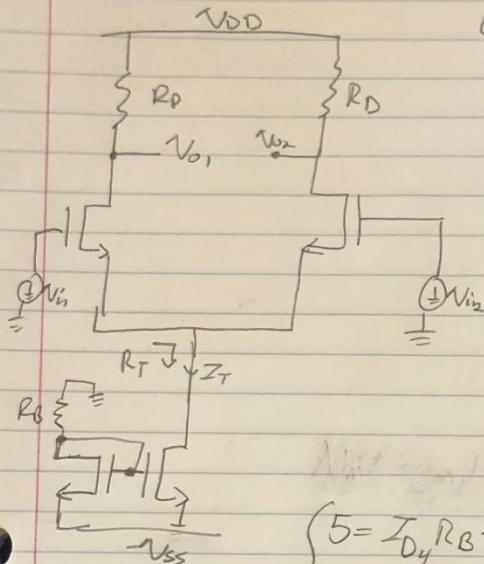Matthew Loden

Lab 5: Design of a MOS Differential Amplifier

Purpose:

In this lab, we will create a MOSFET differential amplifier and determine the CMRR from it. We will also study the differences between this MOS design and last weeks BJT design.

Calculations:

Lab #5

Using CD4007N

$K'n = 70\mu A/v^2$

$V_{tn} = 1.4v$

$W = 170\mu m$

$L = 10\mu M$

$\lambda_n = 0.016 v^{-1}$

Constraints

$V_{ic} = 0v \qquad I_{supply} \leq 0.5mA$

$V_{DD} = V_{ss} = 5v \qquad |A_{dm}| \geq 10$

$THD \leq 5\%$ for $5v$ v_{opeak} @ 1KHz

$\begin{cases} 5 = I_{D_4}R_B + V_{GS4} \\ I_{D_4} = \dfrac{K'n}{2}\dfrac{W}{L}(V_{GS4} - V_{tn})^2 \implies \\ 10 = \sqrt{2K'n\dfrac{W}{2}\dfrac{I_{D4}}{2}} \end{cases}$
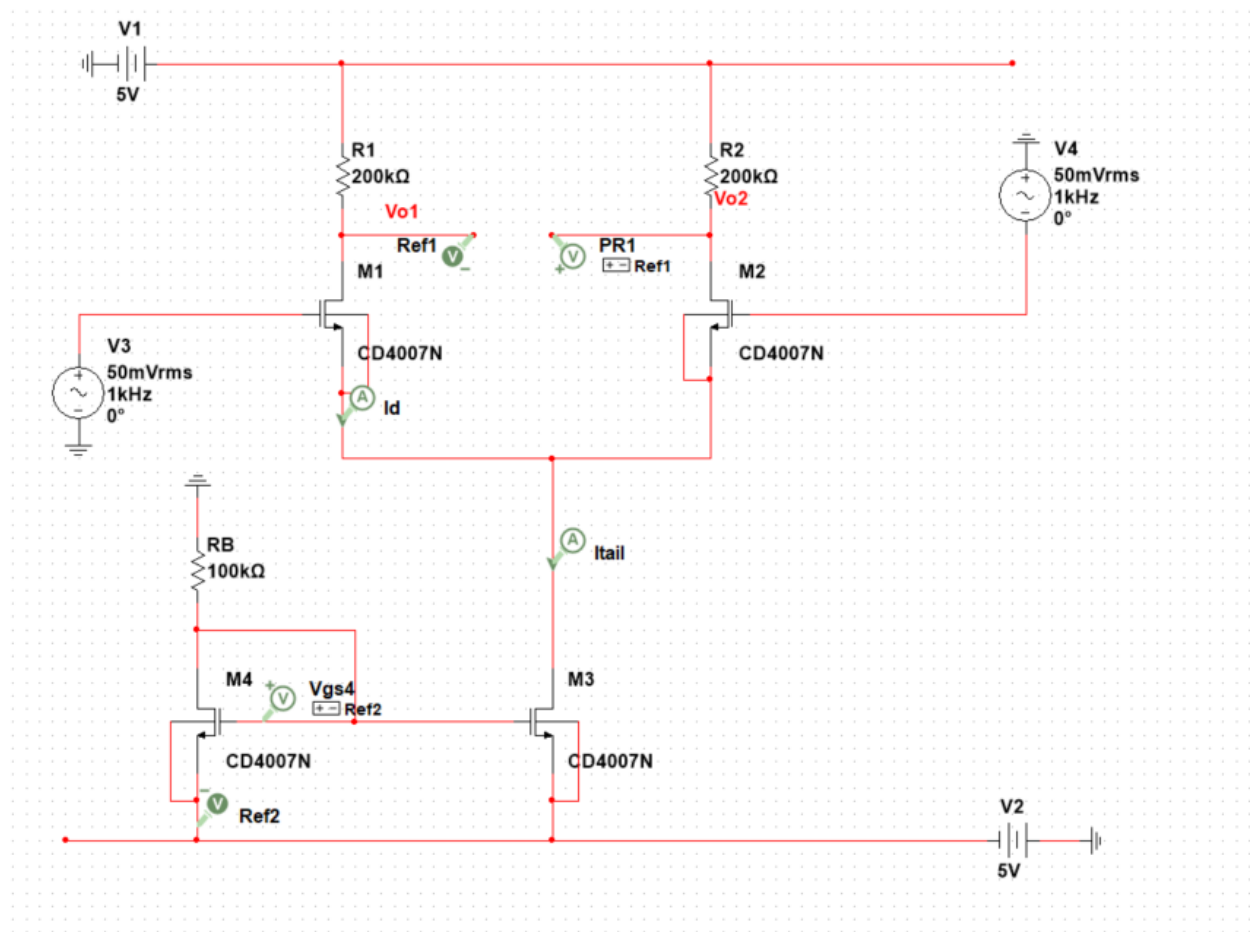
3eqn
3unk

