LABORATORY OF ELECTRONIC CIRCUITS

Laboratory exercise no.: **3**	Consecutive protocol number:	Name and surname: 1. 2. 3.	
Title: **Resonant amplifier**		Dean's group:	Laboratory group:
Date of the measurements:	Date of delivery of the report:		**Grade:**

2.1. The measurement of the frequency response of the amplifier with a single resonant circuit. Set up $V_{we} = 20\,mV_{RMS}$, $f_0 \cong 465\,kHz$. Calculate $K_u = V_{wy}/V_{we}$, and $A_0 = K_u(f_0)$. <u>Note!</u> The probe introduces the constant signal attenuation 1:1700, which should be included in measurements: we *de facto* read out of the voltmeter $V_{wy}/1700$.

<u>Hint</u>! For each of the circuits a, b, c, and d, first we find experimentally frequency f_0 (approx. 465 kHz) for which the output voltage reaches the maximum value $V_{wy,max}$.

Circuit a: WY1, P1- open, P2- closed						Circuit b: WY1, P1- closed, P2- open					
f_{we}		$V_{wy}/1700$		V_{wy}	K_u	f_{we}		$V_{wy}/1700$		V_{wy}	K_u
[kHz]		[mV]		[V]	[V/V]	[kHz]		[mV]		[V]	[V/V]
f_{L10dB}		$0{,}316 \cdot V_{wy,max}$				f_{L10dB}		$0{,}316 \cdot V_{wy,max}$			
f_{L6dB}		$0{,}5 \cdot V_{wy,max}$				f_{L6dB}		$0{,}5 \cdot V_{wy,max}$			
f_{L3dB}		$0{,}707 \cdot V_{wy,max}$				f_{L3dB}		$0{,}707 \cdot V_{wy,max}$			
f_0		$V_{wy,max}$				f_0		$V_{wy,max}$			
f_{H3dB}		$0{,}707 \cdot V_{wy,max}$				f_{H3dB}		$0{,}707 \cdot V_{wy,max}$			
f_{H6dB}		$0{,}5 \cdot V_{wy,max}$				f_{H6dB}		$0{,}5 \cdot V_{wy,max}$			
f_{H10dB}		$0{,}316 \cdot V_{wy,max}$				f_{H10dB}		$0{,}316 \cdot V_{wy,max}$			

Circuit c: WY2, P1- open, P2- closed						Circuit d: WY2, P1- open, P2- closed					
f_{we}		$V_{wy}/1700$		V_{wy}	K_u	f_{we}		$V_{wy}/1700$		V_{wy}	K_u
[kHz]		[mV]		[V]	[V/V]	[kHz]		[mV]		[V]	[V/V]
f_{L10dB}		$0{,}316 \cdot V_{wy,max}$				f_{L10dB}		$0{,}316 \cdot V_{wy,max}$			
f_{L6dB}		$0{,}5 \cdot V_{wy,max}$				f_{L6dB}		$0{,}5 \cdot V_{wy,max}$			
f_{L3dB}		$0{,}707 \cdot V_{wy,max}$				f_{L3dB}		$0{,}707 \cdot V_{wy,max}$			
f_0		$V_{wy,max}$				f_0		$V_{wy,max}$			
f_{H3dB}		$0{,}707 \cdot V_{wy,max}$				f_{H3dB}		$0{,}707 \cdot V_{wy,max}$			
f_{H6dB}		$0{,}5 \cdot V_{wy,max}$				f_{H6dB}		$0{,}5 \cdot V_{wy,max}$			
f_{H10dB}		$0{,}316 \cdot V_{wy,max}$				f_{H10dB}		$0{,}316 \cdot V_{wy,max}$			

1) Calculate the voltage gain $A_0 = K_u(f_0)$ and 3-dB bandwidth Δf_{3dB}.

Circuit	$L = \frac{1}{(2\pi f_0)^2 \cdot C_\Sigma}$	$R_D = 2\pi f_0 \cdot L \cdot Q_L$	$R_\Sigma = \left(\frac{1}{F \cdot r_o} + \frac{1}{R_D} + \frac{1}{p_1^2 \cdot R_0}\right)^{-1}$	$A_{0\,pom}$	$A_0 = g_m{}^* \frac{R_\Sigma}{p_1}$	$\Delta f_{3dB\,pom}$	$\Delta f_{3dB} = \frac{1}{2\pi \cdot R_\Sigma C_\Sigma}$
a: $p_1 = 1$ $R_0 = \infty$							
b: $p_1 = 1$ $R_0 = 18\,k\Omega$							
c: $p_1 = 2$ $R_0 = \infty$							
d: $p_1 = 2$ $R_0 = 4.3\,k\Omega$							

Assume in the calculations: $g_m = 50\,mS$, $Q_L = 50$, $r_0 = 250\,k\Omega$, $C_o \approx 0$, $R_e = 47\,\Omega$, $C_1 = 3.2\,nF$.

Results of auxiliary calculations (L, R_D, R_{Σ_1}, R_{Σ_2}) should be included in the above table. In addition, calculate:

$$g_m^* = \frac{g_m}{1+g_m \cdot R_e} = ..., \quad F = 1 + g_m \cdot R_e = ..., \quad C_\Sigma = \frac{C_1}{2} = ...$$

2) Plot the measured frequency characteristics K_u as a function of frequency (vertical axis: linear, horizontal axis: linear)

3) Compare the theoretically calculated and measured data: the gain A_0 and 3-dB bandwidth Δf_{3dB}.

2.2. Measuring the frequency response of the amplifier with a double resonant circuit (ask the teacher to set up the measuring system)

You should observe the frequency response of the amplifiers with a double and a triple resonant circuits for all values of the coupling capacitances.

Find characteristic frequencies f_1, f_2, and f_3 for the amplifier with a double resonant circuit, where:

f_1 - frequency of the first maximum on the characteristic;

f_2 - frequency of the minimum on the characteristic;

f_3 - frequency of the second maximum on the characteristic.

Amplifier with a double resonant circuit									
$V_{we} = 30\,mV_{RMS}$									
a. $C_{12a} = 68\,pF$ (rotary switch in position 1)					**b.** $C_{12c} = 33\,pF$ (rotary switch in position 3)				
f_{we}		$\frac{V_{wy}}{1700}$	V_{wy}	K_u	f_{we}		$\frac{V_{wy}}{1700}$	V_{wy}	K_u
[kHz]		[mV]	[V]	[V/V]	[kHz]		[mV]	[V]	[V/V]
f_1					f_1				
f_2					f_2				
f_3					f_3				

Draw the measured frequency characteristics for the amplifiers described in the above table, i.e. $K_u(f)$. The ordinate axis: linear, abscissa axis: linear.

For all the measurement results, include your conclusions and observations. Compare the circuits with each other and write your own comments on the results.