Answer Sheet

Task 1.1.1.

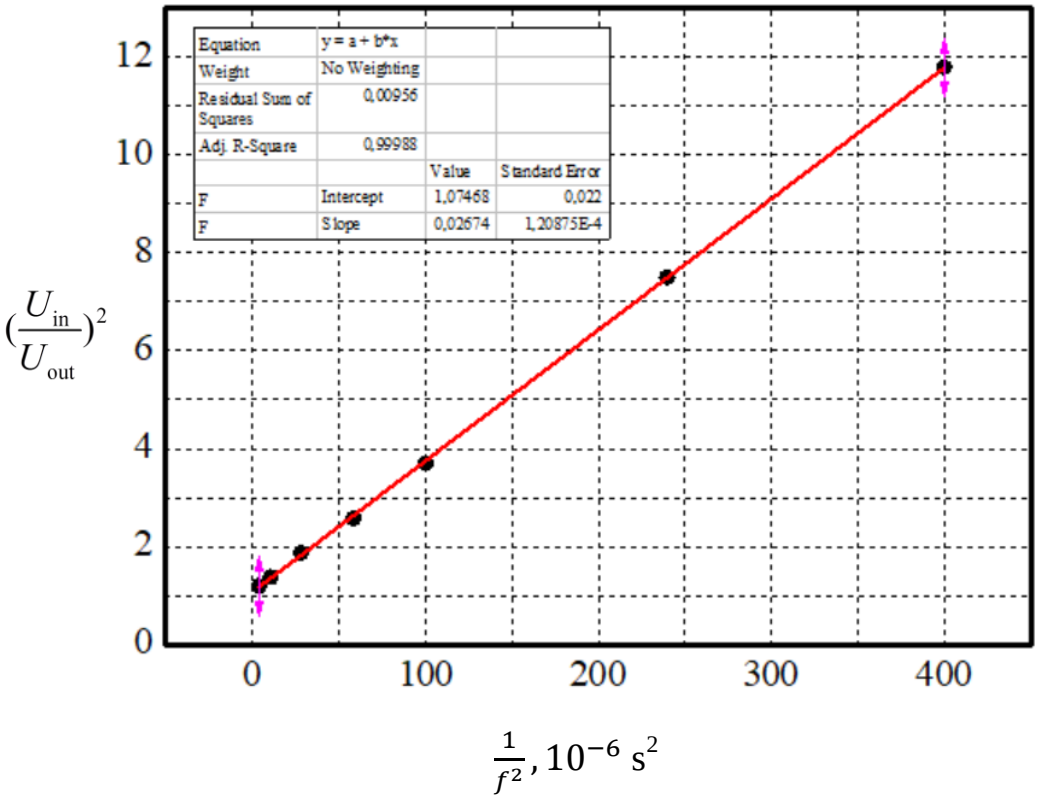
$$\frac{U_{\text{out}}}{U_{\text{in}}} = \frac{R}{\sqrt{R^2 + \frac{1}{\omega^2 C^2}}}$$
$$\Delta\varphi = \arctan\left(\frac{1}{\omega RC}\right)$$

Task 1.1.2.

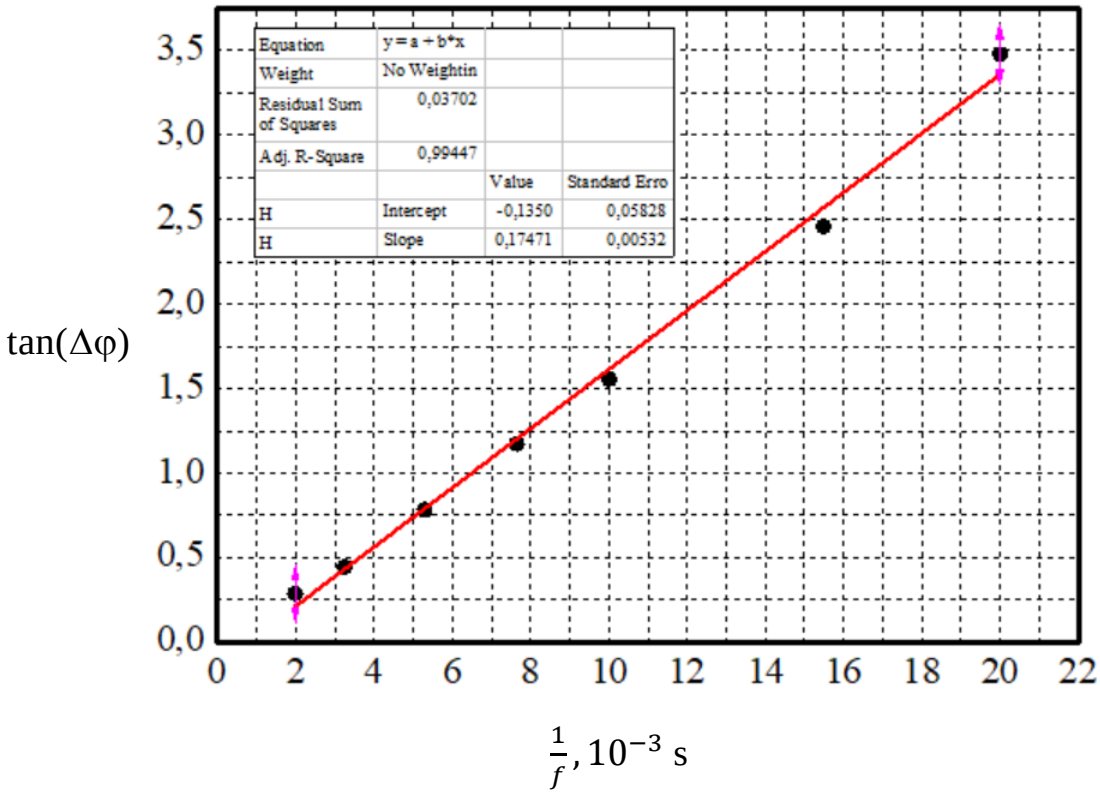
f, Hz	U_{in}, V	U_{out}, V	$\frac{U_{\text{out}}}{U_{\text{in}}}$	$\Delta\varphi$, $^{\text{o}}$	$\frac{1}{f^2}, 10^{-6}$ s^2	$\left(\frac{U_{\text{in}}}{U_{\text{out}}}\right)^2$	$\frac{1}{f}, 10^{-3}$c	tan($\Delta\varphi$)
50,0	23,0	6,7	0,291	73,6	400,00	11,78	20,00	3,4
64,6	23,0	8,4	0,365	66,9	240,37	7,50	15,49	2,35
99,9	22,8	11,8	0,518	57,5	100,20	3,71	10,01	1,57
130,7	22,8	14,2	0,623	50,4	58,54	2,58	7,65	1,21
188,8	23,0	16,8	0,730	37,2	28,05	1,87	5,30	0,76
308,0	23,0	19,6	0,852	25,2	10,54	1,38	3,25	0,47
504,6	23,0	21,0	0,913	15,6	3,93	1,20	1,98	0,28

Task 1.1.3.

The ratio $\frac{U_{out}}{U_{in}}$ versus frequency.



Phase shift $\Delta\varphi$ versus frequency.



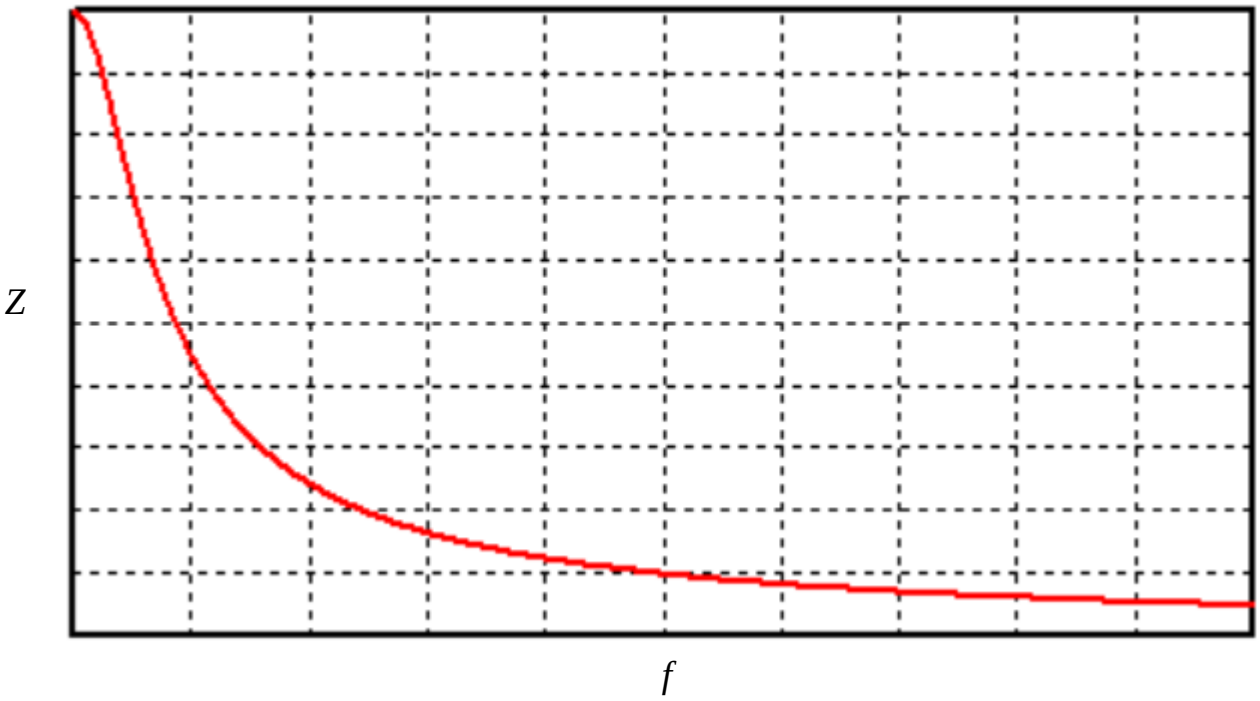
$RC = 9{,}7 \cdot 10^{-4}$ s

Task 1.1.4.

