NEISSE-ELEKTRO 2025

Name:

School:

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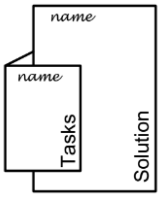
Tasks for the finale; 90 min; with formulary (English edition)
Please **use a separate sheet of paper** for each task.
Write your name and school on **each** of these papers.
At the end, fold your solution sheet according to the picture.



Task 1 (20 points)

For the electrical circuit from Figure 1 please calculate:

a) The current I_x and voltage drop U_x for the resistor R_x when $R_x = 5\Omega$.
b) The current I_x and voltage drop U_x on the resistor R_x when $R_x = 20\Omega$.
c) The value of R_x that gives the highest power P on the resistor R_x.

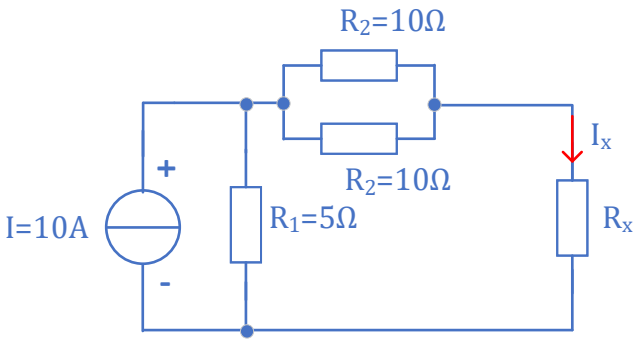


Figure 1

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Task 2 (20 points)

For the electrical circuit from Figure 2, please calculate:

a) The currents I_{12}, I_{23} and I_3.
b) The voltage drop U on resistor R_{23} and voltage drop U on the current source I.
c) The powers P on the resistor R_{12} and R_{23} as well on the sources U and I.

(voltage source: U = 30V, current source I = 5A, I_1 = 10A, I_2 = 5A)

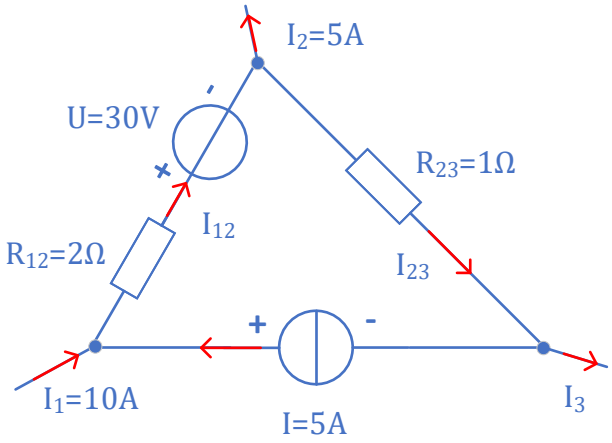

Figure 2

Task 3 (20 points)

The high-capacity capacitor (so called supercapacitor) can be charged over a voltage source U. The charging process starts after closing the switch K (see Figure 3). Before the time when the switch was closed, the capacitor was discharged. The capacitor C is assembled from two materials (conjugated polymers) with different relative permittivities (ε_{r1}=11,29, ε_{r2}=200) and thicknesses ($d_1=5\cdot10^{-10}$m, $d_2=8{,}8549\cdot10^{-9}$ m). The total area S of single plate equals 1,0m^2.

