

Exam Winter Semester 2022

Student Group

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Exam Winter Semester 2022

Additional permitted Aids

- non-programmable calculator,
- formulary (2 DIN A4 pages)

Hits

- The duration of the exam is 60 min.
- Attempts to cheat will lead to exclusion and failure of the exam.
- Withdrawal is no longer possible after these exam has been handed out.
- Please write down intermediate calculations and results on the assignment sheet. (when more space is needed also on the reverse side. In this case: Mark it clearly).
- Always use units in the calculation.
- Use a document-proof, non-red pen.

Only EEE1-relevant Part

This part is only for about 20..25 minutes !

Exercise E1 Resistance of a Wire by Resistivity

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

2. The heating element made of nichrome wire with a temperature coefficient of $1.80 \cdot 10^{-3} \text{ K}^{-1}$ is electrically connected to a power supply. A power dissipation (= heat flow) of $P = 40 \text{ W}$ is necessary.

Determine the current I needed for the operation of heating elements.

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 .

2. Calculate the resistance R of the heating element.

Solution

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

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

Exercise E2 Temperature-dependent Resistance (written test, approx. 6 % of a 60-minute written test, WS2022)

[illegible]

Its temperature coefficients are: $\alpha = 0.01 \sim \{1\} \over \{\rm K\}}$ and $\beta = 71 \cdot 10^{-6} \sim \{1\} \over \{\rm K\}^2\}$

Result The temperature inside the refrigeration system can reach down to $-40 \sim 0^{\circ}\text{C}$.

$$C = \frac{R_s}{\omega L} = \frac{6.5 \times 10^{-3}}{2\pi \times 40 \times 10^3} = 2.58 \times 10^{-8} \text{ F} = 25.8 \text{ nF}$$

The power transfer is $P = I^2 R$ and the heat $Q = I^2 R t$. Therefore, a solution is to turn off the heat pump.

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

$$R = R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2) \quad \&\amp; \quad \Delta T = T_{\text{end}} - T_{\text{start}} \quad \&\& \quad R = 10 \sim \text{m}\{\text{k}\} \cdot \Omega \cdot \left((1 + 0.01 \sim \frac{1}{\text{m}\{\text{K}\}}) \cdot (-40 \sim \text{m}\{\text{C}\} - 25 \sim \text{m}\{\text{C}\}) + 71 \cdot 10^{-6} \sim \frac{1}{\text{m}\{\text{K}\}^2} \cdot (-40 \sim \text{m}\{\text{C}\} - 25 \sim \text{m}\{\text{C}\})^2 \right)$$

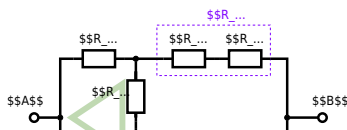
Exercise E3 Pure Resistor Network Simplification (written test, approx. 13 % of a 60-minute written test, WS2022)

The following shall, in with \$B₁ use 200 Cal. Code Regs. § 92.2(a)(1) to (3) and the \$B₁ between \$B₁ and \$B₁.

Solution

$$R \approx 132.8 \sim \Omega$$

Now a wye-delta transformation is necessary.

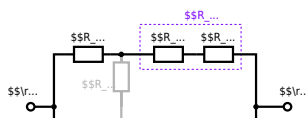


Since $R_2 = R_3$ and based on the equations for the transformation, the transformed R_Y is given as:
$$R_Y = \frac{R_2 \cdot R_2}{R_2 + R_2 + R_2} = \frac{(100 \, \Omega)^2}{3 \cdot 100 \, \Omega} = \frac{1}{3} \cdot 100 \, \Omega = 33.33 \, \Omega$$

The equivalent resistor is given by a parallel configuration of resistors in series:
$$R_{\text{eq}} = R_Y + (R_Y + R_1 + R_1) \parallel (R_Y + R_2) \parallel R_{\text{eq}} = 33.33 \, \Omega + (33.33 \, \Omega + 400 \, \Omega) \parallel (33.33 \, \Omega + 100 \, \Omega) \parallel$$