Element (a circuit constituent): Oscilloscope
Value: 1 MOhm
Instrument: *LCR*-meter

Task 1.1.5.

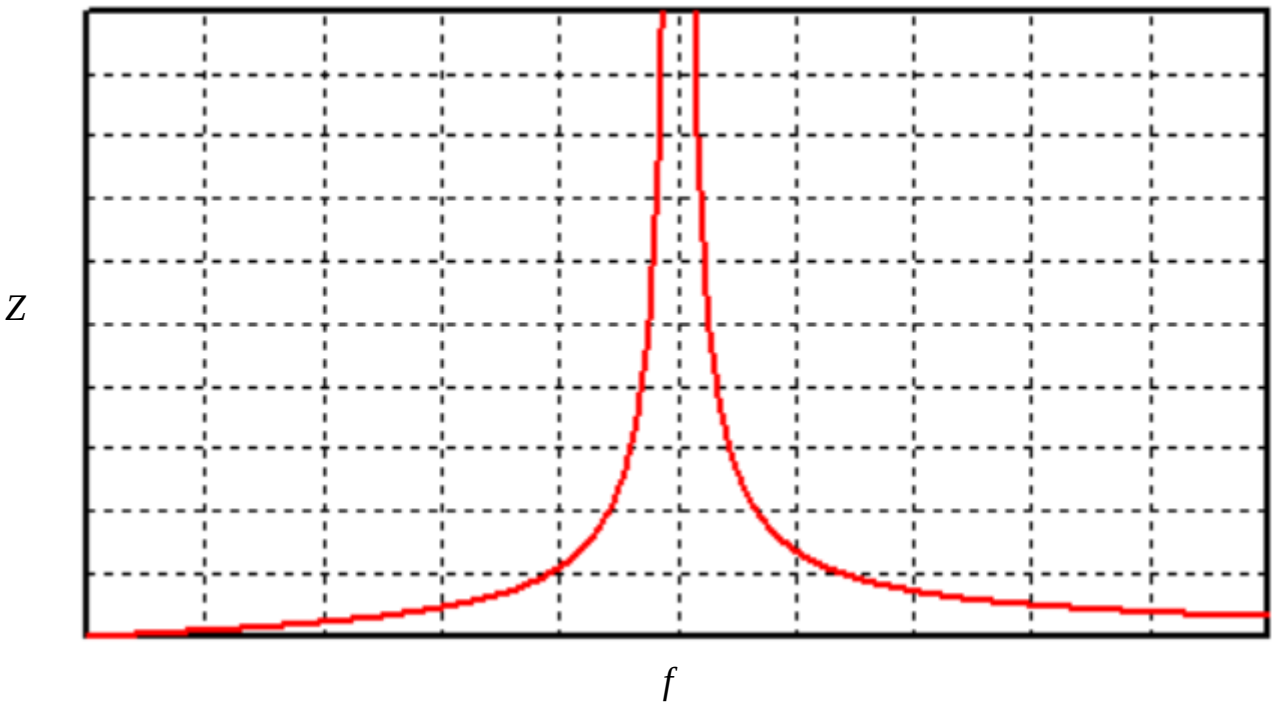
$Z(f) = \dfrac{R}{\sqrt{1 + (\omega RC)^2}}$



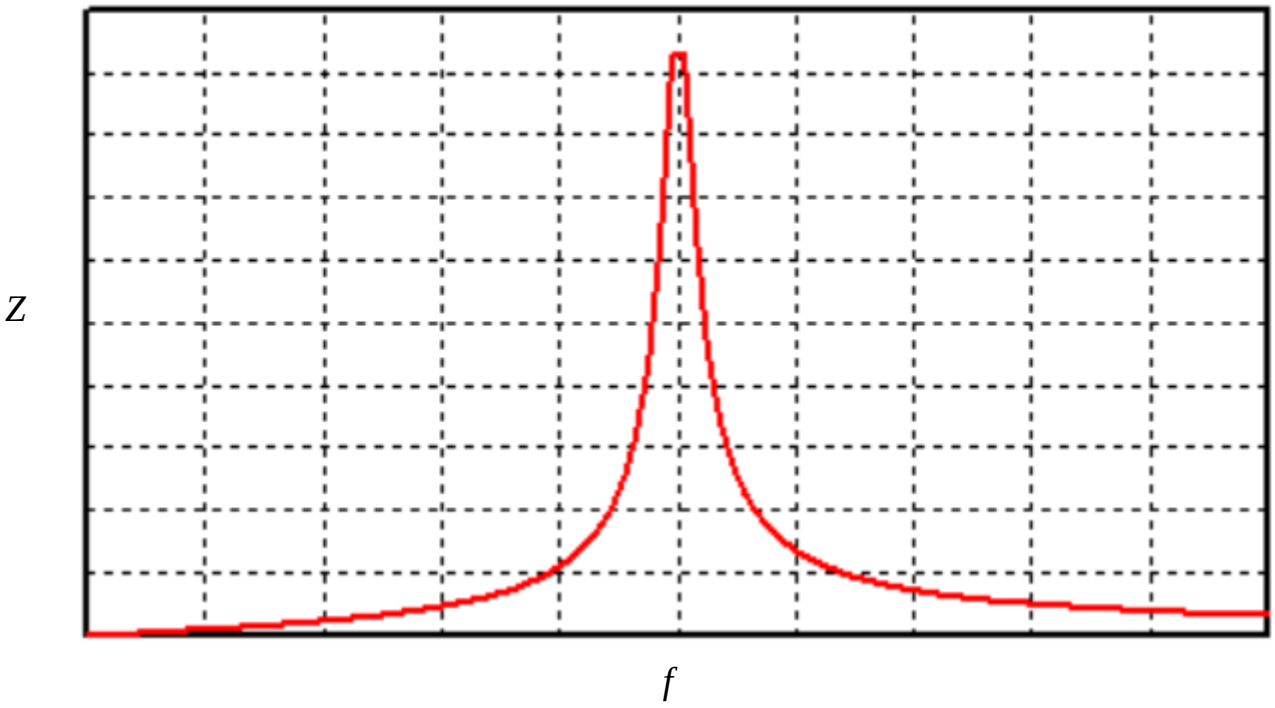
$Z(0) = R$	$Z(\infty) = 0$

Task 1.2.1.

$Z(f) = \left\lvert \frac{\omega L}{\omega^2 LC - 1} \right\rvert$	$f_r = \frac{1}{2\pi\sqrt{LC}}$



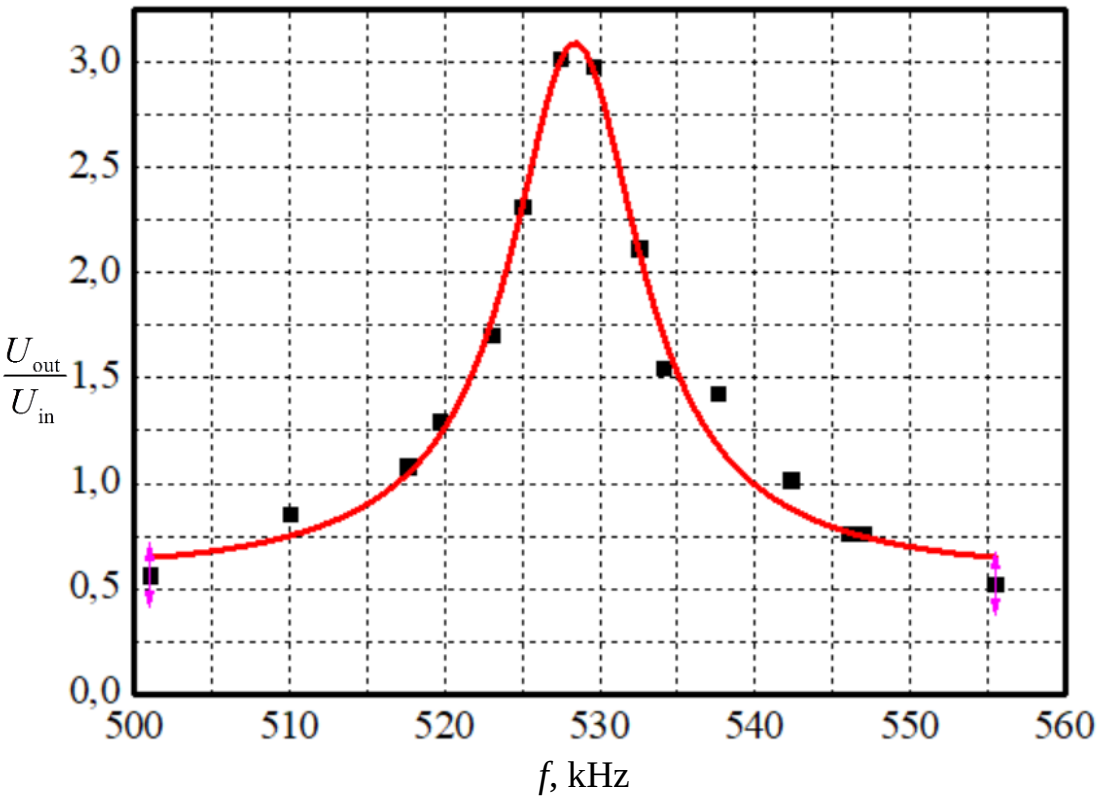
Task 1.2.2.



Task 1.2.3.

f, Hz	U_{in}, V	U_{out}, V	$\frac{U_{out}}{U_{in}}$
501,0	1,02	0,576	0,565
510,0	1,02	0,872	0,855
517,6	1,02	1,100	1,078
517,6	1,02	1,110	1,088
519,7	1,02	1,320	1,294
525,0	1,02	2,360	2,314
523,0	1,02	1,740	1,706
527,4	1,02	3,080	3,020
529,6	1,02	3,040	2,980
532,5	1,02	2,160	2,118
534,1	1,02	1,580	1,549
537,6	1,02	1,460	1,431
542,3	1,02	1,040	1,020
546,0	1,02	0,780	0,765
547,0	1,02	0,780	0,765

The ratio $\frac{U_{out}}{U_{in}}$ versus frequency.