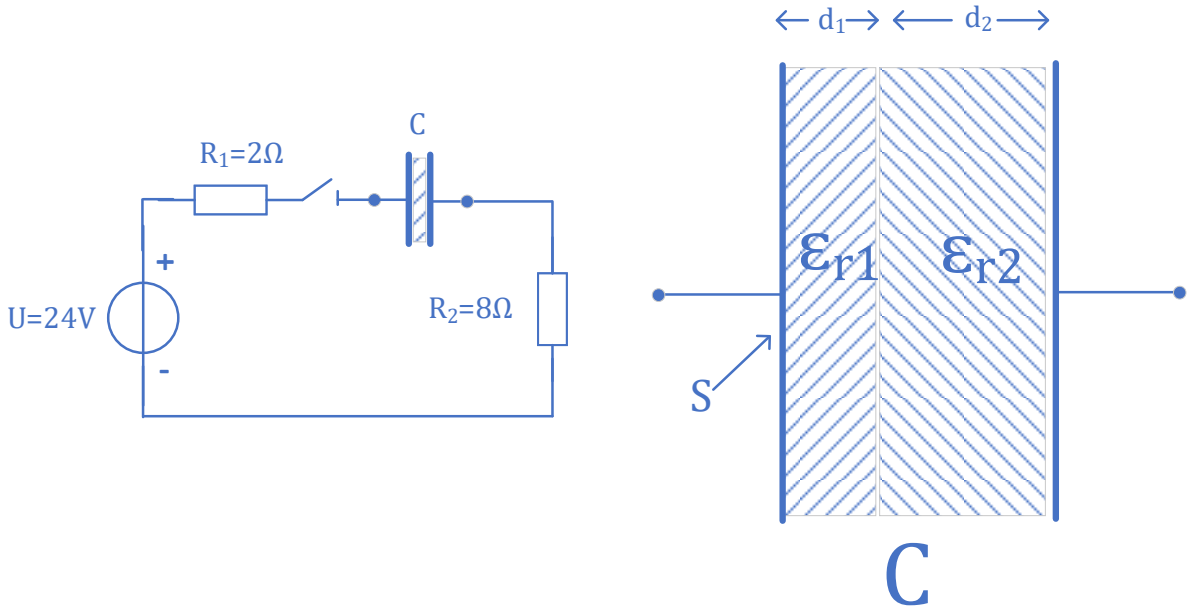

Figure 3

a) Calculate the entire capacity C.
b) Sketch a graph of the voltage across the capacitor C during the charging process.
c) Calculate voltage U and charge amount Q of the capacitor for t=0.1s and t=10s.
d) Calculate the voltage U_1 and U_2 on the two materials for t=0.1s and t=10s.
e) Calculate the stored energy in the capacitor C after the charging process is finished.

Task 4 (20 points)

Given is a homogenous magnetic field B=0,2T which is crossing the closed area with the angle of β=20°. The area is created by two conducting rails and two conducted metal rods. The electrical contact between rods and rails is ideal. The metal rods are moving along the rails at different speeds: v_1 = 0,2m/s and v_2 = 0,5m/s, see Figure 4.

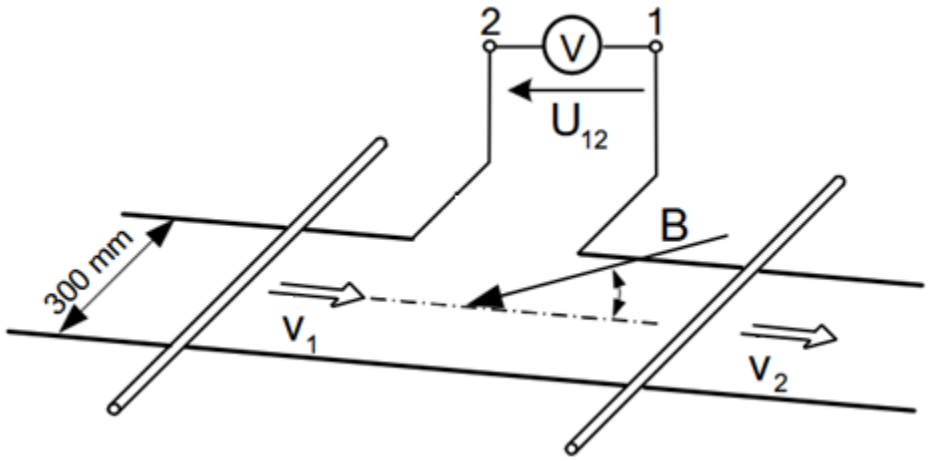

Figure 4

a) Calculate the voltage U_{12} indicated by the voltage measurement device. The loop resistance of the measuring circuit is given by R_s, the internal resistance of the voltage meter is given by R_M (R_M>>R_s).

Task 5 (20 points)

A transformer with an input voltage of U_{in} = 230V was connected to a halogen lamp. The lamp had a power P_1 = 40W and a voltage U_1 = 12V.
When the lamp was replaced with an LED module, the measurement showed a voltage of U_2 = 15V and power P_2 = 6W.

Please assume an ideal transformer with a winding resistance R_T on its secondary side (series connection to the output voltage U_{out} of transformer) and make following calculations:

a) Sketch the schematic for the described circuit and mark relevant voltages and currents.
b) Calculate the inner resistance R_T of the output winding.
c) Calculate the secondary current I in the halogen lamp and LED load.
d) Calculate the effectivenesses η of the circuit for the halogen lamp and the LED module.
e) Calculate the transformer ratio.

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