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

Solution



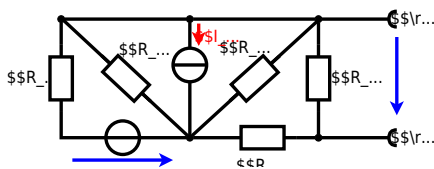
The equivalent resistor is given by a parallel configuration of resistors in series:

$$\begin{aligned} R_{\text{eq}} &= (R_2 + R_1 + R_3) \parallel (R_2 + R_3) \parallel R_4 \\ R_{\text{eq}} &= (100 \, \Omega + 200 \, \Omega + 200 \, \Omega) \parallel (100 \, \Omega + 100 \, \Omega) \parallel \\ R_{\text{eq}} &= (500 \, \Omega) \parallel (200 \, \Omega) \parallel R_{\text{eq}} = \frac{500 \, \Omega \cdot 200 \, \Omega}{500 \, \Omega + 200 \, \Omega} \end{aligned}$$

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

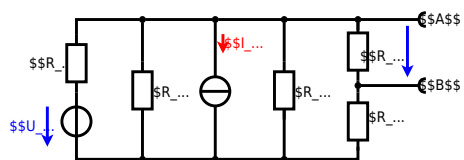
$$\begin{aligned} U_s &= U_{\text{AB}} = 4.5 \, \text{V} \\ R_i &= R_{\text{AB}} = 6 \, \Omega \end{aligned}$$



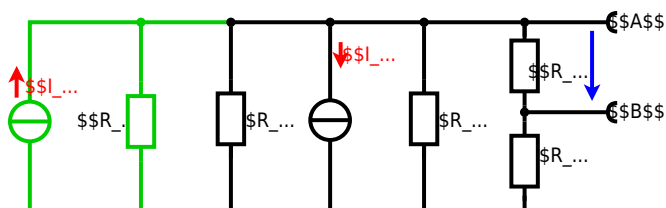
Calculate the internal resistance R_i and the source voltage U_s of an equivalent linear voltage source on the connectors A and B. $\begin{aligned} R_1 &= 5.0 \, \Omega, \quad U_s = 6.0 \, \text{V}, \quad R_3 = 10 \, \Omega, \quad I_4 = 4.2 \, \text{A}, \\ R_5 &= 10 \, \Omega, \quad R_6 = 7.5 \, \Omega,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

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

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

The resulting circuit can again be transformed:



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

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

$$U_{24} = U_{23} \cdot \frac{R_7}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5} = (U_{23} - I_4 \cdot R_1) \cdot \frac{R_7}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5}$$

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

Therefore the voltage between A and B is given as:

$$U_{AB} = U_{24} \cdot \frac{R_7}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5} = (U_{23} - I_4 \cdot R_1) \cdot \frac{R_7}{R_6 + R_7 + R_1 \parallel R_3 \parallel R_5}$$

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

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

Full Exam

These is the full exam

Full exam

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

The heating element made of Nichrome wire with a cross-section of 1.80 mm^2 is used. To achieve a power dissipation (= heat flow) of $P=40\text{ W}$ is necessary. Calculate the current I needed to operate for heating elements. The Nichrome wire has a resistivity of $1.10 \cdot 10^{-6}\Omega\text{ m}$. The heating element is 3 m long and has a diameter of 3.57 mm . Calculate the resistance R of the heating element.

Solution

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

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

$$3 \sim \mathrm{m}} \} \} (3.57 \cdot 10^{-3} \sim \mathrm{m}})^2 \cdot \pi \} \&\& \\\end{align*}$$

[electrical_engineering_and_electronics:task_rj0r6j4apumukrj6_with_calculation](#)
[resistivity, power, exam ee1 ws2022](#)

Exercise E2 Temperature-dependent Resistance (written test, approx. 6 % of a 60-minute written test, WS2022)

A. The diagram explains a thermistor's resistance temperature dependence. The thermistor's resistance is given by the formula $R = R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2)$ for ΔT in $^{\circ}\mathrm{C}$. Its temperature coefficients are: $\alpha = 0.01 \sim \{1\} \over \{\mathrm{K}\}}$ and $\beta = 71 \cdot 10^{-6} \sim \{1\} \over \{\mathrm{K}^2\}$.

Result
The temperature inside the refrigeration system can reach down to $-40 \sim ^{\circ}\mathrm{C}$.

