University of Minnesota-Duluth

EE 2212

Electronics I

Lab 2: Basic OP-Amp Analysis

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Abstract

While most applied Op-Amp circuits employ negative feedback, one must be very careful to not accidentally construct a circuit with positive feedback. This lab shows both positive and negative feedback systems. There are two negative feedback circuits, a Low-pass filter and a high-pass filter. The two have been constructed and the frequency response measured, independently and in a cascade. The positive feedback filter is a Wein bridge oscillator. Initial conditions are added to the oscillator so that the feedback may be recorded. We recorded the response of all circuits both in an actual build, and in a PSpice simulation.

Introduction:

This lab is a more in-depth analysis of active amplifiers with gains greater than 0dB. Three different amplifiers are constructed, two with negative feedback, with a deterministic output for a given input, and once circuit with positive feedback, an undeterministic output for any given input. The two circuits with negative feedback are cascaded to form a second order feedback system.

Background:

The two negative feedback circuits that are constructed are a high pass filter/amplifier, and a low pass filter/amplifier. The two are built around a specific corner frequency. This makes it so that when the two are cascaded together that the circuit selects one frequency that it will amplify the most. The positive feedback circuit is named a wein-bridge oscillator. The oscillator is unstable in any given set of input conditions.

Procedure:

The first circuit (fig.1, right) is constructed on a breadboard using the NE5532P OP-Amp. The circuit is a low pass filter, generally allowing only low frequency signals through the input, and snubbing high frequency inputs. The input/output waveform is recorded for various frequencies above and below the corner frequency (Eqn.1). The results are compared versus A PSpice simulation.
The second circiut is constructed (fig.1, left) is constructed in the same manner, using the NE5532 OP-Amp, and the same frequency response is recorder for that corner frequency (Eqn.2) and compared to another PSpice simulation.
Briefly describe the steps taken to complete the experiment. This should include circuit diagrams, etc. Component values are important. Use standard symbols for circuit elements and label signals where appropriate. SPICE allows you to save circuit diagrams to the clipboard so that you can embed these circuit diagrams in your report.

1 Materials needed for lab:

- Breadboard
- Function Generator
- Oscilloscope
- Resistors as needed
- Capacitors as needed
- Wire as needed

2 Equations

$$f_c = \frac{1}{2\pi C R_4} \tag{1}$$

$$f_c = \frac{1}{2\pi C R_5} \tag{2}$$

Where $\tau = RC$ is the time constant, A is the amplitude, t is the variable time

