Pre-Lab 3: Operational Amplifiers Part 1

ECEN 325 - 511

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Due Date: September 28, 2021

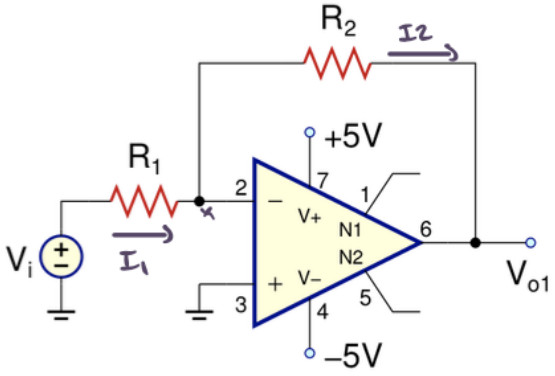
Calculations

1. Read the datasheet for the UA741 opamp and write down the typical values of the following parameters:

Supply Voltage	5V to 15 V -5V to -15 V
Input Offset Voltage	1mV
Voltage Gain	106dB
Power Consumption	50mW
Output Resistance	75Ω
Bandwidth	1MHz
Input Resistance	2MΩ
Input Offset Current	20nA
Slew Rate	0.5V/μs

2. Derive voltage gains
   Circuit A:

Circuit A :



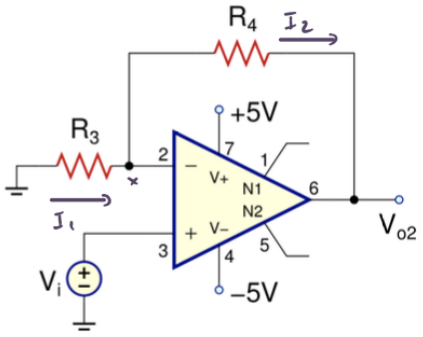
$V_x = 0$ and $I_1 = I_2$

$$\frac{V_i - V_x}{R_1} = \frac{V_x - V_{o1}}{R_2}$$

$$\frac{V_{o1}}{V_i} = \frac{-R_2}{R_1}$$

Circuit B:

Circuit B:



$V_x = V_i$

node: $\frac{V_i}{R_3} + \frac{V_i + V_{o2}}{R_4} = 0$

$V_i(1/R_3 + R_4) - V_{o2}/R_4 = 0 \Rightarrow$

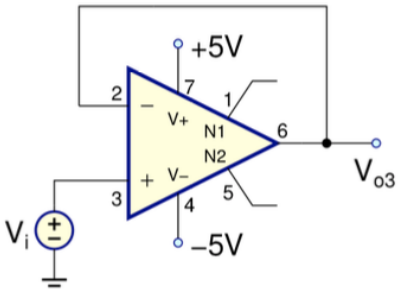
$V_i\left(\frac{1}{R_3+R_4}\right) = \frac{V_{o2}}{R_4}$

$= \frac{V_{o2}}{V_i} = \frac{R_4}{R_3+R_4}$

$$\frac{V_{o2}}{V_i} = 1 + \frac{R_4}{R_3}$$

Circuit C:

Circuit C:



$V_x = V_i$

$V_{o3} = V_i$

$$\frac{V_{o3}}{V_i} = 1$$

3. f R1 = R3 = 10kΩ, find R2 and R4 such that $V_{o1}/V_i = -3$ and $V_{o2}/V_i = 6$.

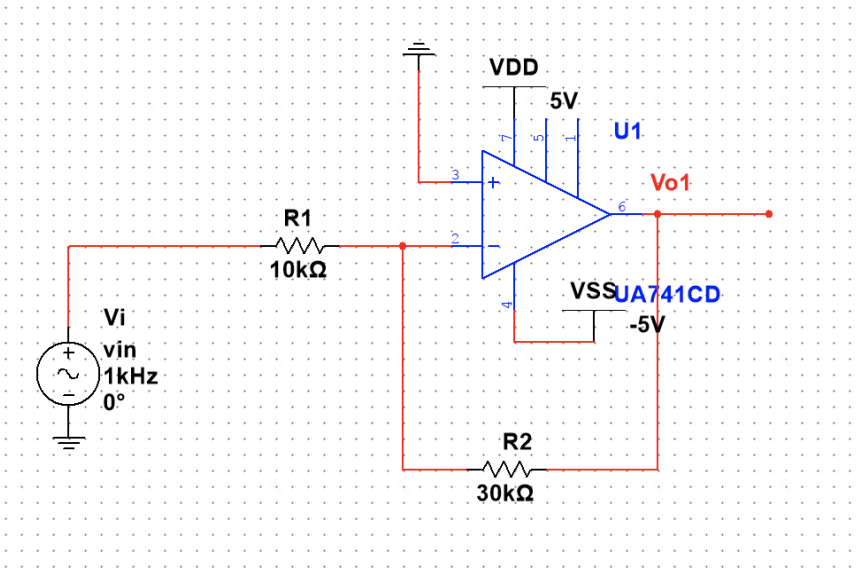
3) $\frac{V_{o1}}{V_i} = \frac{-R_2}{R_1} = -3 = \frac{-R_2}{10k} =$ $R_2 = 30\,k\Omega$

$\frac{V_{o2}}{V_i} = 1 + \frac{R_4}{R_3} = 6 = 1 + \frac{R_4}{10k} =$ $R_4 = 50\,k\Omega$

