallel R_5} = \frac{(U_2 - I_4 R_1)}{R_6 + R_1 \parallel R_3 \parallel R_5}$$

On the right side of the last circuit, there is a voltage divider given by R_{135} , R_6 , and R_7 .

$$U_{AB} = U_{24} \cdot \frac{R_7}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5} = \frac{(U_2 - I_4 R_1) \cdot R_7}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5}$$

For the internal resistance R_i the ideal voltage source is substituted by its resistance ($=0\Omega$, so a short-circuit):

$$R_{AB} = R_7 \parallel (R_6 + R_1 \parallel R_3 \parallel R_5)$$

with $R_1 \parallel R_3 \parallel R_5 = 5\Omega \parallel 10\Omega \parallel 10\Omega = 5\Omega \parallel 5\Omega = 2.5\Omega$:

$$U_{AB} = \frac{6.0V}{5.0\Omega} - 4.2\Omega \cdot \frac{15\Omega \cdot 2.5\Omega}{7.5\Omega + 15\Omega + 2.5\Omega} \quad R_{AB} = 15\Omega \parallel (7.5\Omega + 2.5\Omega)$$

dc network analysis, pure resistor network simplification, delta wye transformation, exam ee1 ws2022

Exercise E2 Temperature-dependent Resistance

(written test, approx. 6 % of a 60-minute written test, WS2022)

2. The diagram shows a thermistor with a resistance of $R_0 = 10\Omega$ at $T_0 = 25^\circ\text{C}$. The thermistor has a temperature coefficient of $\alpha = 0.01\text{K}^{-1}$ and a $\beta = 71 \cdot 10^{-6}\text{K}^2$. Calculate the resistance of the thermistor at $T = -40^\circ\text{C}$.

Result: $R = 10\Omega$ at $T = 25^\circ\text{C}$. Its temperature coefficients are: $\alpha = 0.01\text{K}^{-1}$ and $\beta = 71 \cdot 10^{-6}\text{K}^2$.

The temperature inside the refrigeration system can reach down to -40°C .

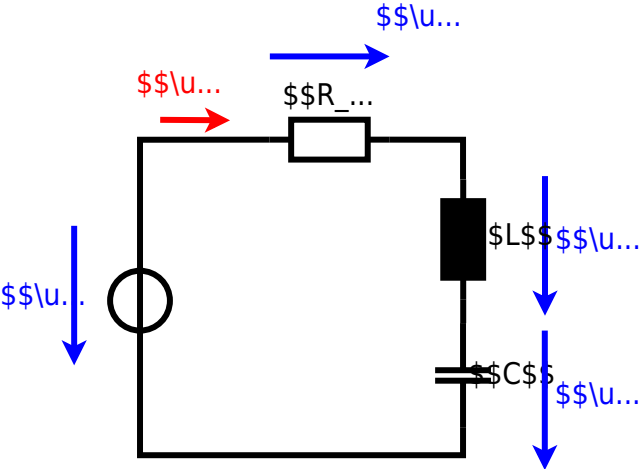
$$R = R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2) = 10\Omega \cdot (1 + 0.01 \cdot (-40 - 25) + 71 \cdot 10^{-6} \cdot (-40 - 25)^2)$$

The power of the resistor $P = U^2/R$ decreases with increasing resistance. Therefore, a solution is to use a heat sink to cool the resistor.