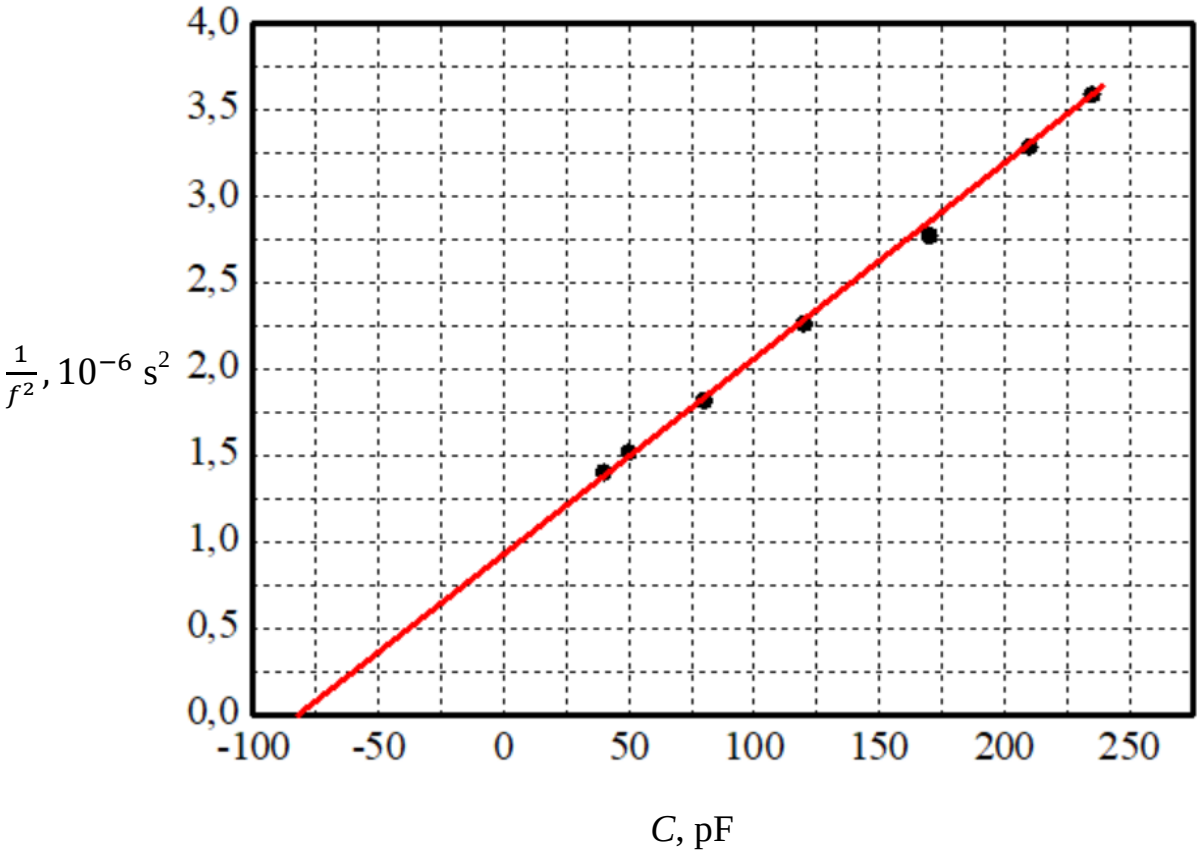
Task 1.2.4.

C = 235 pF	L = 293 μH
f_{theor} = 606 kHz	
f_{graph} = 528 kHz	
Совпадают ли частоты (подчеркните верное):	
Yes	No

Упражнение 1.2.5.

C, pF	f, kHz	$\frac{1}{f^2}, 10^{-6}$ s^2
235	528,0	3,59
210	551,8	3,28
170	600,9	2,77
120	664,8	2,26
80	741,8	1,82
50	811,6	1,52
40	844,5	1,40

Function of resonance frequency versus capacitance.



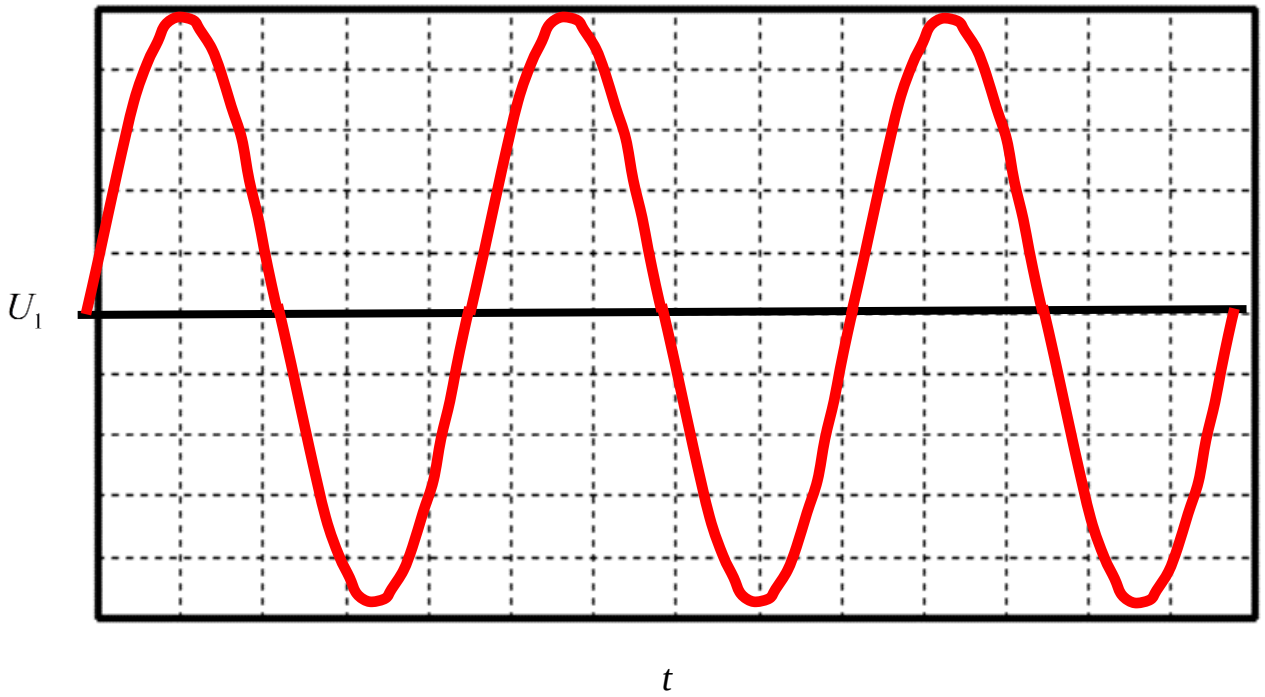
Analytical expression for the function of resonance frequency: $\frac{1}{f_r^2}$
The shift of the plot along the capacitance axis: 81 pF
The element with this capacitance: Oscilloscope

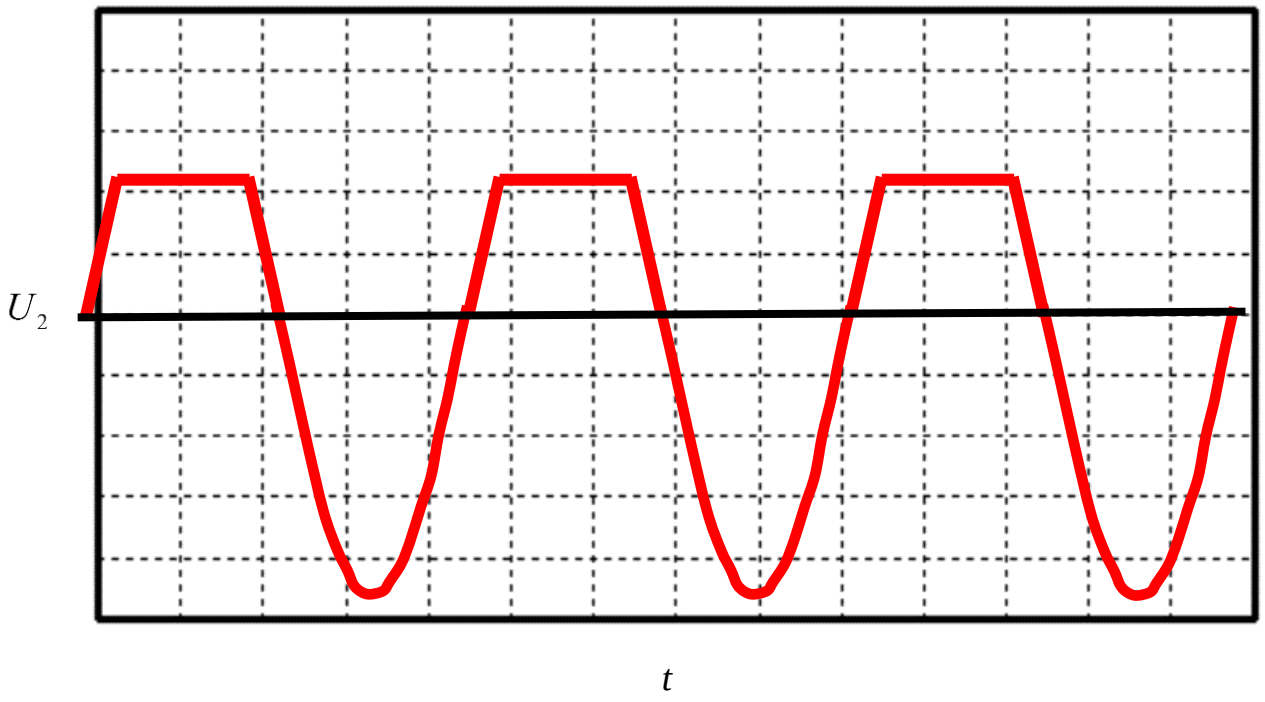
Task 1.2.6.

