

Contestant number:

Submission time:

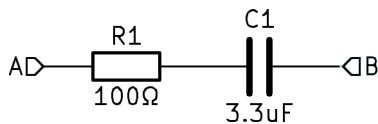
Number of points of the Theoretical part:

Theoretical part – set of questions from electronics (30 points)

Prepare an answer to each question. You get 1 point for each correct answer.

For a task that requires calculation, use the space within the questions or the back of the test. Clearly mark each task with a serial number. Each result must also contain the correct units. A numerical result without units or a sufficiently detailed calculation (or a reasoned result) will not be recognized!

1. Calculate the value of the complex impedance between terminals A-B at a frequency of $f = 480 \text{ Hz}$



Z =

2. Which physical unit is used for the quantity electric field intensity?
3. An ideal transformer has the number of turns on the primary $n_{\text{prim}} = 1200$ and two secondary windings with the number of turns $n_{\text{sek}} = 120$ each. The primary is connected to an alternating voltage $U_{\text{prim}} = 230 \text{ V}$. The secondary windings are connected in series. Calculate the output voltage value. How will the output voltage change if we connect the secondary windings in parallel?

$U_{\text{selection, serial}} =$

$U_{\text{section, parallel}} =$

4. Calculate the length of the radiating element of the quarter-wave vertical antenna for the frequency $f = 144 \text{ MHz}$

$L = \lambda/4 =$

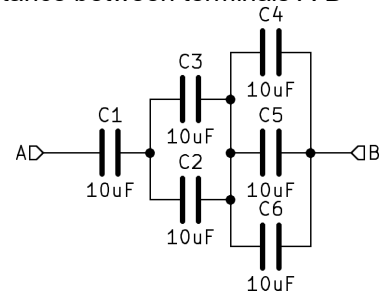
5. A lead-acid battery contains 12 cells, each with an open-circuit voltage $U_{\text{cell}} = 2.148 \text{ V}$ and an internal resistance $R_{\text{cell}} = 0.27 \Omega$. Calculate the no-load voltage of this accumulator, its internal resistance and the value of the maximum short-circuit current.

$U_{\text{accumulator}} =$

$R_{\text{accumulator}} =$

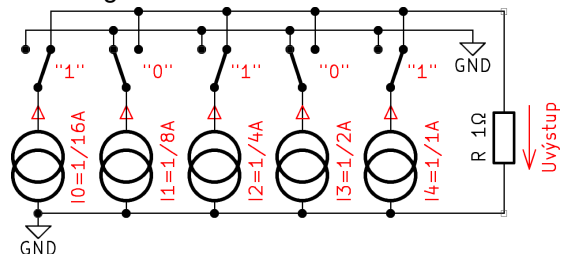
$I_{\text{short}} =$

6. Calculate the value of the equivalent capacitance between terminals A-B



C =

7. A very useful concept for converting a number to an analog value is the so-called current steering DAC. Calculate the magnitude of the output voltage for the input code $N = 10101b$ as shown in the figure:



$U_{\text{output}} =$

8. Jozef brought electricity to his garden house with a 100 m long CYKY 3x1.0 mm² cable. After connecting the electric cooker

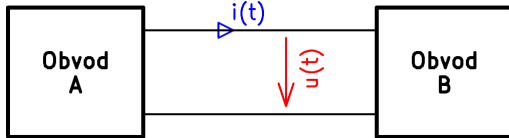


but he found that it was not very warm. What is the total resistance of the supply cable from the distributor?

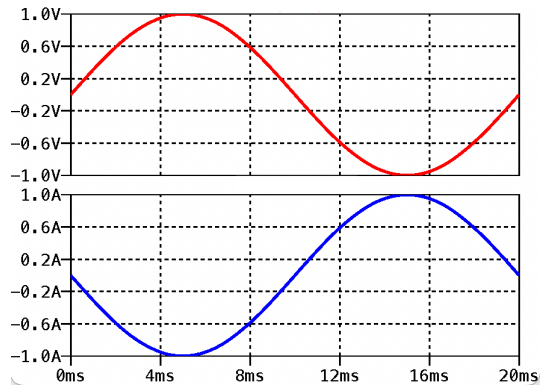
$$\rho_{\text{med}} = 1,78 \times 10^{-8} \Omega \cdot \text{m}$$

R =

9. Circuits A and B are connected by two wires as shown



The voltage and current curves in the circuit are as follows



Which circuit is the source and which is the consumer?

Circuit A:

Circuit B:

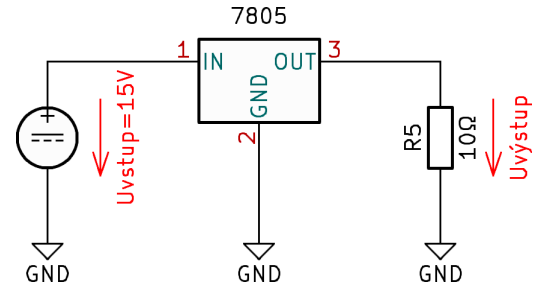
What is the nature of the load?

10. The picture shows the so-called Helmholtz coil. These are two short coils (solenoids) with radius R , which are separated from each other by the exact distance R . What is the important property of the magnetic field on the axis of the coils, which is the reason why they are often used?



Theoretical part, category A

The following figure shows the wiring of the very popular 7805 type linear voltage stabilizer.



