30. Internationale Elektrotechnik-Olympiade der Schulen der Euroregion Neisse

NEISSE-ELEKTRO 2024

Name:

School:

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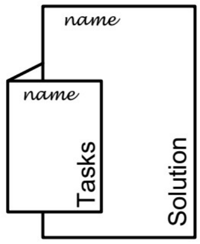

Tasks for the finale; 90 min; with formulary (English edition)
Please **use a separate sheet of paper** for each task.
Write your name and school on **each** of these papers.
At the end, fold your solution sheet according to the picture.

Task 1 (20 points)

For the electrical scheme from figure 1 please calculate the following values:

a) equivalent resistance R_0 of the circuit
b) current I_S
c) voltage drop U_R on resistance 2R

where R = 10Ω. The voltage source U is 100V.

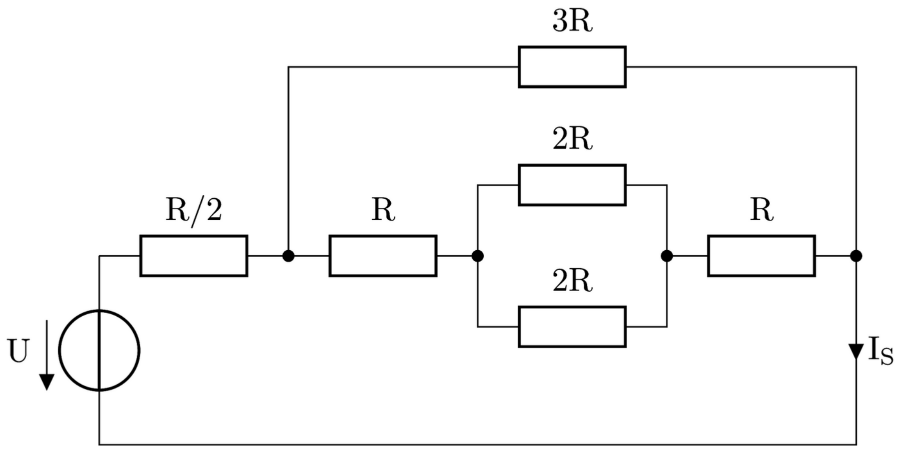

Figure 1

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Task 2 (20 points)

For a special application a real capacitor with different materials was designed. Figure 2 shows the cross section of the capacitive part only.

However, the equivalent circuit of this real capacitor includes a serial resistor R_s with low resistance value of 0.1mΩ. In addition to the capacitive part C and the series resistance R_s, a very high resistance R_p of 10MΩ in parallel should be taken into account.

Relative permitivities:	ε_{r1} = 5,000, ε_{r2} = 2000, ε_{r3} = 3000, ε_{r4} = 2200
Distances:	$d_1 = 5\cdot10^{-12}$m, $d_2 = 2\cdot10^{-11}$ m, $d_3 = 3\cdot10^{-11}$ m
Surface area	S = 0,1129m^2

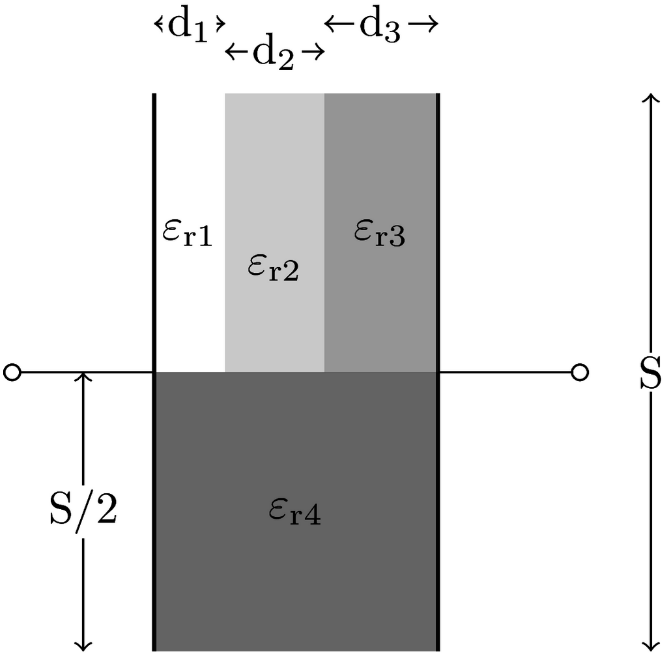

Figure 2

a) Draw the equivalent circuit with all elements.
b) Calculate the capacitance for each capacitor.
c) Calculate the total capacitance of the construction.
d) Calculate total charge if the DC voltage at terminals of the real capacitor is 100V in steady state (after long time).
e) Calculate the resistance of the total capacitance for the nominal frequency of 50 Hz.

Task 3 (20 points)

Given is a node with three currents (figure 3a). Two currents are known with their value over time (figure 3b).

