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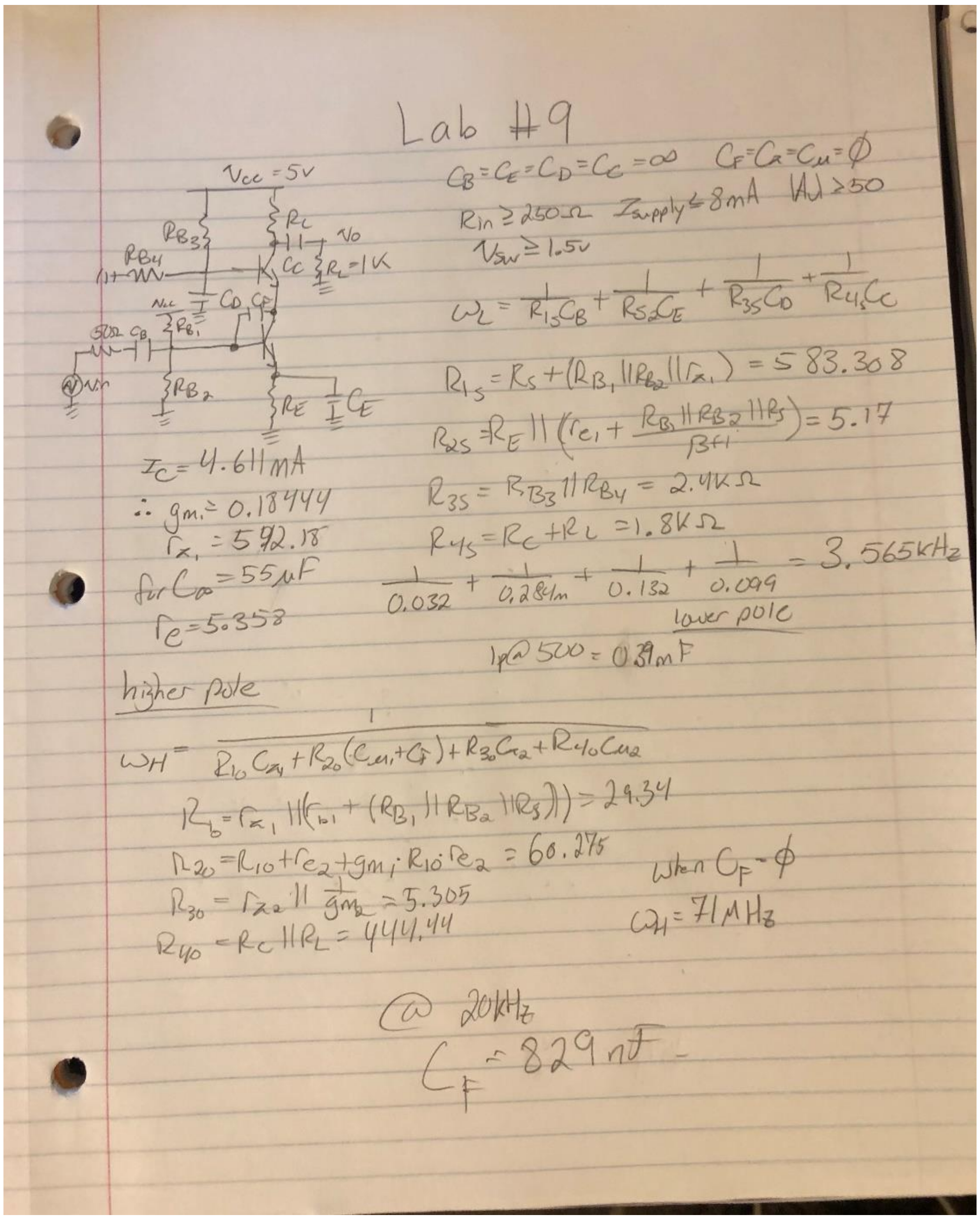
ECEN 326 – 501

Lab 9 – Frequency Response of a Cascode BJT Amplifier

Purpose

In this lab, we analyzed the changes that a BJT amplifier will create with the feedback capacitors. These simulations and measurements will help us to analyze future feedback circuits that are in the cascode configuration.

Calculations



Lab #9

$C_B = C_E = C_D = C_C = \infty$ $C_F = C_\pi = C_\mu = \phi$

$R_{in} \geq 250\Omega$ $I_{supply} \leq 8mA$ $|A_v| \geq 50$

$V_{sw} \geq 1.5V$

$V_{cc} = 5V$, $R_L = 1K$

$$\omega_L = \frac{1}{R_{1s}C_B} + \frac{1}{R_{2s}C_E} + \frac{1}{R_{3s}C_D} + \frac{1}{R_{4s}C_C}$$

$R_{1s} = R_S + (R_{B1} \| R_{B2} \| r_{\pi 1}) = 583.308$

$R_{2s} = R_E \| \left(r_{e1} + \frac{R_{B1} \| R_{B2} \| R_S}{\beta + 1}\right) = 5.17$

$R_{3s} = R_{B3} \| R_{B4} = 2.4K\Omega$

$R_{4s} = R_C + R_L = 1.8K\Omega$

$I_C = 4.611mA$

$\therefore g_{m1} = 0.18444$

$r_{\pi 1} = 592.18$

for $C_\infty = 55\mu F$

$r_e = 5.358$

$$\frac{1}{0.032} + \frac{1}{0.284m} + \frac{1}{0.132} + \frac{1}{0.099} = 3.565kHz$$

lower pole

$1p @ 500 = 0.39mF$

higher pole

$$\omega_H = \frac{1}{R_{1o}C_{\pi 1} + R_{2o}(C_{\mu 1} + C_F) + R_{3o}C_{\pi 2} + R_{4o}C_{\mu 2}}$$

