ECE 214 – Electrical Circuits Lab
Lecture 5

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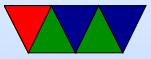
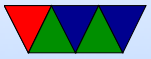
Announcements

- 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.

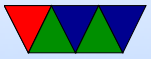


Notes from Previous Labs

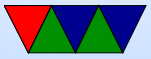
- Why might you get a gain of -10 rather than -4.7 on Inverting Op-amp?
  Know your color codes! Resistors soldered in wrong place on board.

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

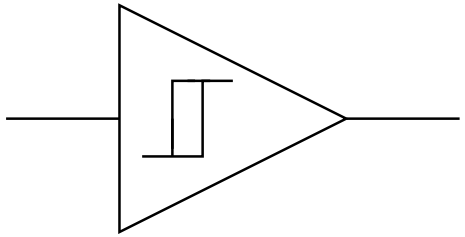
- derivative: sine/cosine, square/impulse, triangle/square (ringing)



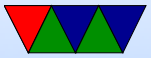
- Analog Computers



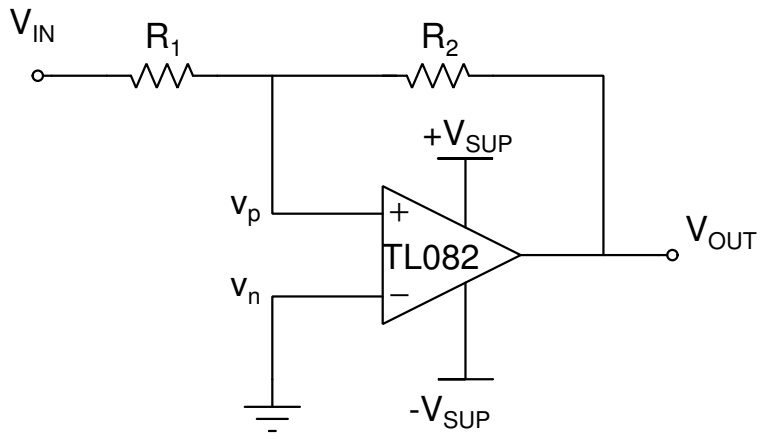
Lab #5 – Schmitt Trigger and Oscillator Circuit



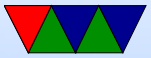
- Invented by Otto H. Schmitt in 1934 as a grad student.
- What are they good for?
- De-bouncing switches?



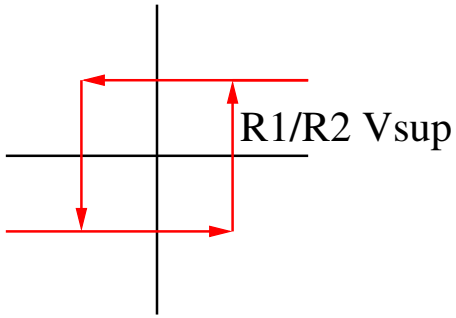
PreLab

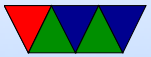


- Positive Feedback (Input to $+$), running in saturation
- If $v_p > v_n, V_{OUT} = V_{SUP}$
- If $v_p < v_n, V_{OUT} = -V_{SUP}$

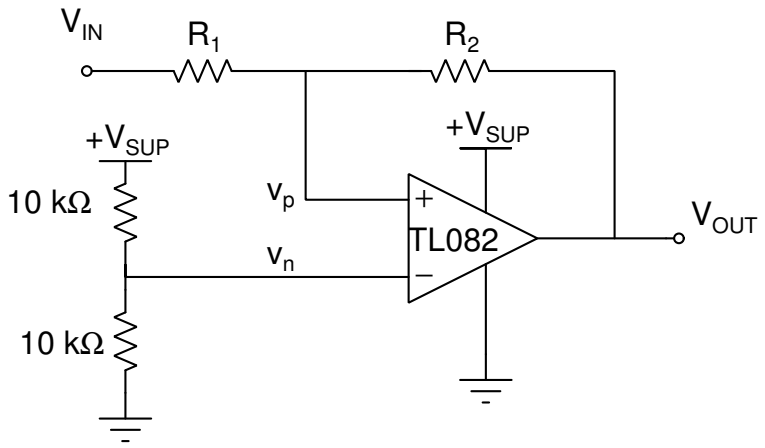


- Superposition principle: calculate each node, setting other V source to 0. Then add.
- $V_n = 0$, $V_p = \frac{R_2}{R_1+R_2} V_{IN} + \frac{R_1}{R_1+R_2} V_{SUP}$
- $V_{IN} = \pm \frac{R_1}{R_2} V_{SUP}$

