EEO353 Lab 2
Negative Feedback and Push-Pull Amplifier

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Copy of Original Assignment

Assignment 2 - Negative Feedback and Push-Pull Amplifier - ABET

This Assignment aims at verifying and expanding, with experiments and supporting simulations, your knowledge and understanding of the negative feedback concept.

Please document each step with snapshots, pictures, and your observations. Wherever possible please include the date and time field and the AD S/N. Please include this page.

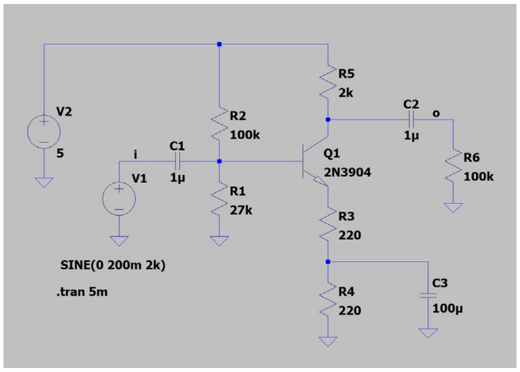

Figure 1

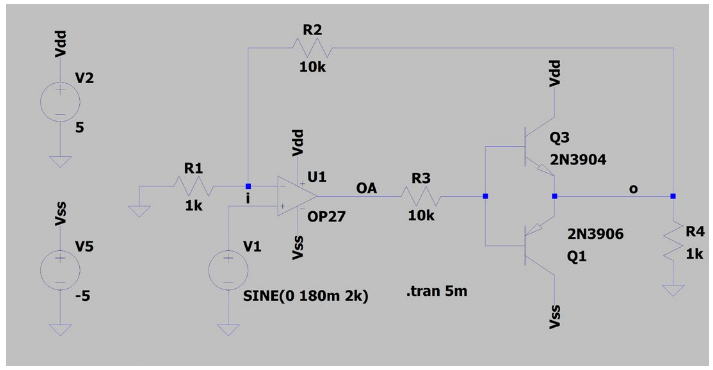

Figure 2

1) Using the simulator, design the configuration in Fig. 1 by connecting the top of capacitor C3 directly to the emitter of Q1 (**8pts**)

> a) adjust the input amplitude to obtain at the output a ~1.5V 2kHz sinusoidal signal
> b) simulate the fast Fourier transform (FFT) using the Hamming window
> c) simulate the frequency response (Bode plot) and measure the -3dB frequency

2) Starting from the previous configuration, connect the top of capacitor C3 at the node between R3 and R4 as shown in Fig. 1 (**8pts**)

> a) adjust the input amplitude to obtain at the output a ~1.5V 2kHz sinusoidal signal
> b) simulate the fast Fourier transform (FFT) using the Hamming window
> c) simulate the frequency response (Bode plot) and measure the -3dB frequency

3) Build the circuits at (1) and (2) and experimentally reproduce all simulations (**30pts**)

4) Using the simulator, design the configuration in Fig. 2 by connecting the right side of R2 to the output OA of U1 (**8pts**)

> a) adjust the input amplitude to obtain at the output a 2V 2kHz sinusoidal signal
> b) simulate the fast Fourier transform (FFT) using the Hamming window

5) Starting from the previous configuration, connect the right side of R2 to the output of the BJT pair (emitters) as shown inFig.2 (**8pts**)

> a) adjust the input amplitude to obtain at the output a 2V 2kHz sinusoidal signal
> b) simulate the fast Fourier transform (FFT) using the Hamming window

6) Build the circuits at (4) and (5) and experimentally reproduce all simulations (**30pts**)

7) Explain in your own words any difference between simulations and measurements, and why the configurations at (2) and (5) have lower distortion (less harmonics) than the configurations at (1) and (4) (**8pts**)) *(ABET PI-63, PI-64)*

Summary

In this lab we explore the negative feedback concept of amplifiers.

1 Using the simulator, design the configuration in Fig. 1 by connecting the top of capacitor C3 directly to the emitter of Q1

a)

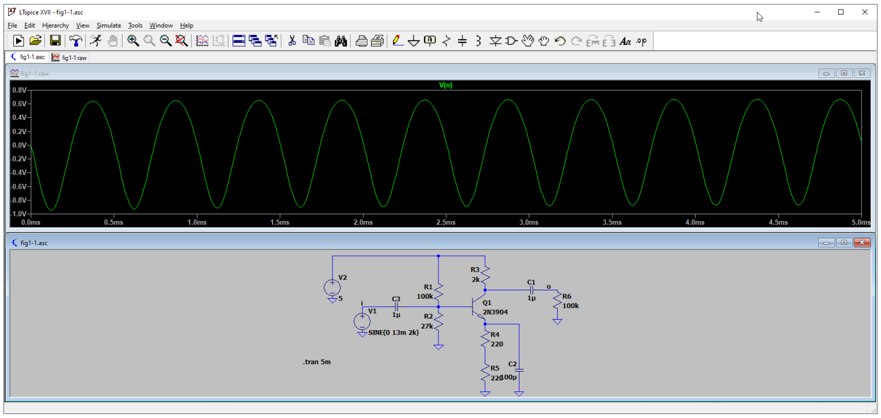

Figure 1: Input amplitude of 13 mV to achieve output signal of $\approx 1.5\,\mathrm{V}, 2\,\mathrm{kHz}$

b)

