Matthew Loden

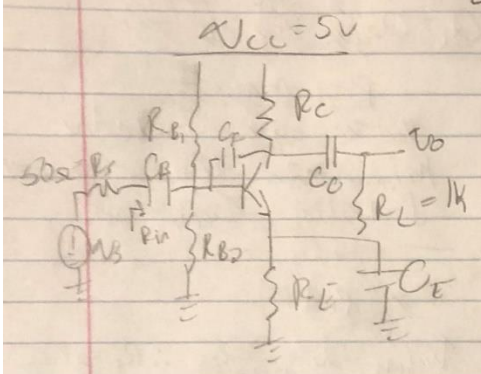
Lab 8: Frequency Response of a BJT amplifier

Purpose:

In this lab we will expereimetn with the frequency response capacitors to determine how they work.

Calculations:

Lab 08



$I_{Supply} \leq 8mA$ $\quad |A_V| \geq 50$

$V_{SW} \geq 1.5$ $\quad C_B = C_C = C_E = \infty$

$C_F = C_\pi = C_\mu = \phi$

$$A_V = \frac{R_C \parallel R_L}{r_e + R_E}$$

$$R_{C,max} = R_L\left(\frac{4.3}{1.5} - 2\right) \Rightarrow R_C \leq 866\Omega$$

$R_C = 750 \Rightarrow I_C = 2.9mA$

$r_\pi = \frac{\beta}{g_m}$

$$\omega_H = \frac{1}{R_T\left[C_\pi + (C_\mu + C_F)\left(1 + g_m R_{C2} + \frac{R_{C2}}{R_{C2}}\right)\right]}$$

$R_T = r_\pi \parallel (r_b + (R_S \parallel R_B)) = 13.944$

$R_{C2} = R_C \parallel R_L = 428.57\Omega$

$C_b = 10$

$C_\pi = 63.49p$ $\quad C_\mu = 27p$

@ $\omega_H = 20kHz$

$C_F = 4.4 \times 10^{-8}$

$44nF$

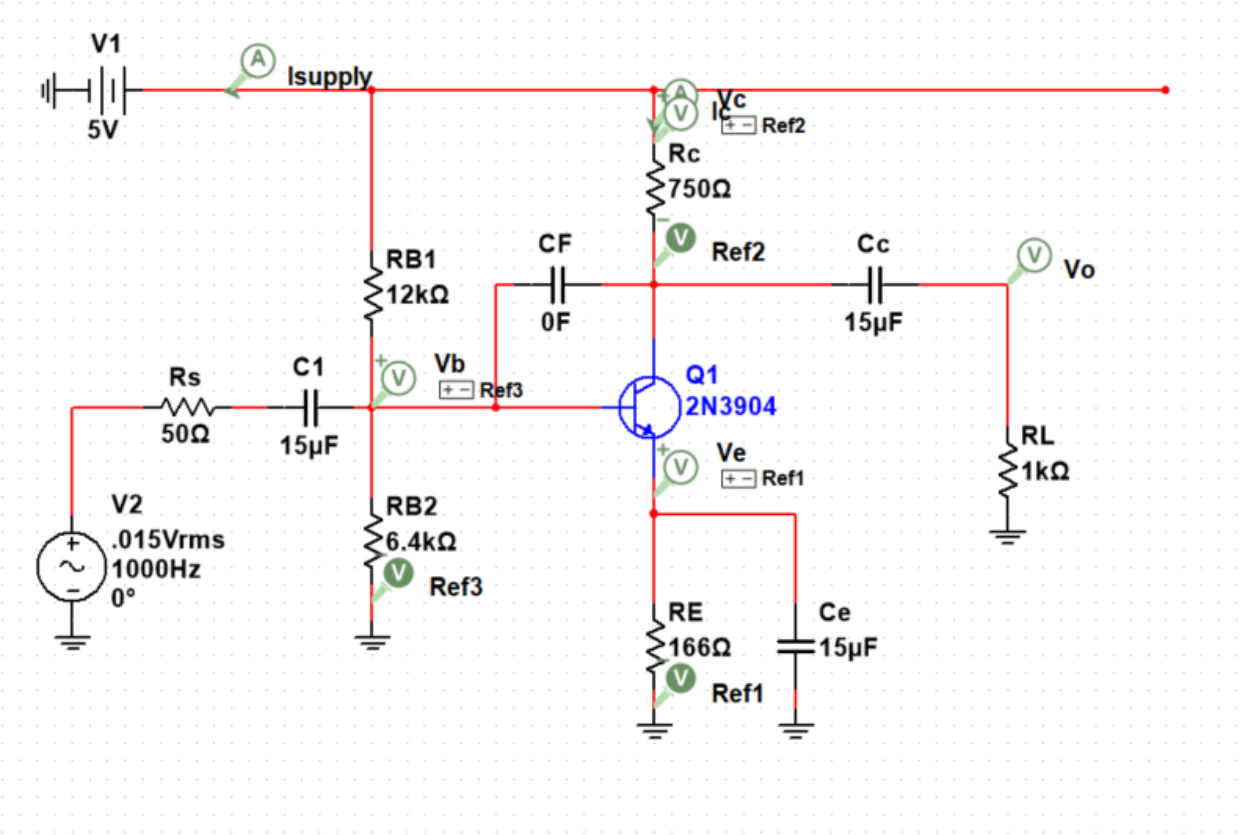
$$\omega_L = \frac{1}{R_{1S} \cdot C_B} + \frac{1}{R_{2S} C_E} + \frac{1}{R_{3S} \cdot C_O} = 72.544Hz$$