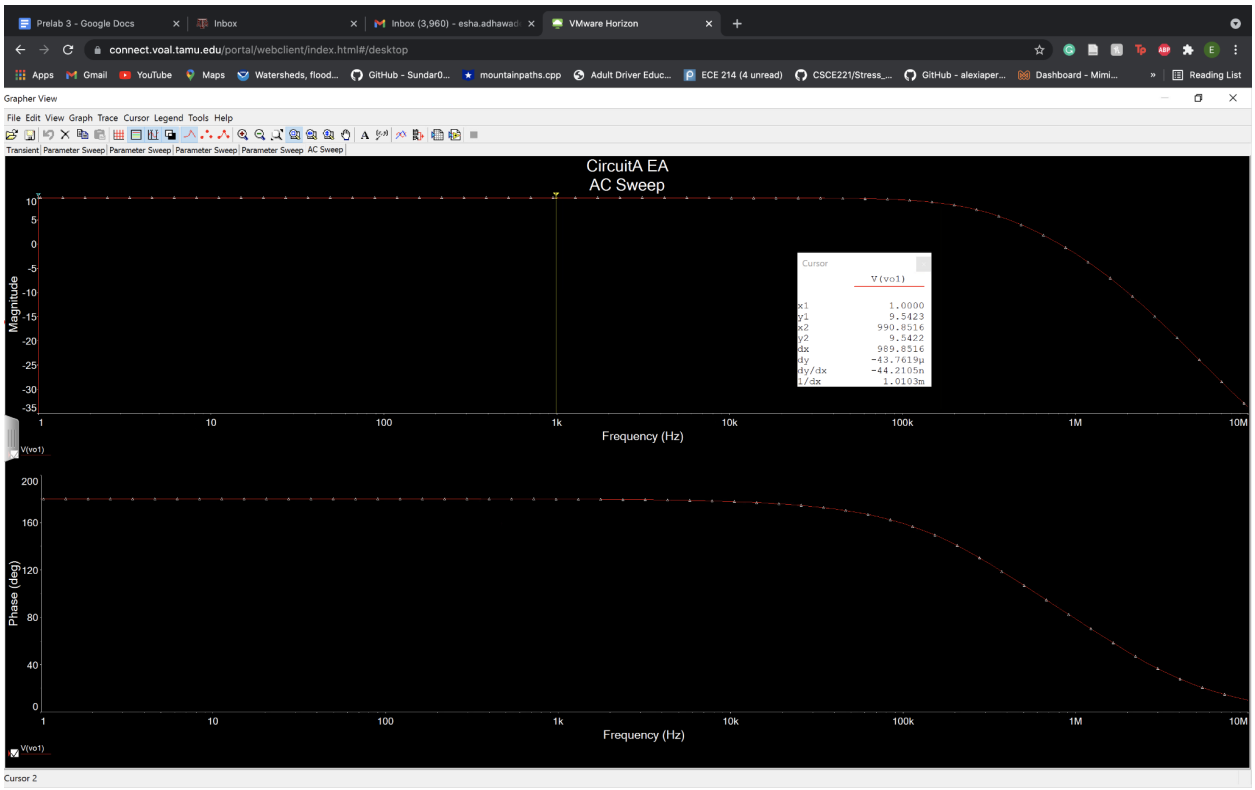
Simulations (on Multisim)