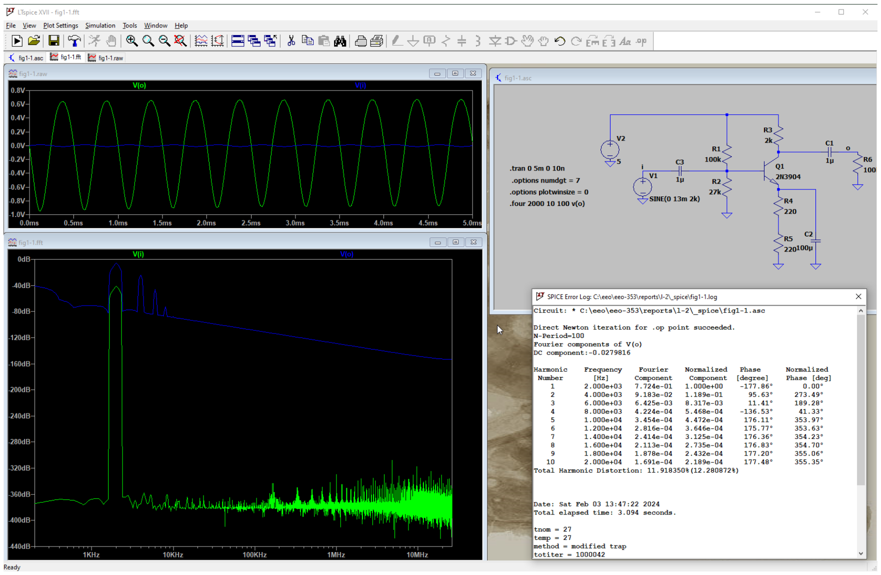

Figure 2: FFT With Hamming window.

c)

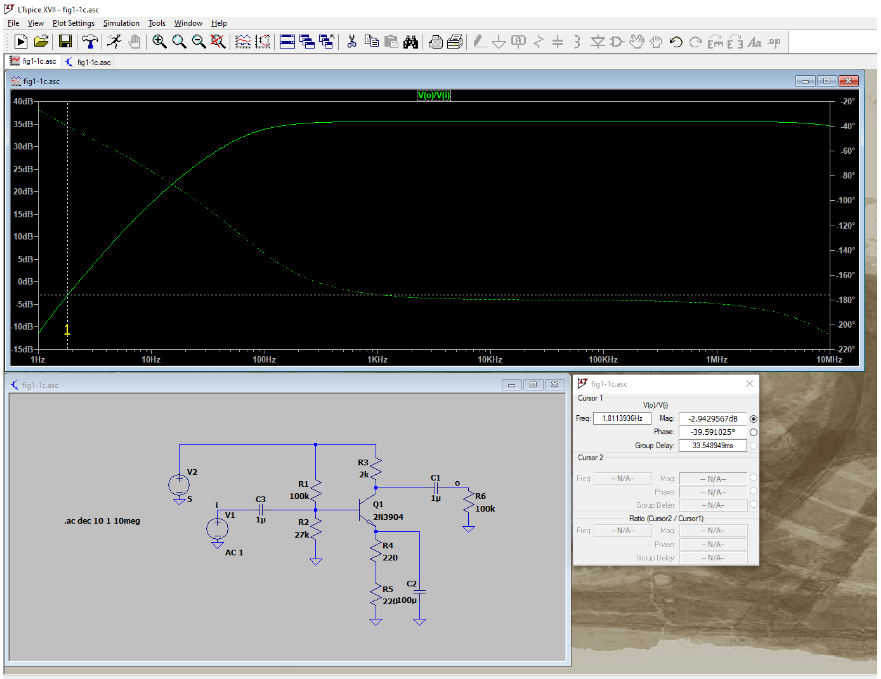

Figure 3: Bode plot showing the $-3\,\text{dB}$ point at $\approx 1.8\,\text{Hz}$ and $\approx -40°$

2 Starting from the previous configuration, connect the top of capacitor C3 at the node between R3 and R4 as shown in Fig. 1

a)