Calculate the resistance of the thermistor at $-40 \sim ^{\circ}\mathrm{C}$.

$$\begin{align*} R &= 6.5 \sim \mathrm{k}\Omega \end{align*}.$$

The power of the resistor $P = U^2 / R$ and the heat $Q = P \cdot t$ is
Solution: The heat flow might heat 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.

$$\begin{align*} R &= R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2) \& | \text{with } \Delta T = T_{\mathrm{end}} - T_{\mathrm{start}} \\ R &= 10 \sim \mathrm{k}\Omega \cdot (1 + 0.01 \sim \{1\} \over \{\mathrm{K}\}} \cdot (-40 \sim ^{\circ}\mathrm{C} - 25 \sim ^{\circ}\mathrm{C}) + 71 \cdot 10^{-6} \sim \{1\} \over \{\mathrm{K}^2\}} \cdot (-40 \sim ^{\circ}\mathrm{C} - 25 \sim ^{\circ}\mathrm{C})^2) \end{align*}$$

[electrical_engineering_and_electronics:task_70jg4yzznocarsq_with_calculation](#)
[temperature dependent resistance, power, heat, exam ee1 ws2022](#)

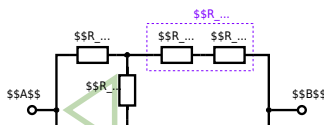
Exercise E3 Pure Resistor Network Simplification (written test, approx. 13 % of a 60-minute written test, WS2022)

The following shall be solved: Calculate the equivalent resistance R_{eq} and the source current I_{A} and I_{B} .

Solution

$$\begin{align*} R_{\mathrm{eq}} &= 132.8 \sim \Omega \end{align*}$$

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:

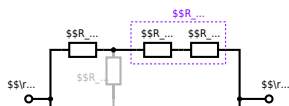
$$R_Y = \frac{R_2 \cdot R_2}{R_2 + R_2 + R_2} = \frac{(100 \, \Omega)^2}{3 \cdot 100 \, \Omega} = \frac{1}{3} \cdot 100 \, \Omega = 33.33 \, \Omega$$

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

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

1. 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:

$$R_{\text{eq}} = (R_2 + R_1) \parallel (R_2 + R_2) \parallel R_{\text{eq}} = (100 \, \Omega + 200 \, \Omega + 200 \, \Omega) \parallel (100 \, \Omega + 100 \, \Omega) \parallel R_{\text{eq}} = (500 \, \Omega) \parallel (200 \, \Omega) \parallel R_{\text{eq}} = \left\{ \frac{500 \, \Omega \cdot 200 \, \Omega}{500 \, \Omega + 200 \, \Omega} \right\} \parallel R_{\text{eq}}$$

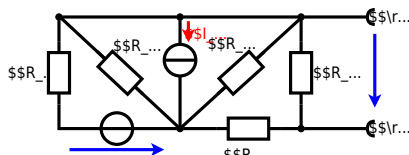
[electrical_engineering_and_electronics:task_x357drkaqv84jnsj_with_calculation](#)
network simplification, exam ee1 ws2022

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

$$U_{\text{s}} = U_{\text{AB}} = 4.5 \, \text{V} \quad R_{\text{i}} = R_{\text{AB}} = 6 \, \Omega$$



Calculated the internal resistance R_{int} and the source voltage U_{oc} of an equivalent linear voltage source on the connectors A and B.

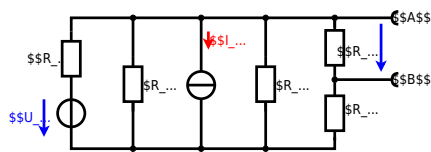
$$R_1 = 5.0 \, \Omega, \quad U_2 = 6.0 \, \text{V}, \quad R_3 = 10 \, \Omega, \quad I_4 = 4.2 \, \text{A},$$

$$R_5 = 10 \, \Omega, \quad R_6 = 7.5 \, \Omega, \quad R_7 = 15 \, \Omega$$

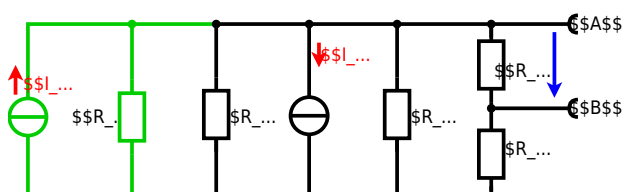
Use equivalent sources in order to simplify the circuit!

