Matthew Loden

ECEN 326 – 501

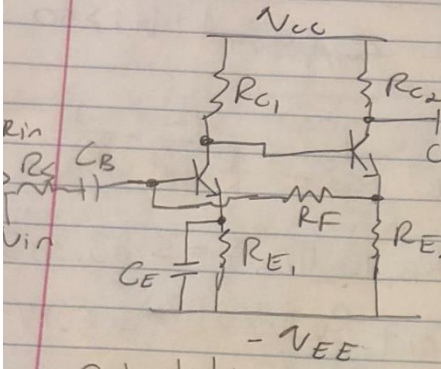
Lab 10: Design of a BJT Feedback Amplifier

Purpose:

This lab is used to determine the effects of adding a feedback component to a cascade BJT amplifier design. This will allow us to greatly increase the gain of the system with different side effects. We will study these differences from the previous labs.

Calculations:

Lab #10



$V_{CC} = V_{EE} = 5V$

$R_S = 50\Omega$ $R_L = 10K\Omega$

$V_{RE_1} \geq 0.4V$ $I_{supply} \leq 10mA$

$\left|\frac{V_O}{V_S}\right| \geq 80$ $V_{sw} \geq 3.5V$

$10mA = I_{C_1} + I_{C_2}$

$\therefore I_{C_1} = 7.6mA$

Calculations

$V_{RE_2} \approx V_{RE_1} + 0.7 \Rightarrow V_{RE_2} = 1.1V$

$V_{RC} \leq V_{CC} + V_{EE} - V_{CE_1} - 1.4$

$V_{RC_1} \Rightarrow 8.2V$

$$\left\{ I_{C_2} = \frac{V_{CC} + V_{EE} - 2V_{RE_2} - V_{CE,sat}}{R_{C_2} + (R_{C_2} \| R_L)} \right\} \Rightarrow 2.41mA$$

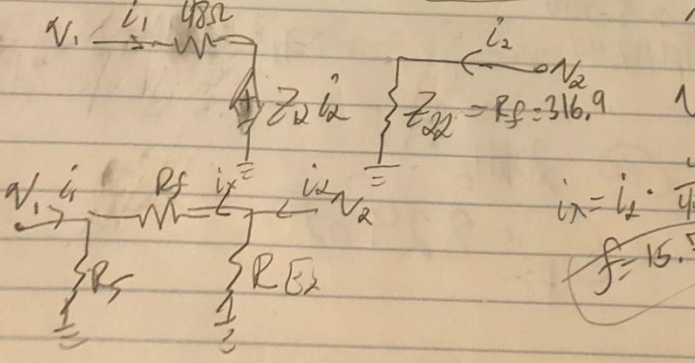
$$V_{SW} = \frac{V_{CC} + V_{EE} - 2V_{RE_2} - V_{CE,sat}}{2 + \frac{R_{C_2}}{R_L}} \Rightarrow R_{C_2} = 1.7K\Omega$$

$R_{E_1} = \frac{V_{RE_1}}{I_{C_1}} = 52.63\Omega$ $R_{C_1} = \frac{V_{RC_1}}{I_{C_1}} = 1.078K\Omega$

$R_{E_2} = \frac{V_{RE_2}}{I_{C_2}} = 456\Omega$

$R_{C_1} = \frac{25mA}{2.41mA} = 10.373$

$L \approx \frac{R_{C_1}}{R_{C_1}} \cdot \frac{R_S}{R_S + R_F} \Rightarrow \boxed{R_F = 989\Omega}$