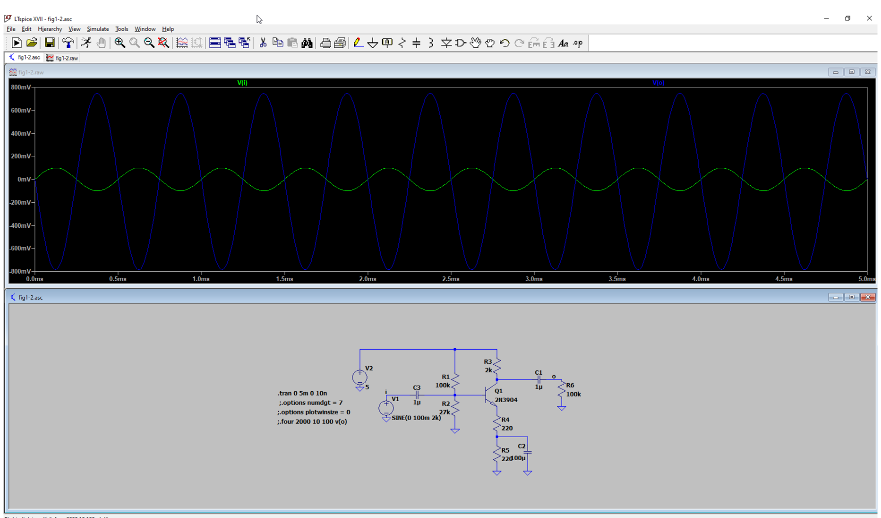

Figure 4: Input amplitude of $100\,\text{mV}$ to achieve output signal of $\approx 1.5\,\text{V}, 2\,\text{kHz}$

b)

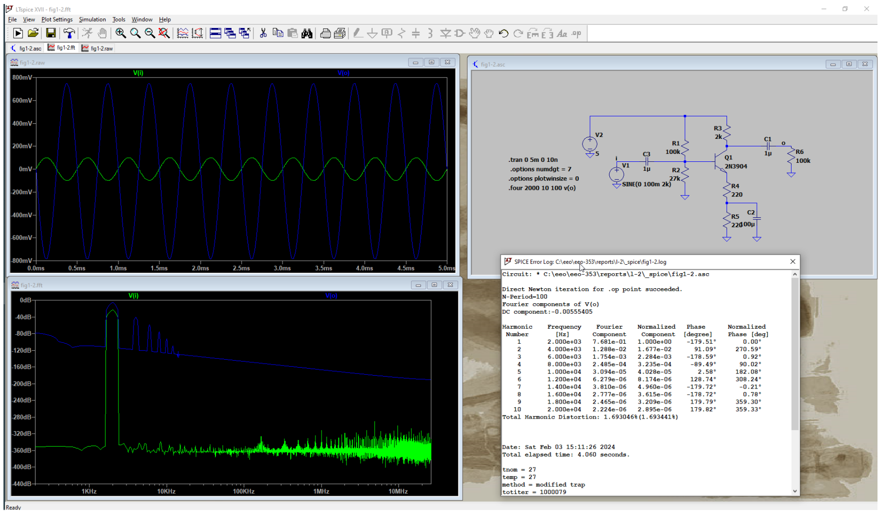

Figure 5: FFT With Hamming window.

c)

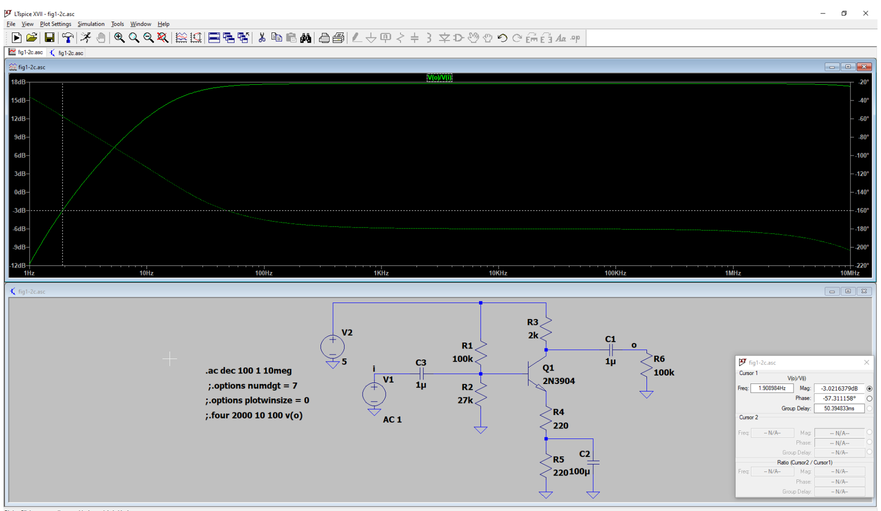

Figure 6: Bode plot showing the $-3\,\mathrm{dB}$ point at $\approx 1.9\,\mathrm{Hz}$ and $\approx -57°$

