ECE 320 - Homework #8

Comparitors, Schmitt Triggers. Due Monday March 6th, 2017

Term Project

i) Design a digital circuit

ii) Split this into three sections - each being a circuit we covered in ECE 320

iii) Design and test each section separately (separate requirements / analysis / test / validation)

Suggestion (if you don't like this one, it's OK to do your own thing)

Light-Controlled Fan

Input:

- Light Sensor
- On/Off Switch. 0V / 5V capable of driving 1mA

Output:

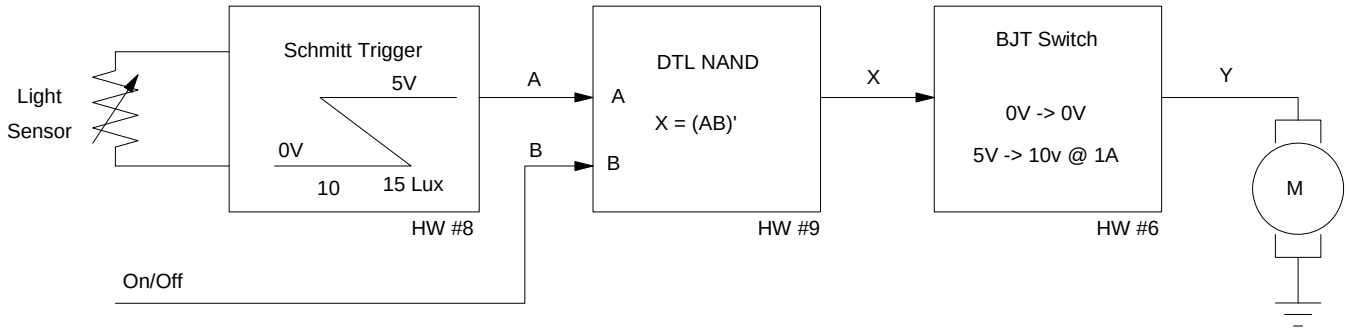
- DC Motor (Fan) drawing up to 1A @ 10V

Relationship

- When the On/Off switch is off (0V), the motor is off.
- When the on/off switch is on (5V)
  - The fan turns off when the light level drops below 10 Lux
  - The fan turns on when the light level goes above 15 Lux, and
  - The fan remains unchanged (on/off) inbetween 10 and 15 lux
- "On" means 10V to the DC motor

Tolerances:

- +/- 1 Lux
- +/- 1 Volt to the DC motor



- A, B, X are a 0V / 5V signal capable of driving 1mA

Problem 1) Specify the overall system requirements (OK to use the above or to modify as you see fit)

Assume you have a light sensor where

$$R = \frac{100{,}000}{Lux}\ \Omega$$

2) Design a circuit which can drive a 1k Ohm load which outputs

- 0V when the light level is less than 10 Lux
- 5V when the light level is more than 10 Lux

