29. Internationale Elektrotechnik-Olympiade der Schulen der Euroregion Neisse

NEISSE-ELEKTRO 2023

Name:

School:

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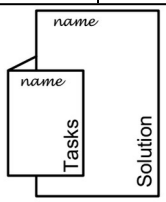
Tasks for the finale; 90 min; with formulary (English edition)
Please **use a separate sheet of paper** for each task.
Write your name and school on **each** of these papers.
At the end, fold your solution sheet according to the picture.



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 flowing in the circuit I_S
c) voltage drop U_R on marked resistance R/4

where R = 5Ω. The voltage source U is 100V.

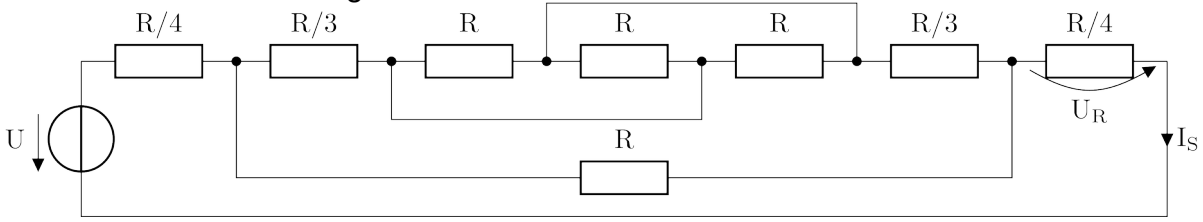


Figure 1

Task 2 (20 points)
In figure 2 a so-called electrical field probe is shown. It constists of two cylindrical capacitors. Such an element is used for measuring of voltages in electrical networks. The main metallic wire with the radius of r_0=0,002m is routed in the middle of the central positioned two cylindrical steel plates with length of 0,3m, radius of r_1=0,01m and r_2=0,0104m respectively. Between plates, the isolation material with relative permittivity of ε_1=2,5 and ε_2=6,0 exists. The second plate is grounded. The first plate is connected with a voltmeter U_{meas}.

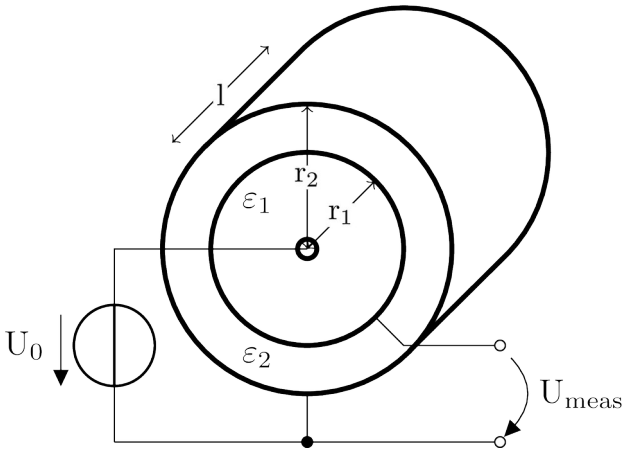


Figure 2

a) Please draw the equivalent circuit for the filed probe from figure 2.
b) Calculate all the relevant capacitances between the plates and wire.
c) Under assumption, that the electrical wire is under a voltage U_0 of 10kV AC, please calculate the voltage U_{meas} which should be displayed on a voltmeter.

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Task 3 (20 points)
The low voltage load with resistance of 5Ω is supplied over the ideal transformer which transfers the typical 230 V 50Hz into secondary 24 V voltage level. The load is connected to the transformer output with a long wire with resistance of 1Ω.

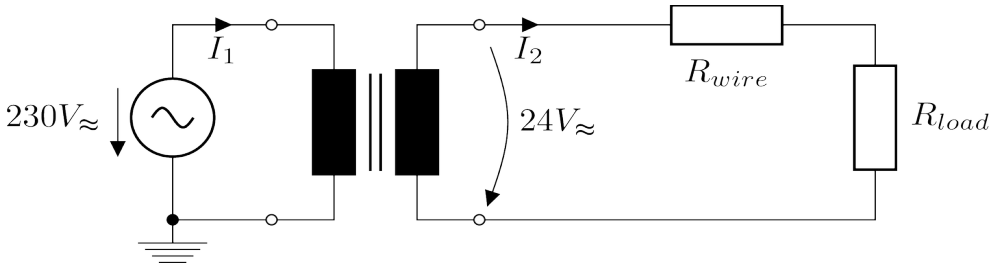

Figure 3

Calculate

a) the current I_1 and I_2
b) and the power on primary side and power of the load.
c) How many windings has the transformer on the secondary side, if the number of the primary windings is 2300?

Task 4 (20 points)
Given is a magnetic core with the following characteristics:

average length of the core l = 5 cm
Area of core A = 0,5 cm^2
relative permeability μ_r = 1000

with two windings of each 10 turns in the opposite direction.

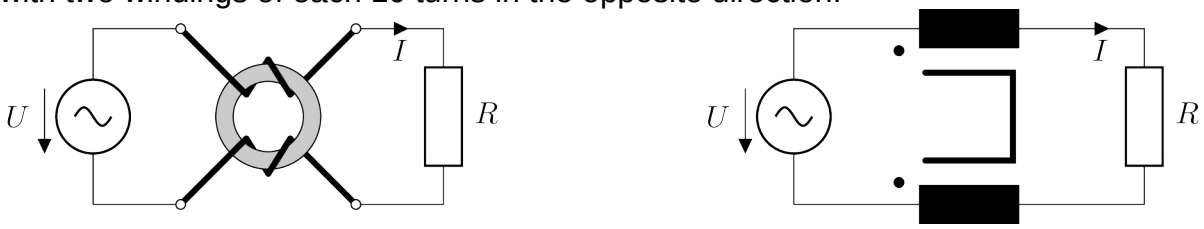

Figure 4

a) Calculate the inductivity L of one winding.
b) Calculate the current in resistor R = 25Ω with a voltage source of 10Veff and 16kHz frequency.
c) Calculate the current in R if only one winding is left in the circuit!

Task 5 (20 points)
Given is the circuit in figure 5. At time t_1 a switch is switched to the voltage source. At time t_2 it switches to the previous position. Before change of switch, the charge process is finished.
U=10V, R_1 = 2kΩ, R_2=1kΩ, C=1µF

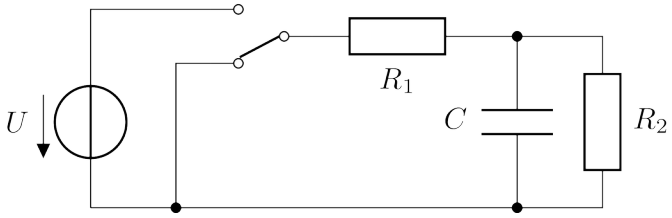

Figure 5

a) Draw the graph with the current I on R_1. Draw the x-axis with the time t_1 and t_2 according to the figure 6. Mark the starting values and the values after the charge process for I after t_1 and t_2.
b) Calculate these four values.

Figure 6

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