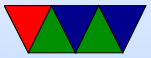




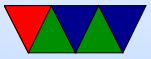
Using a Single Rail



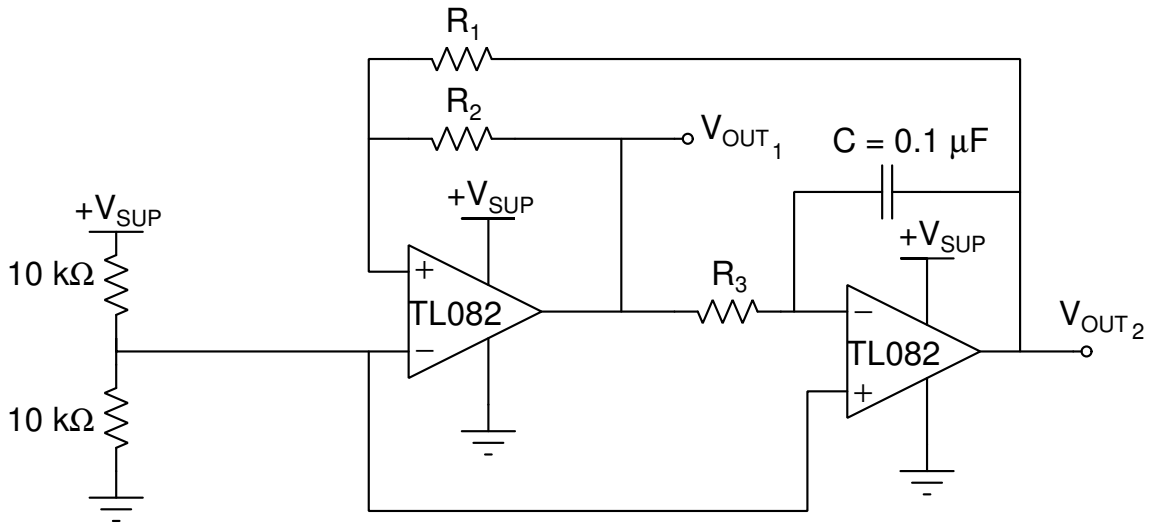
- Calculate so levels separated more than 3.5V but less than 4.5V When supplies 10V and GND
- Use the equation before, then just shift up by 5V at the end.



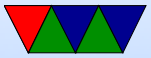
- Make sure current through resistor less than 10mA
- CAUTION! BUILDING THE CIRCUIT
  Connect V+ to 10V, GND and V- together to GND.
  Do not hook up -10V anywhere!
- The parts are not all going to be available on the board, so use a breadboard (on the TI board or your own)
- Your calculated values might not give close enough results. Real-world op-amps are not ideal!



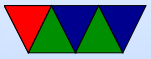
Oscillator



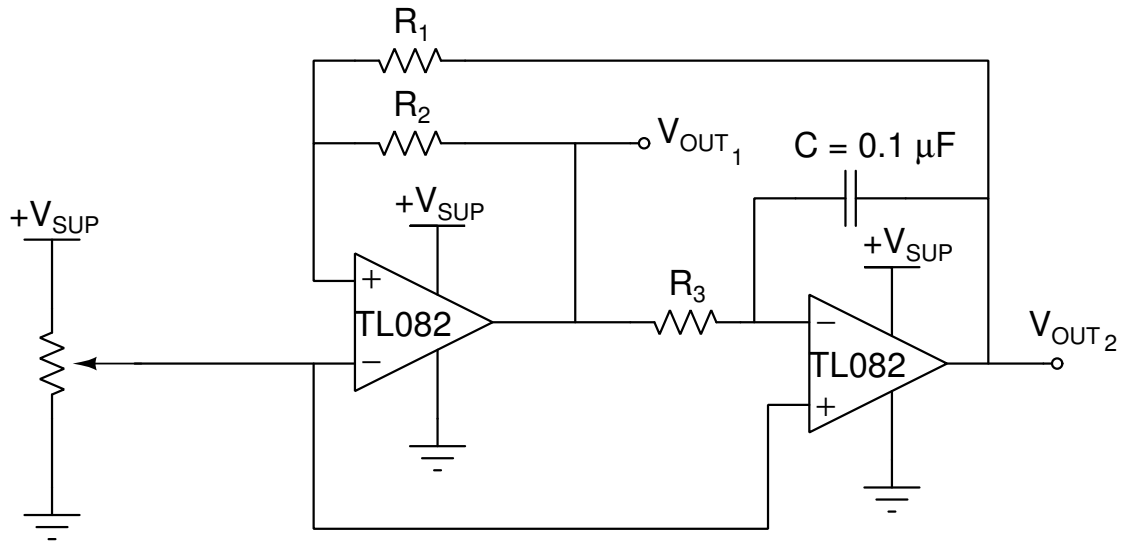
- A Schmitt trigger hooked to an inverting integrator with feedback.



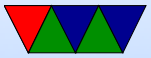
- It has just flipped, to flip back has to go back down by 2*(R1/R2)
- $I_C = \frac{V_S}{R_3}$
- $\Delta t = \frac{C\Delta V}{I_{R3}}$
- Substitute; $\Delta t = 2\frac{R_1}{R_2}V_s(\frac{1}{\frac{V_s}{R_3}}) = \frac{2R_1R_3}{R_2}C$
- $T = 2\Delta t = \frac{4R_1R_3}{R_2}C$
- $f = \frac{1}{T} = \frac{R_2}{4R_1R_3C}$



Reducing even Harmonics

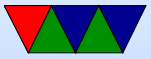


- View the square wave in FFT mode.
- Are there large even harmonics? If so then you can



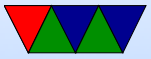
reduce them by adjusting the DC offset.

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



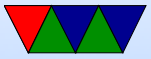
Question

- 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).



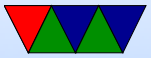
Postlab

- None this week.

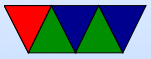


Midterm

- During lecture next week
- Open lab-book. Can use calculator. No laptops.
- 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.