$V_1 = Z_{11} i_1 + Z_{12} i_2$

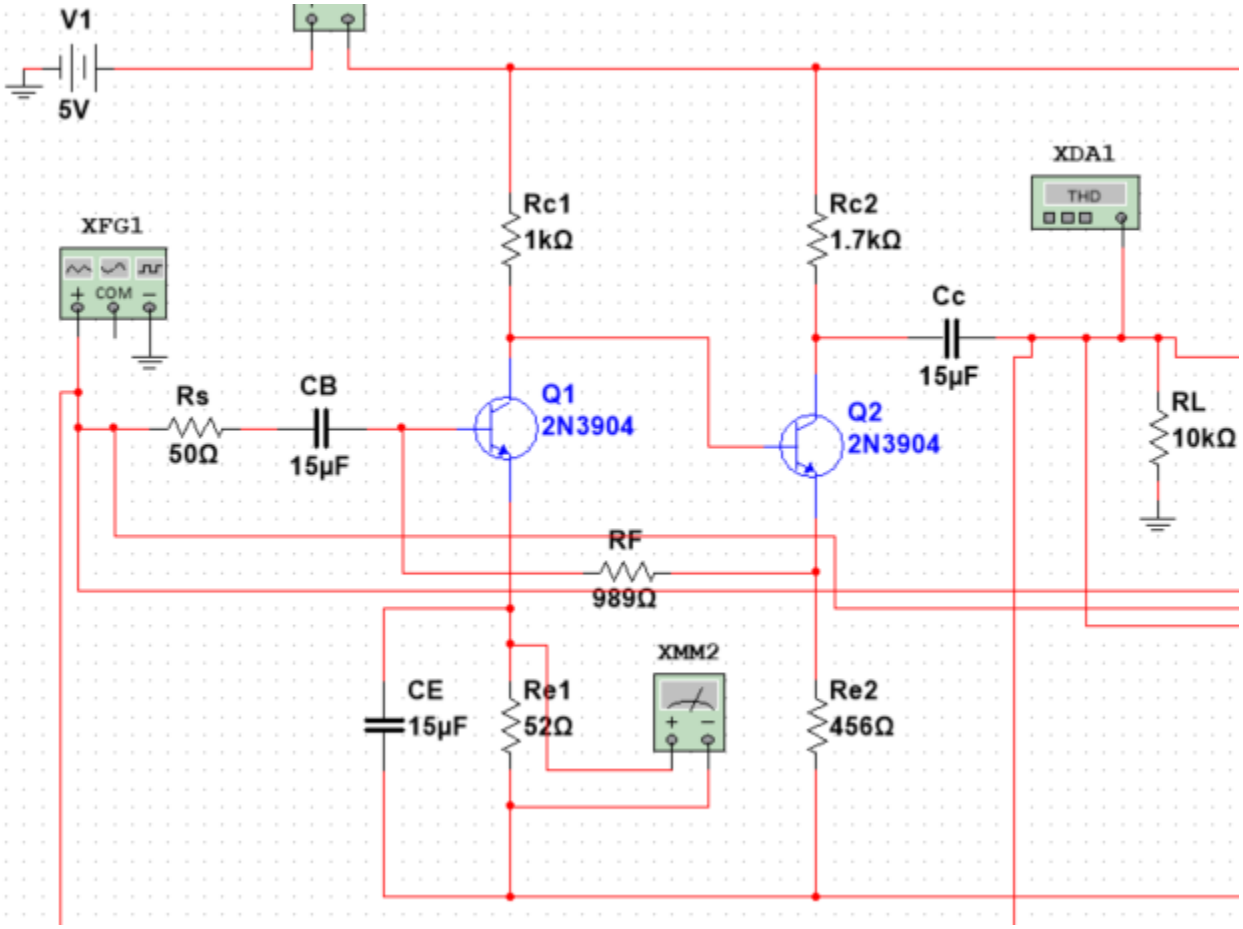
$V_2 = Z_{21} i_1 + Z_{22} i_2$

$i_x = i_2 \cdot \frac{456}{456 + 989}$

$\frac{f}{} = 15.77$

Simulations:

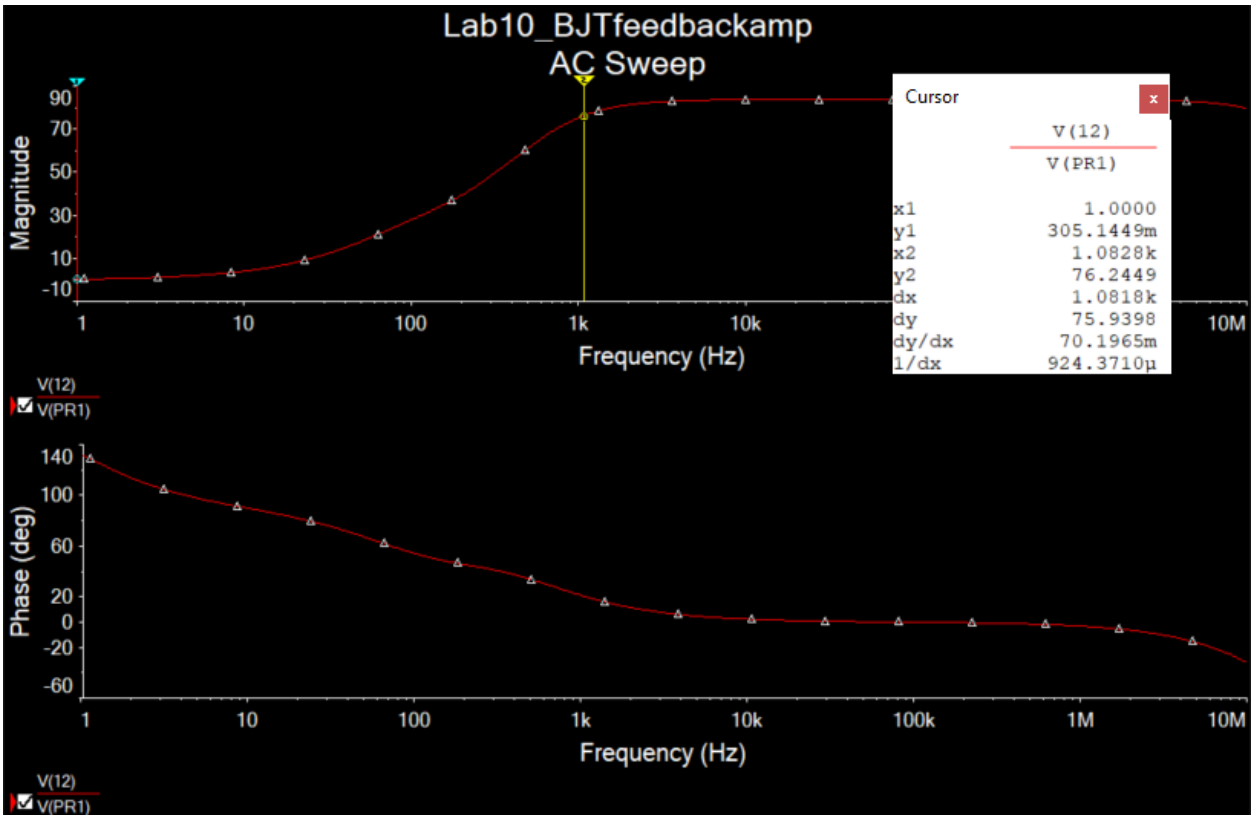
Circuit



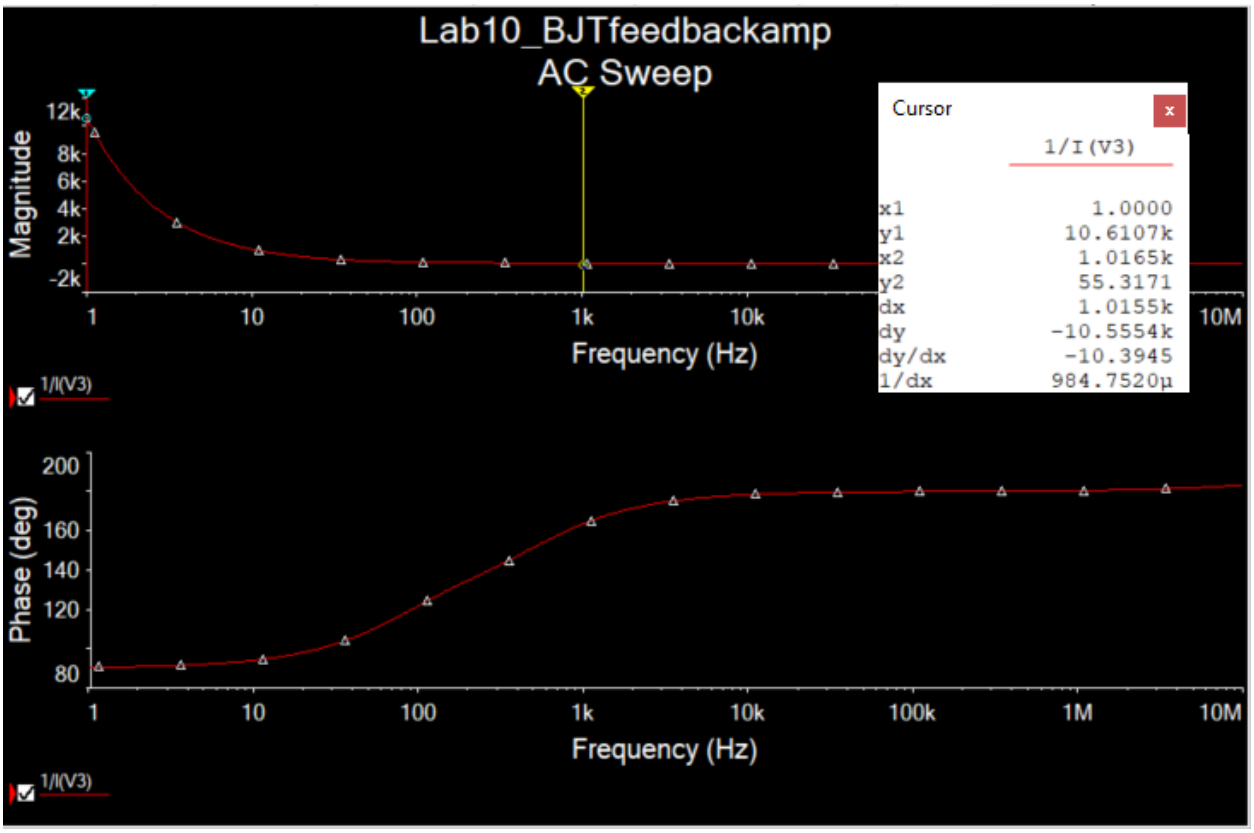
DcOp

	Variable	Operating point value
1	I(Rc1:1) | I(Ic1)	7.57543 m
2	I(Rc2:1) | I(Ic2)	2.54046 m
3	-I(XMM1:2) | I(Isupply)	10.11589 m
4	V(2) | V(Vb1)	-3.87907
5	V(1) | V(Vb2)	-3.16631
6	V(1) | V(Vc1)	-3.16631
7	V(5) | V(Vc2)	681.21038 m
8	V(3) | V(Ve1)	-4.59969
9	V(4) | V(Ve2)	-3.85553