$R_D = 200 K\Omega$

$V_{GS} = 2v$
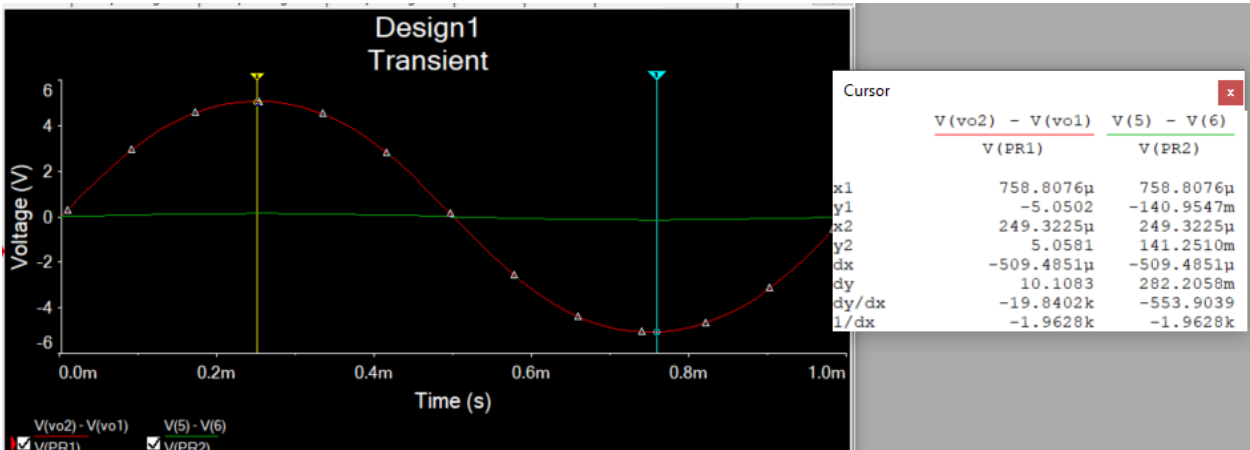
$I_{D_4} = 35\mu A$
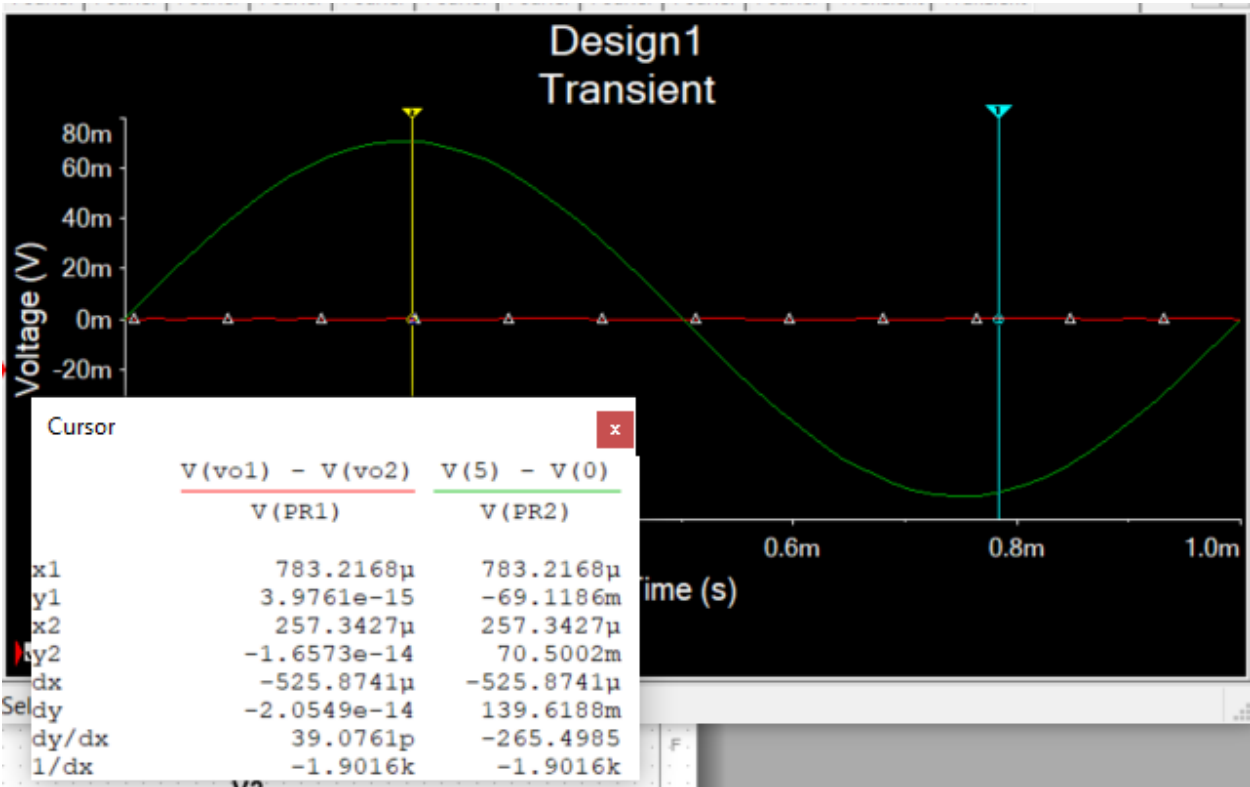
$I_{D_1} = 17.5 mA$

Circuit:

Simulations:

DcOp:

	Variable	Operating point value
1	-I(vM1.PinVoltageS--4:S)-I(vM1.PinVoltageSUB--4:SUB)	I(Id)	17.97058 u
2	I(vM3.PinVoltageD--4:D)	I(Itail)	35.94116 u
3	V(vo2) - V(vo1)	V(PR1)	0.00000e+00
4	V(3) - V(1)	V(Vgs4)	1.61655