$R_{1o} = r_{\pi 1} \| (r_{b1} + (R_{B1} \| R_{B2} \| R_S)) = 29.34$

$R_{2o} = R_{1o} + r_{e2} + g_{m1} \cdot R_{1o} \cdot r_{e2} = 60.275$

$R_{3o} = r_{\pi 2} \| \frac{1}{g_{m2}} = 5.305$

$R_{4o} = R_C \| R_L = 444.44$

when $C_F = \phi$

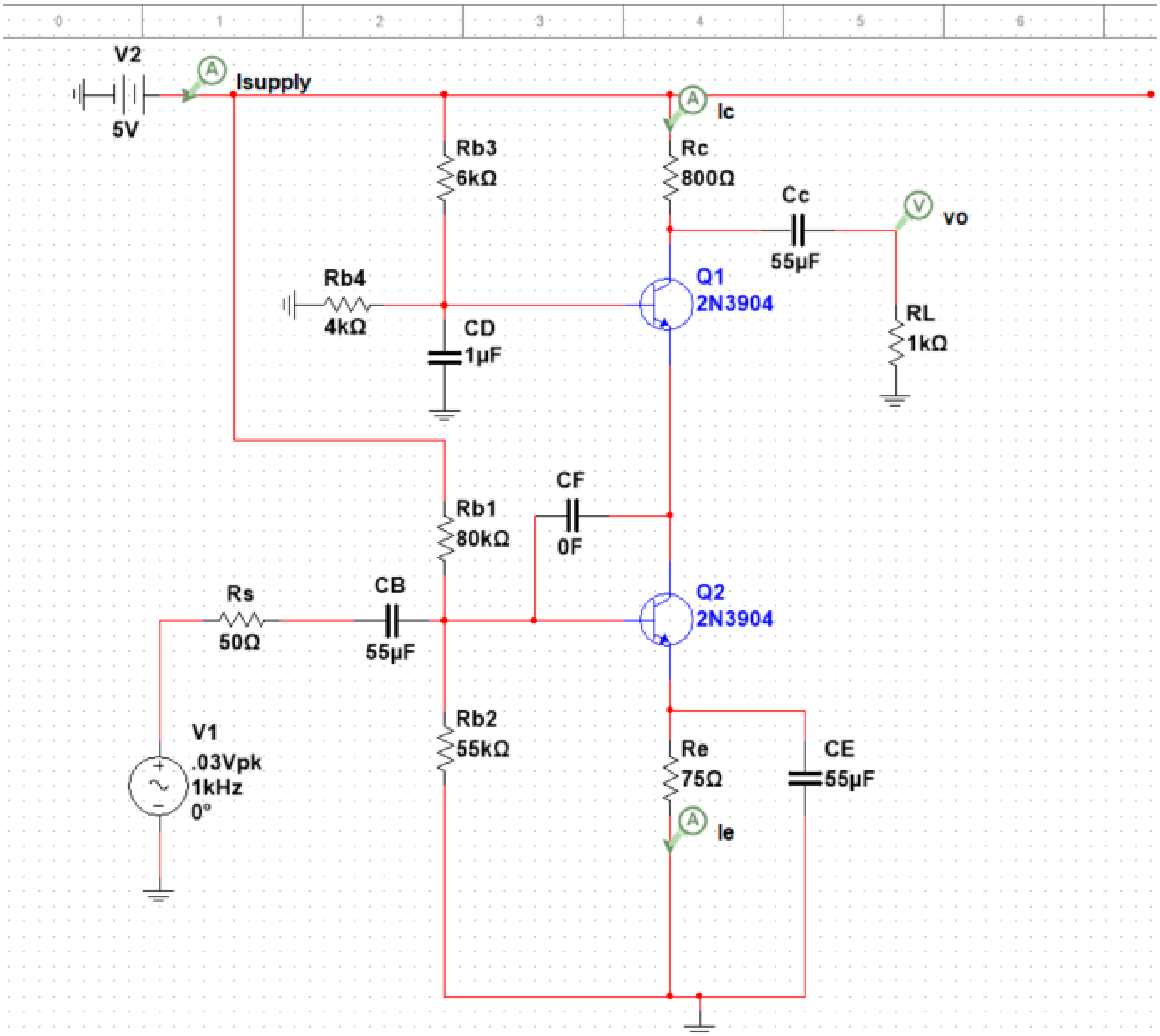
$\omega_H = 71MHz$

@ 20kHz

$C_F = 829nF$

Simulations

Circuit:

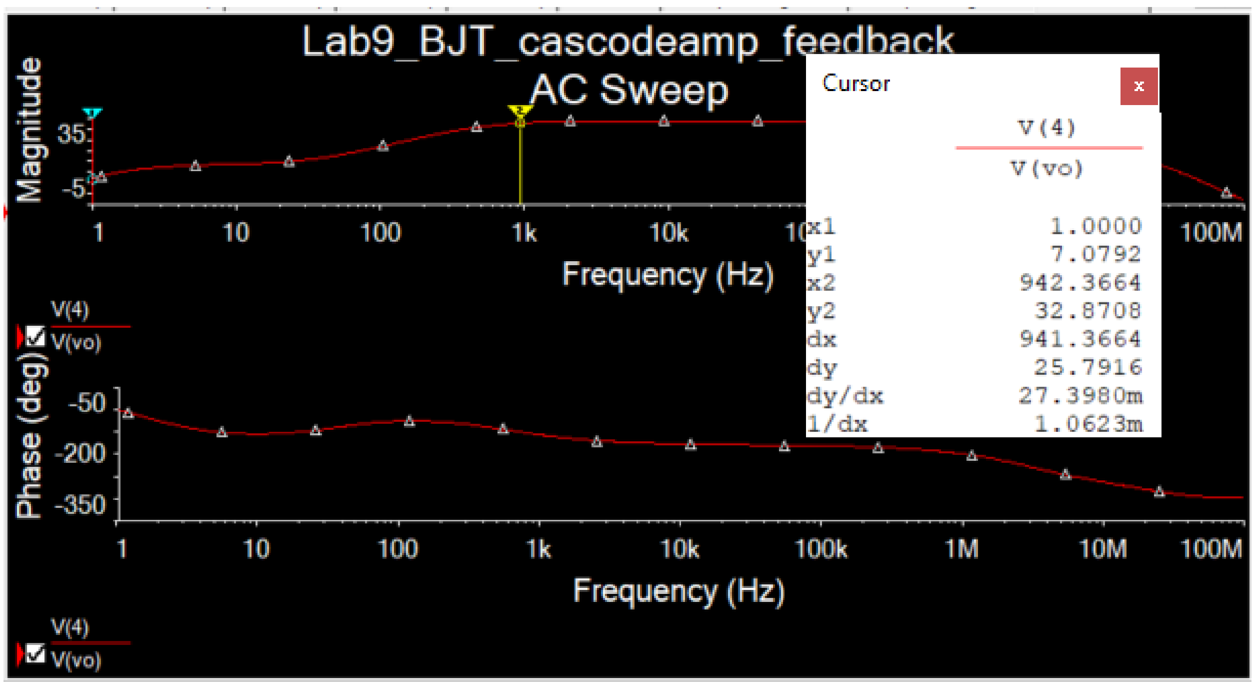


DcOp:

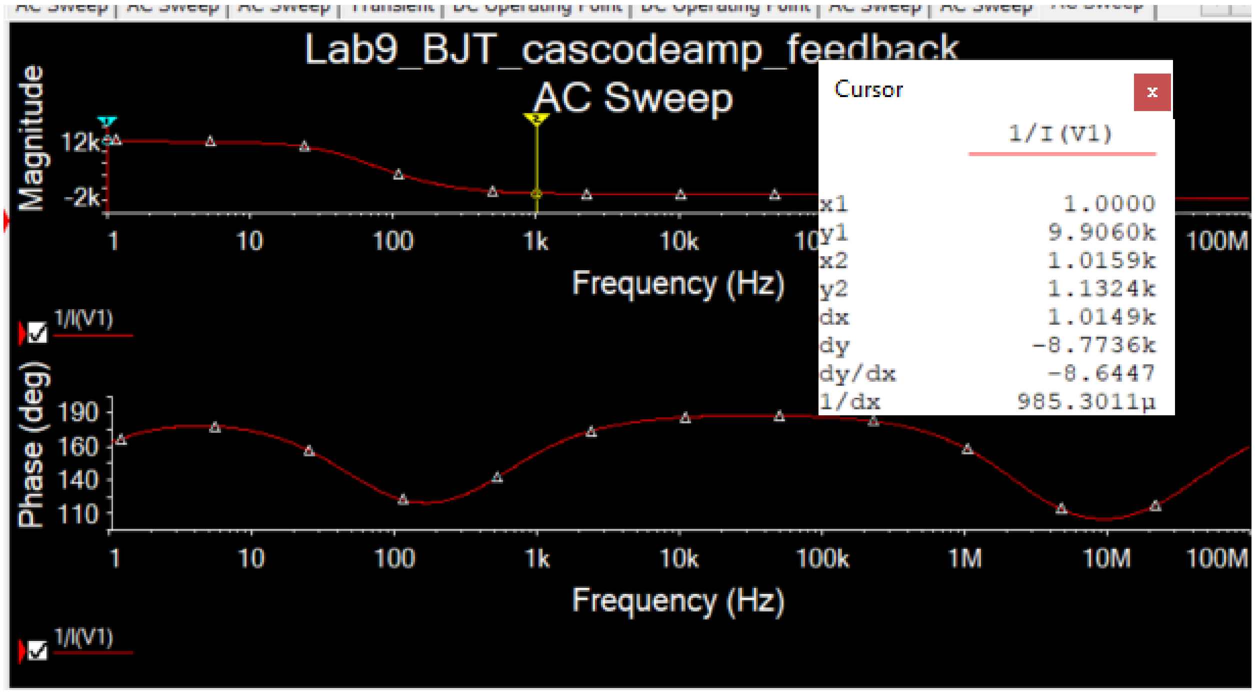
I(Rc:1) | I(Ic)	4.61106 m
-I(Re:2) | I(Ie)	4.69579 m
-I(V2:1) | I(Isupply)	5.18221 m
V(4) | V(vo)	0.00000e+00

	Variable	Operating point value
1	V(2) | V(Vb1)	1.86865
2	V(6) | V(vb2)	1.05936
3	V(3) | V(Vc1)	1.31115
4	V(5) | V(ve1)	1.16107
5	V(9) | V(ve2)	352.18411 m
6	V(4) | V(vo)	0.00000e+00

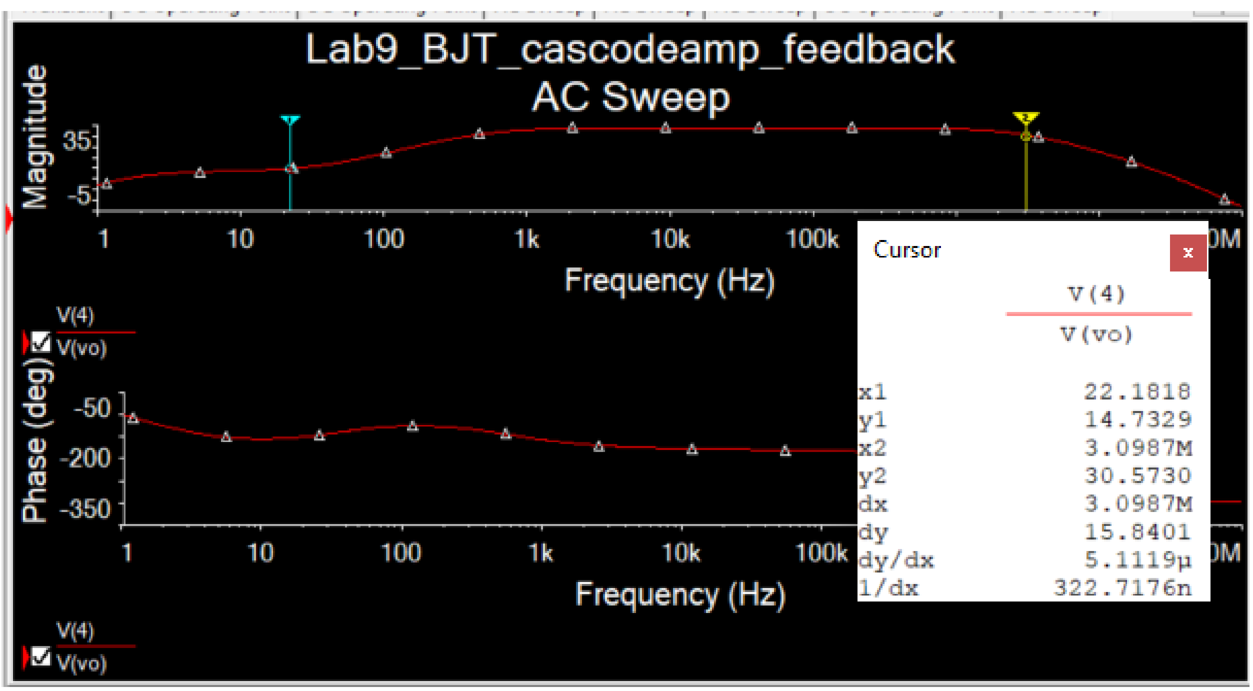
Av:



Rin:



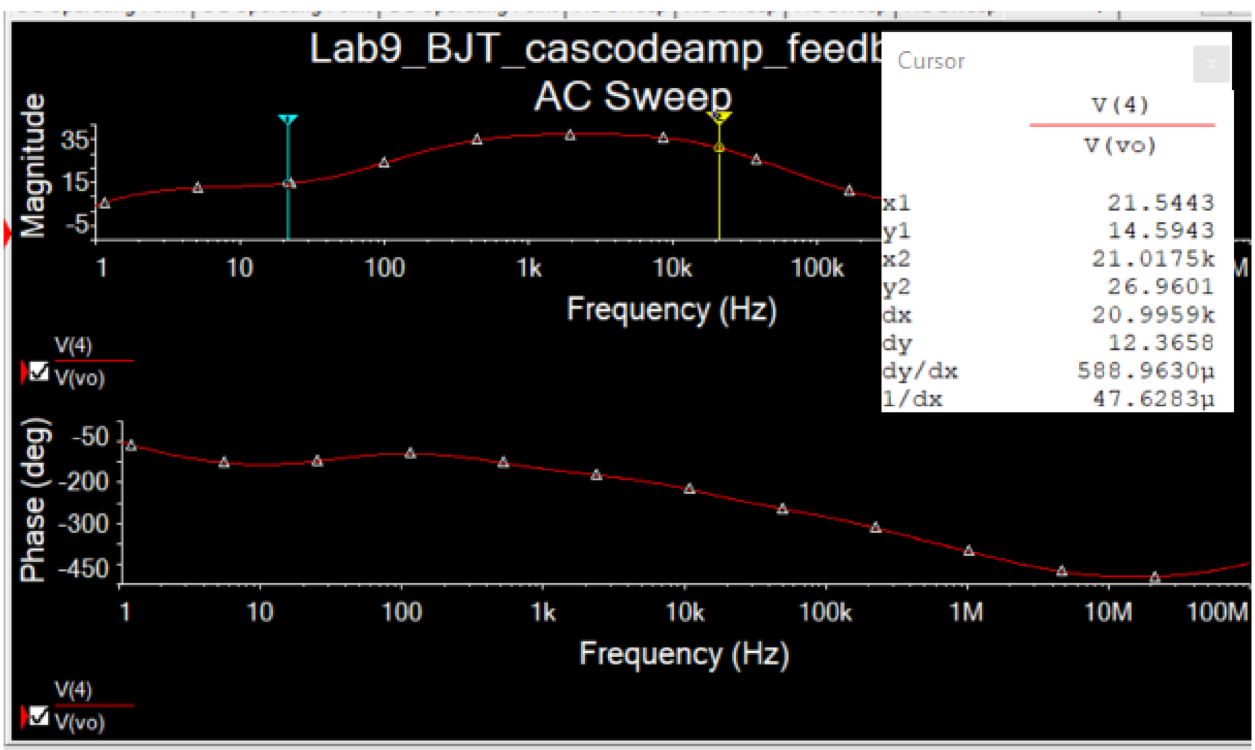
Higher pole when Cf = 0



Model Parameters

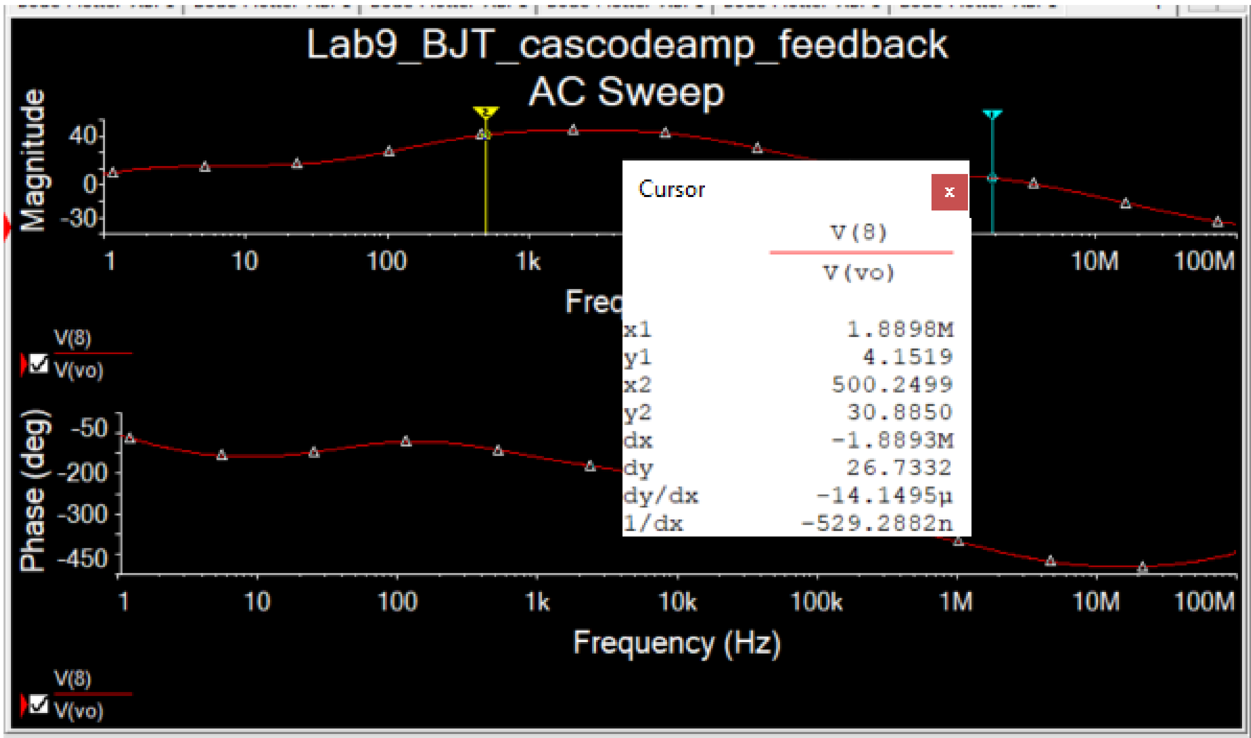
	Variable	Operating point value
1	1/@qq1[gx]	10.00000
2	1/@qq2[gx]	10.00000
3	@qq1[cmu]	172.83401 p
4	@qq1[cpi]	57.51002 p
5	@qq2[cmu]	3.50359 p
6	@qq2[cpi]	57.66711 p

