University of California
Department of Electrical Engineering and Computer Sciences
EECS128, Fall 2001, Prof Hsu

Lab 2: Simple Feedback Circuit

Part 1: Figure 1 shows a simple unity gain amplifier with a push-pull (Class B) amplifier stage that is often used in the output stages of stereos and servo amplifiers. Due to the V_{BE} of the silicon transistors, this circuit has a dead-band between about -0.6v and +0.6v. This 'cross-over' distortion can be nearly eliminated by closing the feedback loop around the push-pull stage as the circuit shown in Figure 2.

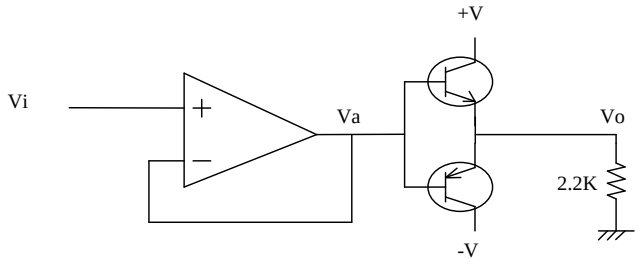


Figure 1

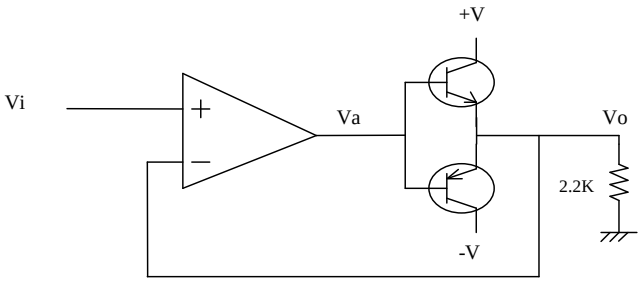


Figure 2

Construct the circuit shown in Figure 1 using a LM741 op-amp and 2N3904 (NPN) and 2N3906 (PNP) transistor. Their pin-outs are shown in Figure 3.

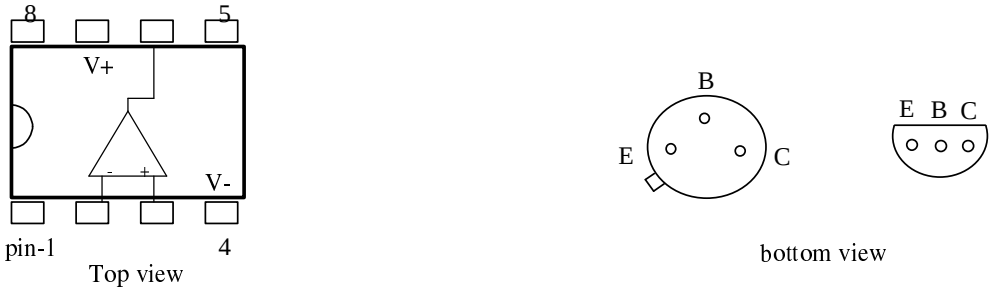


Figure 3

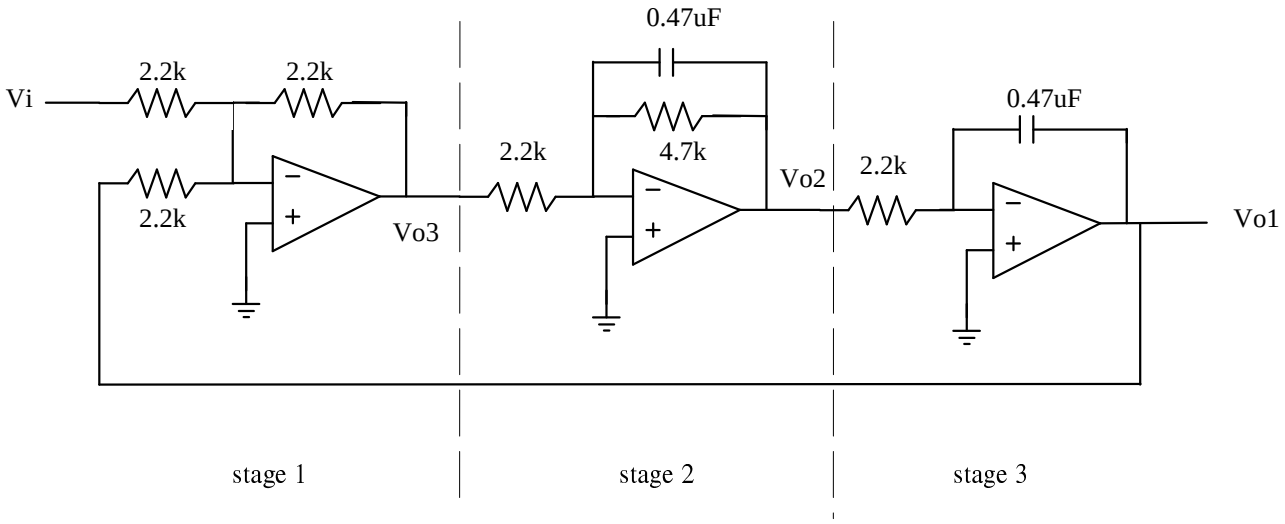
Input a ~1 kHz sinewave to the circuit and observe the waveform at Va and Vo. Include these waveforms in the report. Is this system linear?

Now use the oscilloscope to X-Y plot the transfer characteristic from Vi to Va and from Vi to Vo. Use a 100 Hz sinewave input for Vi viewed on Channel 1 (X), and the other signal on Channel 2 (Y).

Modify the circuit so that the feedback loop is closed around the push-pull stage (as in Figure 2) and repeat the above two steps. Note the difference in the transfer characteristic.

Summarize your experimental results. In particular, explain the difference between the waveforms Vo and Va in these two circuits.

Part 2: Construct the circuit shown below in Figure 4 using the LM741 op-amp.



Lab Measurements: The input to the circuit is Vi and the output is Vo1. Experimentally determine the circuit's frequency response (both magnitude and phase over the range 10 Hz to 1 kHz), and step response (DC gain, damping ratio ζ, natural frequency ω_0, and settling time T_S). Repeat measurements using (a) Vo2 as the output, (b) Vo3 as the output. Use MATLAB to plot the measured frequency response and also the step response.

Theoretical Analysis: Sketch a block diagram in which each stage of the circuit is represented by a transfer function block (the first stage is a summing junction). Determine the transfer function between Vi and Vo1, between Vi and Vo2, and between Vi and Vo3. Calculate the DC gain, damping ratio ζ, natural frequency ω_0, and settling time T_S of these transfer functions. Using MATLAB's *bode* command, make a plot of the frequency response for the transfer functions. Using *hold* in MATLAB or functions in a plotting program, plot the measured response along with the corresponding analytical response.

Discuss your lab results and explain any discrepancies between the lab results and the results from analysis.