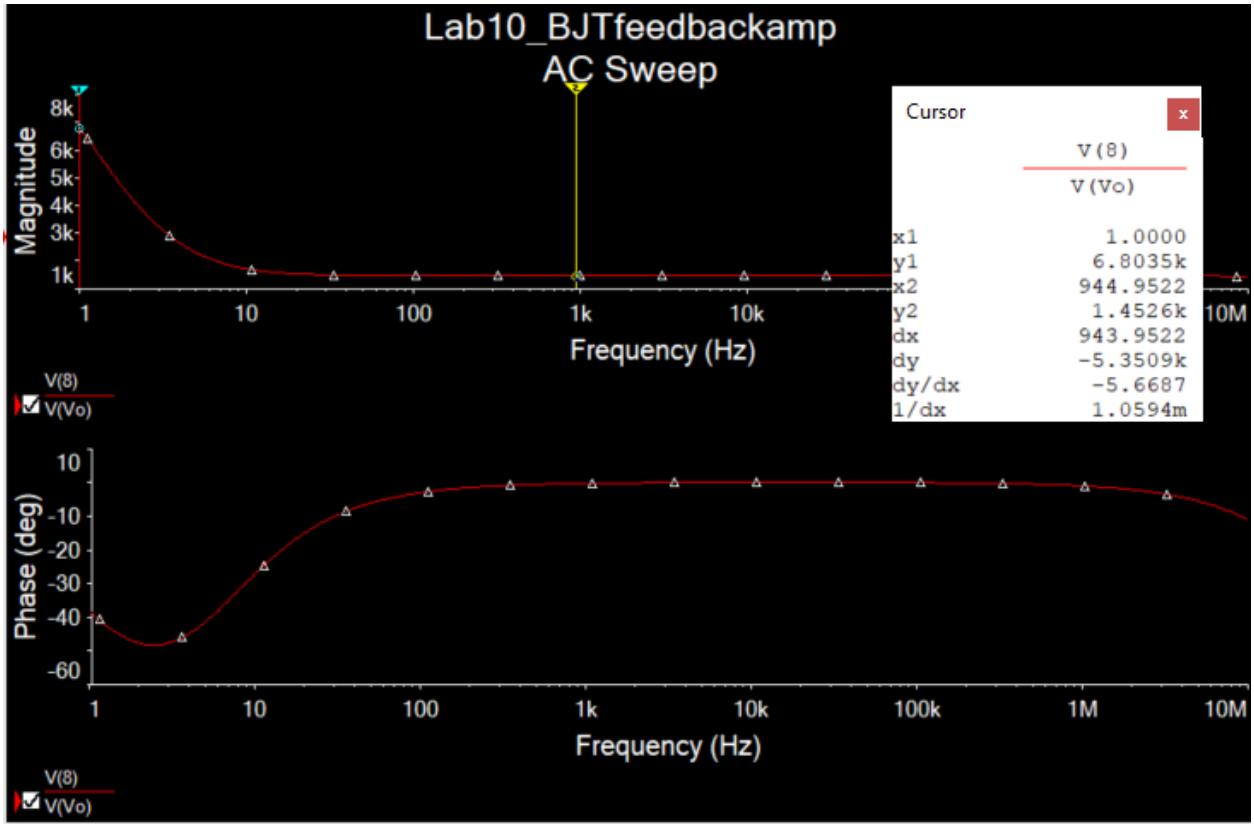
Gain


Lab10_BJTfeedbackamp
AC Sweep
Magnitude
90
70
50
30
10
-10
1
10
100
1k
10k
10M
Frequency (Hz)
Cursor
V(12)
V(PR1)
x1 1.0000
y1 305.1449m
x2 1.0828k
y2 76.2449
dx 1.0818k
dy 75.9398
dy/dx 70.1965m
1/dx 924.3710µ
V(12)
V(PR1)
Phase (deg)
140
100
60
20
0
-20
-60
1
10
100
1k
10k
100k
1M
10M
Frequency (Hz)
V(12)
V(PR1)

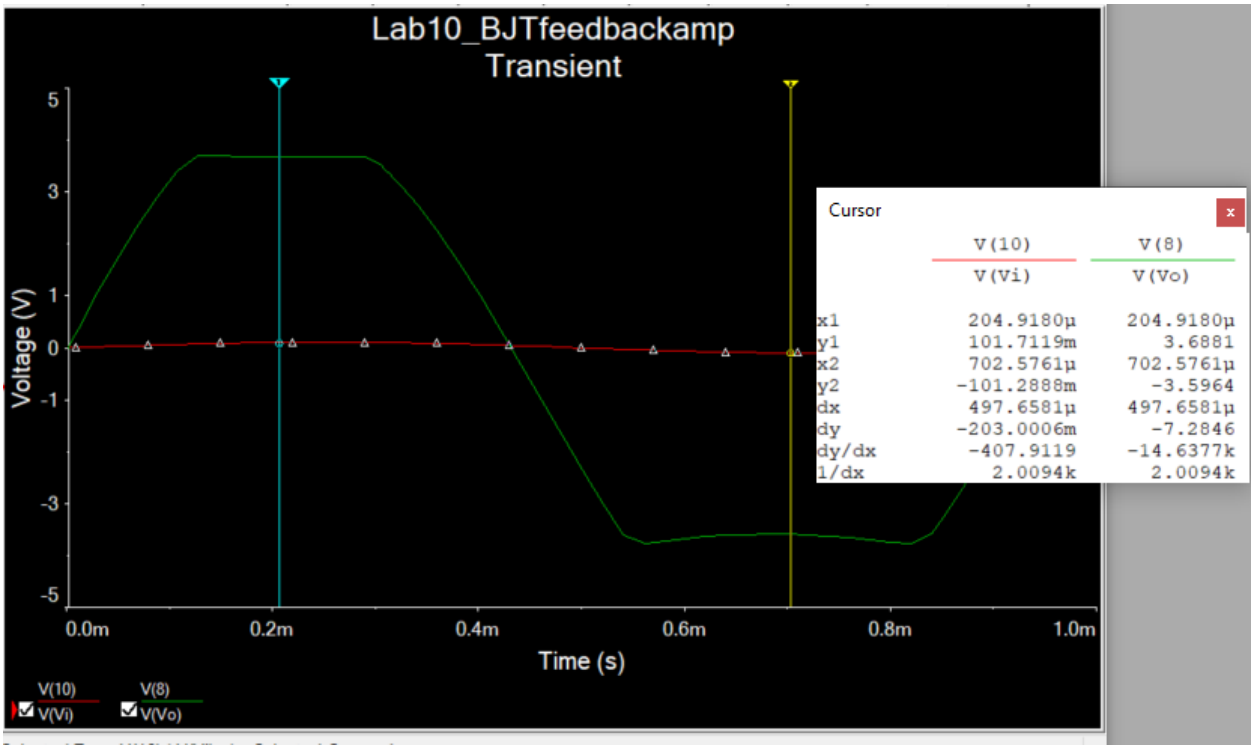
Ri


Lab10_BJTfeedbackamp
AC Sweep
Magnitude
12k
8k
6k
4k
2k
-2k
1
10
100
1k
10k
10M
Frequency (Hz)
Cursor
1/I(V3)
x1 1.0000
y1 10.6107k
x2 1.0165k
y2 55.3171
dx 1.0155k
dy -10.5554k
dy/dx -10.3945
1/dx 984.7520µ
1/I(V3)
Phase (deg)
200
160
140
120
80
1
10
100
1k
10k
100k
1M
10M
Frequency (Hz)
1/I(V3)