3 Build the circuits at (1) and (2) and experimentally reproduce all simulations

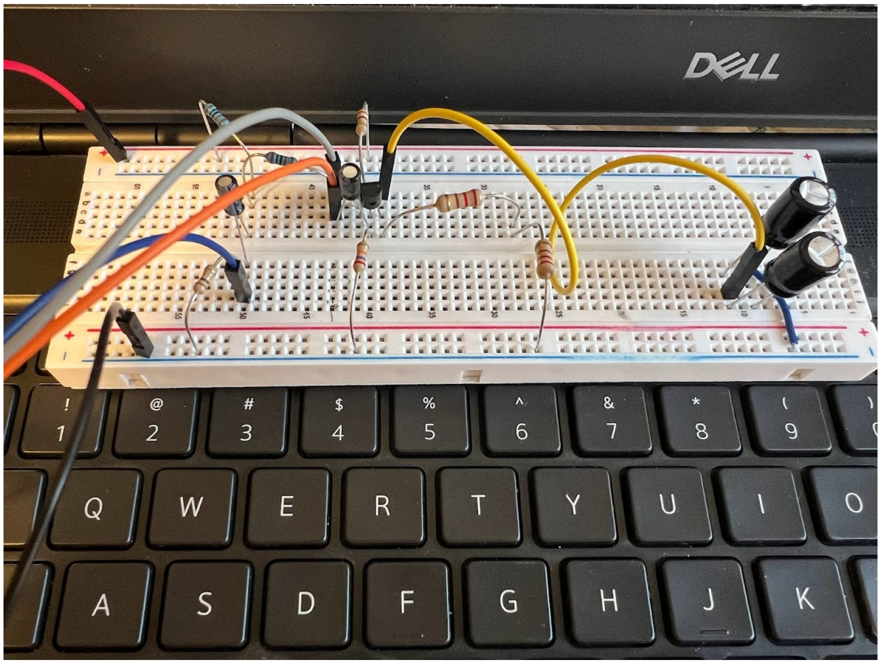

Figure 7: Circuit Prototype

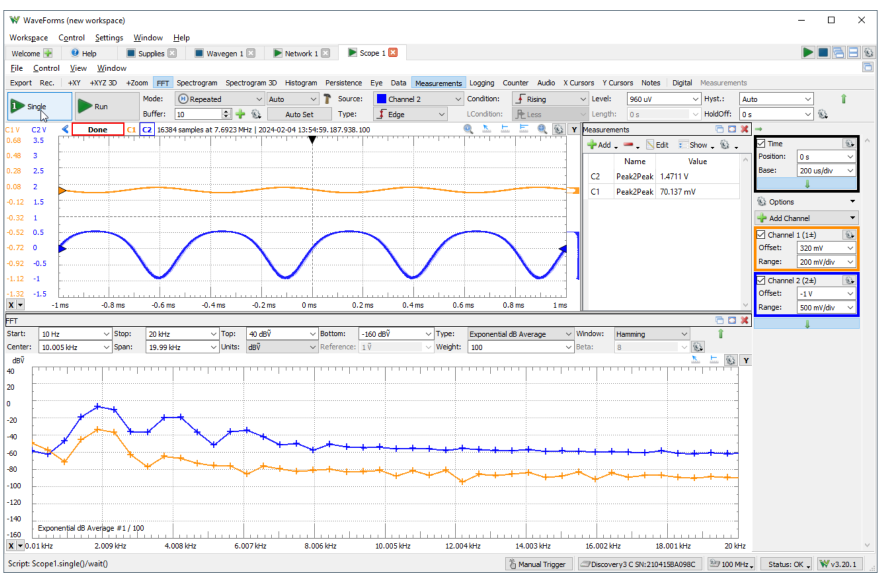

Figure 8: Input amplitude of $\approx 70\,\mathrm{mV}$ to achieve output signal of $\approx 1.5\,\mathrm{V}, 2\,\mathrm{kHz}$. The FFT shows a peak at $\approx 2\,\mathrm{kHz}$