Aid:
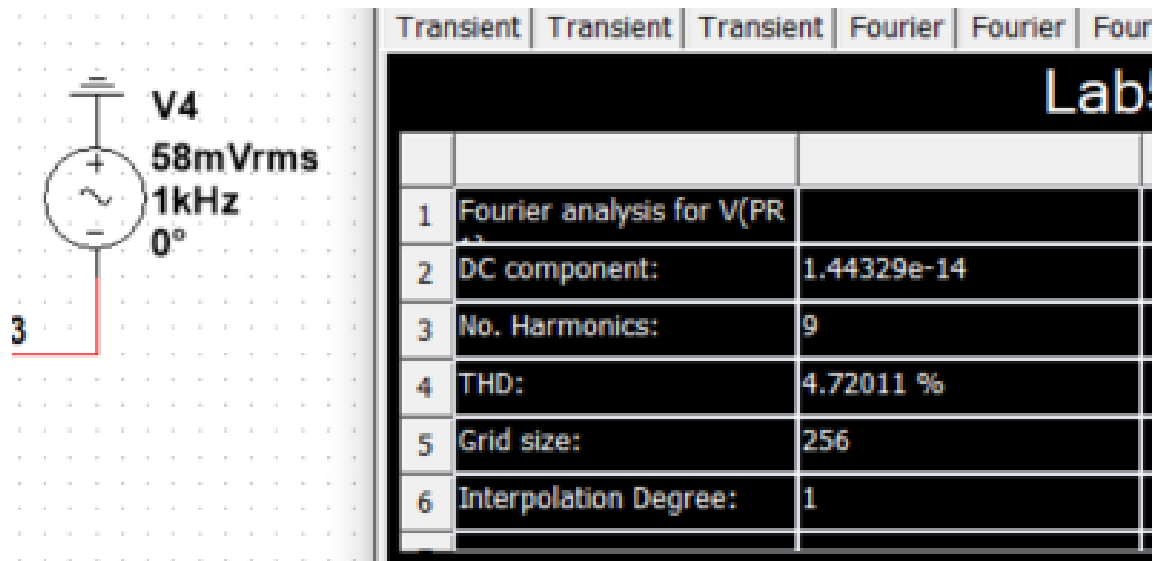

=10/.282 = 35.46

Aic:

= 2.054e-14 / .139 = 1.47e-13

THD:

V4
58mVrms
1kHz
0°

3

Lab

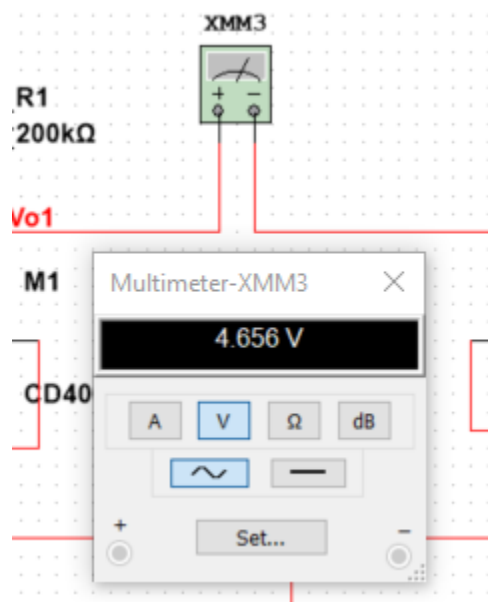