ECE 214 – Electrical Circuits Lab
Lecture 5

Vince Weaver
http://www.eece.maine.edu/~vweaver
vincent.weaver@maine.edu

17 February 2015
Announcements

• Midterm next week (Tuesday the 24th)

• Lab notebooks due (Thursday the 26th by 5pm)

• No lab next week! (Unless you are Monday lab). Labs will resume with Lab#6 after spring break.

• No Monday lab immediately after break.
Microcap

- Postlab. Op-amp problems?
- Try using the “Generic” op-amp which you can find on the side bar.
- Make sure when you create a 1M resistor use 1meg or 1000k. 1m means 1 mili-ohm.
Notes from Previous Labs

• Why might you get a gain of -10 rather than -4.7 on Inverting Op-amp? Know your color codes! Resistors soldered in wrong place on board.

• Integrate: sine/cosine, square/triangle, triangle/parabolas (not sine), sawtooth/bumpytops

• derivative: sine/cosine, square/impulse, triangle/square (ringing)
• Analog Computers
Lab #5 – Schmitt Trigger and Oscillator Circuit

- Invented by Otto H. Schmitt in 1934 as a grad student.
- What are they good for?
- De-bouncing switches?
PreLab

- Positive Feedback (Input to +), running in saturation

- If $v_p > v_n$, $V_{OUT} = V_{SUP}$

- If $v_p < v_n$, $V_{OUT} = -V_{SUP}$
• Superposition principle: calculate each node, setting other V source to 0. Then add.

• \( V_n = 0 \), \( V_p = \frac{R_2}{R_1 + R_2} V_{IN} + \frac{R_1}{R_1 + R_2} V_{SUP} \)

• \( V_{IN} = \pm \frac{R_1}{R_2} V_{SUP} \)
Using a Single Rail

- Calculate so levels separated more than 3.5V but less than 4.5V when supplies 10V and GND.

- Use the equation before, then just shift up by 5V at the end.
• Make sure current through resistor less than 10mA

• CAUTION! BUILDING THE CIRCUIT
  Connect V+ to 10V, GND and V- together to GND. Do not hook up -10V anywhere!

• The parts are not all going to be available on the board, so use a breadboard (on the TI board or your own)

• Your calculated values might not give close enough results. Real-world op-amps are not ideal!
Oscillator

- A Schmitt trigger hooked to an inverting integrator with feedback.
• It has just flipped, to flip back has to go back down by $2^{*}(R_1/R_2)$

• $I_C = \frac{V_S}{R_3}$

• $\Delta t = \frac{C \Delta V}{I_{R3}}$

• Substitute; $\Delta t = 2\frac{R_1}{R_2} V_s\left(\frac{1}{V_s}\right) = \frac{2R_1R_3}{R_2} C$

• $T = 2\Delta t = \frac{4R_1R_3}{R_2} C$

• $f = \frac{1}{T} = \frac{R_2}{4R_1R_3C}$
Reducing even Harmonics

- View the square wave in FFT mode.
- Are there large even harmonics? If so then you can...
reduce them by adjusting the DC offset.

- Put a variable resistor into the input and adjust the voltage offset until the even harmonics are minimized.
Question

• If circuit starts out exactly in balance, how does oscillation start?

• May be a problem if you try to simulate with microcap.

• In real world enough random noise to kick off (unstable equilibrium).
Postlab

- None this week.
Midterm

- During lecture next week
- Know how to read an oscilloscope display
  This includes voltages, times, Lissajous, and Fourier screens.
- Know how to set up a function generator.
- Be able to quickly find and answer questions on the pre,
lab, and post from your lab book.
Lab-notebooks

• Turn in by 5pm Thursday the 26th.