E190V S15 Lab2

The Setup:

Most operational amplifiers have a great deal in common with Honda Civics and stock Windows operating systems. All three of these products are designed to be palatable to a wide variety of consumers and to be used under some truly bizarre conditions without a hiccup. In this lab we'll be looking at the Gentoo Linux or Stock Racers of the op-amp world: externally compensated op-amps.

A general purpose operational amplifier has an internal compensation network that ensures the op-amp is stable for any load, but general purpose op-amps sacrifices performance and flexibility for this stability. The LT1008 is an externally compensated op-amp and we'll be exploring its properties with the end goal of improving on the performance of the OP07, a more garden variety op-amp.

Exercises:

The circuits in this lab should frequently flirt with instability. Be sure that you are mindful of the effects of your test input frequency, test input amplitude, wiring choices, compensation choices on the stability of your amplifier. Also pay close attention to the various non-linear regimes your amplifier can fall into, notably clipping and slewing.

Be sure to record appropriate waveforms and other experimental data for all of the exercises.

1. Use the LT1008 to build a unity gain follower with no external compensation (leave pins 1 and 8 floating). Is it stable? Justify your answer with a block diagram.
2. Touch your finger to pin 1 and your thumb to pin 8, what happens? If you're not seeing anything, squeeze the pins.
3. Configure the LT1008 as a non-inverting amplifier with a gain of 2. Use standard (dominant pole) compensation to stabilize the amplifier by connecting a 1nF capacitor between pins 1 and 8. Measure a step response and a Bode plot of the closed loop amplifier. Repeat for 100pF and 20pF compensation capacitors. Calculate the phase margins and the static errors of each of these closed loop configurations.
4. Add a 1nF capacitor to the output of the 20pF configuration. Is the amplifier stable? Justify your answer with a block diagram. Find the maximum capacitive load for this configuration.
5. Compare all of these results against the datasheet for the LT1008. Explain any discrepancies.

The Challenge:

Design a compensation network which can drive a larger capacitive load than the OP07 and which has zero steady state error for a ramp input, a closed loop gain of 10, and the largest possible bandwidth. (There will be a bonus points available for the highest bandwidth.) Your performance will be best if you use every possible tool to compensate the amplifier, including minor loop feedback and major loop compensation networks.

Provide a careful analysis of your compensation network, including a block diagram, measured dynamics of each block, analysis of the amplifier's slewing behavior, and a comparison of how the amplifier behaves under different capacitive loads than the load that your network is targeting.

Deliverables:

- A LT1008 configured to meet the design specifications of the lab.
- A report which describes the results of the exercises, the compensation strategy for the LT1008, and the design process. The report must also include data which proves that your compensation strategy works.