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 :
$$R_{135} = R_1 || R_3 || R_5 || I_{24} = I_2 - I_4 = \left\{ \frac{U_2}{R_1} \right\} - I_4$$
 The resulting circuit can again be transformed:



Here, the U_{24} is calculated by I_{24} as the following:
$$U_{24} = R_{135} \cdot I_{24} = \left(\frac{U_2}{R_1} - I_4 \right) \cdot R_1 || R_3 || R_5$$

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

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

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

$$U_{AB} = \left(\frac{6.0\text{V}}{5.0\Omega} - 4.2\Omega \right) \cdot \frac{15\Omega \cdot 2.5\Omega}{7.5\Omega + 15\Omega + 2.5\Omega} || R_{AB} = 15\Omega || (7.5\Omega + 2.5\Omega)$$

[electrical_engineering_and_electronics:task_6tttque1e2nf2c7_with_calculation](#)
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)**

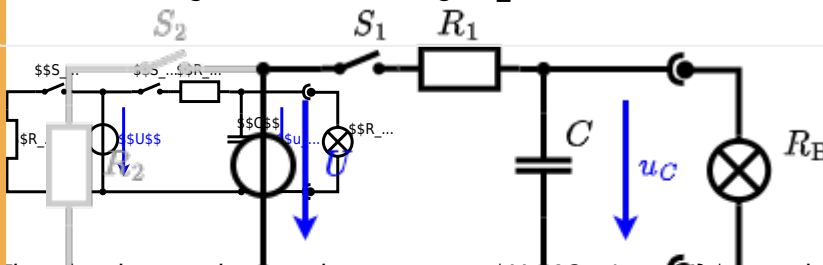
The capacitor becomes fully charged at the moment $t_0 = 0 \text{ s}$ when the switch S_1 is closed. Calculate the voltage $u_c(t_2)$ across the capacitor at $t_2 = 1 \text{ ms}$ after closing the switch.

Solution:

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

Solution: The equivalent voltage source is $U_{\text{eq}} = U \cdot \frac{R_B}{R_1 + R_B} = 12 \text{ V} \cdot \frac{12 \Omega}{20 \Omega + 12 \Omega} = 4.8 \text{ V}$. The internal resistance is $R_{\text{eq}} = R_1 \parallel R_B = 7.7 \Omega$.

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 .



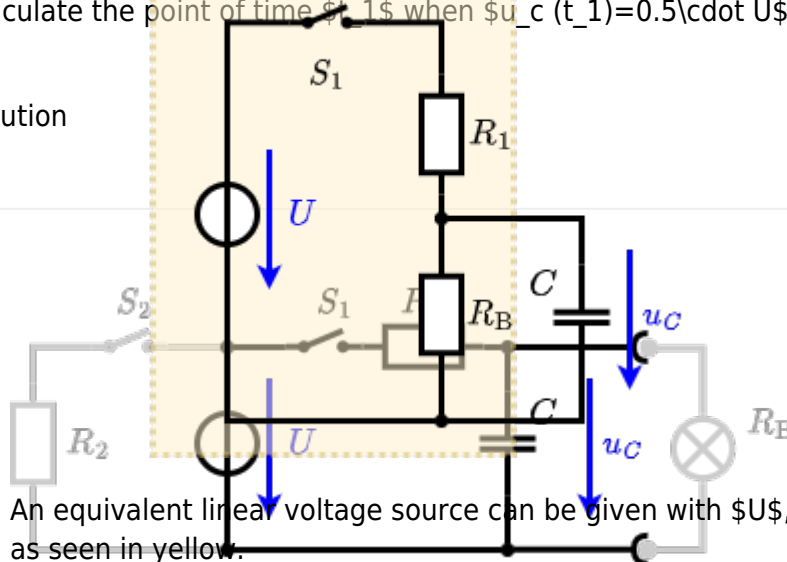
The circuit contains a voltage source $U = 12 \text{ V}$, a switch S_1 , a resistor of $R_1 = 20 \Omega$ and a capacitor of $C = 100 \mu\text{F}$.

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 $u_c(t_0) = 0 \text{ V}$.

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.

The voltage across the capacitor is $u_c(t) = U_{\text{eq}} \cdot (1 - e^{-t/\tau})$ where $\tau = R_{\text{eq}} \cdot C$.

The following formula describes the time course of $u_c(t)$ which has to be rearranged to:

$$u_c(t) = U_{\text{eq}} \cdot (1 - e^{-t/\tau}) \quad \text{with } U_{\text{eq}} = 4.8 \text{ V} \text{ and } \tau = 7.7 \Omega \cdot 100 \mu\text{F} = 0.77 \text{ ms}$$

$$0.5 \cdot U_{\text{eq}} = U_{\text{eq}} \cdot (1 - e^{-t/\tau}) \quad \text{with } U_{\text{eq}} = 4.8 \text{ V}$$