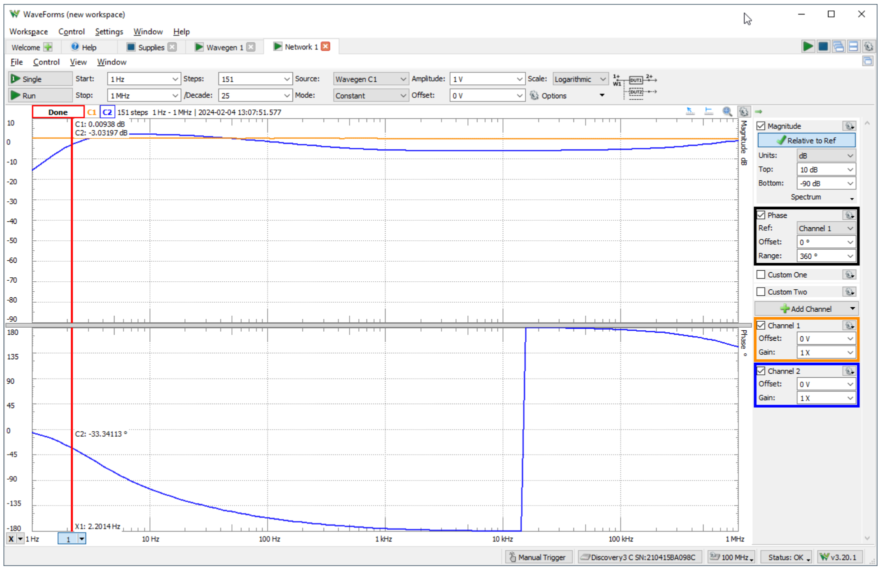

Figure 9: Bode plot showing the $-3\,\mathrm{dB}$ point at $\approx 2.2\,\mathrm{Hz}$ and $\approx -33°$

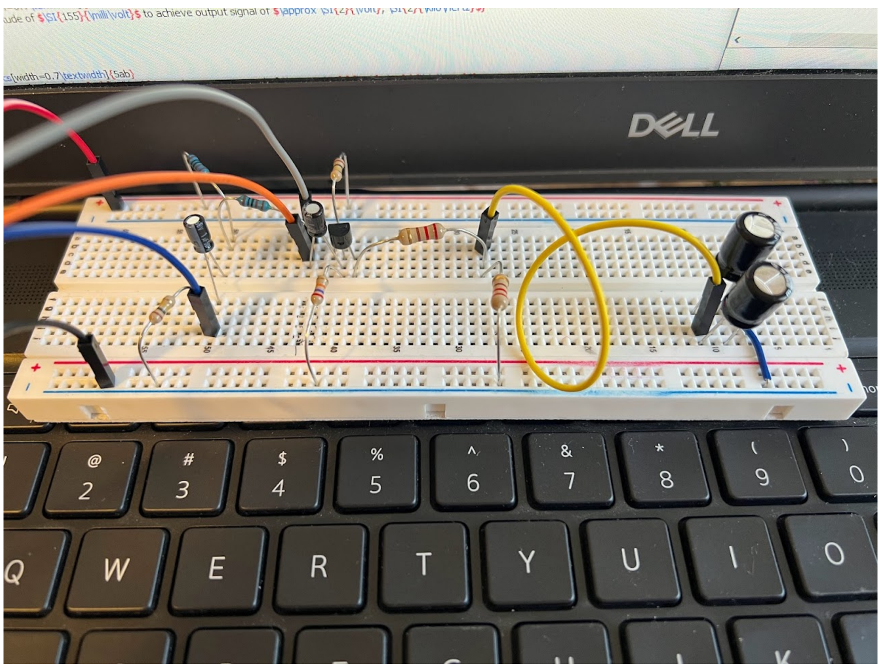

Figure 10: Circuit Prototype

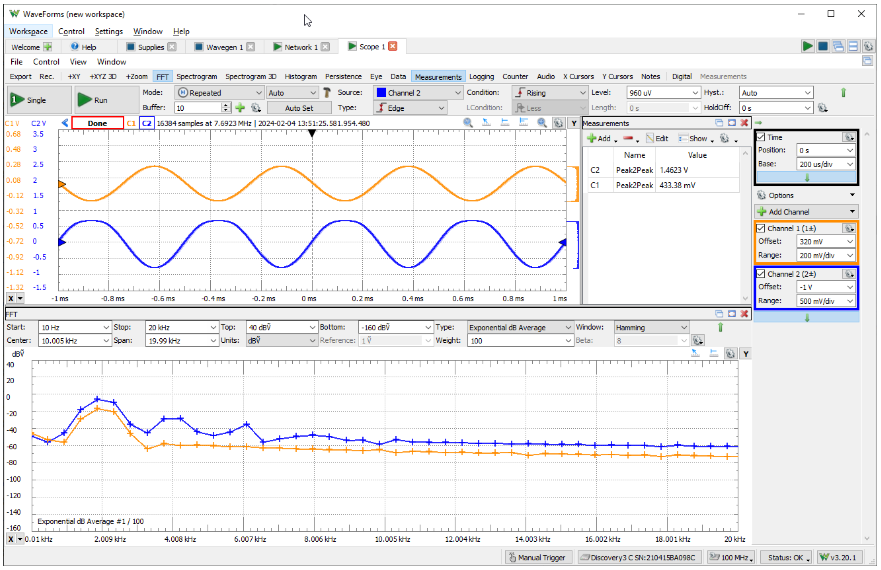

Figure 11: Input amplitude of $\approx 433\,\text{mV}$ to achieve output signal of $\approx 1.5\,\text{V}, 2\,\text{kHz}$. The FFT shows a peak at $\approx 2\,\text{kHz}$