Circuit A

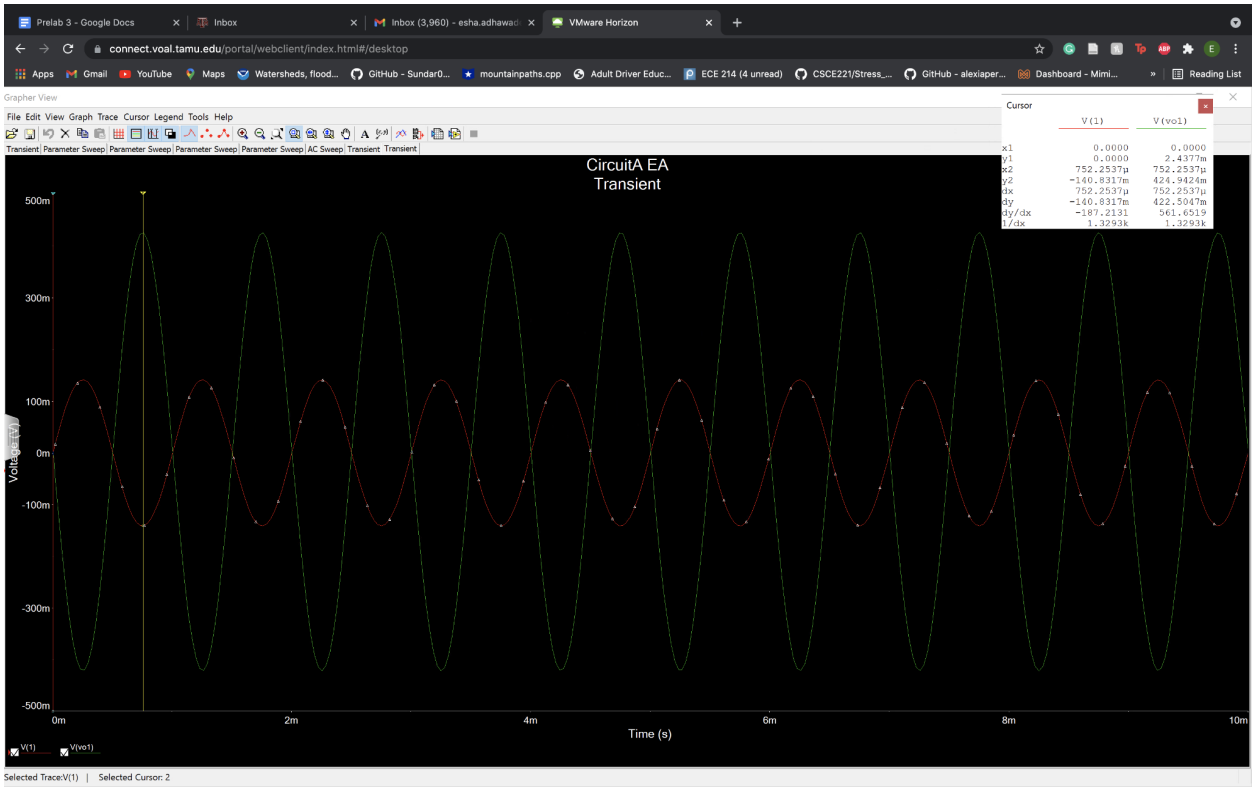
1. Schematic



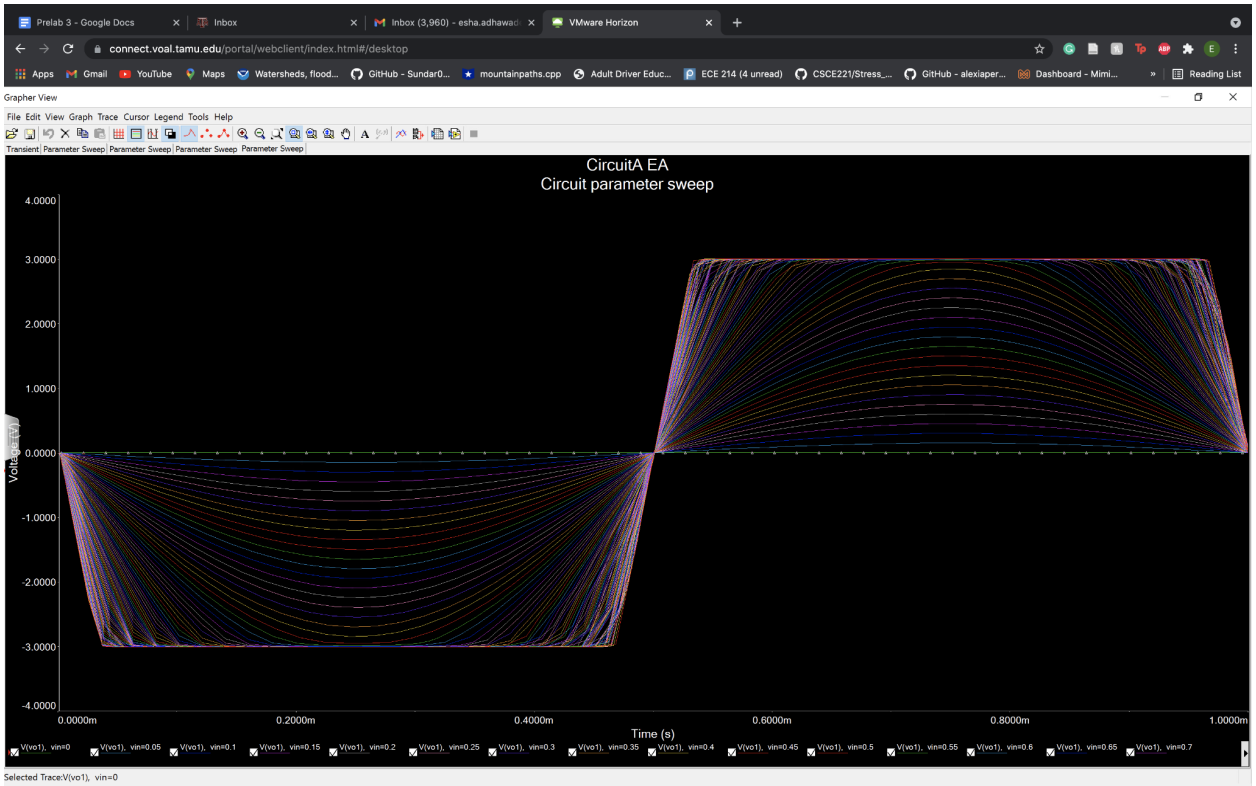
2. AC Sweep



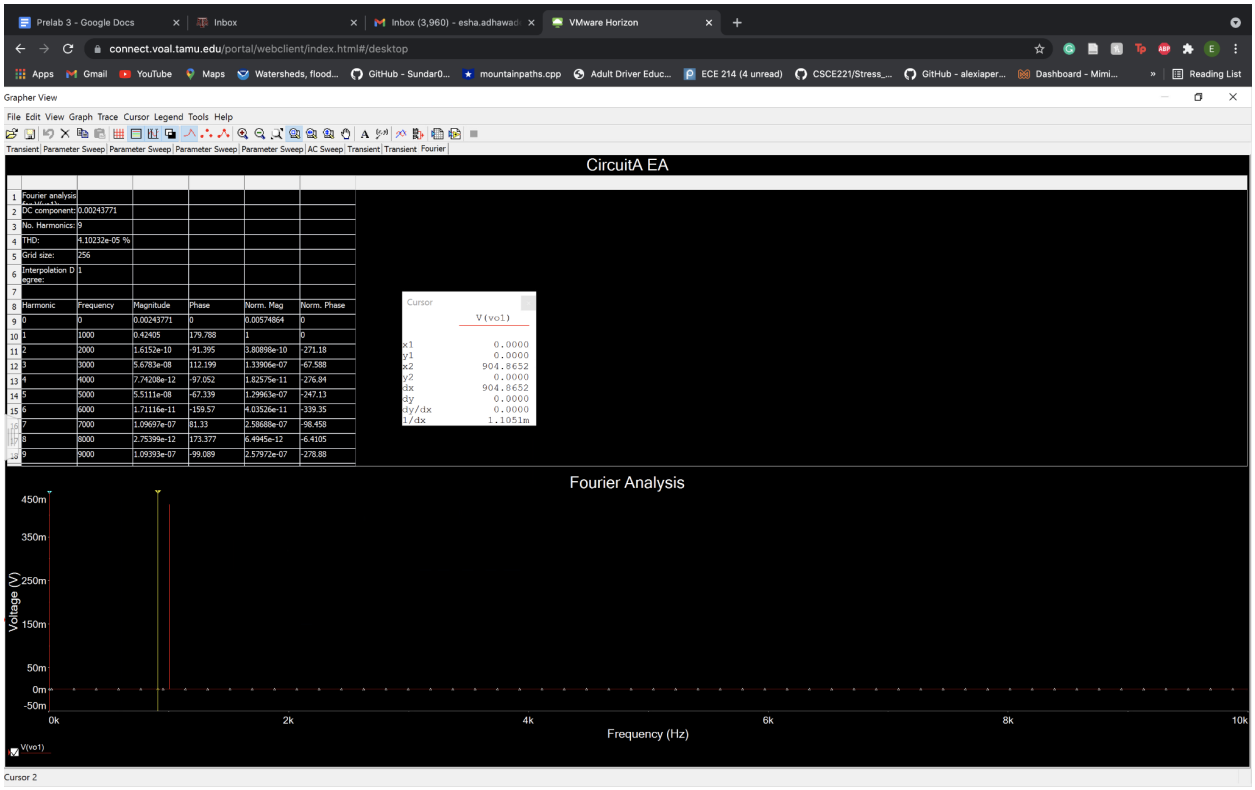
3. Transient



4. Circuit Parameter Sweep

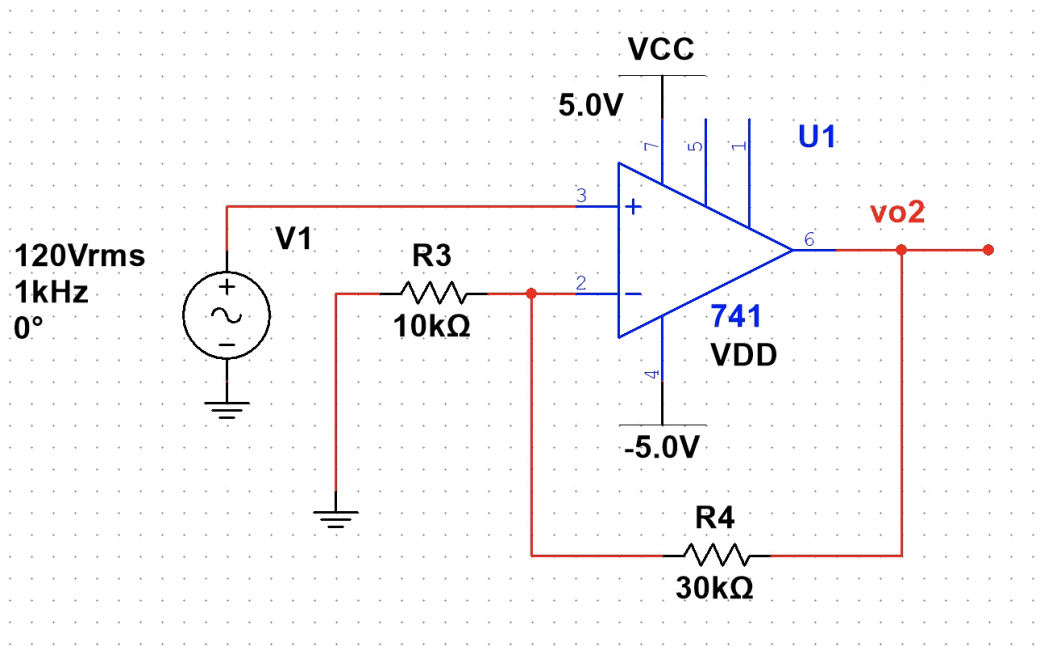