Therefore, with constant U and increasing R the power decreases. Ten times more resistance decreases the heat flow to one-tenth.

$$R = R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2) \quad \text{with } \Delta T = T - T_0 \\ R = 10\Omega \cdot (1 + 0.01 \cdot (-40 - 25) + 71 \cdot 10^{-6} \cdot (-40 - 25)^2)$$

[illegible]



Solution

$$\begin{aligned} P &= U \cdot I = R \cdot I^2 \quad \rightarrow \quad I = \sqrt{\frac{P}{R}} = \sqrt{\frac{40 \text{ W}}{0.33 \text{ } \Omega}} \end{aligned}$$

$$\begin{aligned} R &= \rho \cdot \frac{l}{A} \quad \& \quad A = r^2 \cdot \pi = \frac{1}{4} d^2 \cdot \pi \quad \& \quad R = \rho \cdot \frac{4 \cdot l}{d^2 \cdot \pi} \quad \& \quad R = 1.10 \cdot 10^{-6} \text{ } \Omega \cdot \frac{4 \cdot 3 \text{ m}}{(3.57 \cdot 10^{-3} \text{ m})^2 \cdot \pi} \end{aligned}$$

resistivity, power, exam ee1 ws2022

Exercise E5 Charging Capacitors

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

The circuit (without the light bulb) also takes the form of an RC circuit. 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.

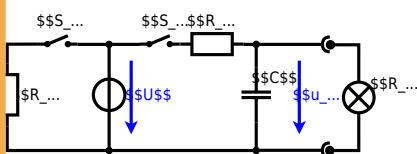
Solution

Hint: To solve this, first create an equivalent linear voltage source from U , R_1 , and R_2 .

$$\Delta U = U \cdot \frac{R_2}{R_1 + R_2} = 12 \text{ V} \cdot \frac{20 \text{ } \Omega}{20 \text{ } \Omega + 792 \text{ } \Omega} = 0.299 \text{ V}$$

Solution $\Delta U = 0.299 \text{ V}$. The ideal voltage source ΔU is in series with the voltage U and the resistor R_1 . The voltage U is independent of this circuit.

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_2 .



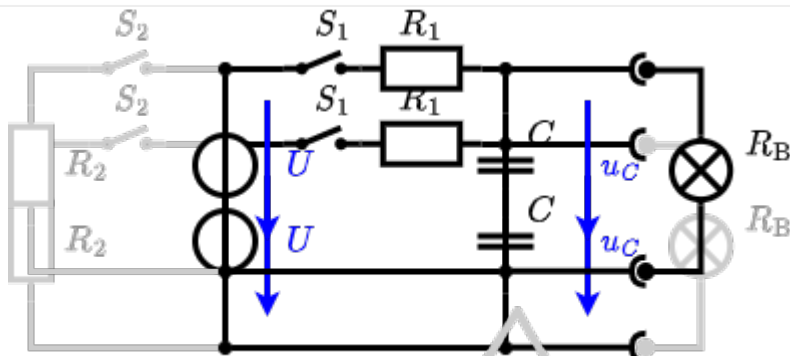
The circuit contains a voltage source $U = 12 \text{ V}$, a switch S_1 , a resistor of $R_1 = 20 \text{ } \Omega$ and a capacitor of $C = 100 \text{ } \mu\text{F}$.

The switch S_2 to an additional consumer R_2 will be considered to be open for the first tasks. At the moment $t_0 = 0 \text{ s}$ the switch S_1 is closed, the voltage across the capacitor is $u_c(t_0) = 0 \text{ V}$.

1. 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

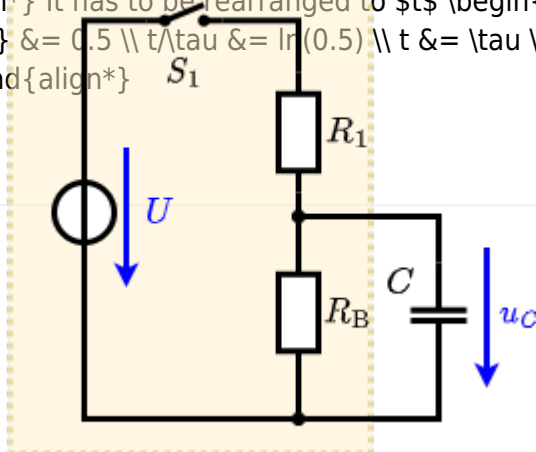


So, here only R_1 and C gives the time constant: $\tau = R_1 \cdot C$

The following formula describes the time course of $u_C(t)$ which has to be $u_C(t_1) = 0.5 \cdot U$:

$$u_C(t) = U \cdot (1 - e^{-t/\tau}) = 0.5 \cdot U$$

It has to be rearranged to $(1 - e^{-t/\tau}) = 0.5$

$$e^{-t/\tau} = 0.5 \quad \ln(0.5) = -t/\tau \quad t = \tau \cdot \ln(0.5) \quad t = R_1 \cdot C \cdot \ln(0.5)$$


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: $U_s = U \cdot \frac{R_B}{R_1 + R_B} = \frac{1}{2} \cdot U$ The internal resistance is given by substituting the ideal voltage source with its resistance ($= 0 \Omega$, short-circuit).

$$R_i = R_1 \parallel R_B = 10 \Omega$$

$$u_C(t_2) = U_s \cdot (1 - e^{-t_2/(R_i \cdot C)}) = \frac{1}{2} \cdot U \cdot (1 - e^{-1 \text{ ms} / (10 \Omega \cdot 100 \mu\text{F})})$$

charging capacitors, dc network analysis, pure resistor network simplification, delta wye transformation, exam ee1 ws2022

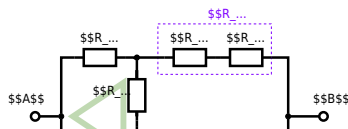
Exercise E3 Pure Resistor Network Simplification (written test, approx. 13 % of a 60-minute written test, WS2022)

The following shall be solved: Calculate the equivalent resistance R_{eq} between the terminals a and b of the circuit shown. $R_1 = 10 \Omega$, $R_2 = 20 \Omega$, $R_3 = 30 \Omega$, $R_4 = 40 \Omega$, $R_5 = 50 \Omega$, $R_6 = 60 \Omega$, $R_7 = 70 \Omega$, $R_8 = 80 \Omega$, $R_9 = 90 \Omega$, $R_{10} = 100 \Omega$.

Solution

$$R_{\text{eq}} = 133.8 \, \Omega$$

Now a wye-delta transformation is necessary.



Since $R_2 = R_3$ and based on the equations for the transformation, the transformed R_Y is given as:

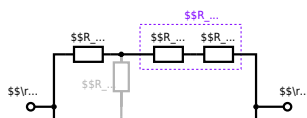
$$R_Y = \frac{R_2 \cdot R_2}{R_2 + R_2 + R_2} = \frac{(100 \, \Omega)^2}{3 \cdot 100 \, \Omega} = \frac{1}{3} \cdot 100 \, \Omega = 33.33 \, \Omega$$

The equivalent resistor is given by a parallel configuration of resistors in series:

$$R_{\text{eq}} = R_Y + (R_Y + R_1 + R_1) \parallel (R_Y + R_2) \parallel R_{\text{eq}} = 33.33 \, \Omega + (33.33 \, \Omega + 400 \, \Omega) \parallel (33.33 \, \Omega + 100 \, \Omega)$$

.. The switch shall now be open. Calculate the equivalent resistance R_{eq} between A and B .

Solution



The equivalent resistor is given by a parallel configuration of resistors in series:

$$\begin{aligned} R_{\text{eq}} &= (R_2 + R_1 + R_1) \parallel (R_2 + R_2) \\ R_{\text{eq}} &= (100 \sim \Omega + 200 \sim \Omega + 200 \sim \Omega) \parallel (100 \sim \Omega + 100 \sim \Omega) \\ R_{\text{eq}} &= (500 \sim \Omega) \parallel (200 \sim \Omega) \\ R_{\text{eq}} &= \{ \{ 500 \sim \Omega \cdot 200 \sim \Omega \} \over { 500 \sim \Omega + 200 \sim \Omega } \} \end{aligned}$$

network simplification, exam ee1 ws2022

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