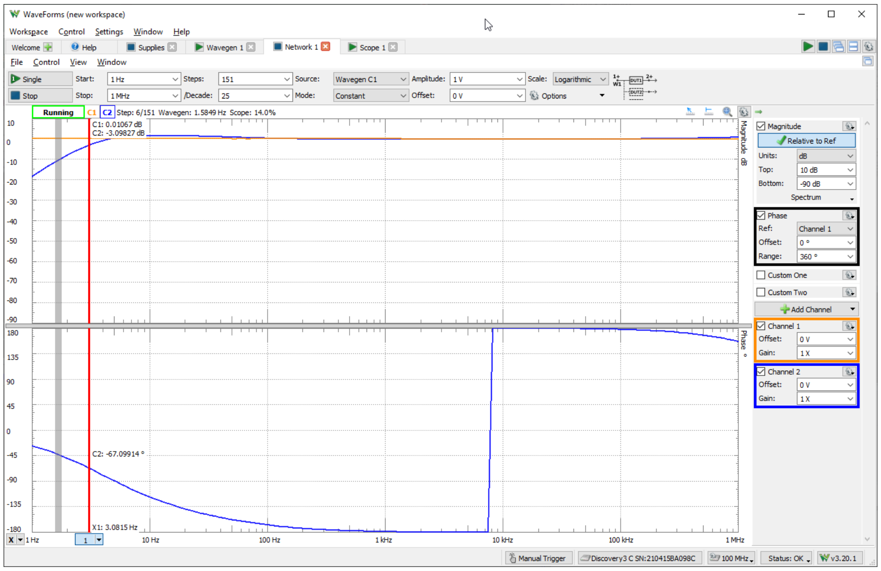

Figure 12: Bode plot showing the $-3\,\text{dB}$ point at $\approx 3.1\,\text{Hz}$ and $\approx -67°$