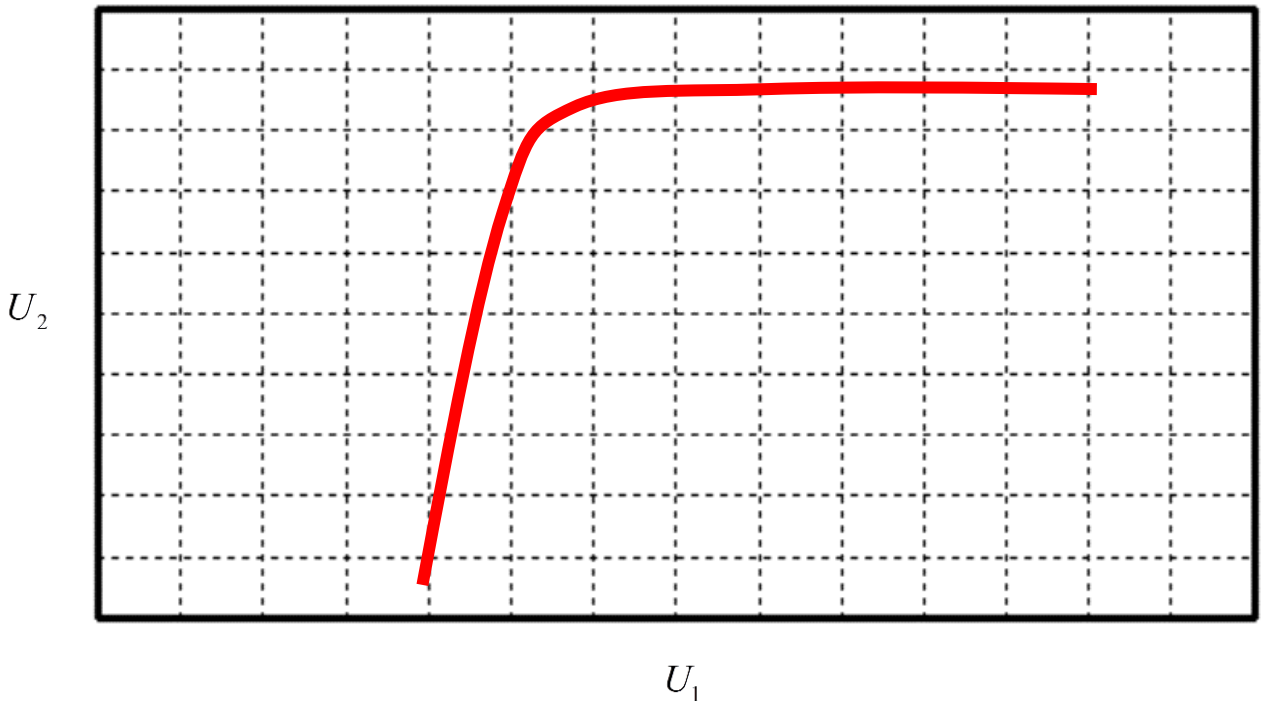
Working frequency of *LCR*-meter: 890 Hz

Task 1.3.1.

Saturation current of the diode: 2,0÷5,0 μA

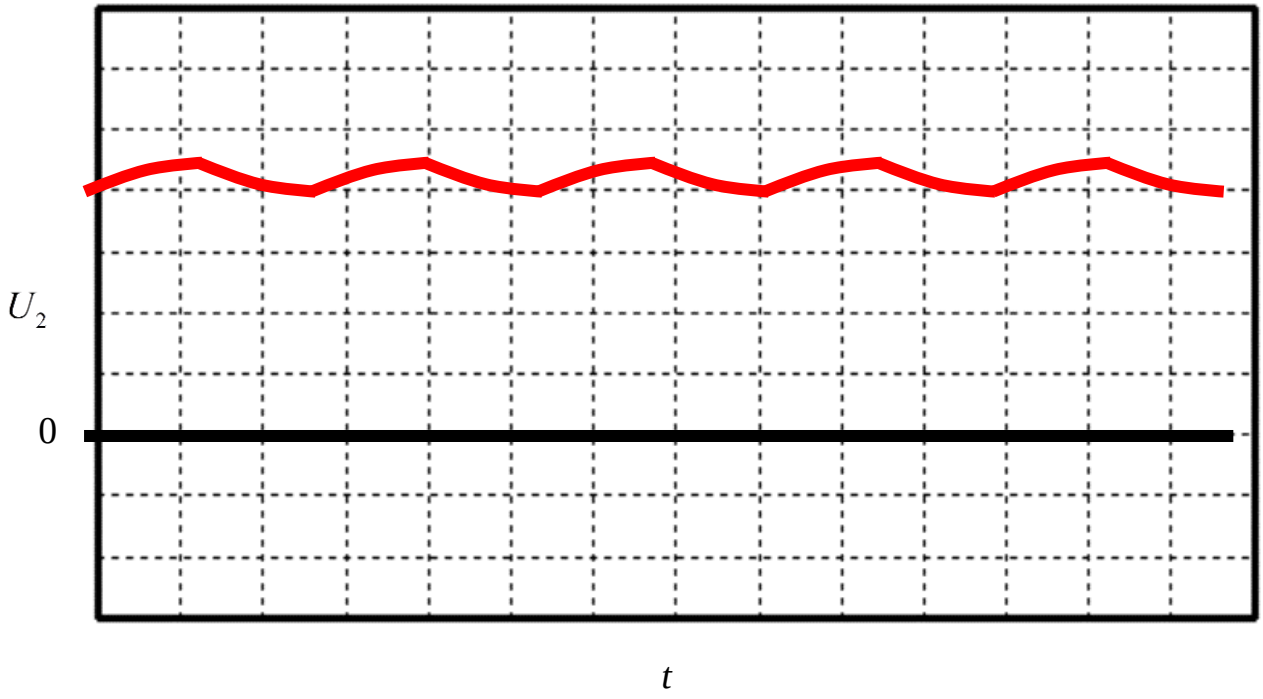



U_2
t

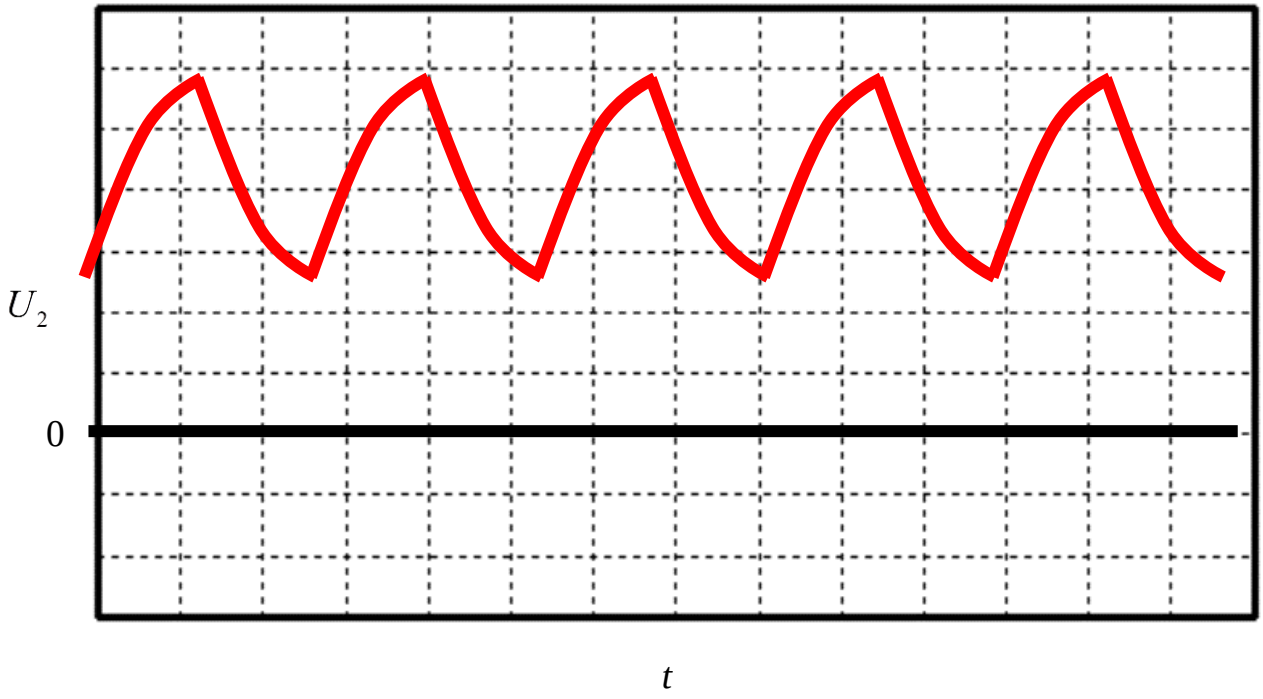

U_2
U_1

Task 1.3.2.

Waveform at the maximum frequency.



Waveform at the frequency less by two orders of magnitude.