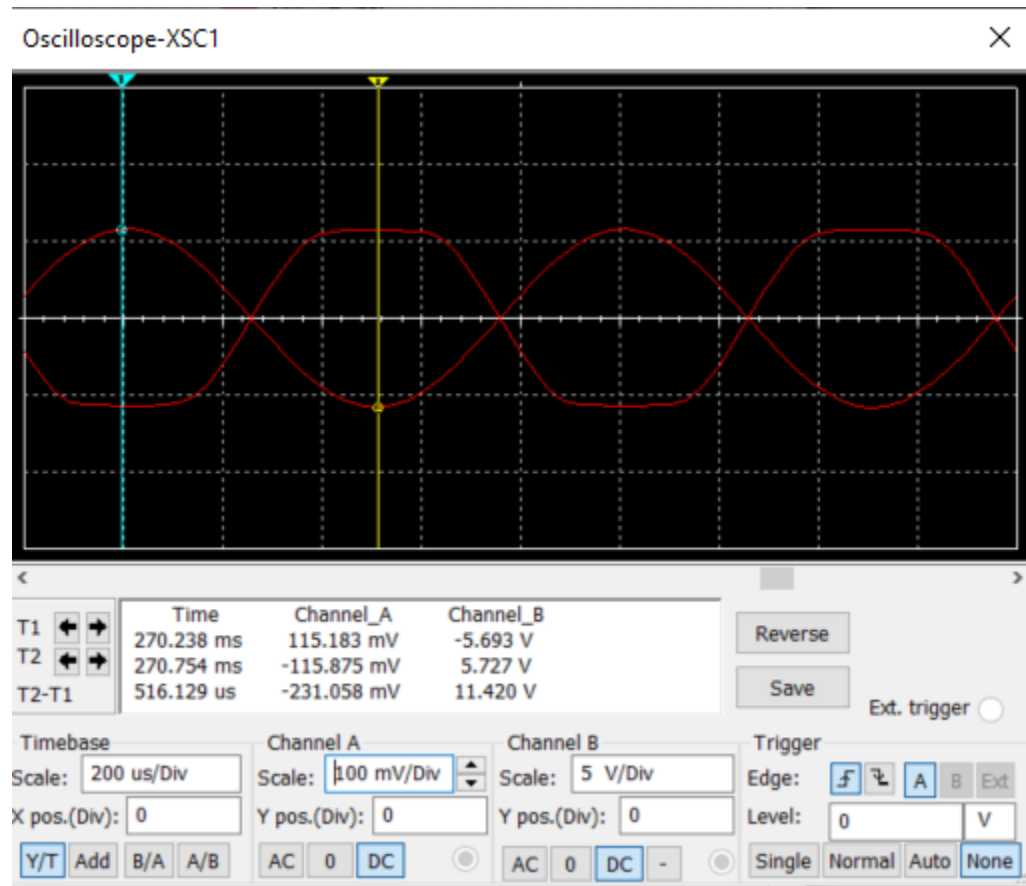|		
1	Fourier analysis for V(PR	
2	DC component:	1.44329e-14
3	No. Harmonics:	9
4	THD:	4.72011 %
5	Grid size:	256
6	Interpolation Degree:	1

