

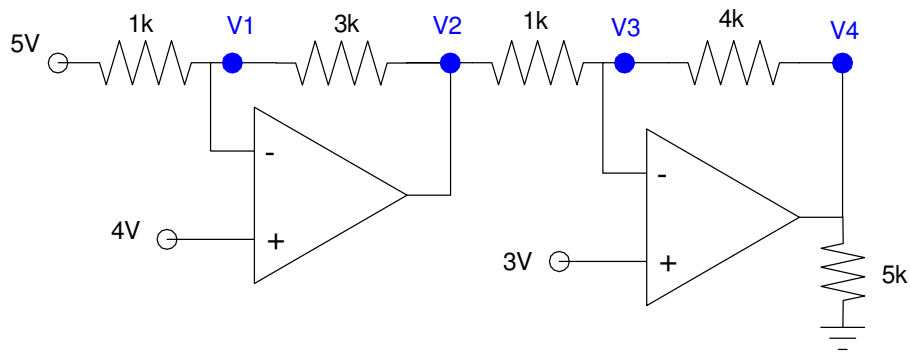
ECE 211: Homework #5

Ideal Op-Amps, Amplifiers, Comparitors, & Schmitt Triggers

Ideal Op-Amps

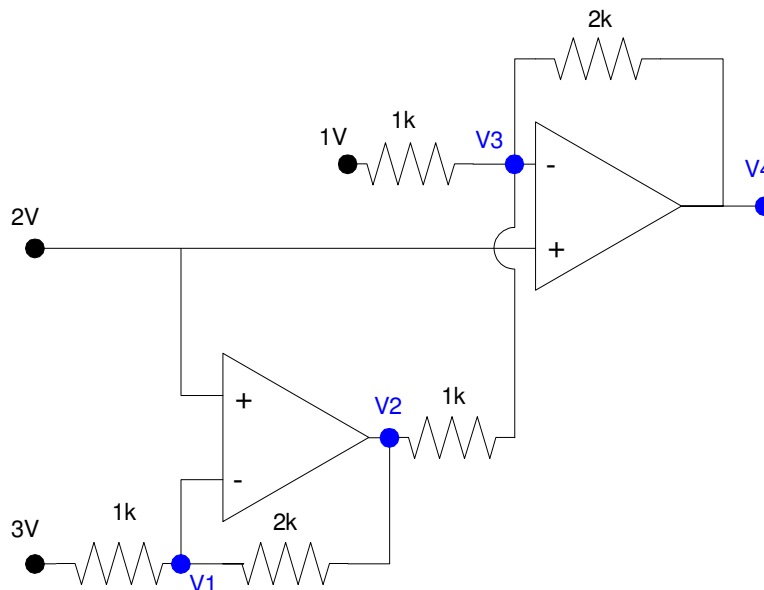
- 1) Write the voltage node equations for the following op-amp circuit. Assume ideal op-amps.
 - Solve for V1, V2, V3, and V4
- 2) Check your answers using CircuitLab
 - Assume LM394 op-amp (doesn't really matter)

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Problems 1-2

- 3) Write the voltage node equations for the following op-amp circuit. Assume ideal op-amps.
 - Solve for V1, V2, V3, and V4
- 4) Check your answers using CircuitLab
 - Assume LM394 op-amp (doesn't really matter)



Problems 3-4

Amplifiers

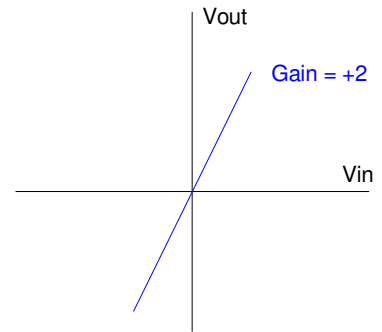
5) Design an op-amp circuit to implement

$$Y = 2X$$

Simulate this circuit in Circuitlab with

- $x(t) = 1V_p$, 1kHz sine wave

Is Y two times X?