When higher frequency is set to 20kHz



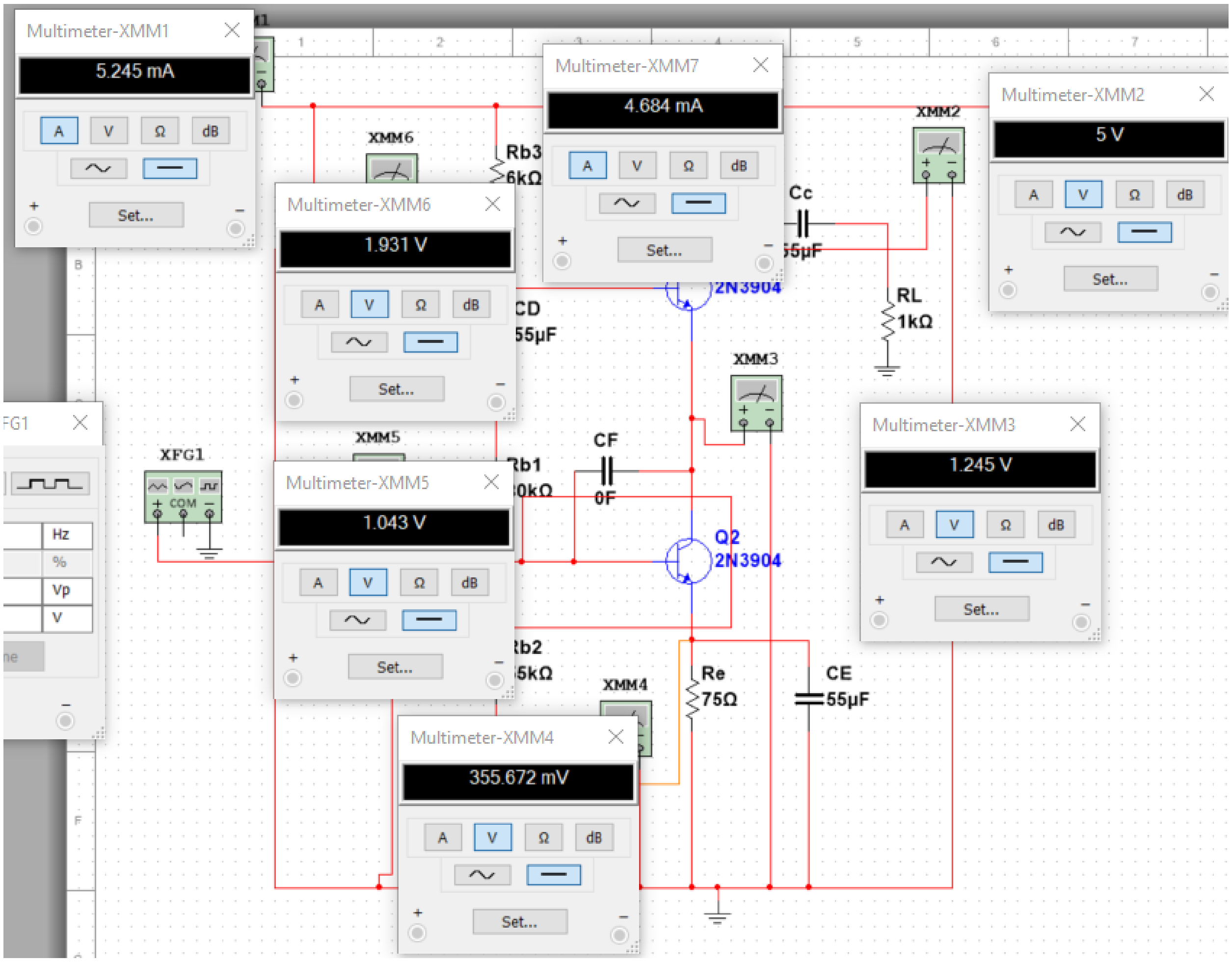
cF = 100nF

Lower Frequency at 500Hz

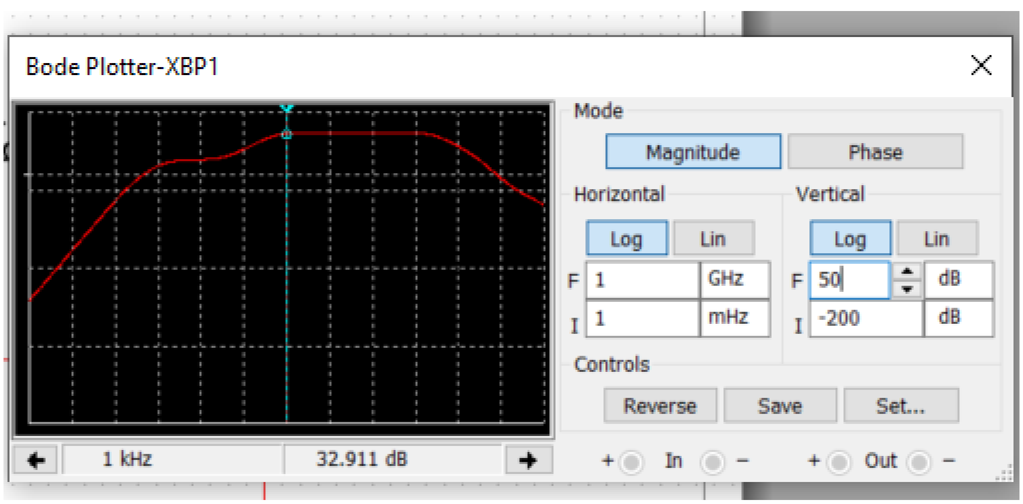


Measured