Measurements:

DcOp:
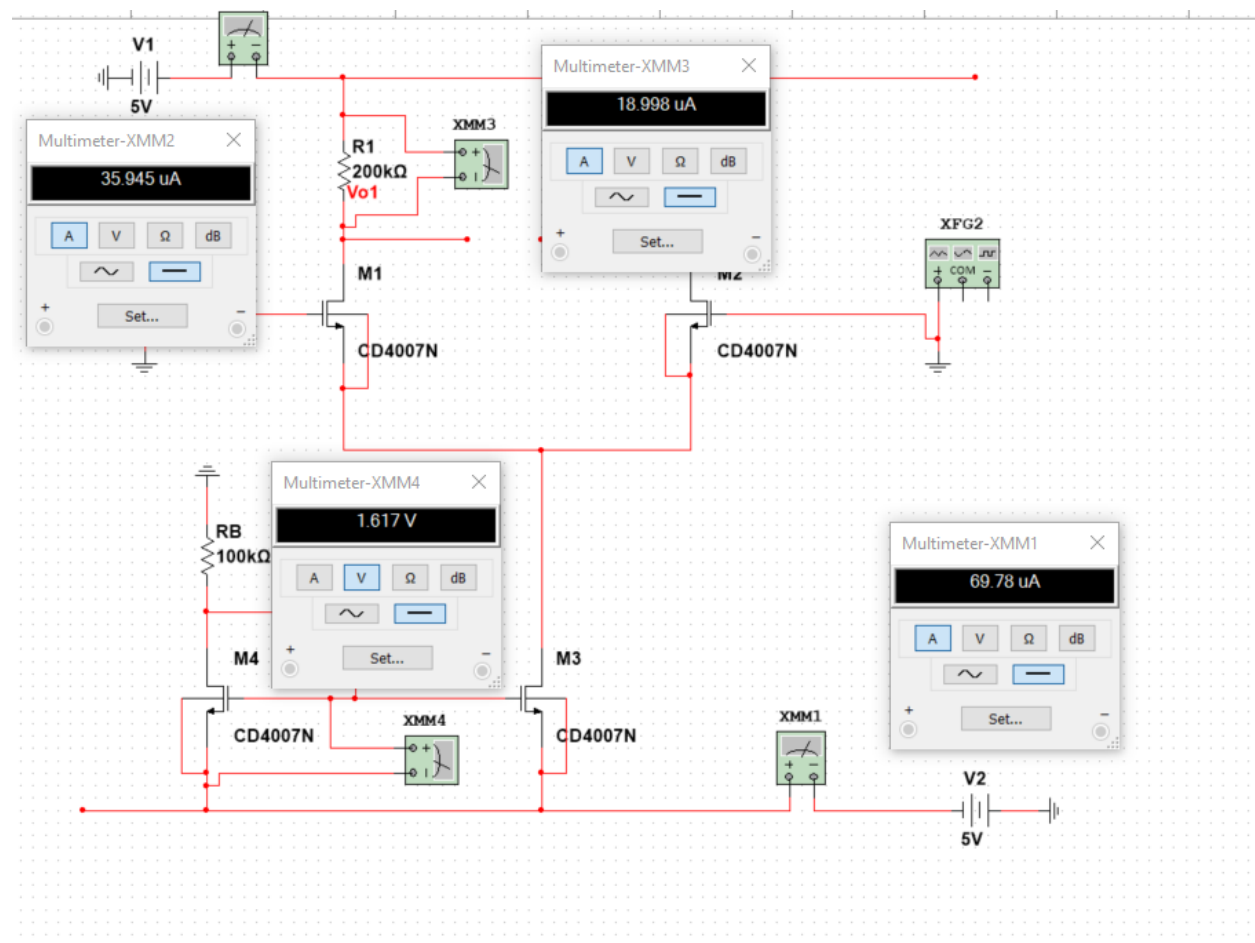
Vov:
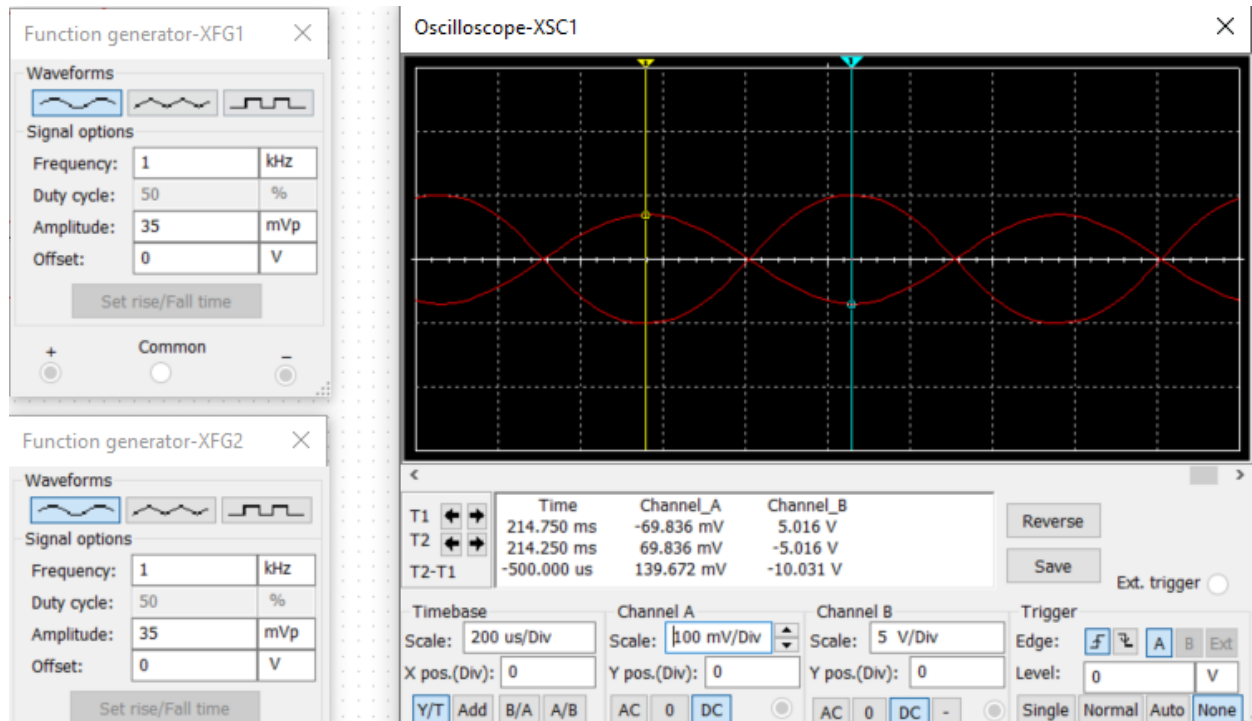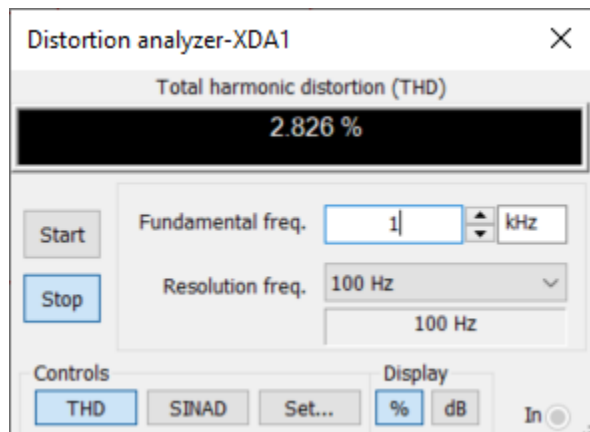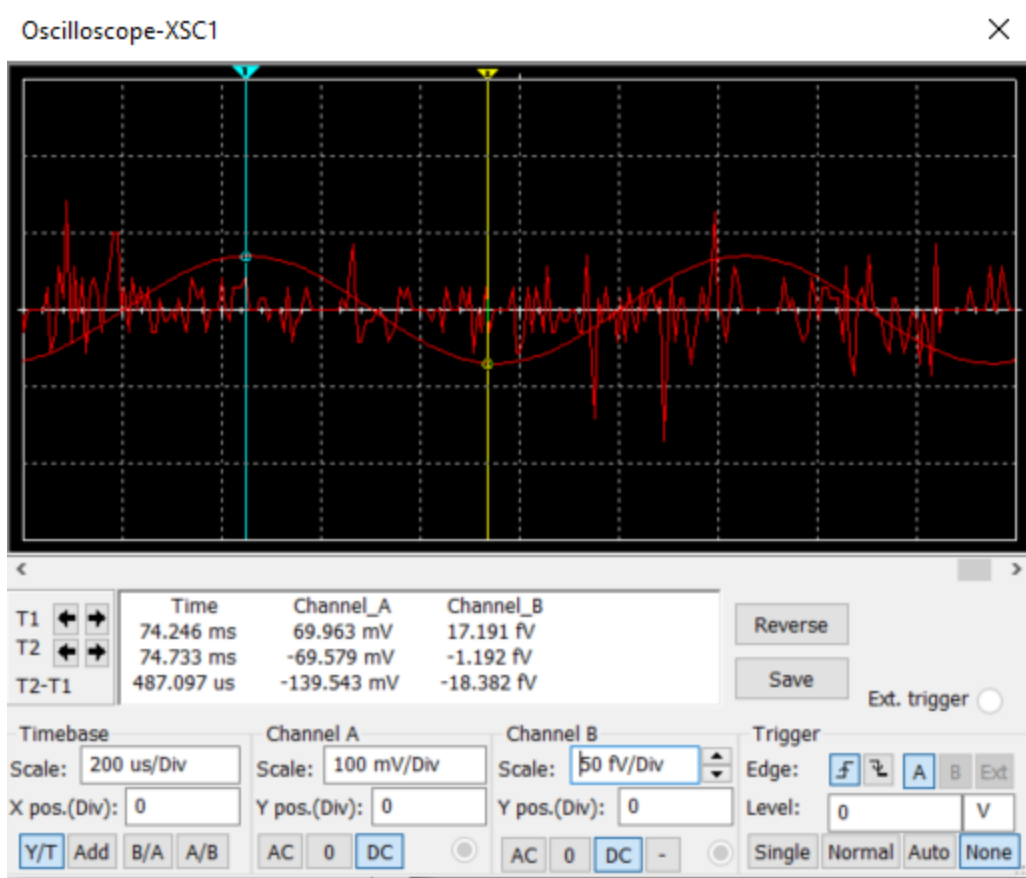

Adm:

= 11.420 / 0.231 = 49.43

0 to 5 volt peak to peak

THD at this value

Acm:

CMRR: -197.75dB

Results Explained:

	Calculations	Simulations	Measurements
Vgs4	2v	1.61v	1.617v
Itail	35uA	35.94uA	35.945uA
Id	17.5uA	17.97uA	18.998uA
Aid	>10	35.46	49.43
Isupply	<500uA	35.94uA	35.945uA

As you can see, all of my simulated values closely match my measurement values. The biggest differences comes from the gain values however I used different input amplitudes to measure these different values to get the correct level of THD. The calculations are all met however my Vgs4 value is a little bit off.