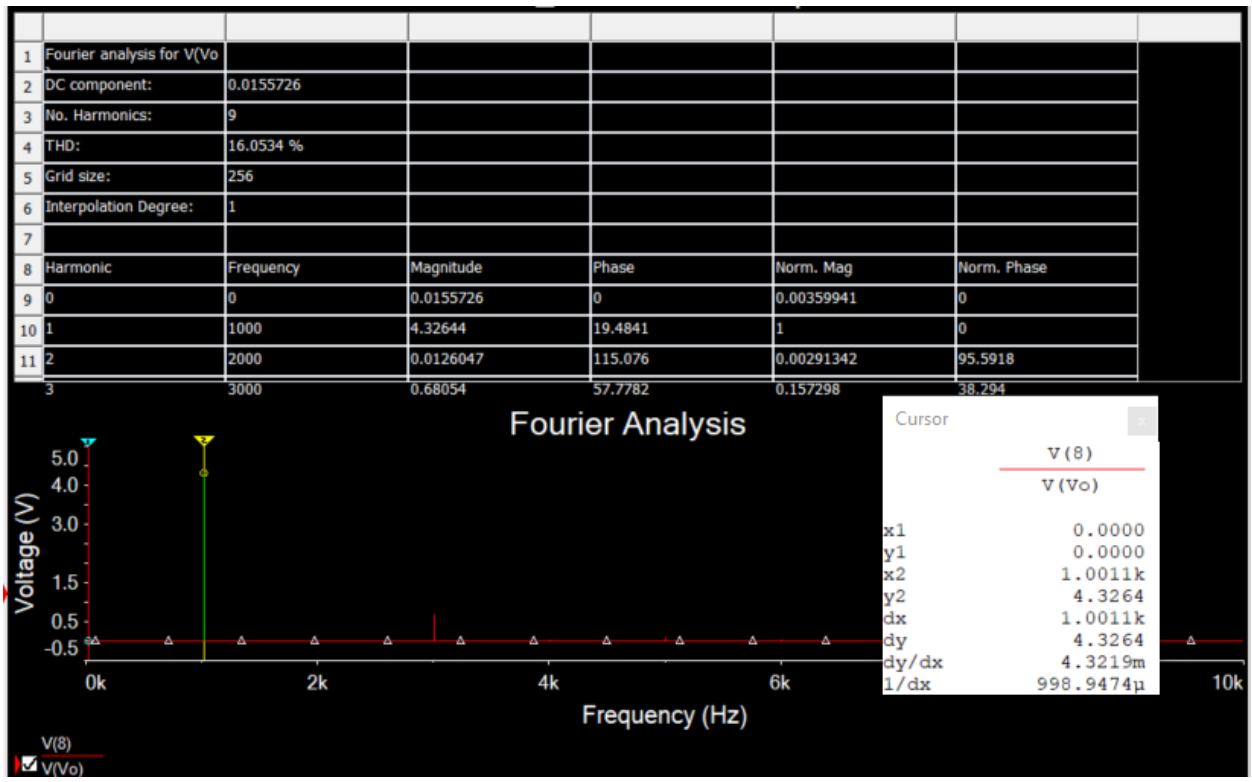
Ro



Unclipped output of 0-3v



THD at above value

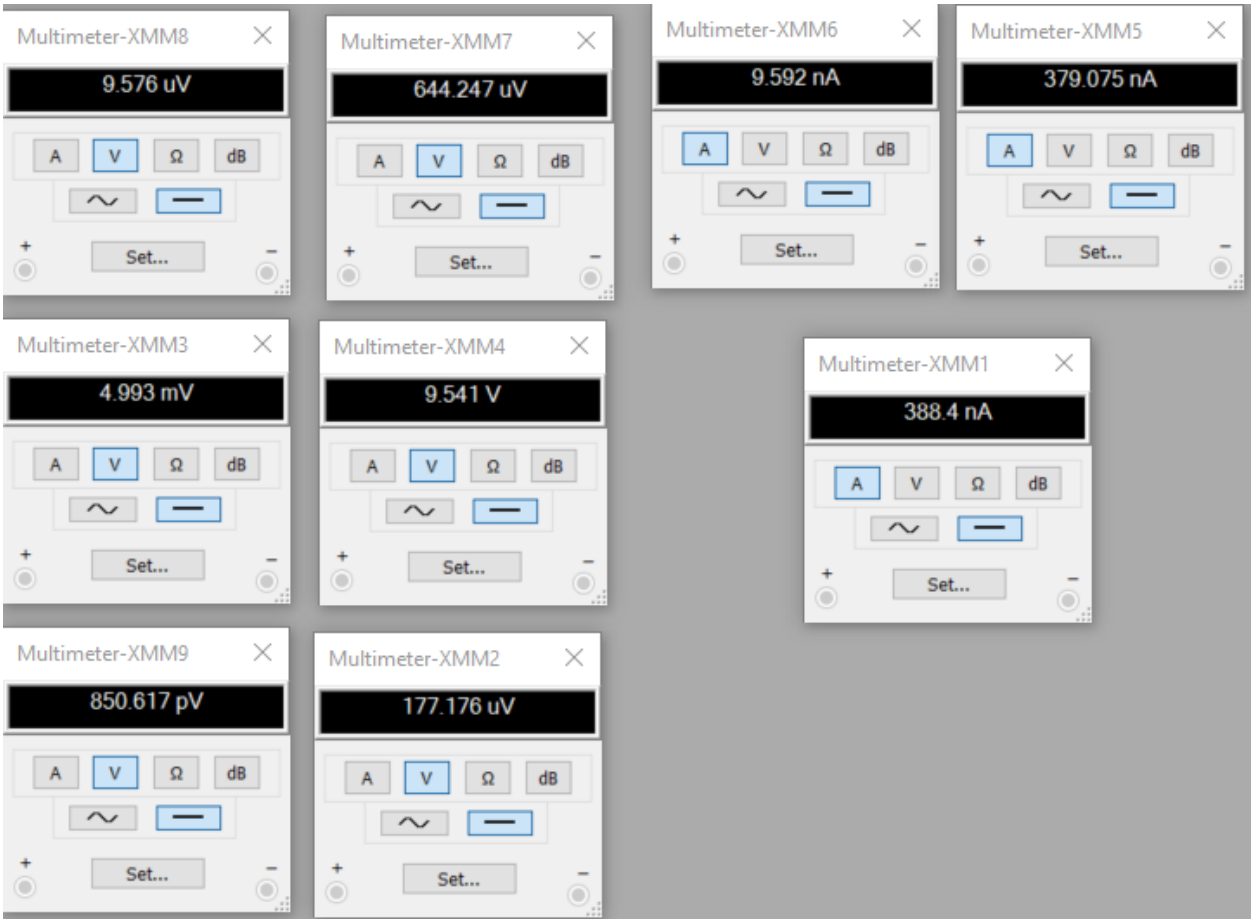


1	Fourier analysis for V(Vo					
2	DC component:	0.0155726				
3	No. Harmonics:	9				
4	THD:	16.0534 %				
5	Grid size:	256				
6	Interpolation Degree:	1				