5. Fourier Simulation

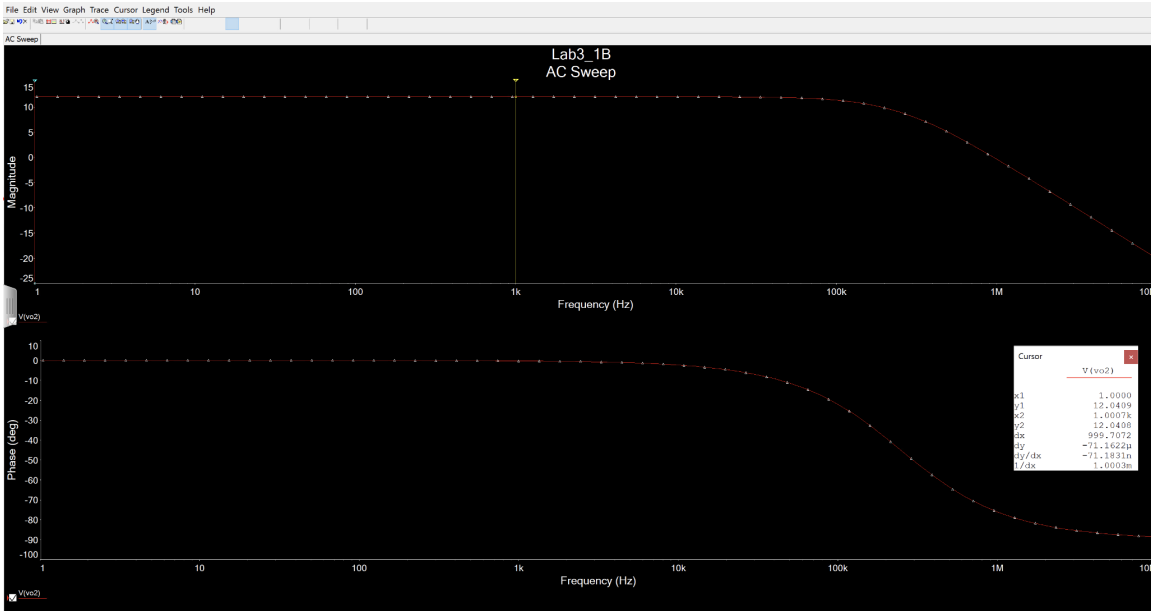


Circuit B

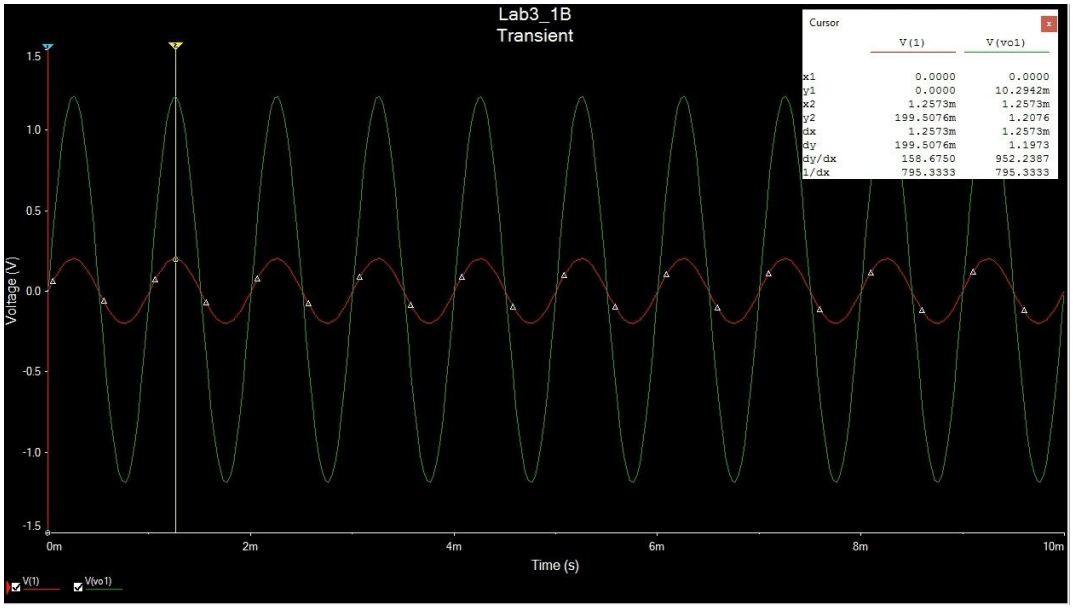
1. Schematic



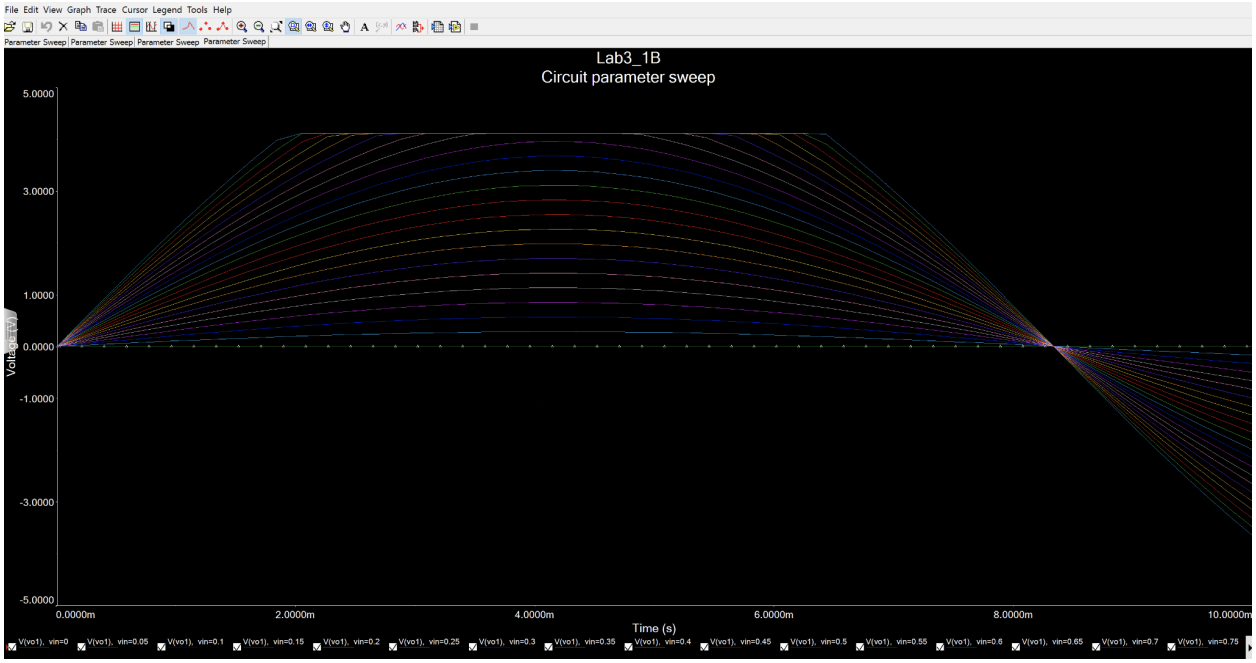
2. AC Sweep



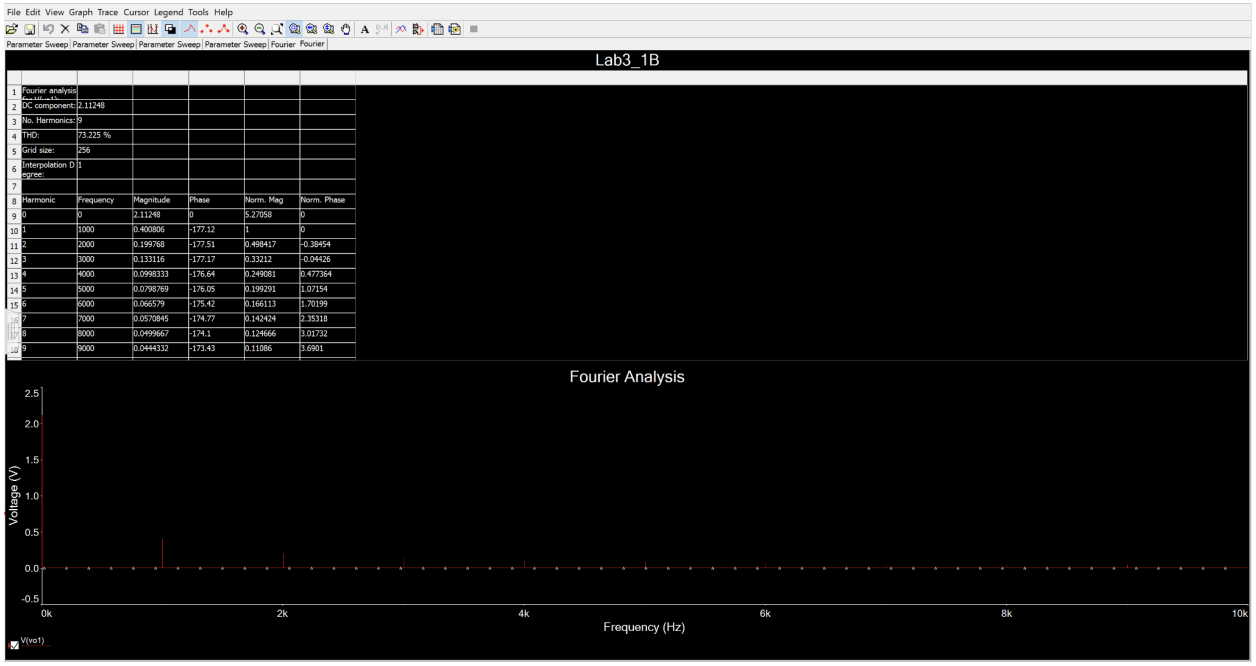
3. Transient