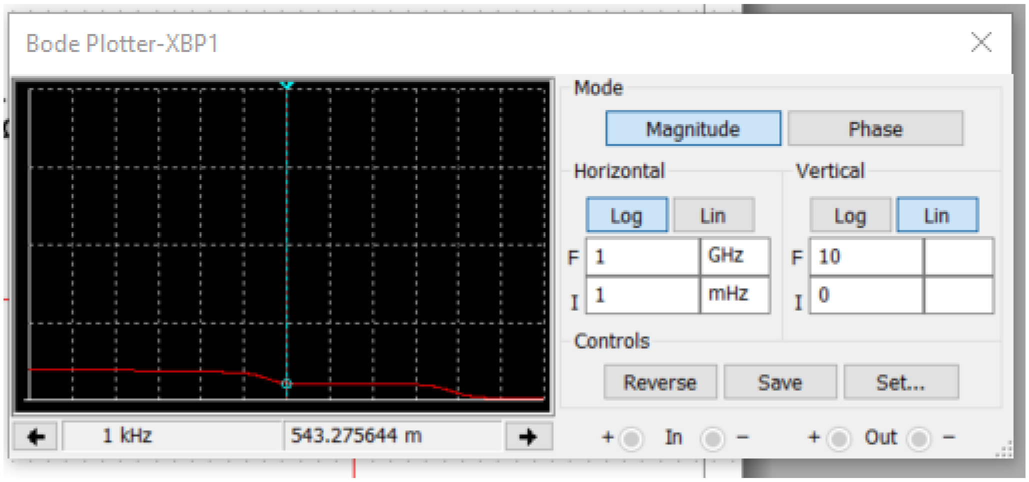
DcOp



Av

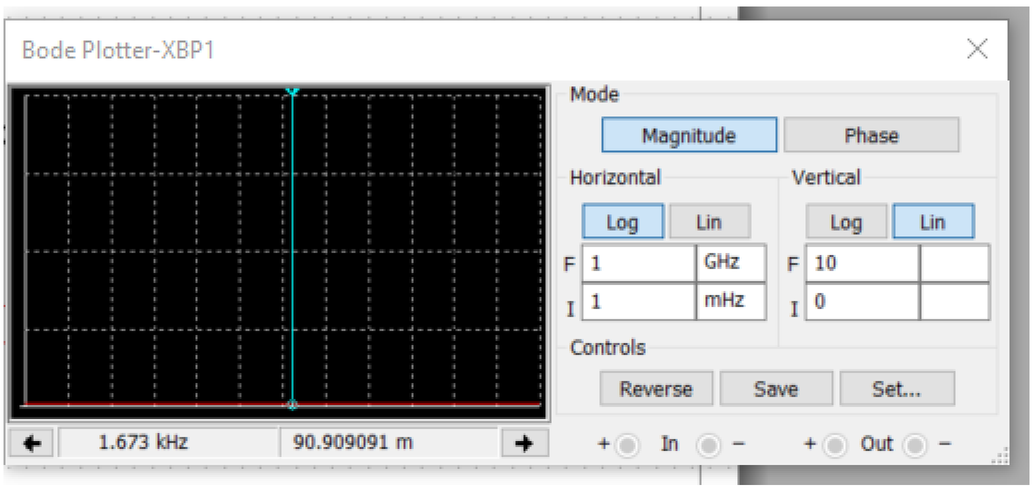


Rin @ 1kHz test:



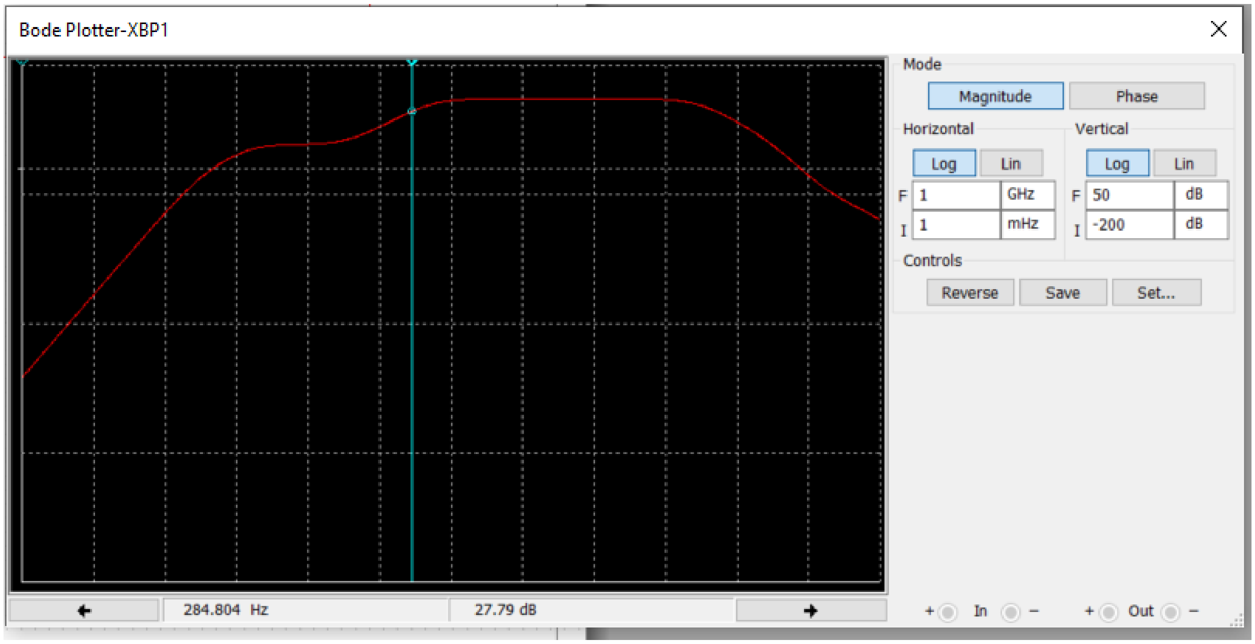
=847Ω

Rout @ 10k Test:

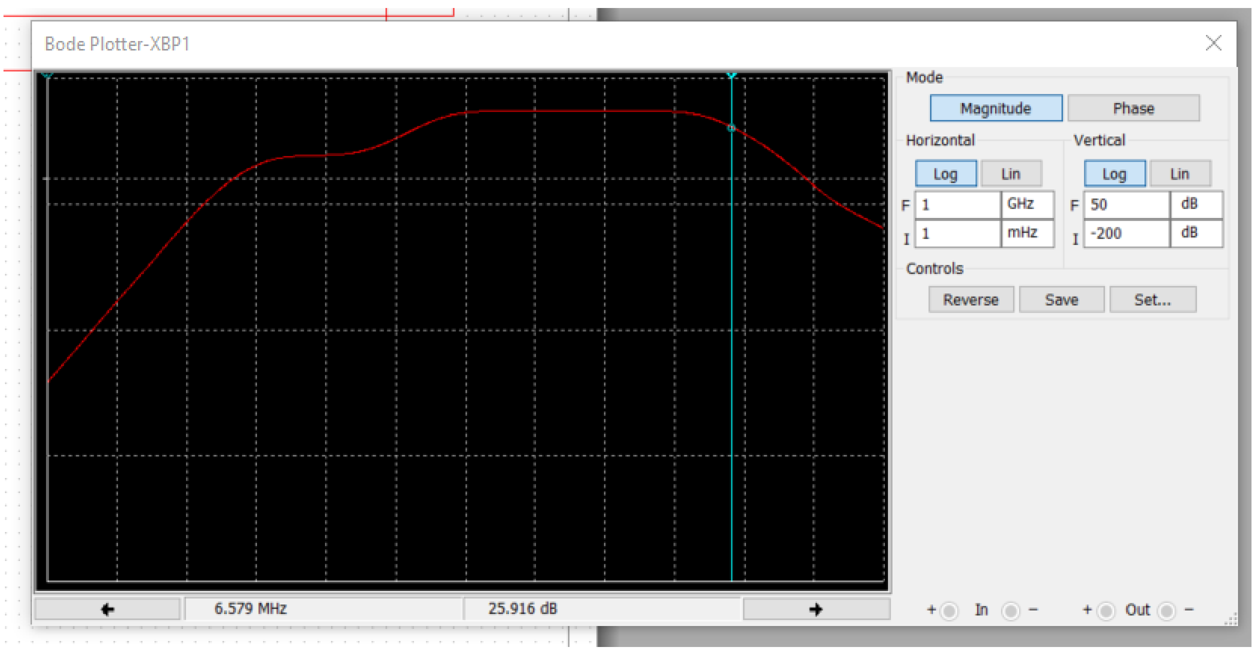


=8.406kΩ

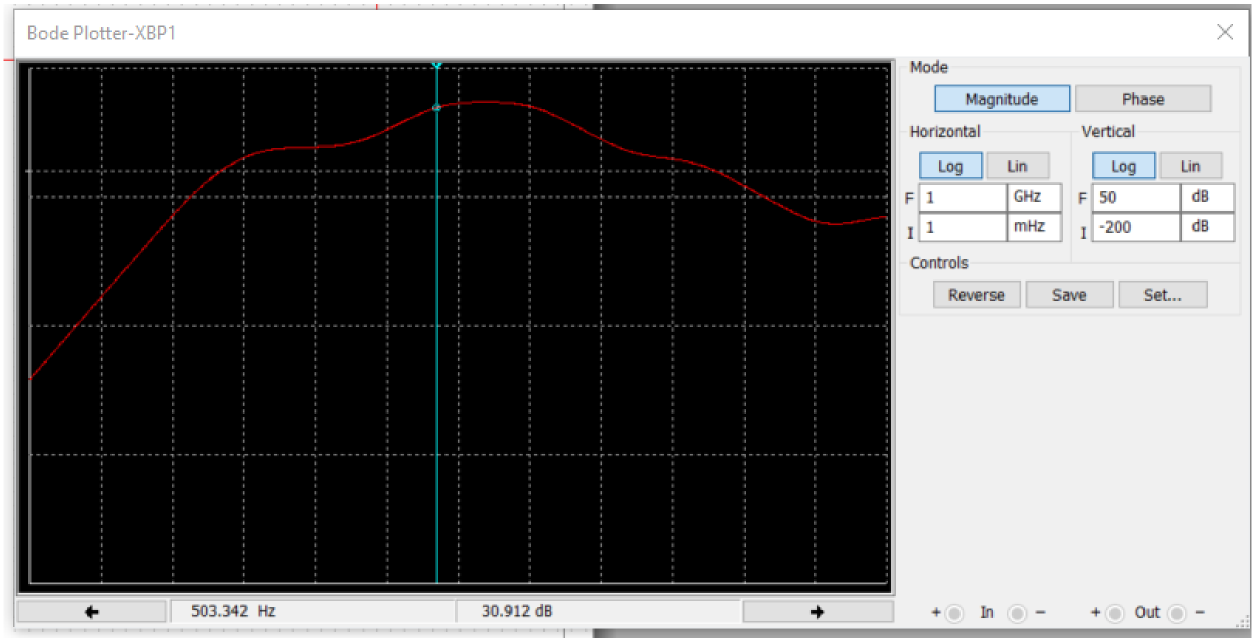
Lower Pole with Cf = 0



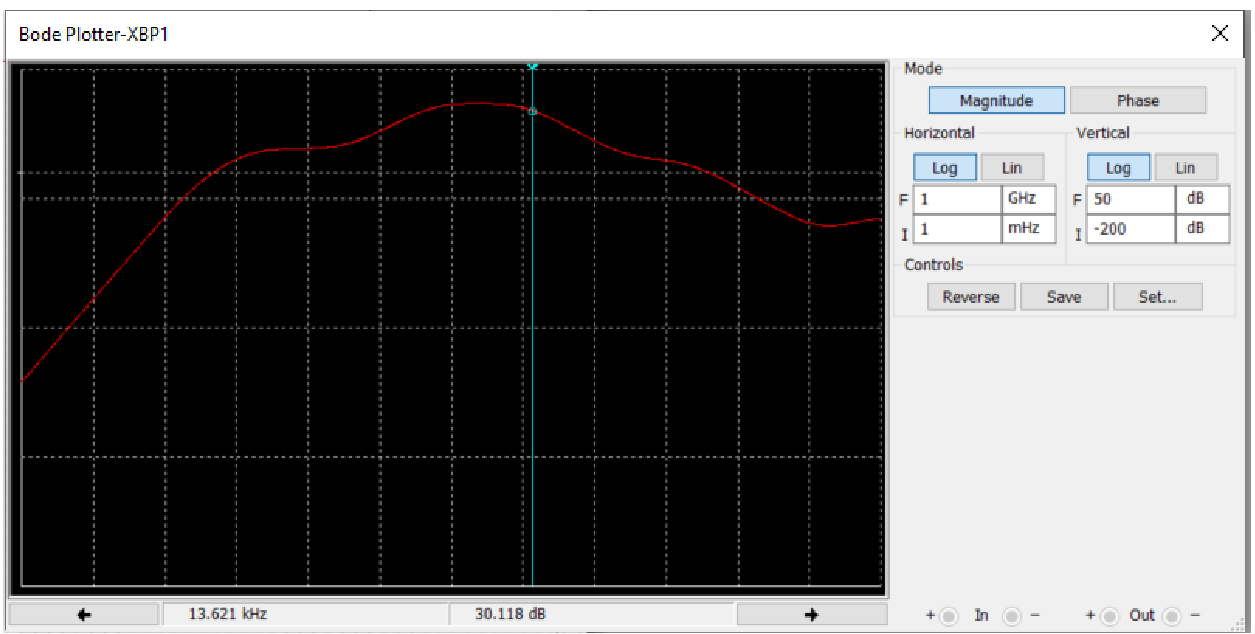
Higher Pole with Cf = 0



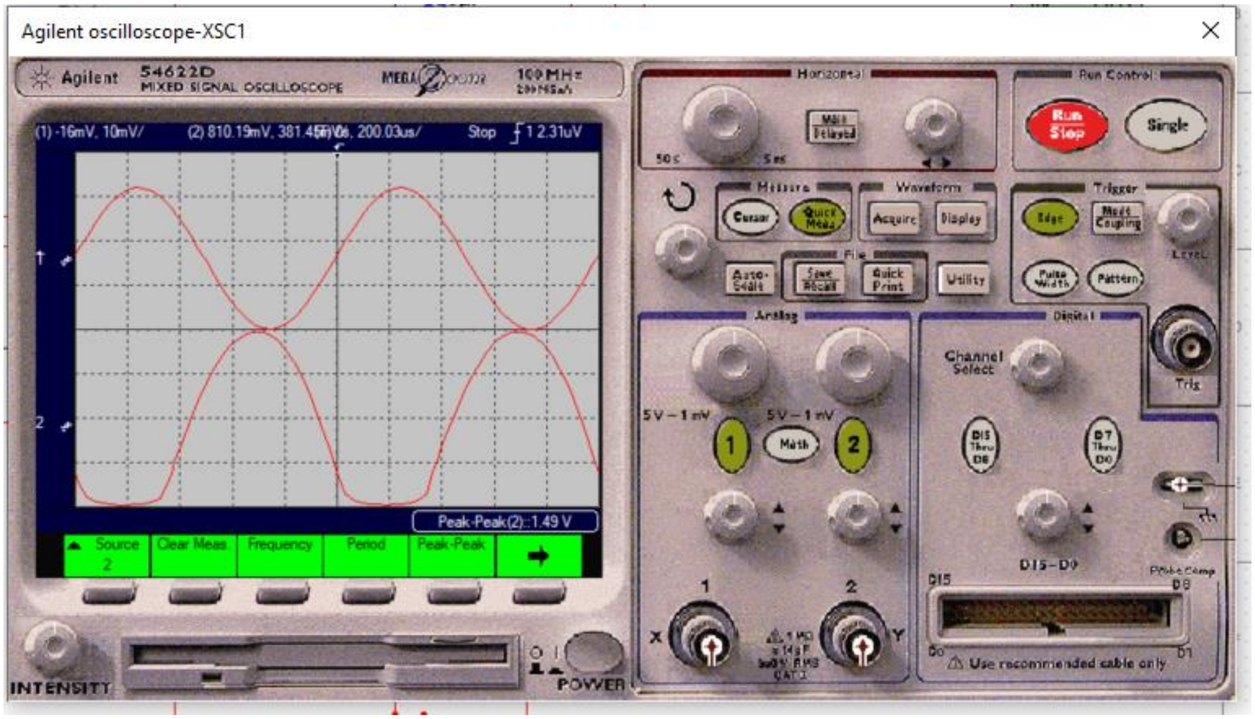
Lower pole estimated at 500Hz



Higher pole estimated at 20kHz



Maximum Unclipped Output



Results

	Calculated	Simulated	Measured
Isupply	< 8mA	5.182mA	5.245mA
Vc	1.3v, 1.2v	1.31v, 1.161v	5v, 1.245v
Ve	1.2v, 500mv	1.161v, 3.52mv	1.245v, 355mv
Vb	1.9v, 1.2v	1.86865v, 1.059v	1.931v, 1.043v
Av	50dB	32dB	33dB
Rin	250 <	1kΩ	847Ω
Rout	-	-	8.4kΩ
Higher Frequency	71MHz	3MHz	7MHz
Lower Frequency	3.565kHz	300Hz	284Hz
Caped at 20kHz	20Hz	21kHz	13.03KHz
Caped at 500Hz	500Hz	500Hz	503.21Hz
CF measure	829nF	100nF	100nF
Vswing unclipped	>3vPtoP	1.49v	1.5v

Results Discussed

There is good comparisons with the DC analysis and the input resistances. The gain is a little on the lower side with the circuit however it meets the other requirements. A big issue is with the calculation of the Cf value that resulted in the correct 20kHz values. This value was moved to simulate and measure the correct data however the calculated value is 9 times larger. This is likely to a mathematical mistake made on my part however there is similar increase from the lower pole frequency. This increase at the lower pole is not as significant however and could be a rounding error somewhere. Another large area of issue is the estimated higher frequency with CF = 0. This value was calculated to be massive however it came out to be relatively smaller. This value is still relatively large in both cases however it is strange. I believe that this error could also be the result of calculation error. In the previous lab, this value for fH was close to 1MHz which is similar in magnitude to our calculations this lab. When bounded to the 20kHz higher pole frequency, the previous lab was also a little lower on the calculation however still similar enough to represent the correct frequency. The CF value in the previous lab was also much smaller which makes me think that this value will need to increase as there are more stages added to the system.