7						
8	Harmonic	Frequency	Magnitude	Phase	Norm. Mag	Norm. Phase
9	0	0	0.0155726	0	0.00359941	0
10	1	1000	4.32644	19.4841	1	0
11	2	2000	0.0126047	115.076	0.00291342	95.5918
	3	3000	0.68054	57.7782	0.157298	38.294

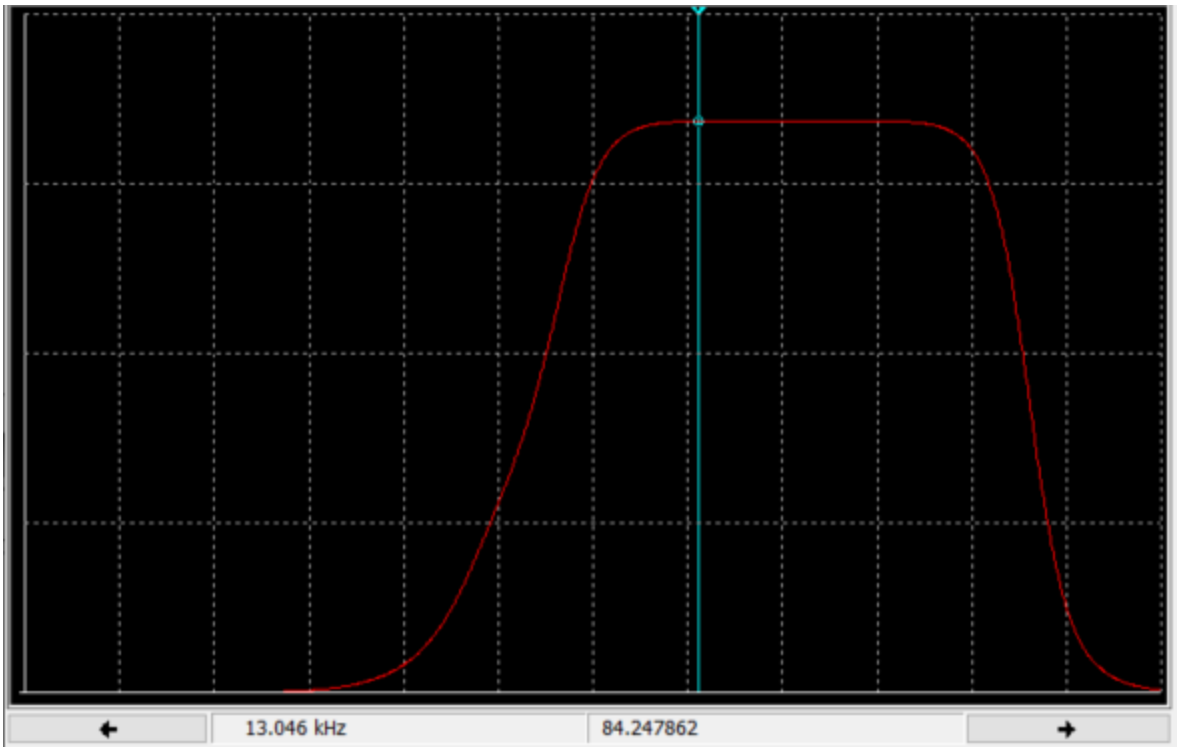
=16.05%

Measurements:

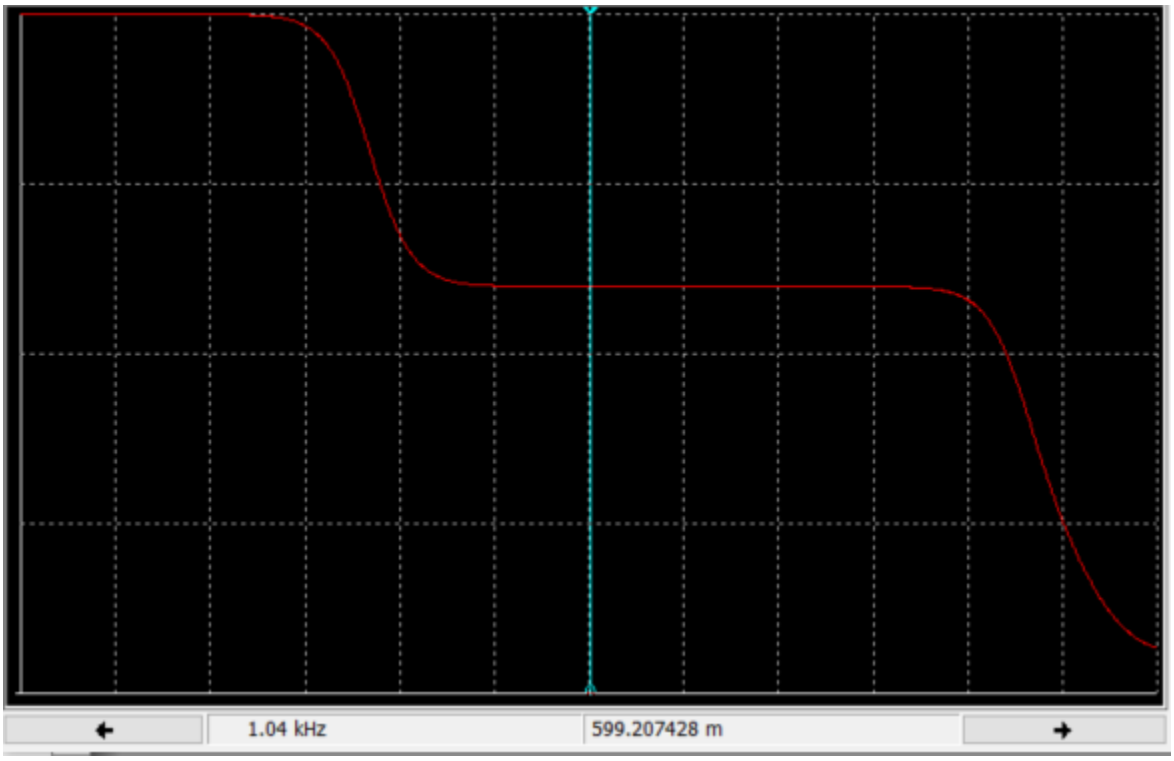
DcOp



Gain

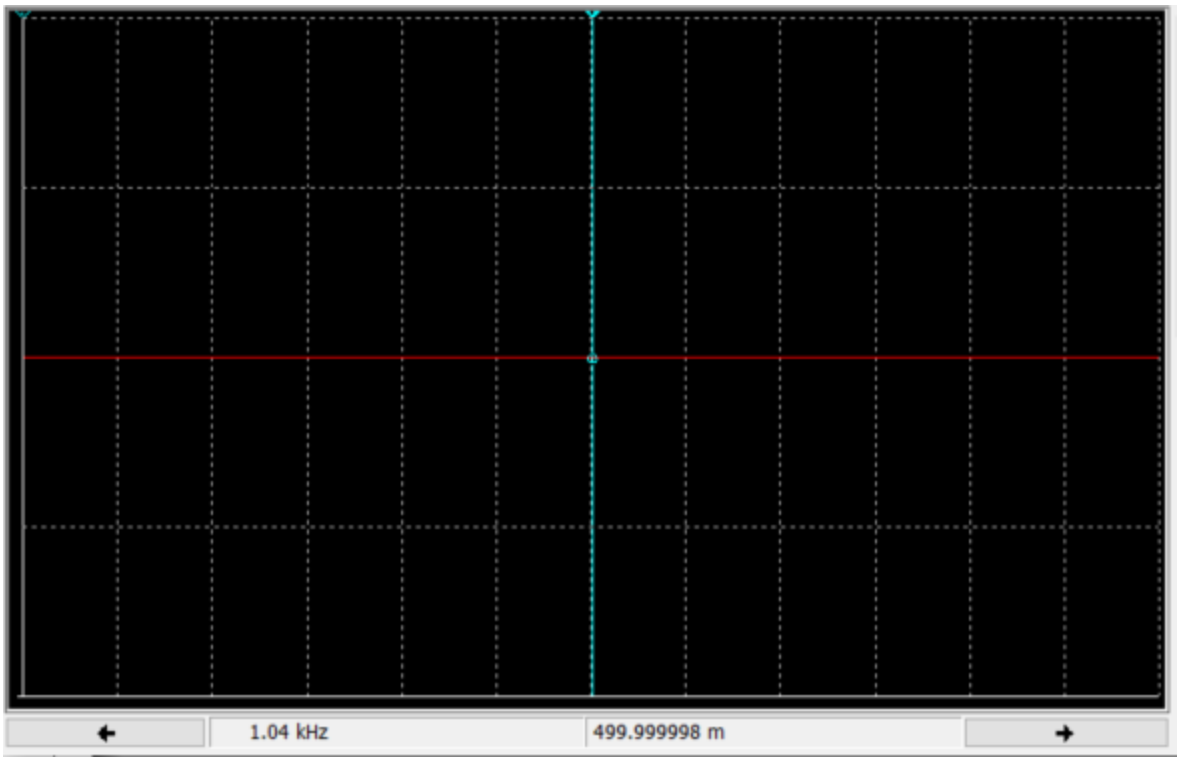


Rin



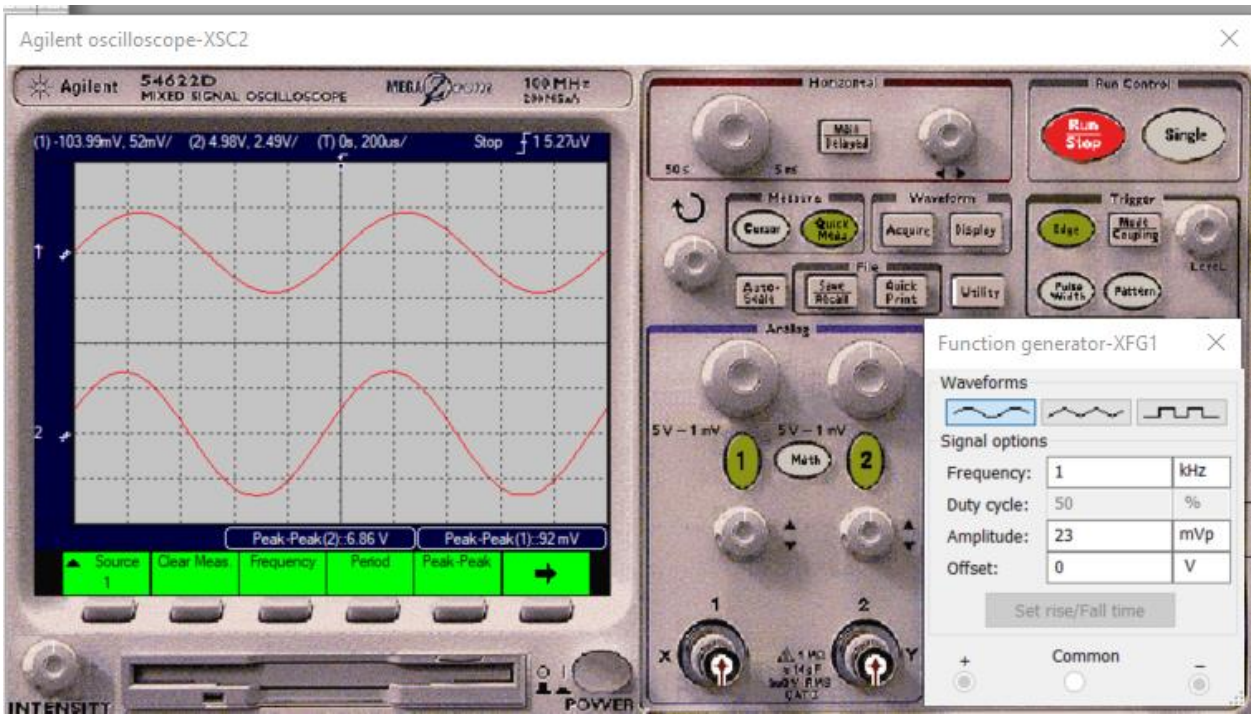
=668Ω

Rout

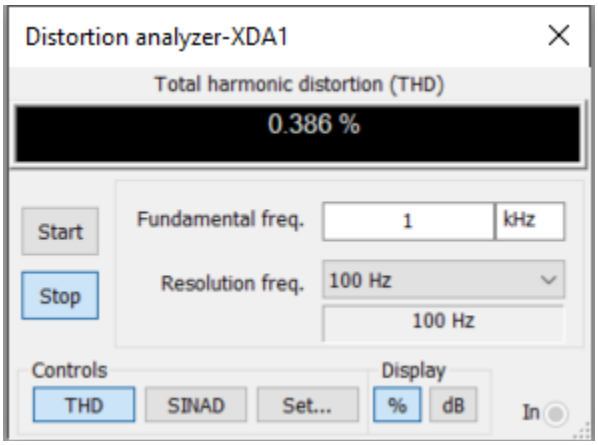


=10.04kΩ

Unclipped Output



THD at that value



Results Discussed

	Calculated	Simulated	Measured
Isupply	<10mA	10.11mA	388nA
Ic1	7.6mA	7.575mA	9.502nA
Ic2	2.41mA	2.54mA	379nA
Vc1	-3.2v	-3.166v	9.578uv
Vc2	0.7v	0.681v	644.247uv
Vb1	-3.5v	-3.87v	4.9983mv
Vb2	-3.2v	-3.166v	9.3541v
Ve1	-4.5v	-4.599v	850.617pv
Ve2	-3.9v	-3.855v	171.176uv
Gain	~80	76	84
Ri	-	34Ω	668Ω
Ro	-	55Ω	10.04kΩ
Unclipped Swing	>3.5v	3.5v	3.5v
THD	-	16%	0.386%

The major differences come from the dc operation section of my work. This is more than likely just how the simulation will calculate the value with the measurements. I more than likely placed them improperly. The real work comes from the other aspects of the circuit. The input and output resistances are fairly different from each other however that is not a huge issue with the circuit.