4. Circuit Parameter Sweep



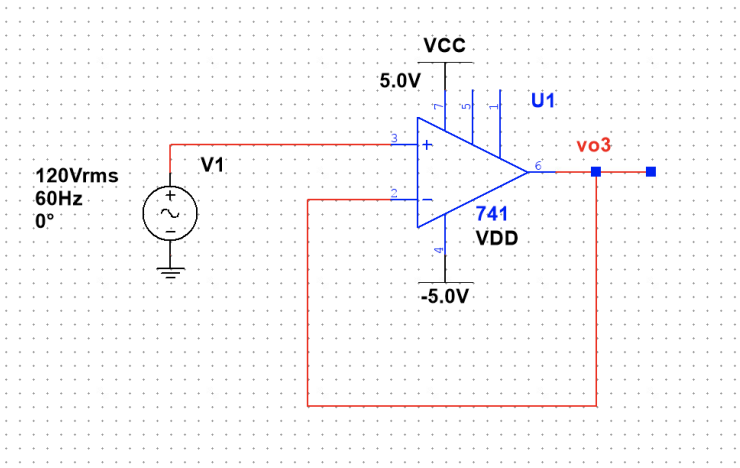
5. Fourier Simulation



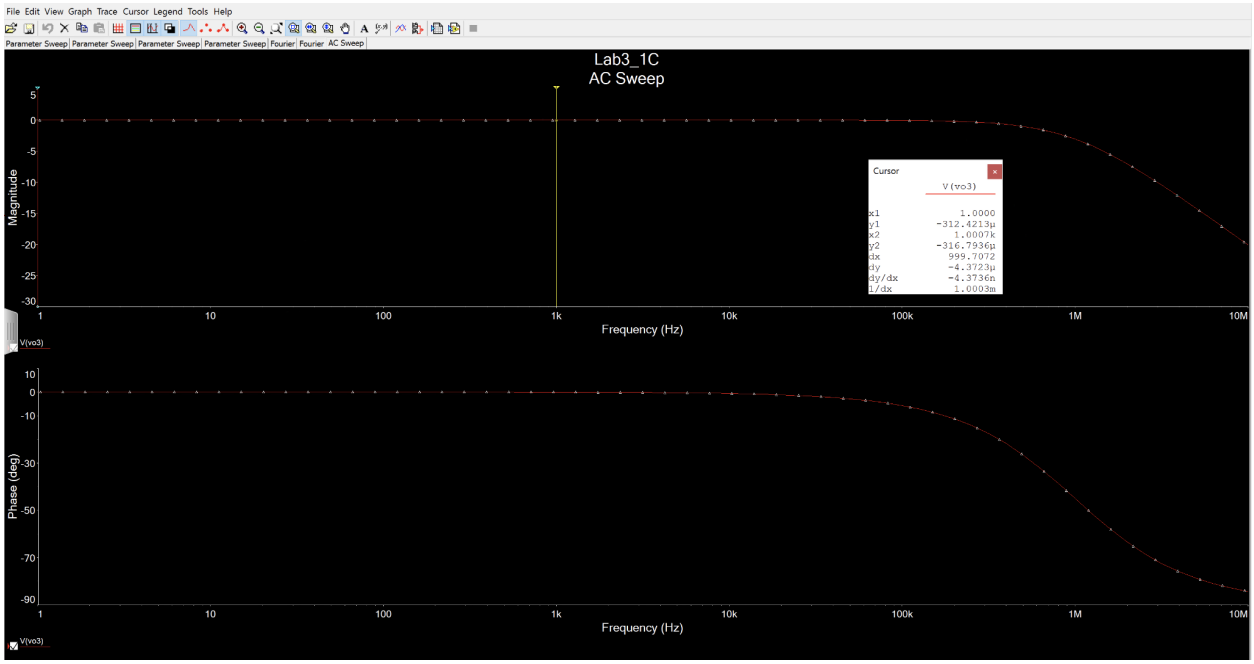
1	Fourier analysis					
2	DC component:	2.11248				
3	No. Harmonics:	9				
4	THD:	73.225 %				
5	Grid size:	256				
6	Interpolation D egree:	1				
7						
8	Harmonic	Frequency	Magnitude	Phase	Norm. Mag	Norm. Phase
9	0	0	2.11248	0	5.27058	0
10	1	1000	0.400806	-177.12	1	0
11	2	2000	0.199768	-177.51	0.498417	-0.38454
12	3	3000	0.133116	-177.17	0.33212	-0.04426
13	4	4000	0.0998333	-176.64	0.249081	0.477364
14	5	5000	0.0798769	-176.05	0.199291	1.07154
15	6	6000	0.066579	-175.42	0.166113	1.70199
16	7	7000	0.0570845	-174.77	0.142424	2.35318
17	8	8000	0.0499667	-174.1	0.124666	3.01732
18	9	9000	0.0444332	-173.43	0.11086	3.6901