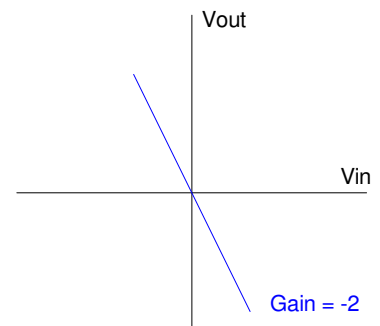
6) Design an op-amp circuit to implement

$$Y = -2X$$

Simulate this circuit in Circuitlab with

- $x(t) = 1V_p$, 1kHz sine wave

Is Y two times X and 180 degrees out of phase?



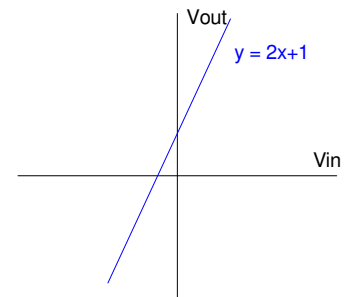
7) Design an op-amp circuit to implement

$$Y = 2X - 1$$

Simulate this circuit in Circuitlab with

- $x(t) = 1V_p$, 1kHz sine wave

Is Y two times X, in-phase, and shifted down by 1V?



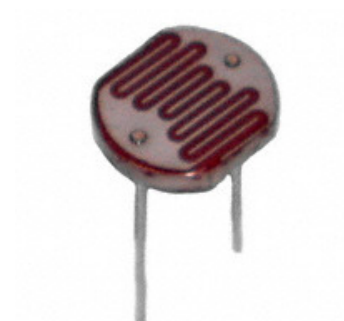
Comparitors & Schmitt Triggers

8) Using your light sensor, measure the resistance

- When the lights in your room are turned on
- When the lights in your room are turned off

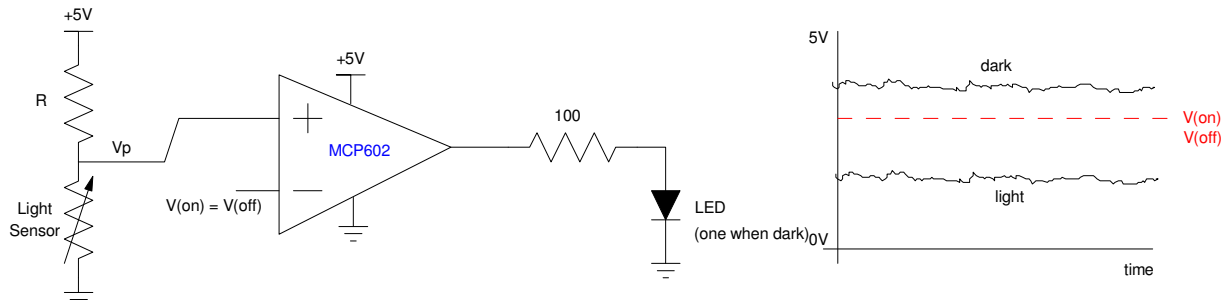
Design a voltage divider to convert this resistance to a voltage. Calculate the voltage

- When the light is on
- When the light is off



9) (Comparator) Pick a voltage between $V(\text{light})$ and $V(\text{dark})$. Design a circuit which turns on and off at this voltage:

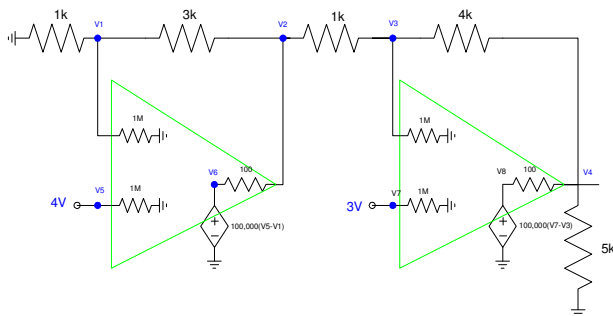
- 0V when the lights are turned on, and
- 5V when the lights are turned off