$$0.5 = 1 - e^{-t/\tau} \quad \text{with } \tau = 0.77 \text{ ms}$$

$$e^{-t/\tau} = 0.5 \quad \text{with } \tau = 0.77 \text{ ms}$$

$$-t/\tau = \ln(0.5) \quad \text{with } \tau = 0.77 \text{ ms}$$

$$t = -\tau \cdot \ln(0.5) = 0.77 \text{ ms} \cdot \ln(2) \approx 0.53 \text{ ms}$$

$$\frac{\{1\}}{2} \cdot U \cdot (1 - e^{\frac{1}{10} \cdot \Omega \cdot 100 \cdot \mu F})) \end{align*}$$

electrical_engineering_and_electronics:task_tb6pi8dgh0m2e2pw_with_calculation
charging capacitors, dc network analysis, pure resistor network simplification, delta wye
transformation, exam ee1 ws2022

Exercise E6 Analyzing complex Impedances

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

2. Given circuit diagram below, calculate the effective value $\underline{U}$ of the voltage $\underline{u}$ across the load resistor R_L and the effective value $\underline{I}$ of the current i through the load resistor R_L . (R and X_L) shall be given.

After analysis, the following information should be extracted and documented in phase diagram (Z) and the effective value $\underline{U}$ and $\underline{I}$ shall be given.

.. Calculate the physical values of the two components.

$$\begin{aligned} \underline{U} &= \sqrt{0.24^2 + 4.68^2} = 4.72 \text{ V} \\ \underline{I} &= \sqrt{0.24^2 + 4.68^2} = 4.72 \text{ A} \end{aligned}$$

Solution

$$\begin{aligned} \underline{U} &= \sqrt{0.24^2 + 4.68^2} = 4.72 \text{ V} \\ \underline{I} &= \sqrt{0.24^2 + 4.68^2} = 4.72 \text{ A} \end{aligned}$$

$$\underline{U} = \sqrt{0.24^2 + 4.68^2} = 4.72 \text{ V}$$

$$\underline{I} = \sqrt{0.24^2 + 4.68^2} = 4.72 \text{ A}$$

$$\underline{U} = \sqrt{0.24^2 + 4.68^2} = 4.72 \text{ V}$$

electrical_engineering_and_electronics:task_jti0uzudcmg4u22t_with_calculation
complex impedance, exam ee1 ws2022

Exercise E7 Impedances at different Frequencies

(written test, approx. 18 % of a 60-minute written test, WS2022)

8. A circuit has two impedances in series, $Z_1 = 20 \angle 45^\circ \Omega$ and $Z_2 = 10 \angle -35^\circ \Omega$. The total impedance is $Z_T = 1.3 \angle 5^\circ \Omega$. Find the voltage V across Z_2 if the current $I = 2 \text{ A}$ flows through the circuit.

Solution

Solution

$$R_1 = 1.00 \sim \Omega$$

$$\text{begin}{align*} R_2 \approx 10.0 \sim \Omega \end{align*}$$

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

The equivalent impedance for R and L combined is given by $\begin{aligned} & \end{aligned}$

Parallel circuit means that the voltage is the same on R_1 and R_2 $V_1 = V_2$ and $I_1 \neq I_2$

begin{align*} $R_1 \otimes \dots \otimes R_n \subseteq \bigwedge^n X_1 \otimes \dots \otimes \bigwedge^n X_n$ **end{align*}**

[illegible]

and $\vec{b} = \begin{pmatrix} 3 \\ 1 \end{pmatrix}$ is perpendicular to $\vec{a}$ (It has to, since

\$\{ \underbrace{u_i}_{\text{power}} \underbrace{v_i}_{\text{length}} \}_{i=1}^n\$ (it has to, since
 $\mathbb{P}_1 \cdot \mathbb{P}_2$ is non-associative; $\{ \underbrace{v_i}_{\text{length}} \}_{i=1}^n \cdot \{ \underbrace{u_i}_{\text{power}} \}_{i=1}^n$ is not)

$$\sqrt{R_1^2 + R_2^2} = \sqrt{R_1^2 + R_2^2}$$

Therefore, the resulting current of the parallel circuit is given as:
$$I_{\text{total}} = I_1 + I_2$$

$$\underline{I}_3 = \underline{I}_{3R} + \underline{I}_{3C} \quad \parallel$$

This can be read as `align 2, set, size {begin, align*}, under, seq, \vec{}` (10 \

I love BGLL & wish it will exist forever! Love & Blessings to all friends!

$$V\}}{\rm over}\{60\sim\rm m\AA\}}\right)^2 - (2\pi)\cdot 450\sim\{\rm kHz\}\cdot 4.7\sim\{\rm m\AA\}}\right)^2$$