Circuit C

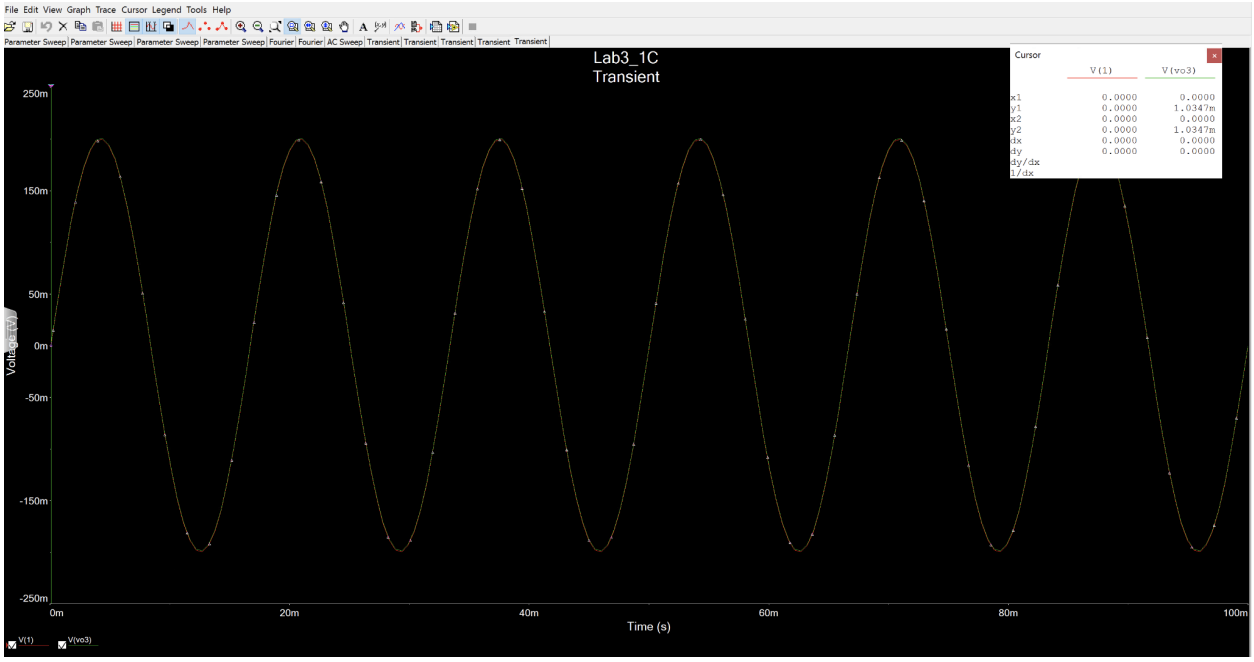
1. Schematic



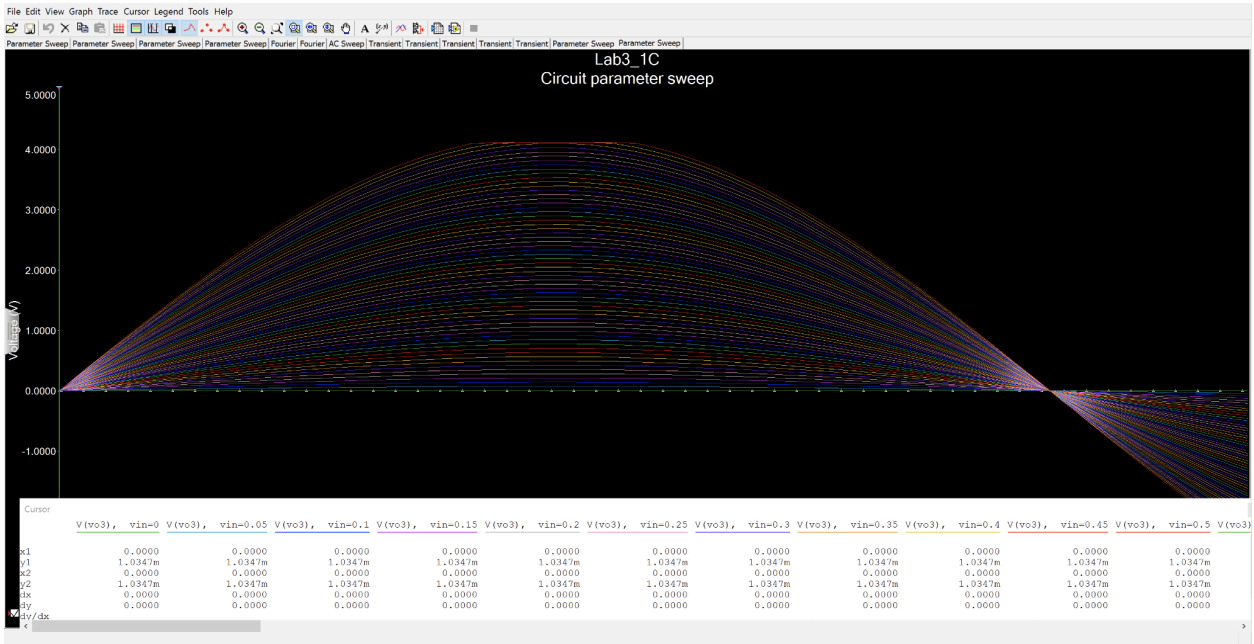
2. AC Sweep



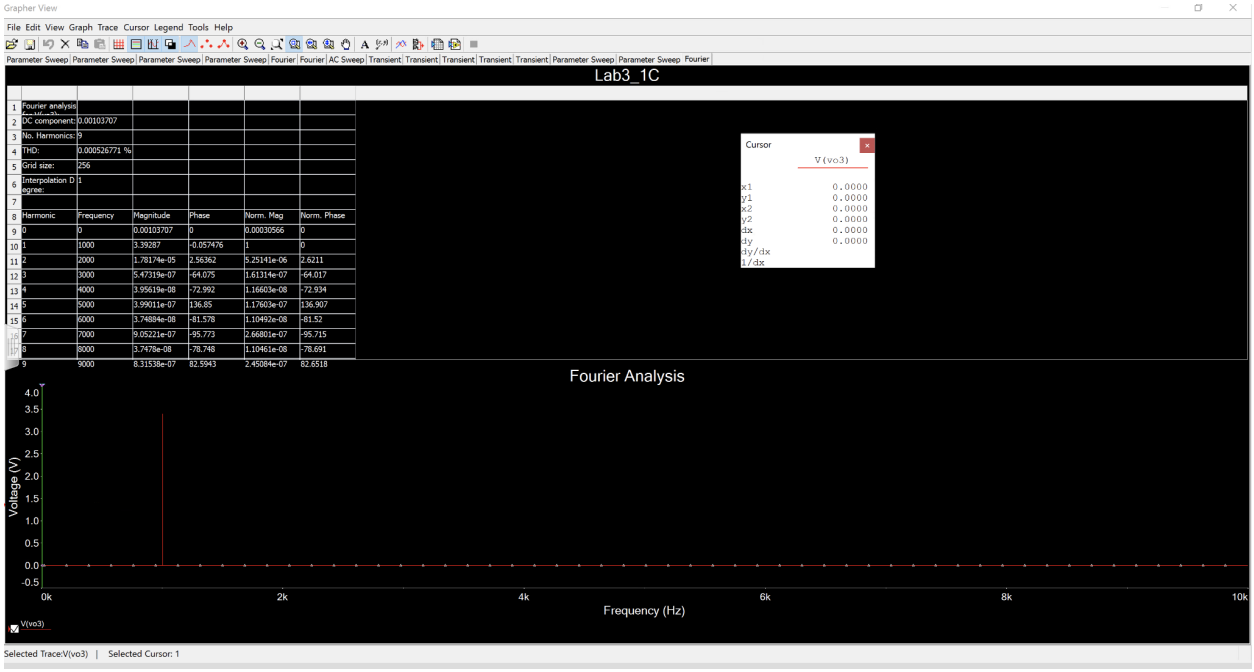
3. Transient



4. Circuit Parameter Sweep



5. Fourier Simulation



1	Fourier analysis					
2	DC component:	0.00103707				
3	No. Harmonics:	9				
4	THD:	0.000526771 %				
5	Grid size:	256				
6	Interpolation Degree:	1				
7						
8	Harmonic	Frequency	Magnitude	Phase	Norm. Mag	Norm. Phase
9	0	0	0.00103707	0	0.00030566	0
10	1	1000	3.39287	-0.057476	1	0
11	2	2000	1.78174e-05	2.56362	5.25141e-06	2.6211
12	3	3000	5.47319e-07	-64.075	1.61314e-07	-64.017
13	4	4000	3.95619e-08	-72.992	1.16603e-08	-72.934
14	5	5000	3.99011e-07	136.85	1.17603e-07	136.907
15	6	6000	3.74884e-08	-81.578	1.10492e-08	-81.52
16	7	7000	9.05221e-07	-95.773	2.66801e-07	-95.715
17	8	8000	3.7478e-08	-78.748	1.10461e-08	-78.691
18	9	9000	8.31538e-07	82.5943	2.45084e-07	82.6518