$R_{1S} = R_S + (R_B \parallel r_\pi) = 4.223k\Omega$

$R_{2S} = R_E + \left(\frac{r_\pi + (R_B \parallel R_S)}{\beta + 1}\right) = 215.86$

$R_{3S} = R_C + R_L = 1750\Omega$

Circuit:

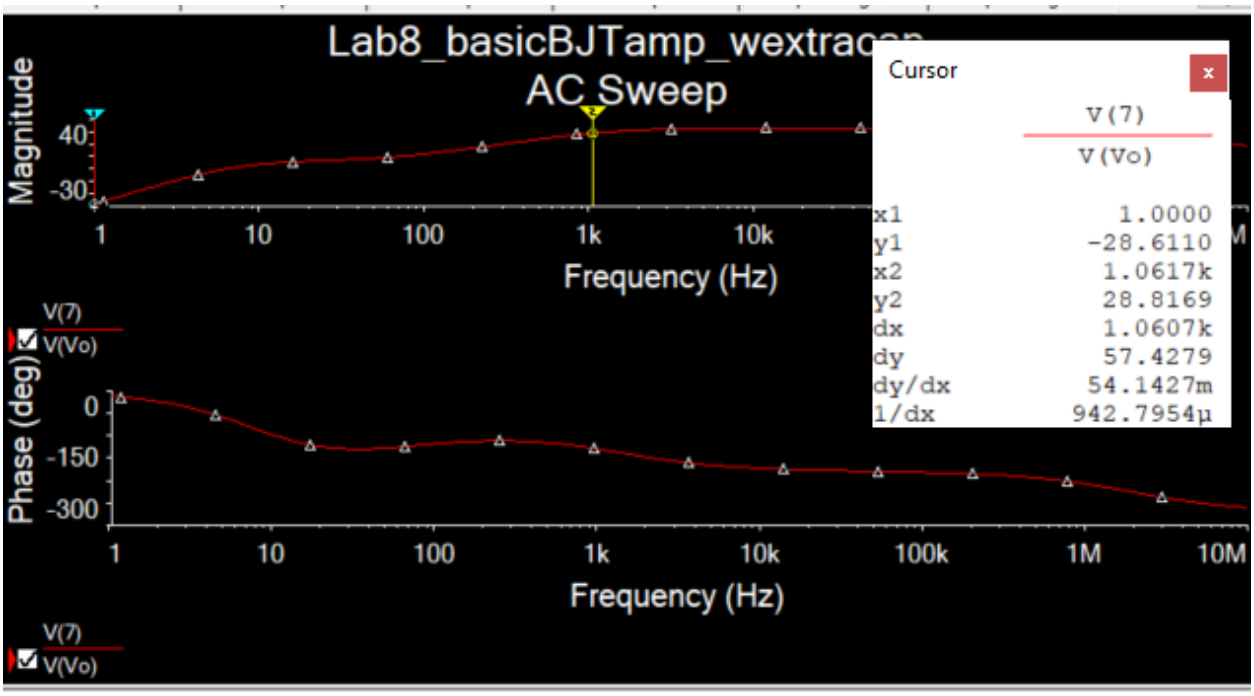


Simulations:

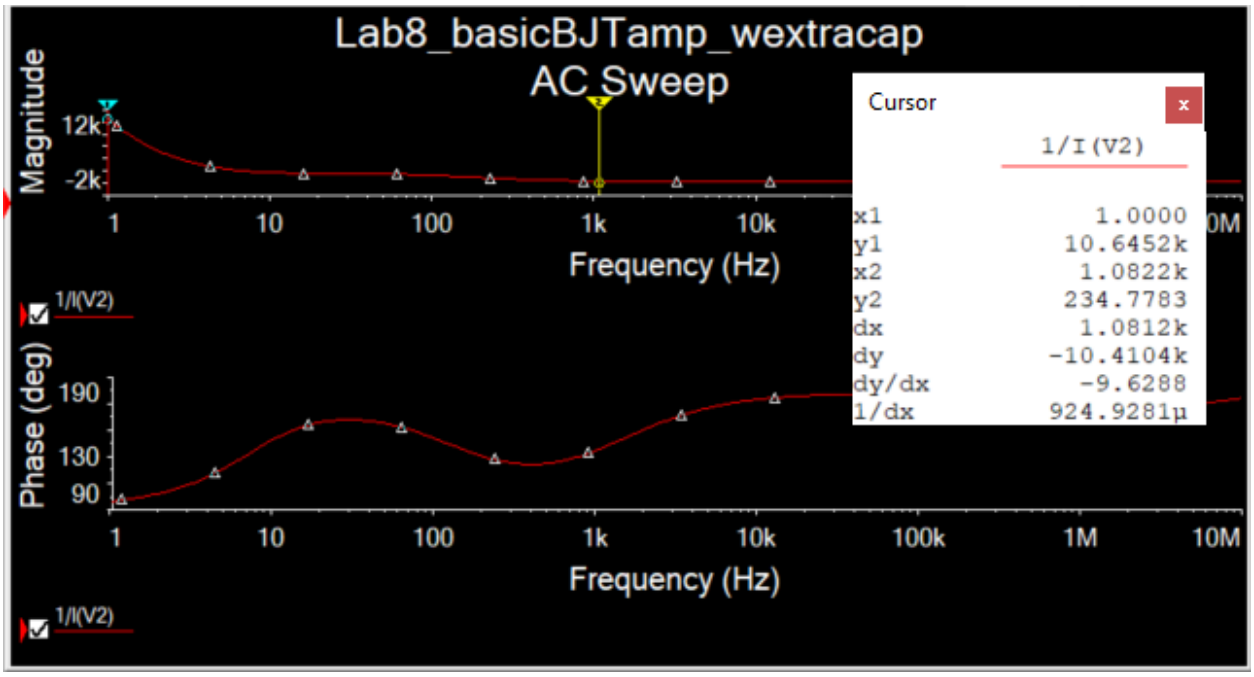
DcOp:

	Variable	Operating point value
1	I(Rc:1) | I(Ic)	5.22762 m
2	I(V1:1) | I(Isupply)	-5.51224 m
3	V(4) - V(0) | V(Vb)	1.58458
4	V(1) - V(2) | V(Vc)	3.92072
5	V(3) - V(0) | V(Ve)	873.93177 m
6	V(7) | V(Vo)	0.00000e+00

Av:

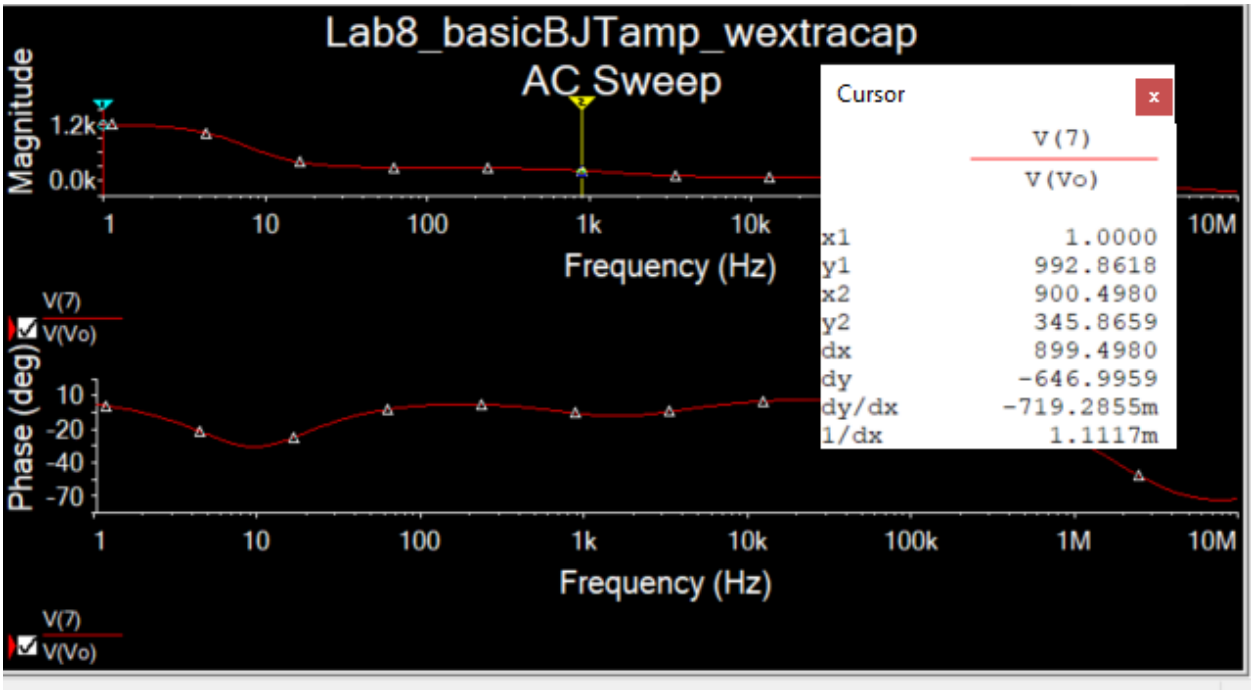


Rin:

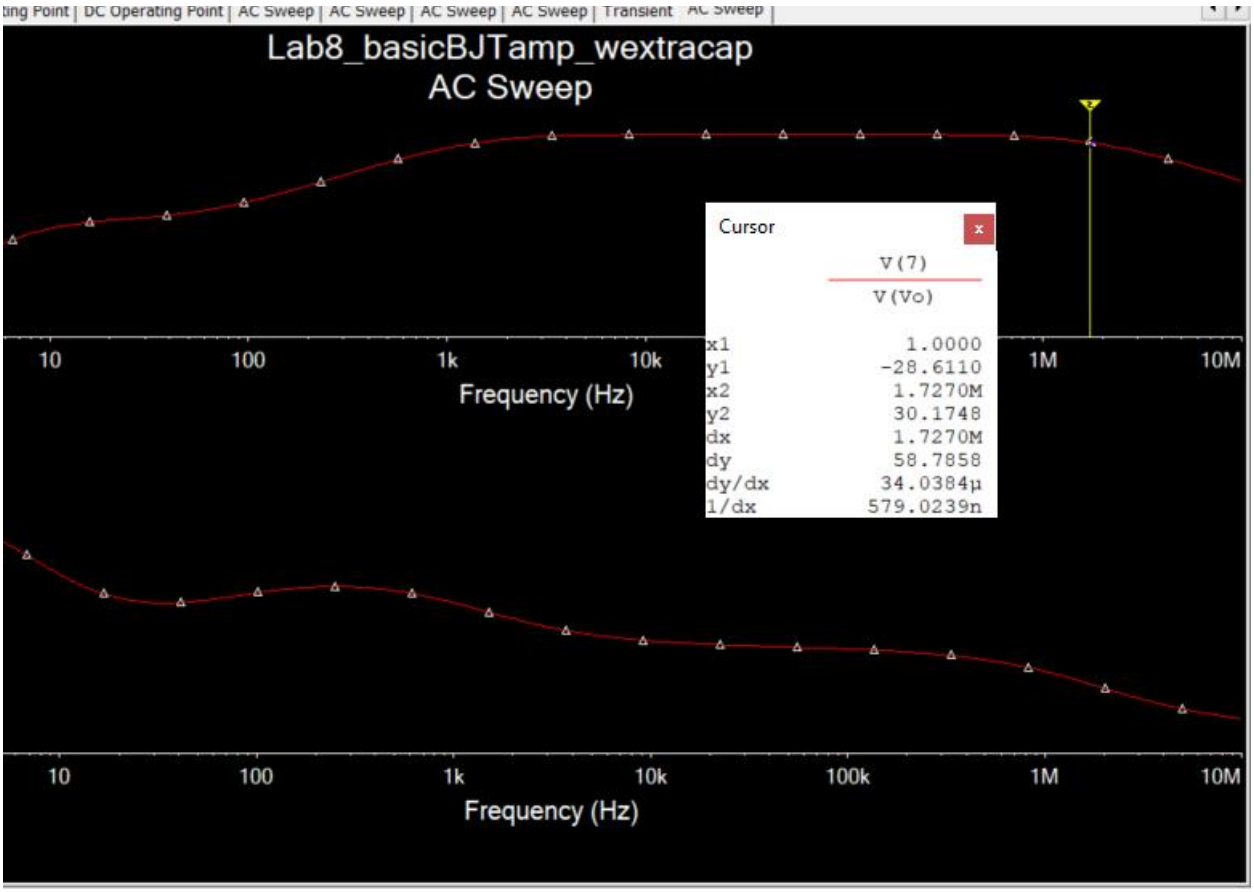


=234Ω

Rout:



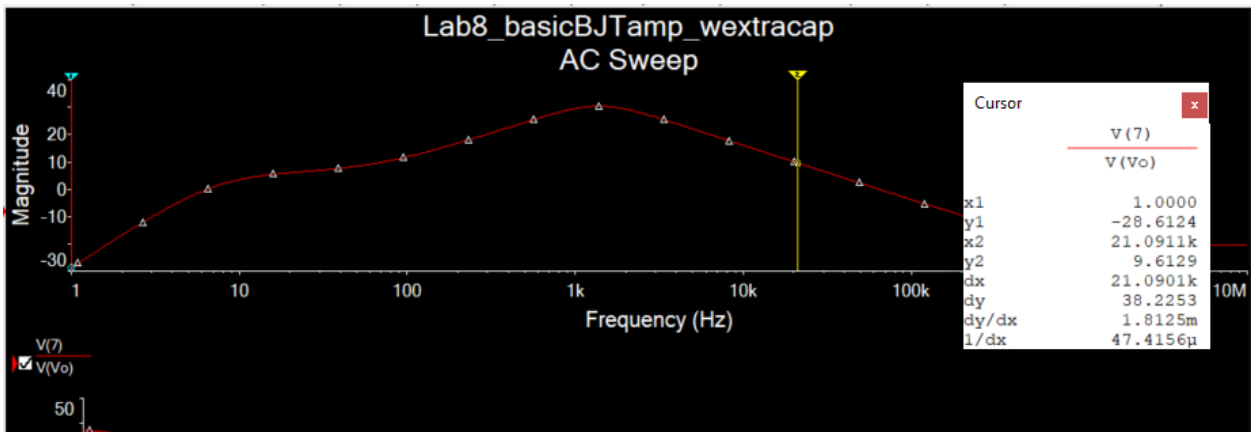
Higher 3db pole



Capacitor information:

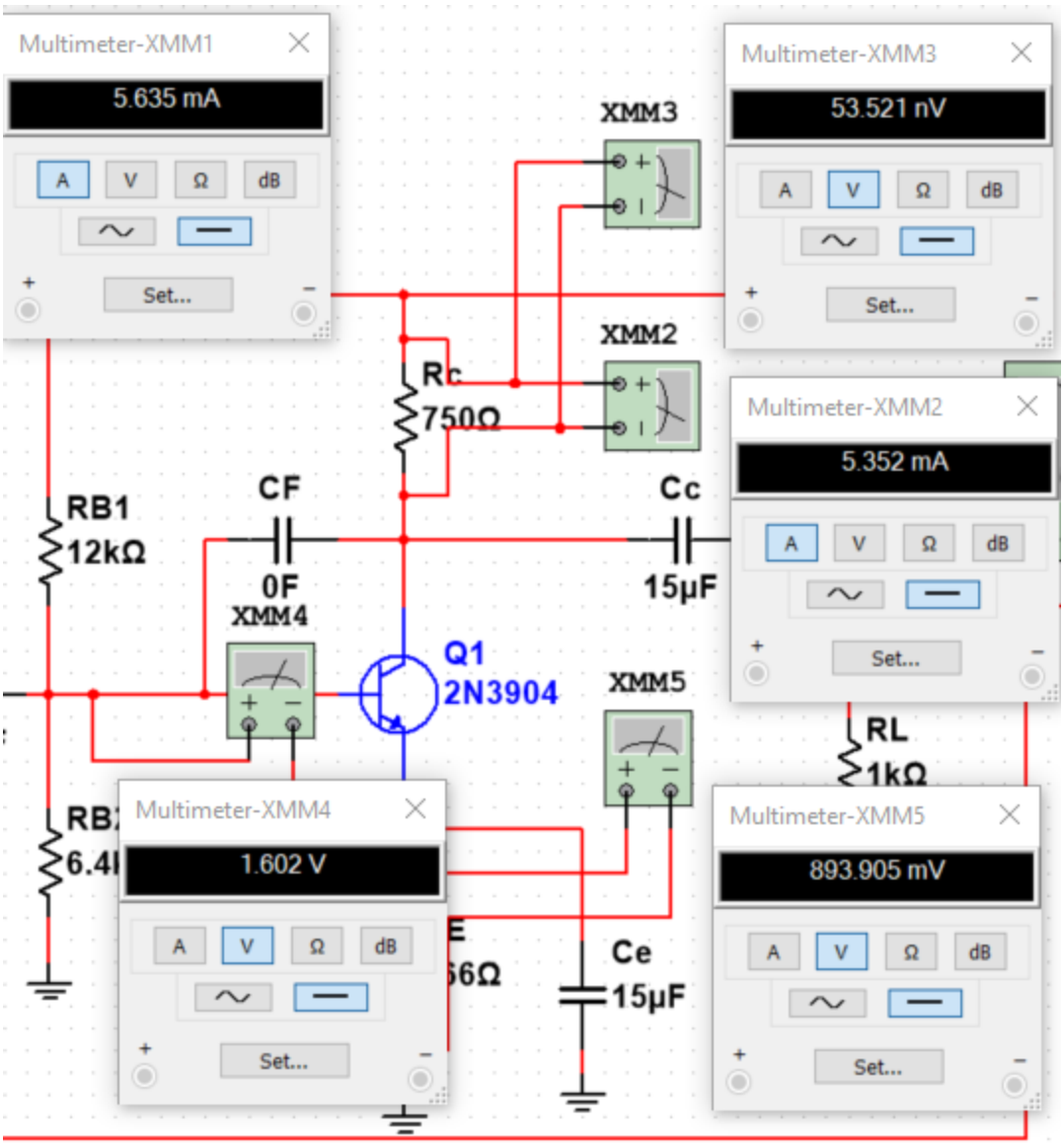
	Variable	Operating point value
1	1/@qq1[gx]	10.00000
2	@qq1[cmu]	27.96793 p
3	@qq1[cpi]	63.49053 p