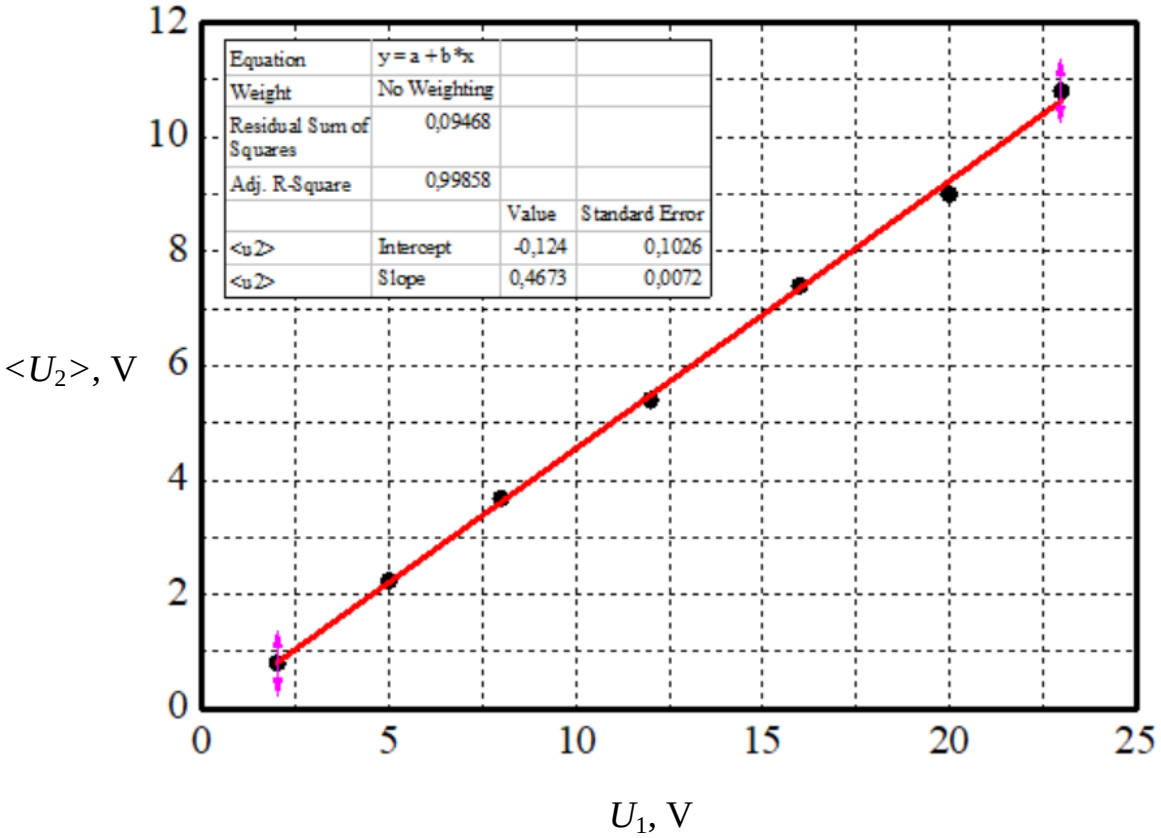
Task 1.3.3.

Rectification frequency (underline the correct answer):		
increases	decreases	does not change

U_1, V	$<U_2>$, V
23,0	10,8
20,0	9,0
16,0	7,4
12,0	5,4
8,0	3,7
5,0	2,2
2,0	0,8

Angular slope of the dependence of $<U_2>$ от U_1:
0,46

Voltage at the rectifier output versus voltage amplitude at the rectifier input.

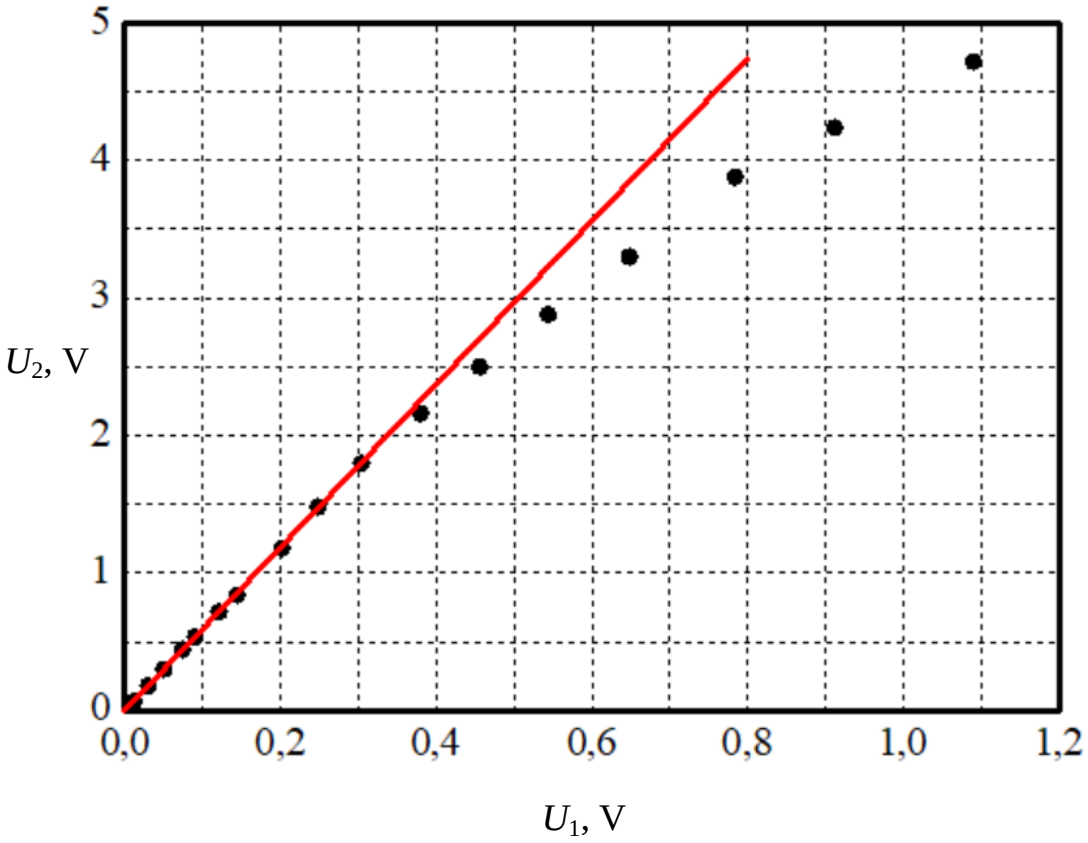


Task 1.3.4.

Range of resistances of the variable resistor: 370 – 500 Ω
Gain: 5,9
Amplitude at the amplifier input when switching to nonlinear mode: 0,30 V

U_1, V	U_2, V
0,012	0,068
0,030	0,180
0,050	0,302
0,074	0,444
0,090	0,536
0,121	0,720
0,144	0,840
0,202	1,180
0,248	1,480
0,304	1,800
0,380	2,160
0,456	2,500
0,544	2,880
0,648	3,300
0,784	3,880
0,912	4,240
1,090	4,720

Voltage at the amplifier output versus voltage amplitude at the amplifier input.



Task 1.3.5.

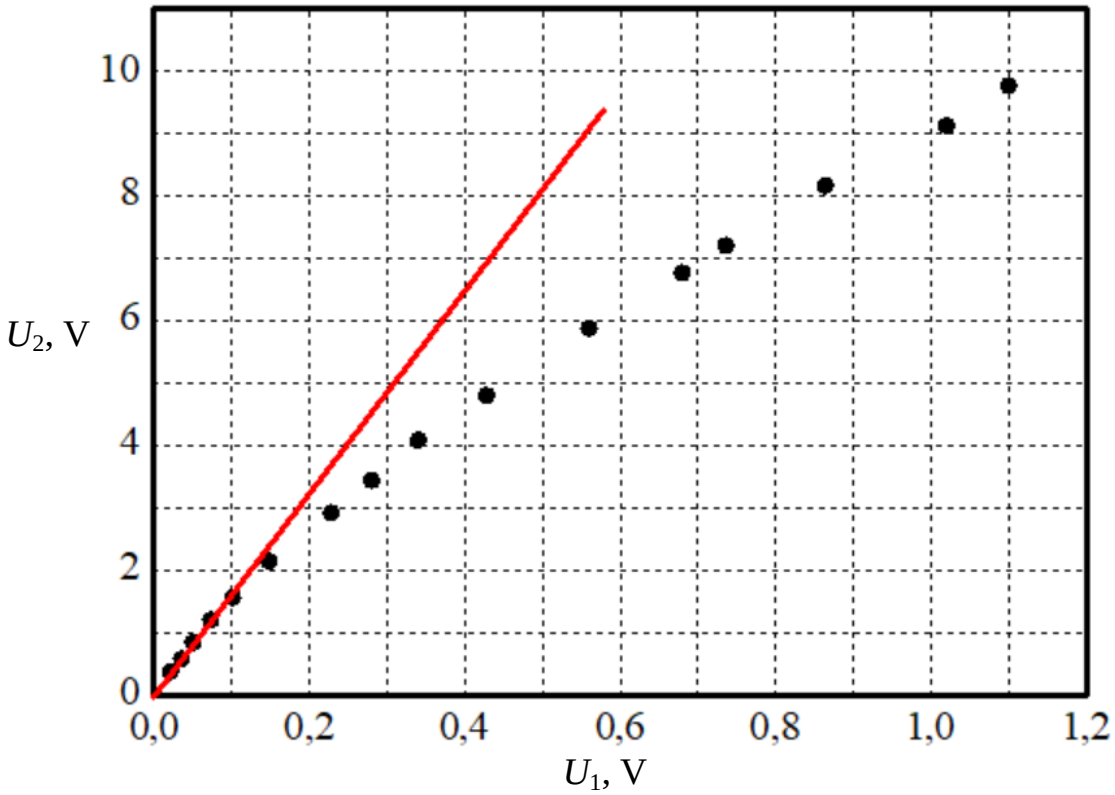
Frequency at the maximum gain: 748 kHz
Phase shift between the input and output signals at the resonance frequency: 180˚

Task 1.3.6.

U_1, V	U_2, V
0,021	0,38
0,035	0,58
0,050	0,84
0,073	1,20
0,101	1,56
0,148	2,14
0,228	2,92
0,280	3,44
0,340	4,08
0,428	4,80
0,560	5,88
0,680	6,76
0,736	7,20
0,864	8,16
1,02	9,12
1,10	9,76

Angular slope of the dependence of U_2 on U_1: 15,5

Output voltage amplitude versus input voltage amplitude of the resonance amplifier.



Task 1.3.7.