3 Schematics

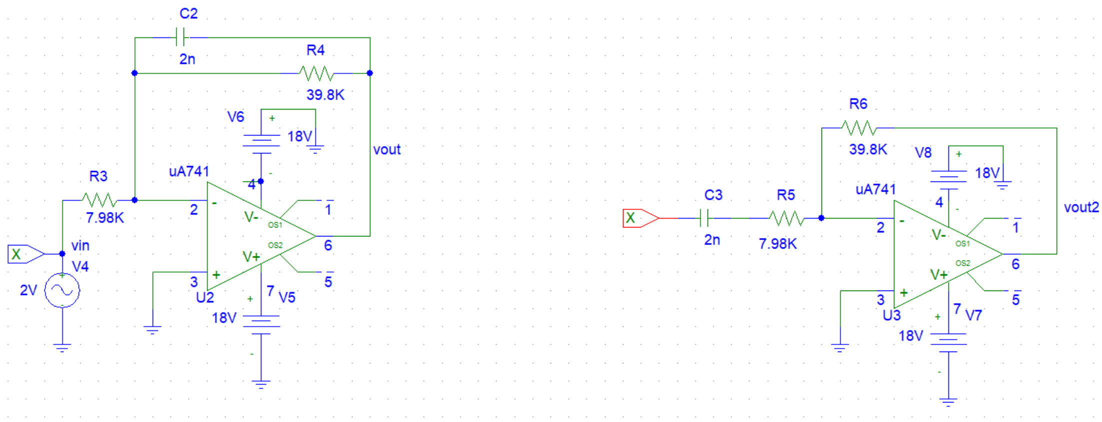
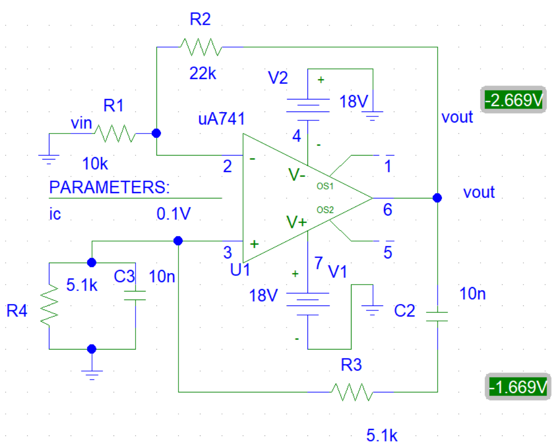
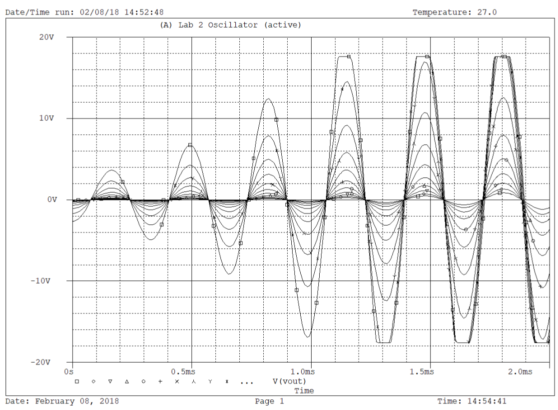


Figure 1: Right: High pass active filer. Left:Low pass active filter



(a) schematic



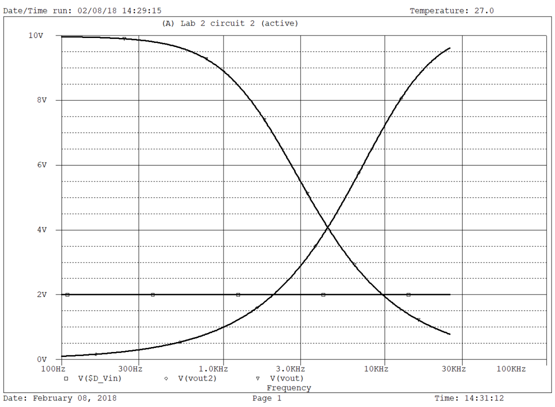
(b) results V. initial condition

Figure 2: Positive feedback generator (Wein Bridge)

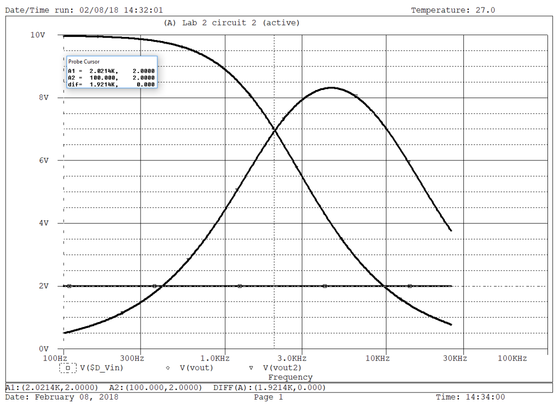
Measurement and Analysis of Results:

We found that the LM741 to produce highly unexpected results. As a result, we switched to the Texas Instruments op-amp NE5532 OP-Amp. This op-Amp pushed much more accurate results when used in the same circuit. We think this is because the LM741s in the lab are DC coupled, while the NE5532 is AC coupled (virtually).

4 Graphs:



(a) Top:Low pass Bottom:High pass



(b) Top:Low pass Bottom:Cascaded output

Figure 3: PSpice frequency response

Conclusion:

Real life circuits must be constructed with much more precise parts than in a PSpice simulation. The tolerance can cause some minor obstructions in design. That said, the results are very similar for frequencies below about 20KHz, after which the slew rate of the op-Amp overtook the response.