4 Using the simulator, design the configuration in Fig. 2 by connecting the right side of R2 to the output OA of U1

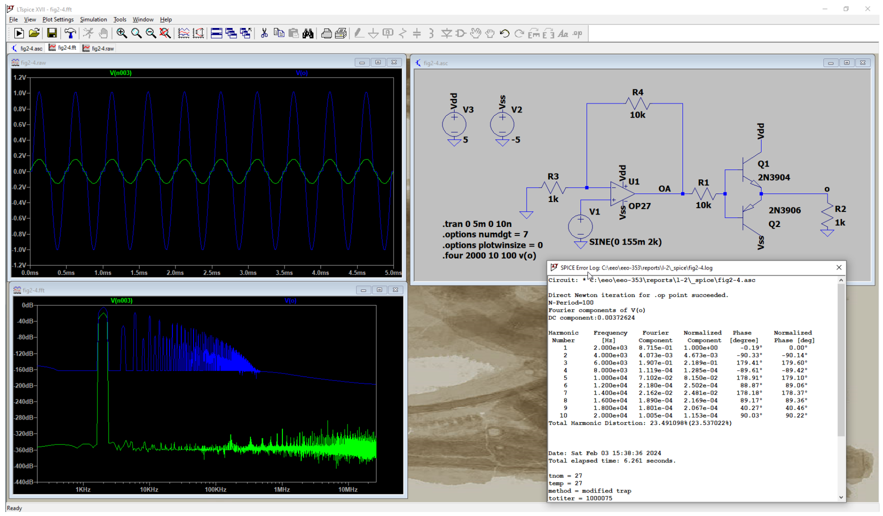

Figure 13: Input amplitude of 155 mV to achieve output signal of ≈ 2 V, 2 kHz

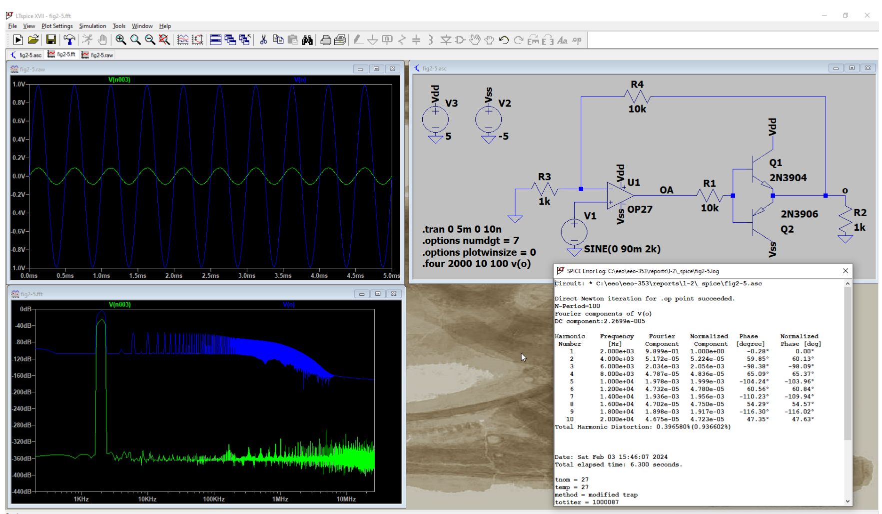

Figure 14: Input amplitude of 90 mV to achieve output signal of ≈ 2 V, 2 kHz

5 Build the circuits at (4) and (5) and experimentally reproduce all simulations

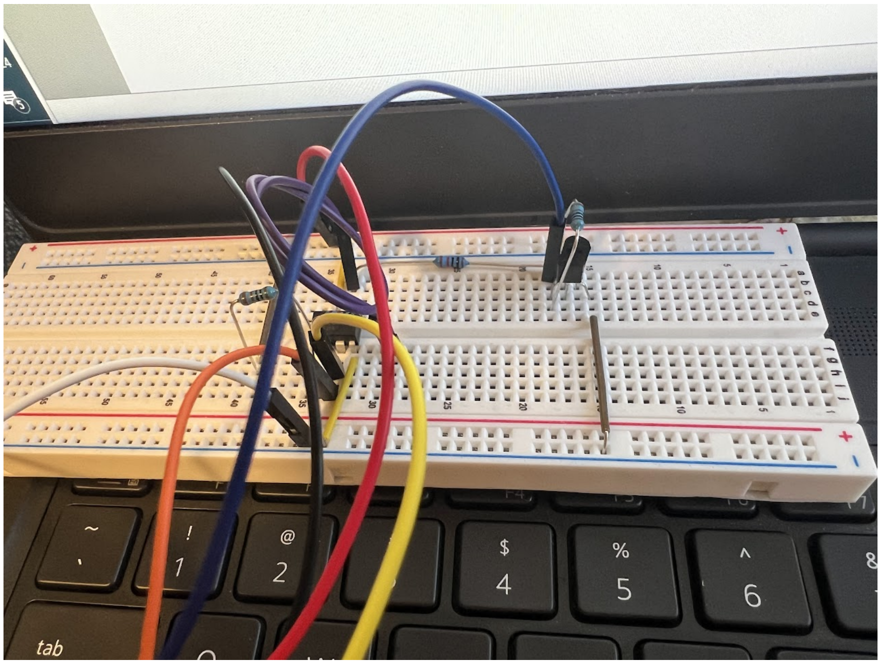

Figure 15: Circuit Prototype

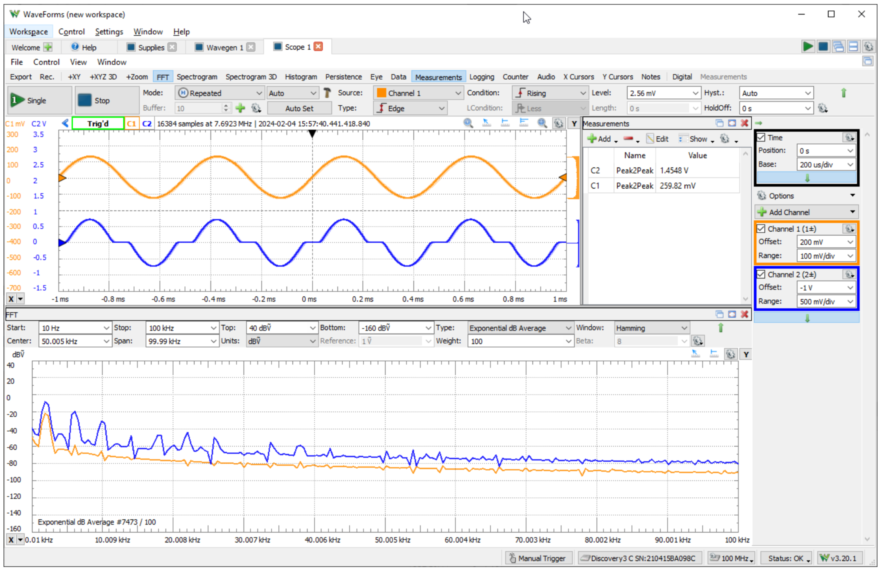

Figure 16: Input amplitude of $\approx 260\,\text{mV}$ to achieve output signal of $\approx 1.5\,\text{V}, 2\,\text{kHz}$. The FFT shows a peaks of many harmonics.