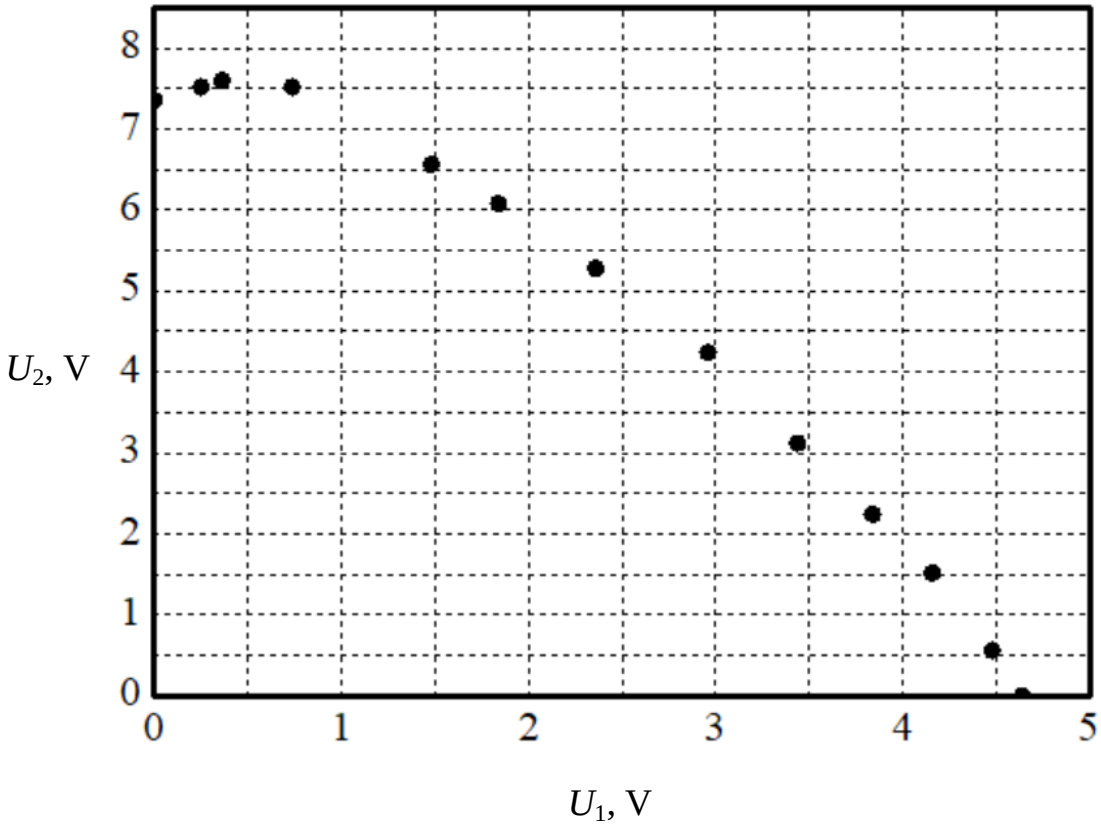
Number of turns of secondary winding:
12-13

Task 1.3.8.

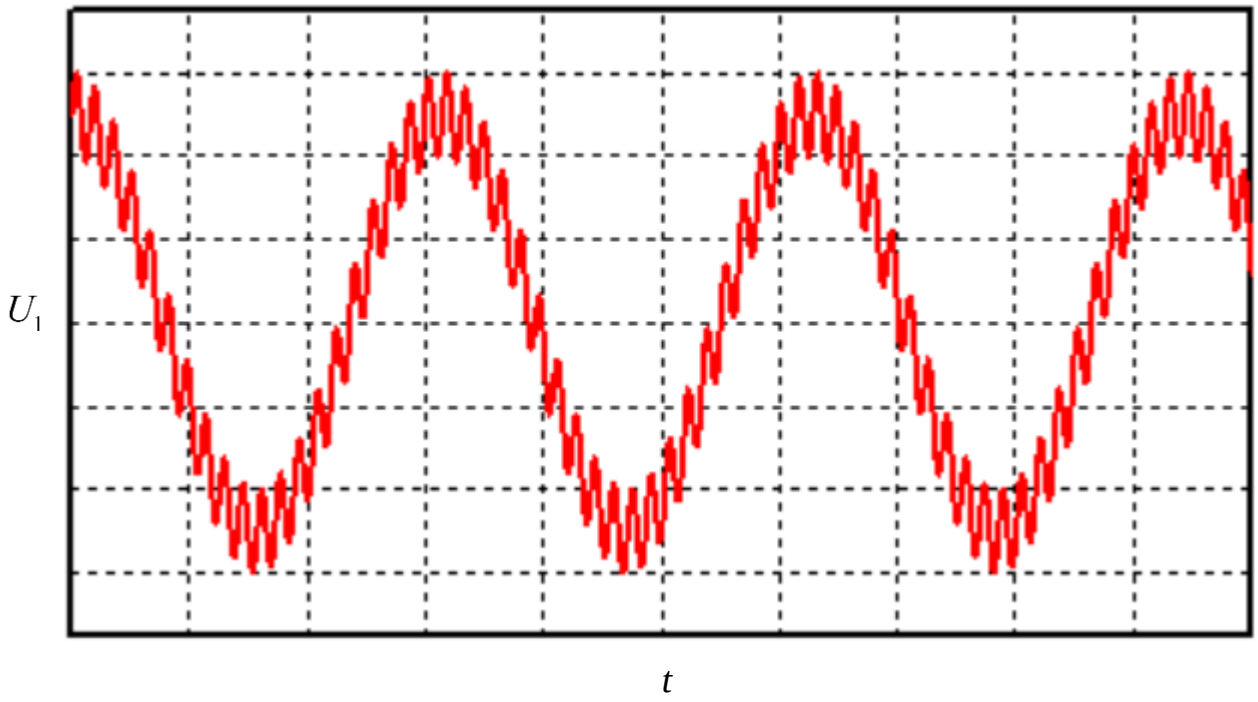
U_1, V	U_2, V
0	7,36
0,248	7,52
0,36	7,60
0,736	7,52
1,48	6,56
1,84	6,08
2,36	5,28
2,96	4,24
3,44	3,12
3,84	2,24
4,16	1,52
4,48	0,56
4,64	0

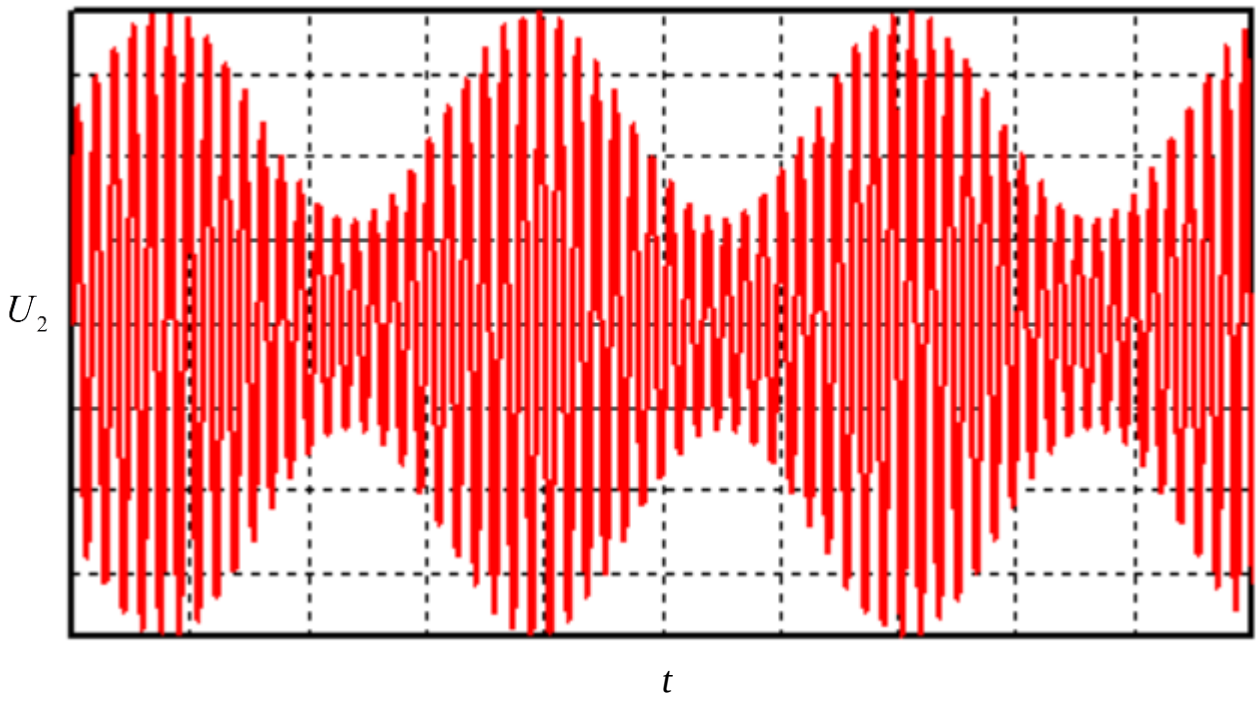
Gate voltage at which generation fails:
4,7 V

Voltage amplitude at the output of HF oscillator versus average gate voltage:



Task 1.3.9.