9. What is the output voltage value of the stabilizer?

U_{Output} =

10. Calculate the efficiency of this stabilizer if $U_{\text{output}} = 15 \text{ V}$. Neglect the own consumption of the 7805

$\eta =$

11. Let us consider the ideal elements resistor, capacitor and coil. Which type of circuit cannot be realized from them and why? (circle)

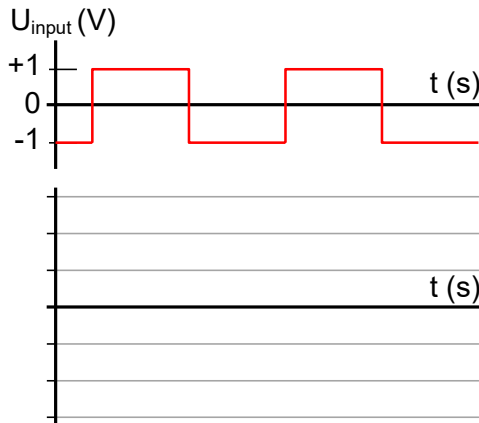
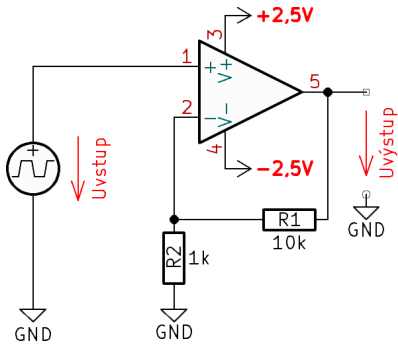
Low-pass filter - high-pass filter
 – band-pass filter – band-stop
 – amplitude limiter (limiter) – series resonance circuit – parallel resonance circuit – alternating coupling element

Reason:

12. Draw the complete circuit of a common-emitter transistor amplifier for AC signals. Label all important terminals and signals

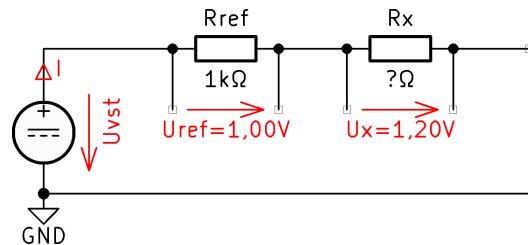


13. The picture shows the connection with a real operational amplifier and the signal we use to wake it up. The operational amplifier is of the rail-to-rail type. Plot the course of the output signal in the graph. Describe the axes properly.



16. Draw a typical volt-ampere characteristic of a silicon Zener diode with $U_z = 6\text{ V}$ (in forward and closed directions), mark important points and values

The figure shows a documented resistance measurement using the comparison method. R_{ref} is a reference resistor of known value, R_x is an unknown resistor whose value we measure



16. What is the main difference/complication in using thyristor and transistor in DC switching circuits?
17. What minimum number of bits do we need to write the entire decimal number 32 (without a sign) in the binary system?
14. Draw the time course of the amplitude modulated signal
15. Which parameter of a bipolar transistor expresses its current amplification factor?

17. Explain the principle of measuring resistance by the comparative method

18. Calculate the resistance value of the R_x resistor

$$R_x =$$

Bonus:

What will be the error of the calculated R_x value if we know that the reference resistor R_{ref} has a tolerance of $\pm 1\%$?

Assume that we know the value of R_{ref} exactly. What will be the error of the calculated R_x value if we use a voltmeter with an accuracy of $\pm 1\%$ to measure the voltage drops U_{ref} and U_x but it will be exactly the same voltmeter. First we measure U_{ref} and then U_x . Consider that the size of U_{ref} and U_x are very similar, as in the picture. Explain...





19. A magnetoelectric measuring device has a coil resistance of $R = 250 \Omega$ and reaches full deflection at a flowing current of $I = 100 \mu\text{A}$. Suggest how to wire it as a DC voltmeter with a range of 100 V. Draw a diagram and calculate the values of all elements
24. A segment of the digital communication signal is recorded on the oscilloscope screen. The vertical and horizontal axis settings of the oscilloscope are highlighted at the bottom of the oscillogram. Measure signal amplitude and bit duration (edge-to-edge time)



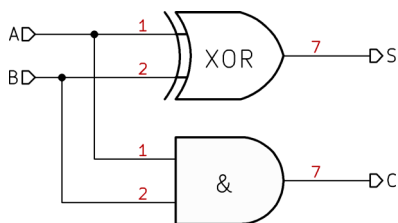
Amplitude =

Time 1 bit =

Bonus:

What is the bit rate of this communication line?

20. Write the truth table of the circuit from the figure



A	B	C	S

Bonus:

This circuit has a very specific function, what kind of logic circuit is it?

21. The microcontroller has digital outputs of the CMOS type 3.3 V. We want to use it to control a relay with a coil with a nominal working voltage of 24 V and a resistance of 330Ω . Suggest how to safely connect the relay coil to the microcontroller pin, draw the complete schematic and calculate the values of all the elements.

22. What are the names of the electrodes of the MOSFET type transistor?

23. Why is the signal for "ground" and power often distributed as a whole, continuous plane (polygon) on printed circuit boards and not through individual thin wires?

29. The amplifier has a harmonic signal with amplitude $U_{\text{INPUT}} = 100 \text{ mV}$ connected to the input. We measured the voltage at the output with the amplitude $U_{\text{OUTPUT}} = 3.16 \text{ V}$. Calculate its gain in linear scale (A) and gain in decibels (G)

A =

G =

30. What is a typical use of a Peltier cell in electronic systems?