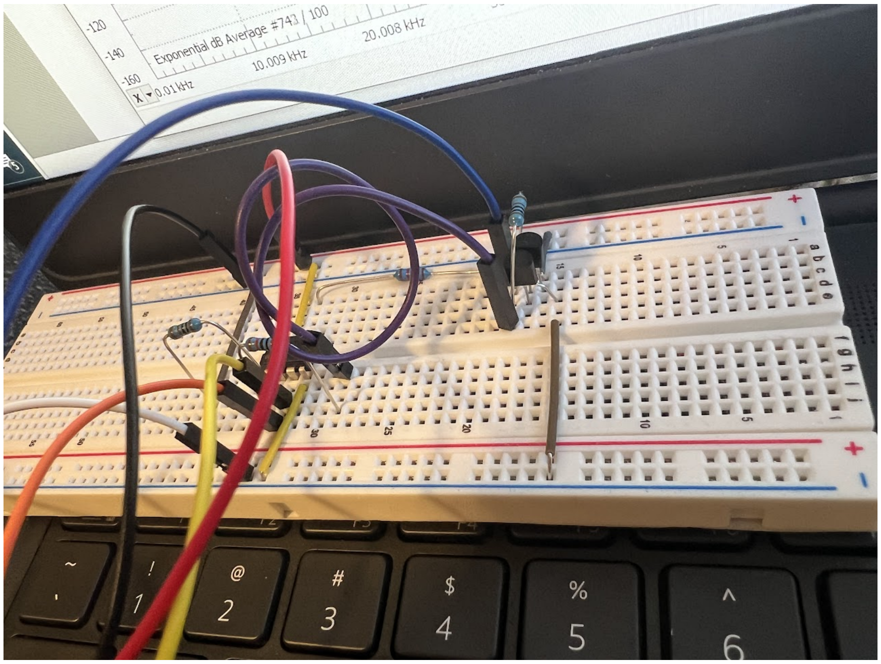

Figure 17: Circuit Prototype

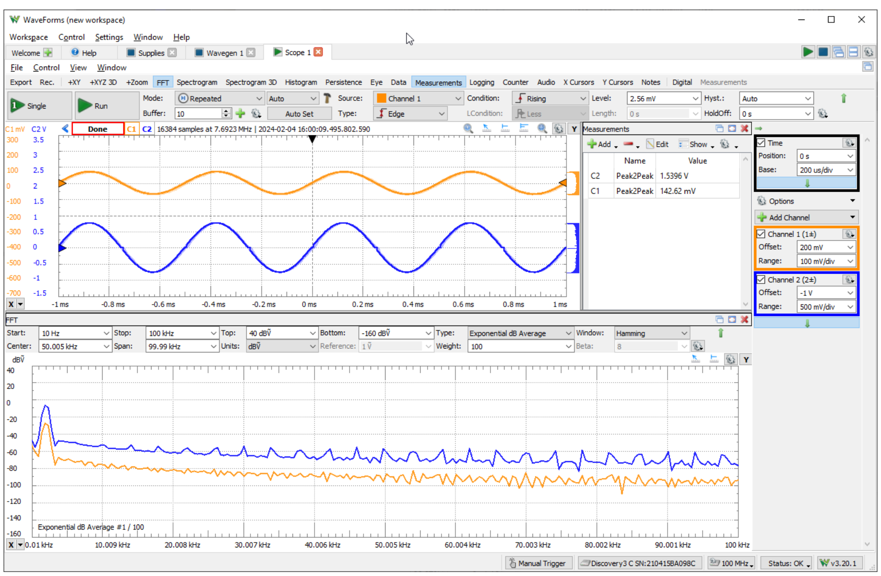

Figure 18: Input amplitude of $\approx 143\,\mathrm{mV}$ to achieve output signal of $\approx 1.5\,\mathrm{V}, 2\,\mathrm{kHz}$. The FFT shows a peak at $\approx 2\,\mathrm{kHz}$

6 Explain in your own words any difference between simulations and measurements, and why the configurations at (2) and (5) have lower distortion (less harmonics) than the configurations at (1) and (4)

I observe some variation between the simulation and experiments. I believe this can be attributed to the value and tolerance of parts used, the construction method (breadboard) and parallel/series combinations to achieve the desired values. It can also be observed that in the initial configurations the amplifiers exhibit signifiant noise. After adding negative feedback, the noise floor is lowered significantly. This comes at a cost of reduced amplifier gain.

Separately it is observed that the output of the second circuit has an output similar to that of a triac when no negative feedback is applied. Additionally, where negative feedback is applied to the second circuit, noise goes down, but it appears that the gain goes up.