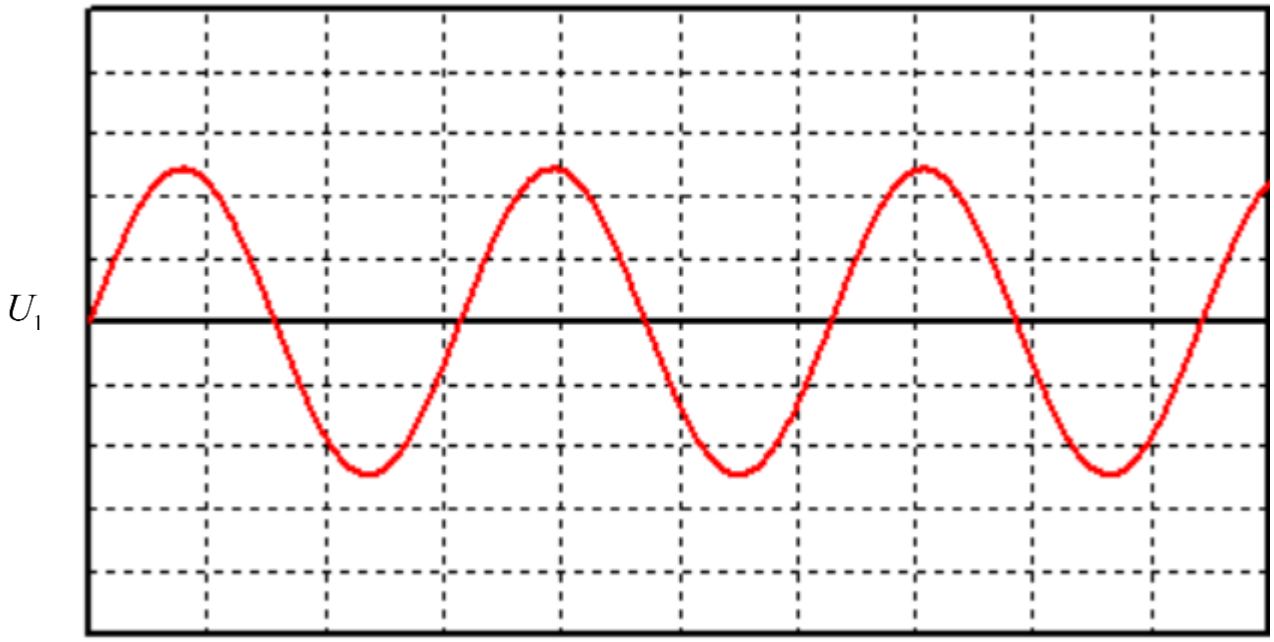


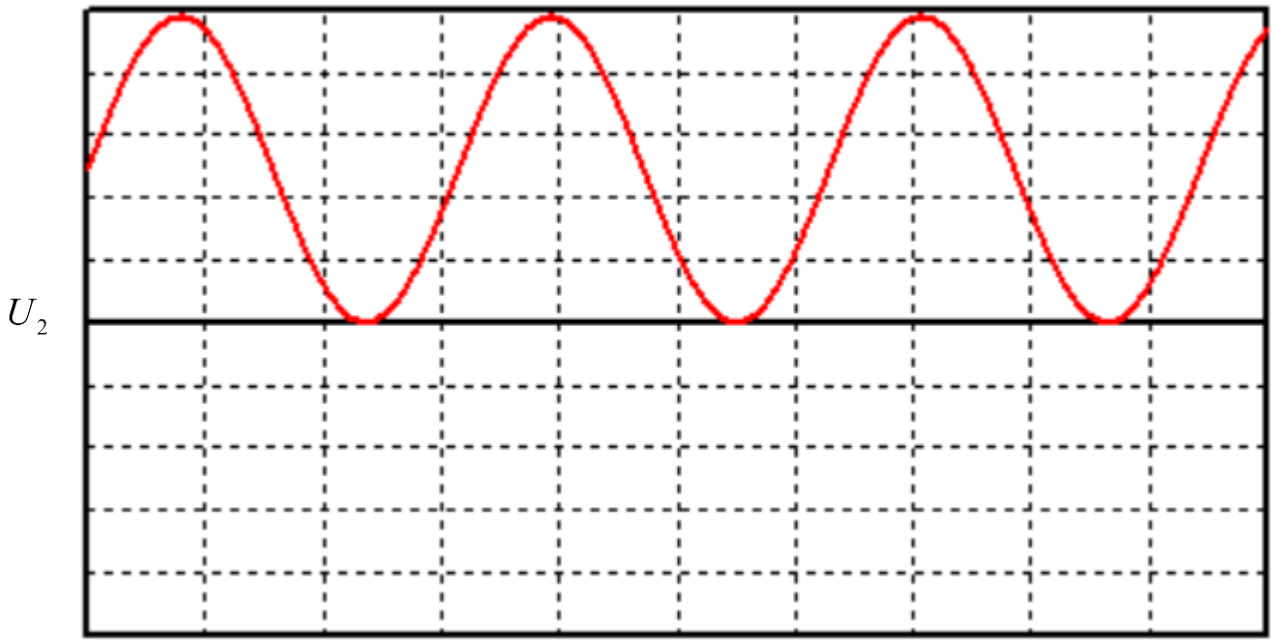


Task 1.4.1.

Capacitor value:
0,02 μF

Task 1.4.2.





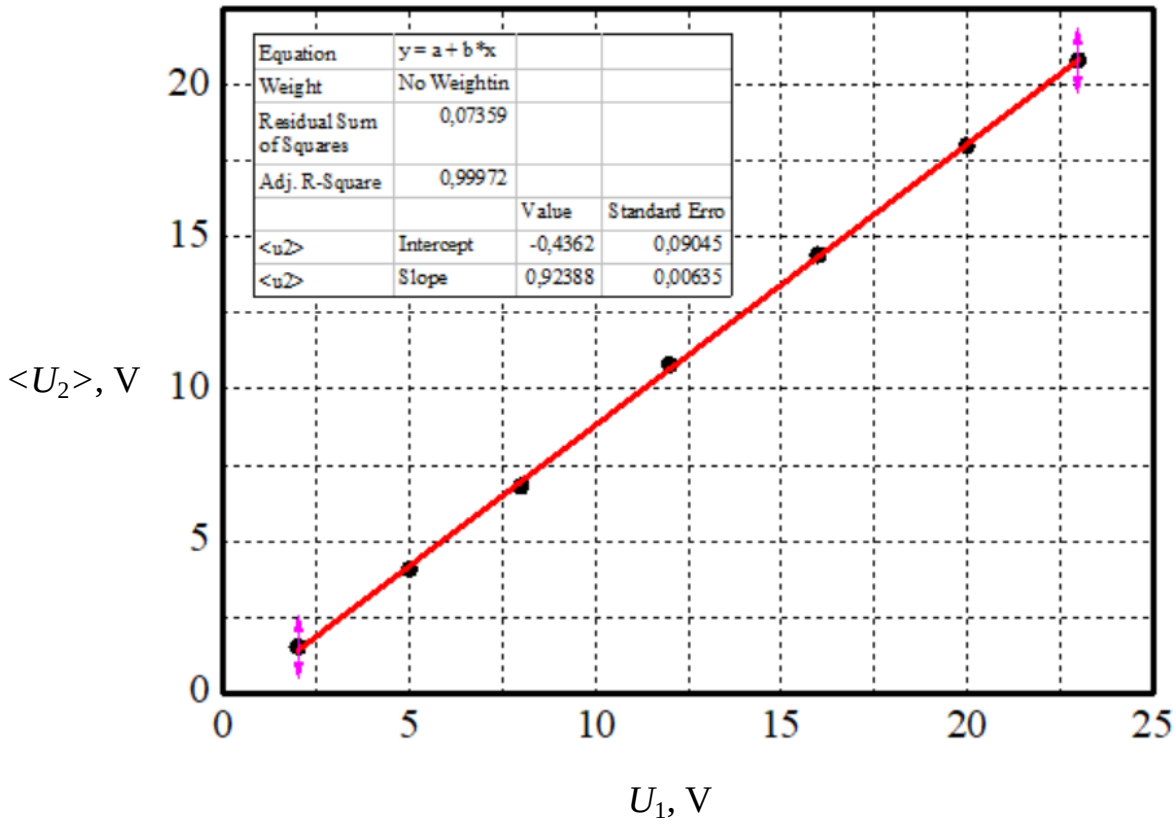
Does signal at the circuit output depend on average input voltage? (underline the correct answer):	
Yes	No

Task 1.4.3.

Angular slope of the dependence of $\langle U_2 \rangle$ on U_1: 0,92
Ratio of angular coefficients: 2

U_1, V	$\langle U_2 \rangle$, V
23,0	20,8
20,0	18,0
16,0	14,4
12,0	10,8
8,0	6,8
5,0	4,1
2,0	1,5

Average voltage at the output versus voltage amplitude at the detector input.



Task 2.1.2.

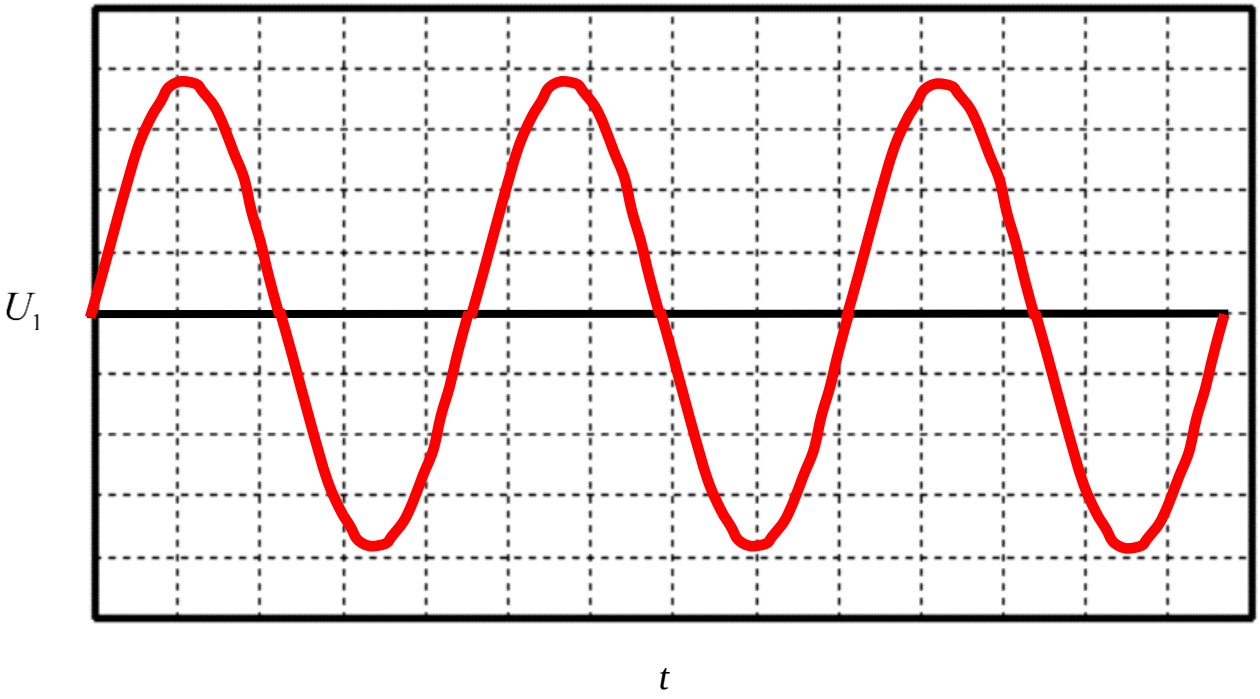
Gain K_1 of the first amplification stage: 4,8

Task 2.1.4.