At pole 20khz

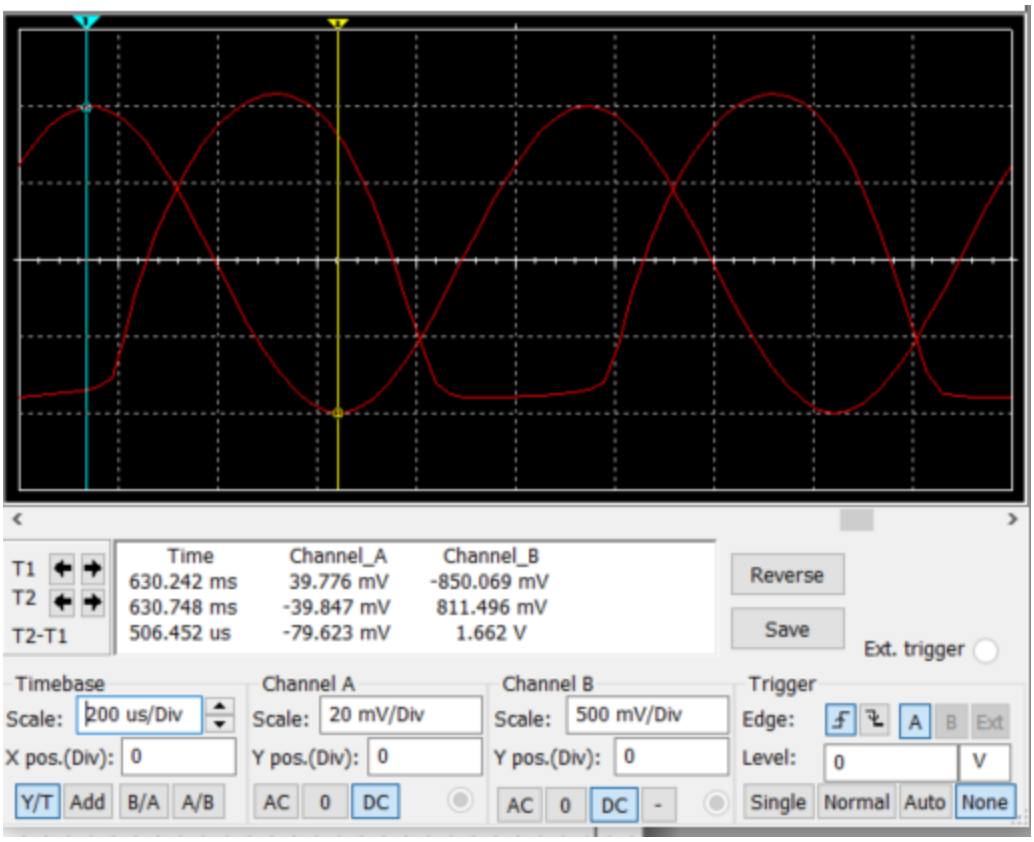


Measurements

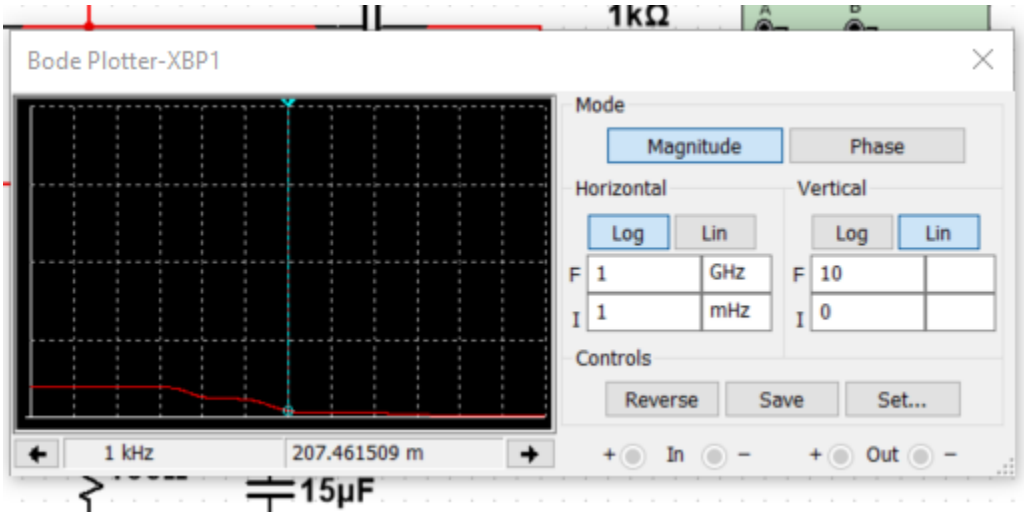
DcOp:


Multimeter-XMM1
5.635 mA
A
V
Ω
dB
Set...
Multimeter-XMM3
53.521 nV
XMM3
XMM2
Rc
750Ω
Multimeter-XMM2
5.352 mA
RB1
12kΩ
CF
0F
XMM4
Cc
15µF
Q1
2N3904
XMM5
RL
1kΩ
Multimeter-XMM4
1.602 V
Multimeter-XMM5
893.905 mV
Ce
15µF

Av:

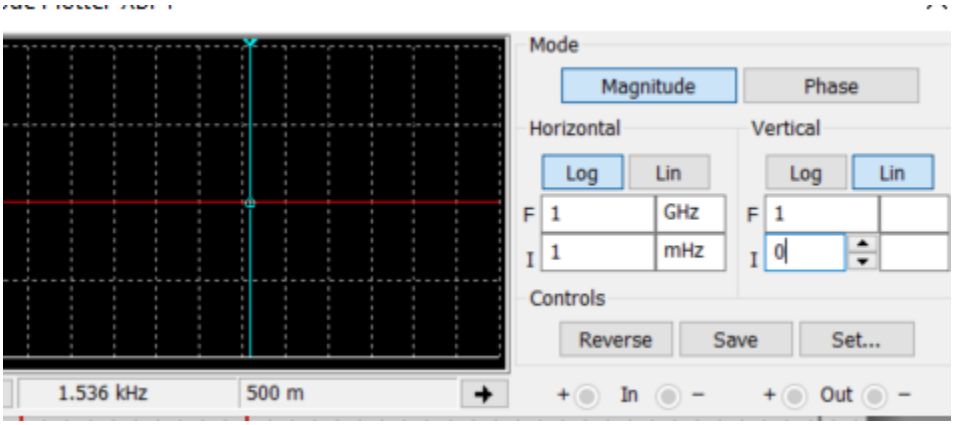


Rin: @ 1k



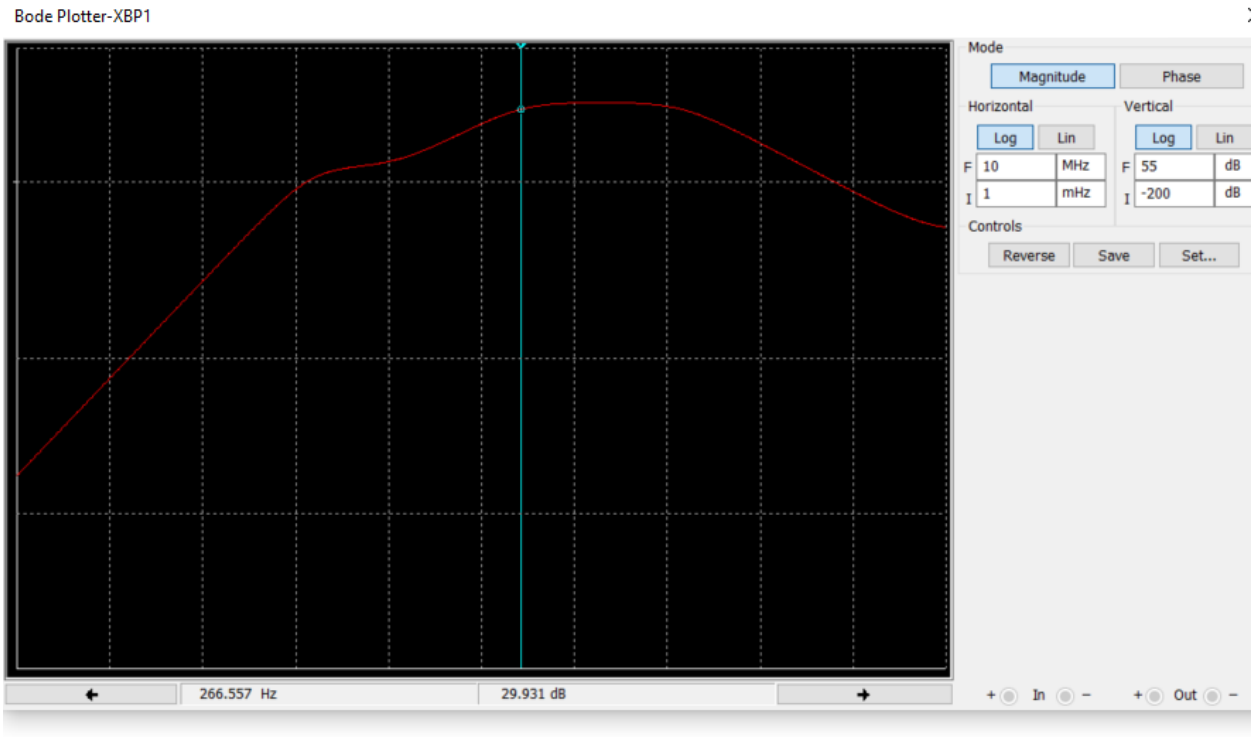
=261.03

Rout: @1k

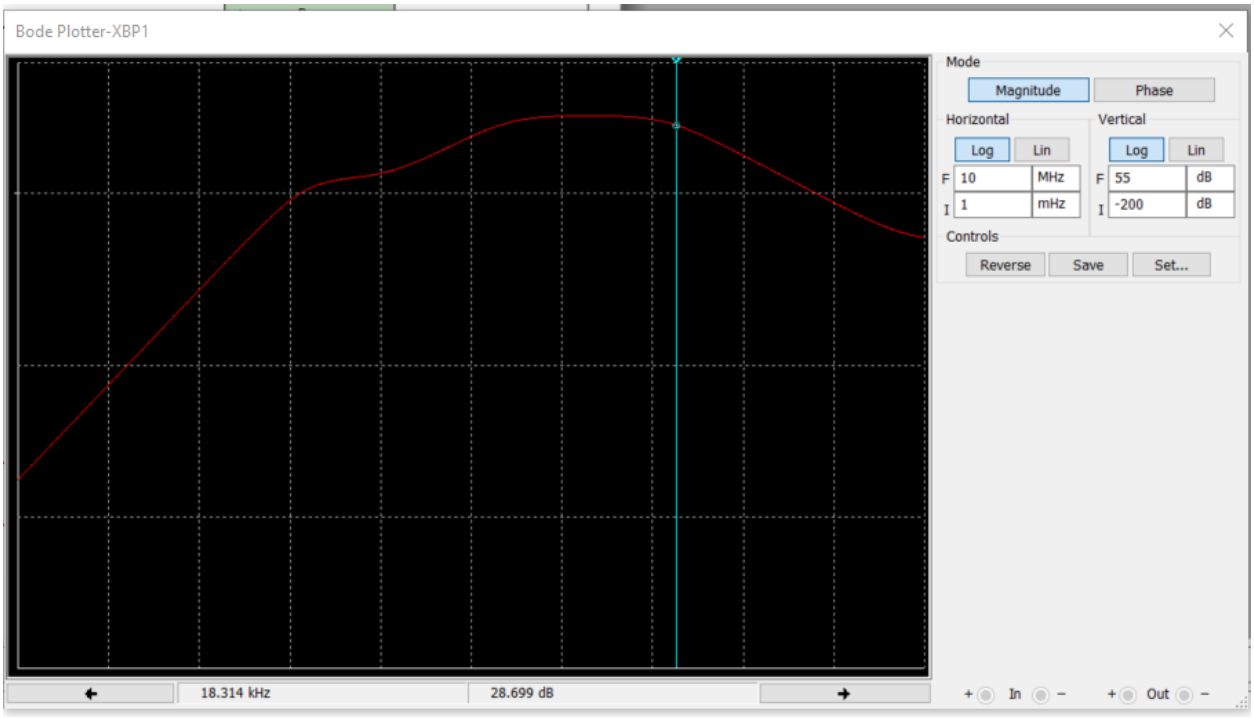


=1000

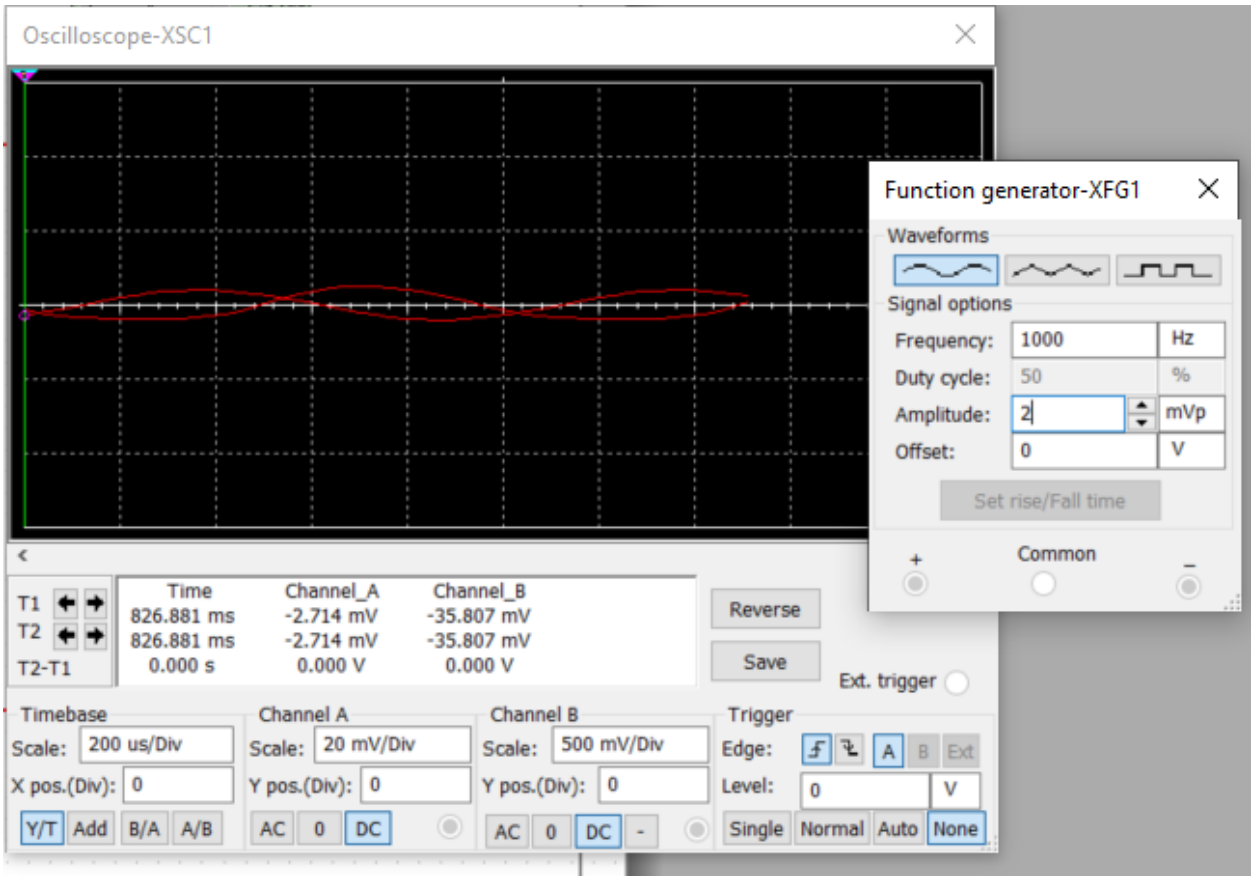
Lower frequency



Higher frequency



Maximum Unclipped amplitude



	Calculated	Simulated	Measured
Ic	2.9mA	5.22mA	5.352mA
Isupply	>8mA	5.51mA	5.635mA
Vc	2.175v	3.907v	53.521nV
Ve	1v	0.873v	0.893v
Vb	3.26v	1.5845v	1.602v
Av	50dB	28.06dB	32dB
Rin	>250Ω	234Ω	261Ω
Rout	-	345Ω	1000Ω
Lower frequency	72.544 Hz	142.67 Hz	266.55 Hz
Higher frequency	20 kHz	1.02 MHz	18.314 kHz
Cpi	-	63.49p	-
Cmu	-	27p	-
Cb	-	10	-
Cf	4.4n	3.5n	4.4n

Results Explained and Compared:

The Dc Operation point data was relatively correct for all of the information gathered. The largest difference came from the measured voltage across the collector. I believe this is just an error with the wiring of the simulation that resulted in the correct value not being displayed. Another large point of issue is that my gain is much lower than the lab called for however I spent much time here trying to get a larger gain to no avail. The main point of the lab, the frequency information was somewhat correct. I believe that the simulated data for the higher frequency was not done properly and resulted in a massive value.