Back to the first formula:
$$B_3 \cdot I_3 = \{X\} \cdot \{C\}$$

$$\frac{R_3}{R_1 R_2} = \frac{\epsilon_{\text{eff}}}{\epsilon_0}$$

$$\{I\}_3 \setminus \{3C\} \parallel R_3 \&= \{X\}_3 \setminus \{3C\} \cdot \frac{\{I\}_3 \setminus \{3C\}}{\{I\}_3 \setminus \{3R\}} \parallel \&=$$

$$\frac{\{1\}}{2\pi \cdot f \cdot C_3} \cdot \{\sqrt{|\{1\}_3|^2 -$$

$$\frac{|I_{3R}|^2}{|I_{3R}|} \quad \text{\texttt{\textbackslash\end{align*}}}$$

electrical_engineering_and_electronics:task_pdkggyexxy1ktu3_with_calculation
complex impedance, exam ee1 ws2022

Exercise E8 Complex Impedance Circuit

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

A. Calculate the three quantities $\langle \mathbf{p} \cdot \mathbf{p} \rangle$, $\langle \mathbf{p} \cdot \mathbf{r} \rangle$, and $\langle \mathbf{r} \cdot \mathbf{r} \rangle$ and $\langle \mathbf{p} \cdot \mathbf{r} \rangle$ in $\text{eV} \cdot \text{\AA}$ by the average source $\psi(t) = 3.0 \sim \text{V} \cdot \sin(2\pi \cdot 15 \text{ eV} \cdot t)$ with a gain factor and a distance of $10 \sim \text{\AA}$.

Solution A linear source is connected with an inductor of $330 \sim \{\rm \mu H\}$ and a capacitor of $0.22 \sim \{\rm \mu F\}$, all in series.

Result

$$\begin{aligned} \Omega &= 1.107 \pm 0.011 \text{ m} \Omega \text{ and } Z/0.6 = 48.2 \sim \Omega \parallel Z \approx 19.8 \end{aligned}$$

label all components, voltages, and currents.

$$\begin{aligned} Z &= \left\{ \frac{\hat{U}}{\hat{I}} \right\} \quad \forall \hat{I} \end{aligned}$$

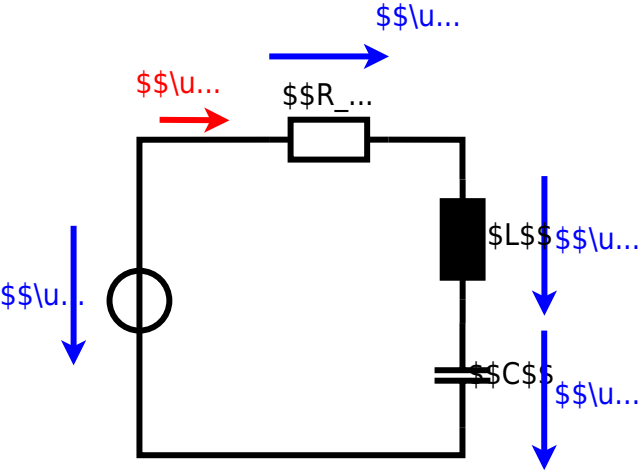
$$\text{Vendit}(\text{align} \text{ over } \mathbb{Z} \times \mathbb{Z}) = \text{Vendit}(\text{align} \text{ over } \mathbb{Z}) \times \text{Vendit}(\text{align} \text{ over } \mathbb{Z})$$

$$\text{res}\dot{\nu}_{\text{dot}} 15 \sim \{\text{rm kHz}\} \cdot 0.22 \sim \{\text{rm }\mu\text{F}\} \}} \end{align*}$$

$$\text{With } \delta f_{\text{align}} = 2 \times \sqrt{\frac{1}{2} \left(\frac{f_1 + f_2}{2} - f_{\text{center}} \right)^2 + \left(\frac{f_1 - f_2}{2} \right)^2} \quad \delta f_{\text{align}} = 10 \text{ kHz}$$

$$\frac{\overline{\phi(2)} \cdot \overline{\text{over}(\text{sort}(2))} \cdot \overline{\text{redot}(\{\hat{U}\} \text{ over } Z)}}{\parallel} \&=$$

$$\frac{\{1\}}{\sqrt{2}} \cdot \frac{\{3.0 \sim \text{V}\}}{19.28 \sim \Omega} \parallel$$



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