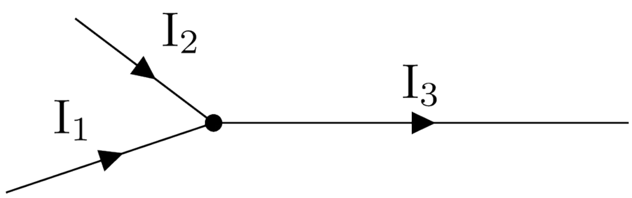

Figure 3a

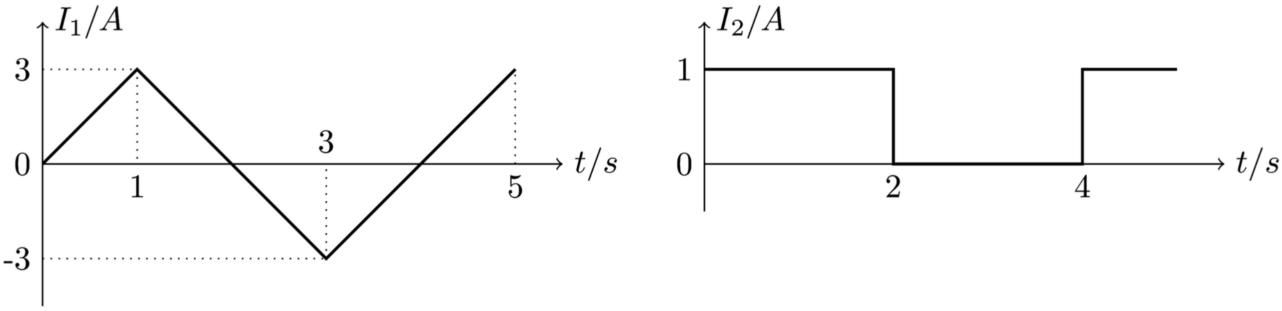

Figure 3b

a) Draw the current I_3 over the time. Mark the maximum a minimal current in your sketch
b) Calculate the values from a).
c) For the wire with current I_3: draw the value of the magnetic flux density B at a distance r = 0,01cm caused by I_3 over time. Assume a infinite long wire. Mark the maximum and minimal values.
d) Calculate maximum and minimum value of flux density of c).

Task 4 (20 points)

Given is a transformer with an AC input voltage U_{in} = 230V with N_p = 400 windings on the primary high voltage side and two secondary windings with N_{s1} = 20 and N_{s2} = 40.

The thermal losses in magnetic core of transformer are reflected by resistance R_{Mp}=10kΩ. The thermal losses of the windings of secondary sides are reflected by R_{s1}=0,5Ω, and R_{s2}=1Ω respectively.

Both outputs of the transformer are connected with LED lamps with nominal power P_{n1} = 5 W (at U_{n1}=12V) and P_{n2}= 10 W (at U_{n2}=24 V). Assume the LEDs as fixed value resistors for your calculations.

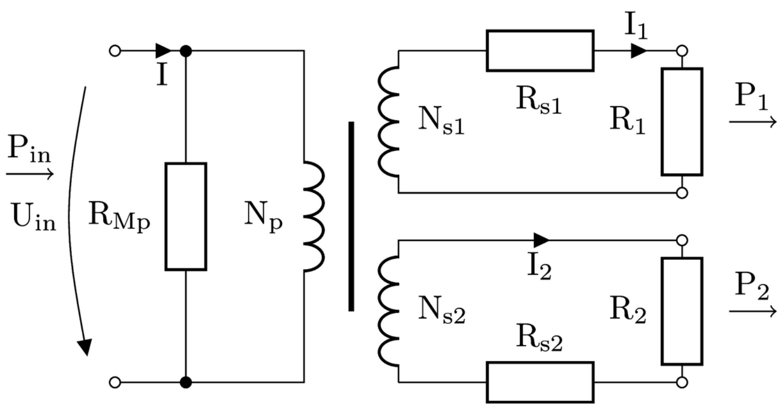

Figure 4

a) Please calculate the current I on the primary side
b) Calculate the power P_{in} on the primary side
c) Calculate the effectiveness of this circuit during parallel operation of both LEDs.

Task 5 (20 points)

A metal wire is moving in direction of the DC source U = 3,5V with the constant speed of v=36 km/h on two parallel infinite long busbars with distance to each other of d=1,5m (see figure 5). The resistance of the busbar is neglected. The constant magnetic flux density B=0,1T occurs in this area. Please calculate:

a) the induction voltage due to movement of the wire
b) current flowing in the circuit
c) generated power needed to guarantee the movement with constant speed v (remark: in kinetics, the power is reflected as |P|=|F·v|)

The resistance of the of wire is R_{WIRE} = 0,1Ω and resistance of the source R is 0,4Ω.

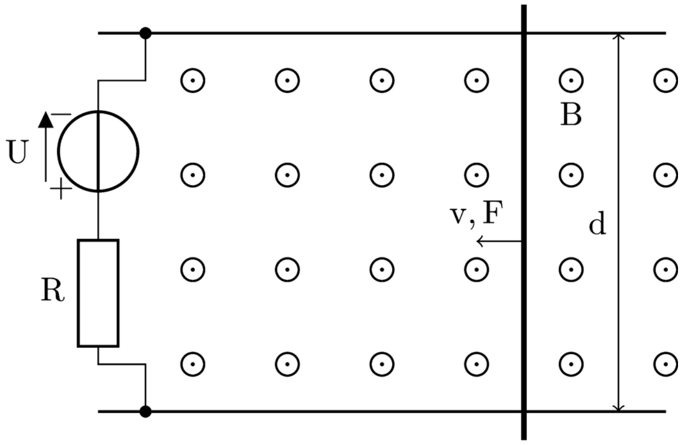

Figure 5