Problem #9

10) (Schmitt Trigger) Pick two different voltages between $V(\text{light})$ and $V(\text{dark})$. Design a circuit which outputs

- 0V when voltage goes below $V(\text{off})$ and
- 5V when the voltage goes above $V(\text{on})$



Problem #10

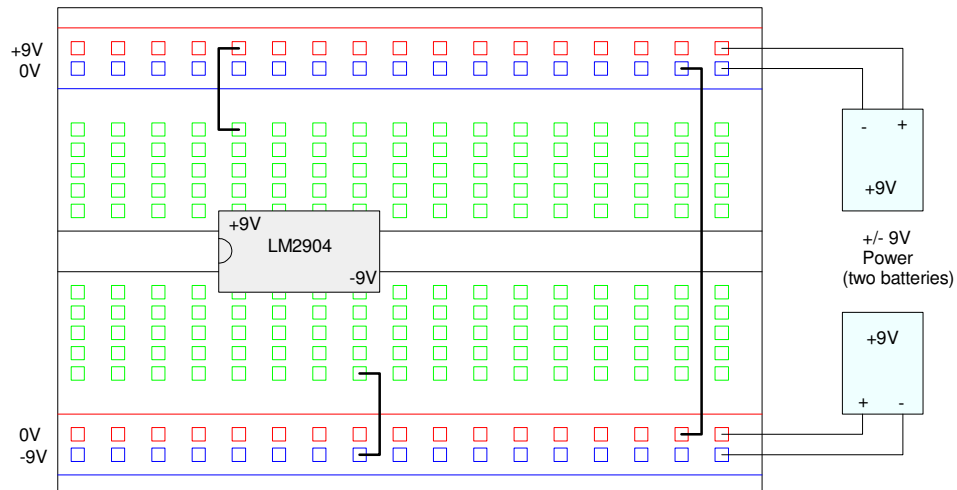
Lab

11) Build either a comparator or Schmitt trigger on your breadboard

- Include a photo of your finished breadboard circuit

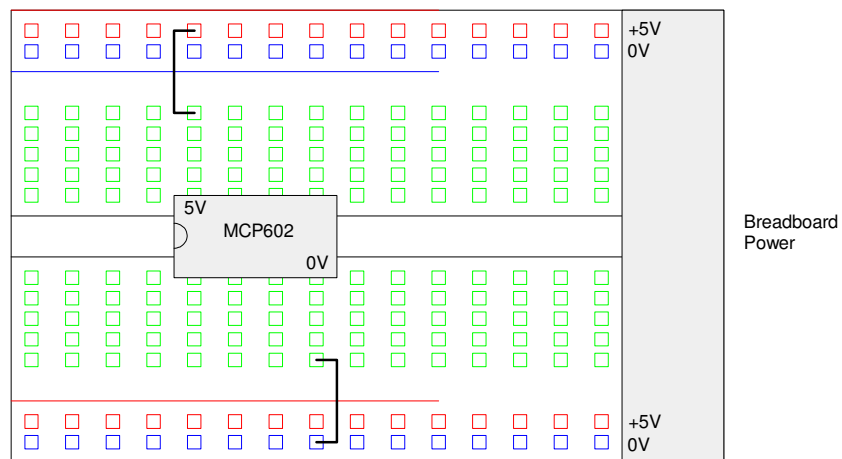
12) Collect measurements to verify the operation of your circuit

- Measure $V(\text{on})$
- Measure $V(\text{off})$
- Measure the current to the diode when on



Breadboard power for an amplifier circuit ($y = 2x$, $y = -2x$, $y = 2x - 1$)

If building digital logic, use an MCP602 op-amp with a 5V powered breadboard



Breadboard & power for a digital circuit (comparator & Schmitt trigger)