EE420 Lab - Week 8
Wein Bridge Oscillator

24th May 2005

1 Overview

This week use an op-amp to build a sine wave oscillator.

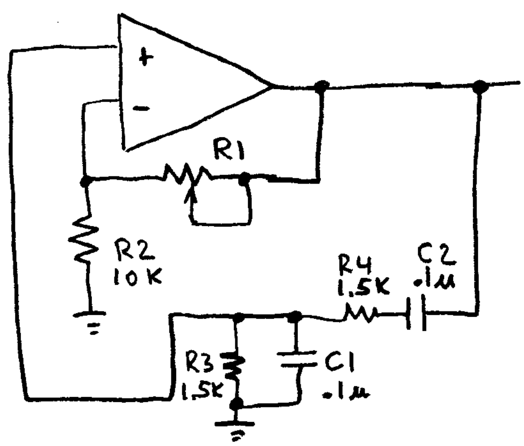
2 Objectives

1. To study an oscillator that uses an op-amp.

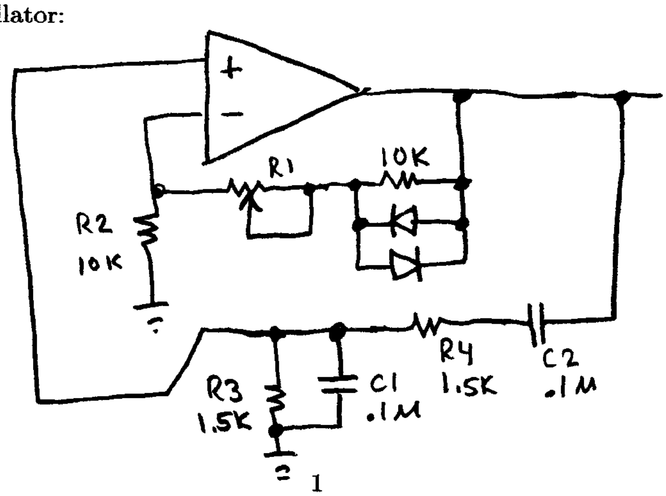
3 Background

In this experiment, we build a simple Wein Bridge oscillator. First, we will build a simple one without amplitude stabilization. Then we will modify it to add a pair of diodes to stabilize the amplitude.

Here the simple oscillator:



Here is the better oscillator:



4 Experiment

1. Build the oscillator circuit as shown in the first schematic. Initially adjust the pot to the middle. Use the fixed power supply to power your circuit.
2. Apply power and observe the output. Adjust the pot for minimum sustained sine wave oscillation. What happens when it is set too high? too low?
3. Print the waveform (1) with the proper setting, and (2) with the pot set a little bit too high. Reset it to the proper setting.
4. Turn power off, and measure the resistance of the pot.
5. Modify your circuit as shown in the second schematic.
6. Apply power and observe the output. Adjust the pot for minimum sustained sine wave oscillation. What happens when it is set too high? too low? Is the behavior different than it was?
7. Print the waveform (1) with the proper setting, and (2) with the pot set a little bit too high. Reset it to the proper setting.
8. Put a fixed resistor (18k) in place of the pot, and put the pot in place of R5. Adjust it as you did before. What happens when it is set too high? too low? Is the behavior different than it was? Measure the resistance for the best sine wave.
9. Print the waveform (1) with the proper setting, and (2) with the pot set a little bit too high. Reset it to the proper setting.
10. Put back the 10k resistor. Check it with both resistors fixed. How does it work? Print the waveform.

5 Analysis

5.1 Manual analysis

Perform a DC bias point analysis and AC small signal analysis, and verify that it works as predicted.

5.2 Simulation

Using a simulator, verify the results you calculated and measured. Make all of the same measurements as you did in the lab. Compare the simulation to what you measured.

6 Report

6.1 Executive summary (on cover)

Show a schematic of your best oscillator, with a snapshot of its output.

6.2 More detailed summary.

Write a paragraph on what you learned, and point out any surprises. Does it match the simulation? Did the simulation give you grief? Explain. Limit this section to one page,

6.3 Journal

Provide a journal of what you did, with enough detail that someone else can reproduce your experiment and verify your work.

6.4 Analysis

Provide your manual analysis of the circuit. Your analysis should show how to determine the frequency of oscillation, and verify that a gain of 3 is required.

6.5 Simulation

Simulating oscillators can be a challenge.

Try to simulate the circuit. Use a voltage controlled voltage source (type "E") with a gain of 10000 to model the op-amp. First, try it as you have always done a transient analysis. It will not do anything. Try both circuits.

To make it oscillate, you need to give it a kick. Specify a non-zero initial condition on one of the capacitors. Add "IC=1" to the capacitor line. It now reads something like "C1 (1 0) .1u IC=1". You also need to tell it to use the initial condition. To do this, add the word "UIC" to the command that runs the transient analysis. "UIC" means "use initial conditions".

As I said here, the op-amp is a voltage controlled voltage source, without clipping. In gnucap, you can make it clip by making its value "tanh (10k, 15)" which says that the gain is 10k and it clips at 15 volts, with a hyperbolic tangent shape. Try this. Note especially the difference for the first circuit.

7 Bonus #1 (2 pts)

For a bonus, what happens when you simulate a simple LC circuit? If it is lossless, just a parallel LC circuit should be an oscillator. You need to specify an initial condition on either the L or the C, and use the "UIC" keyword on the transient command. Play with the initial condition to see the effect. Unfortunately (or perhaps fortunnately) these ideal components don't exist in the real world.

8 Bonus #2 (double credit for a good job)

How would you make a tunable oscillator, like we have in the lab? Submit a design for one that covers 10 Hz to 100 KHz, in decade ranges. Also, add a level control and buffer, so the load is not directly connected to the oscillator stage. It should have output resistance of 50 Ω, and be able to drive a 50 Ω load to 10 V p-p.