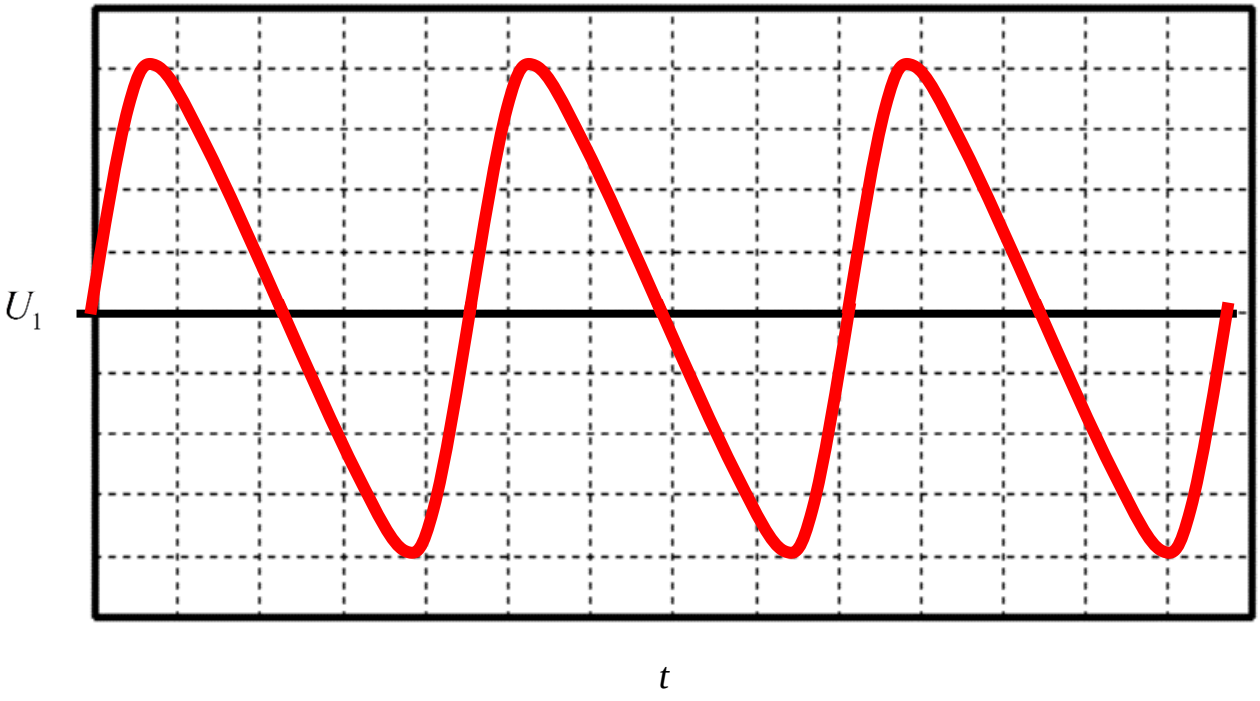
Net gain K of two stage amplifier: 20,0
Formula relating the net gain K and gains K_1 and K_2 of the stages: $K = K_1 K_2$
Gain K_2 of the second stage: 4,2

Task 2.1.5.

Detection at 1 kHz.



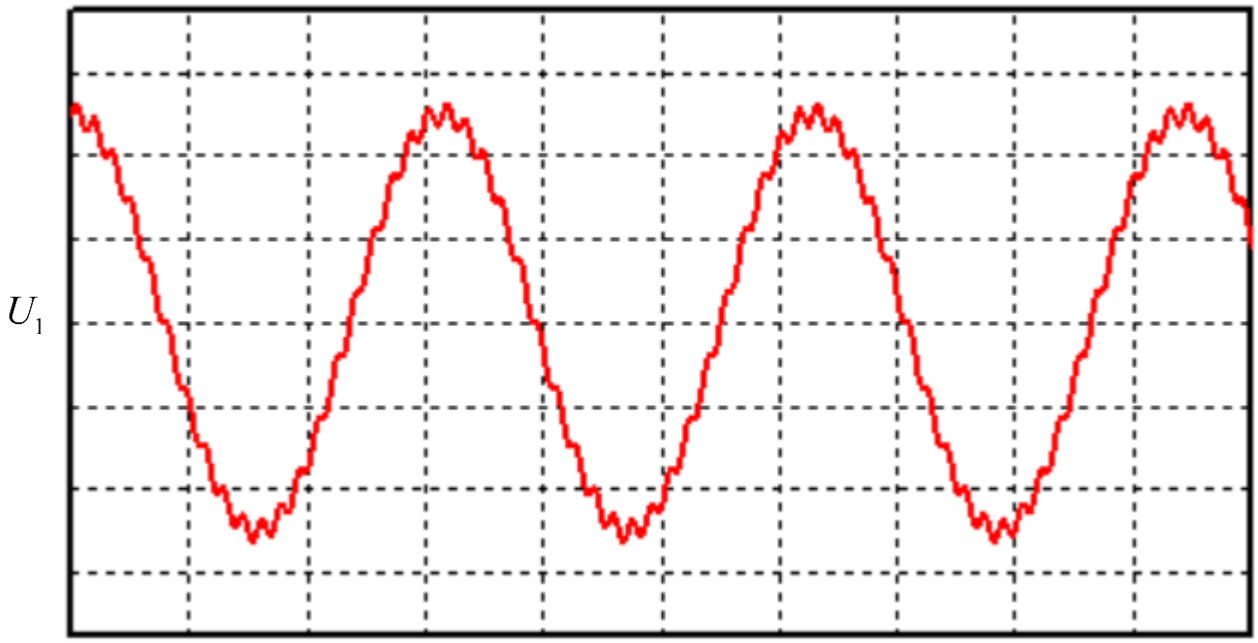
Detection at 5 kHz.



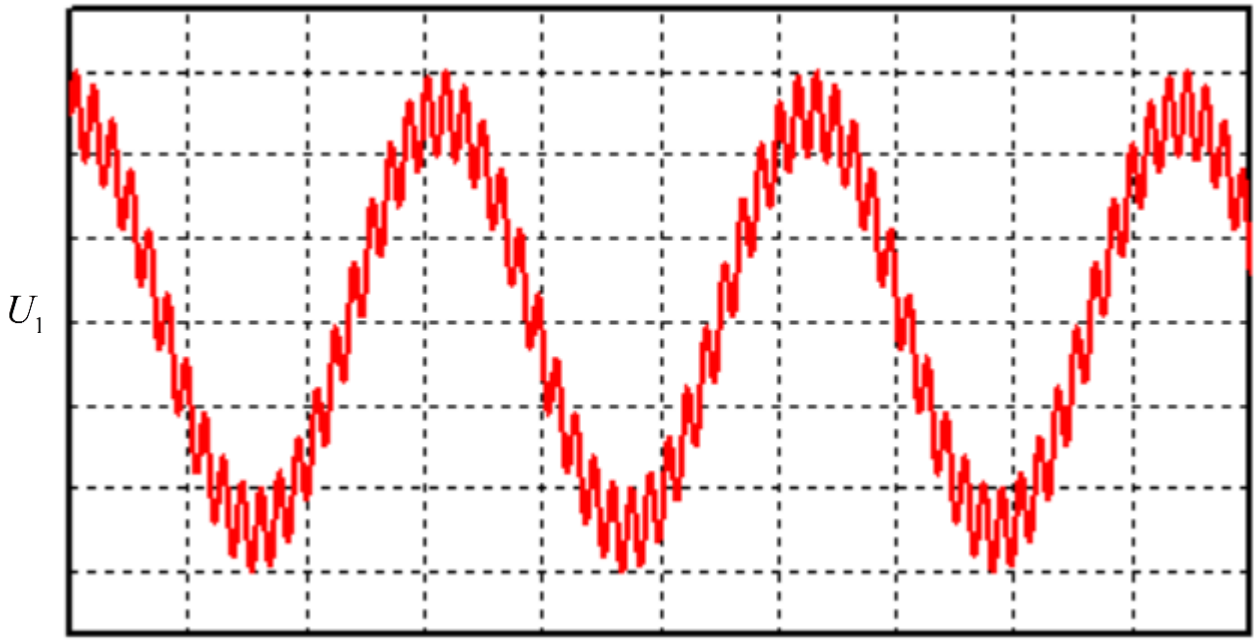
Task 2.1.6.

Headphone resistance:
18 Ω

With capacitor.



Without capacitor.



Impedance magnitude at 1 kHz: 18 Ω
Impedance magnitude at 500 kHz: 3 Ω

Task 2.2.1.

A way to change the adjustment range of *LC*-circuit: It is necessary to reduce the inductance of the circuit. To do this, pull the core out of the coil.

Task 2.2.2.

Carrier frequency (indicate units of measurement): 2,45 MHz
Modulation frequency (indicate units of measurement): 880 Hz

Task 2.2.3.

Sequence of «dots» and «dashes» coding the word: – – | – – – | • • • | – • – • | – – – | • – –
The word in English letters: M O S C O W