At 10 Lux

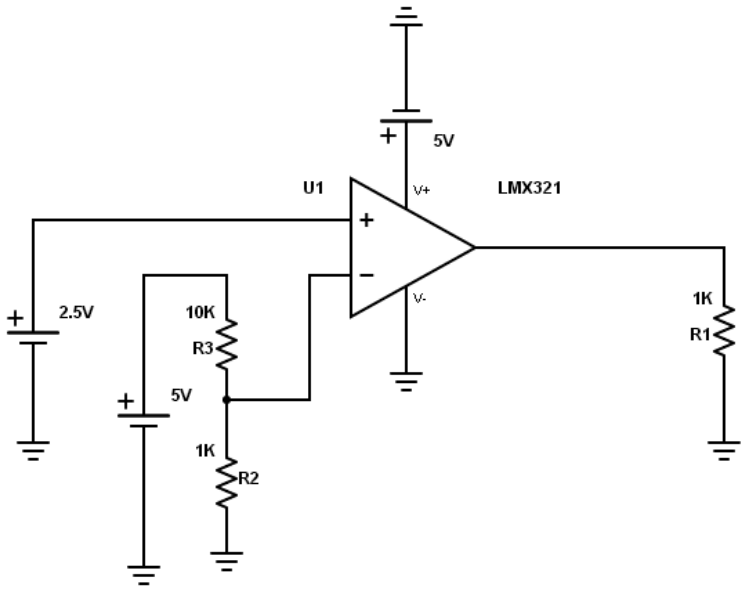
$$R = 10k\Omega$$

Add a voltage divider with a 10k resistor. This turns 10 Lux into 2.5V

When the light gets bright

- R goes to zero
- Va goes to zero
- Vout goes to 5V

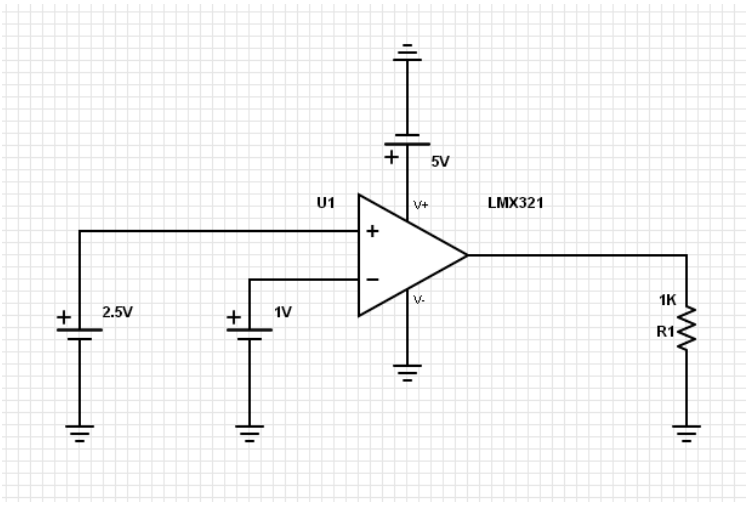
so connect the voltage divider to the - input

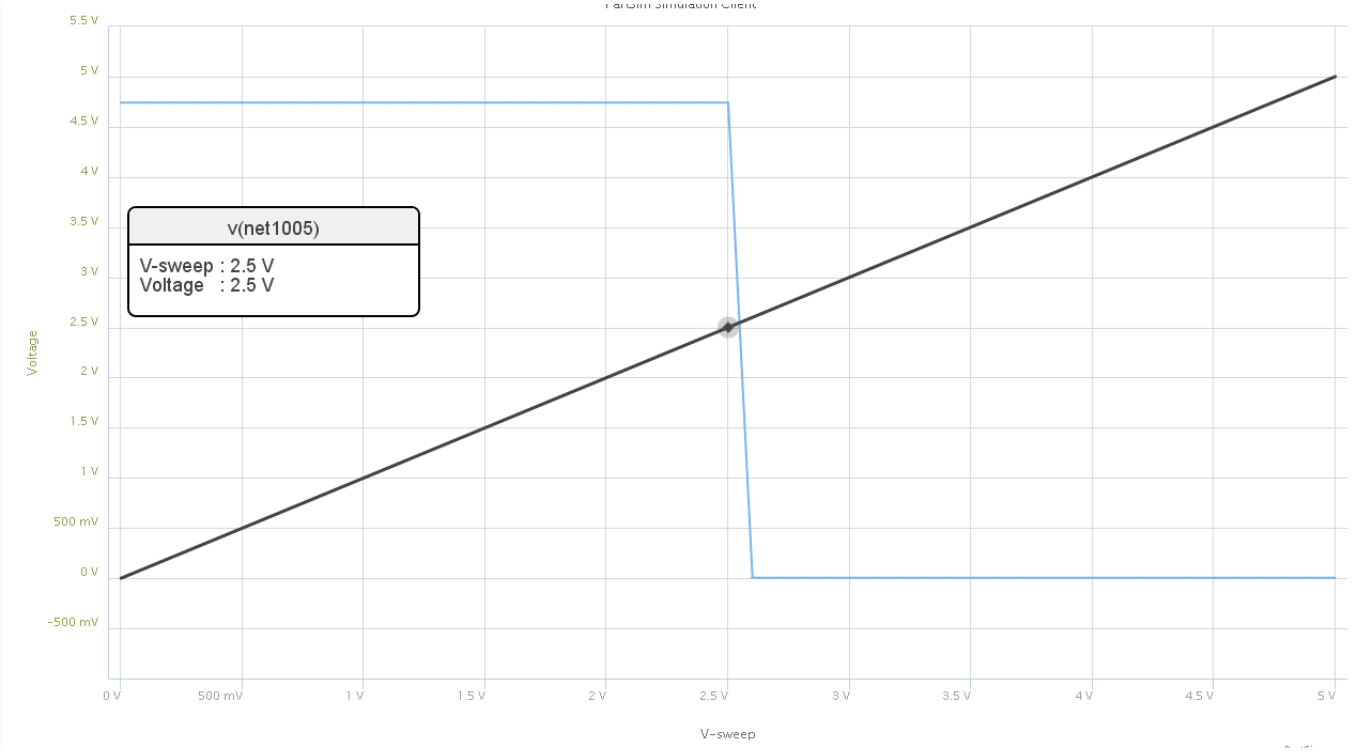


Comparitor. R2 is the light sensor

3) Verify your design in PartSim

I can't sweep R in PartSim, so instead replace the voltage divider with a DC votlage and sweep the voltage





Yup -

- It switches at 2.5V
- The output goes low (0V) when the input goes high

3) Design a circuit which can drive a 1k Ohm load which outputs

- 0V when the light level is less than 10 Lux
- 5V when the light level is more than 15 Lux
- Remains unchanged between 10 Lux and 15 Lux

Use the same voltage divider (10k / R)

At 10 Lux

R = 10k

Va = 2.50V

Vo goes low

At 15 Lux

R = 6666

Va = 2.00V

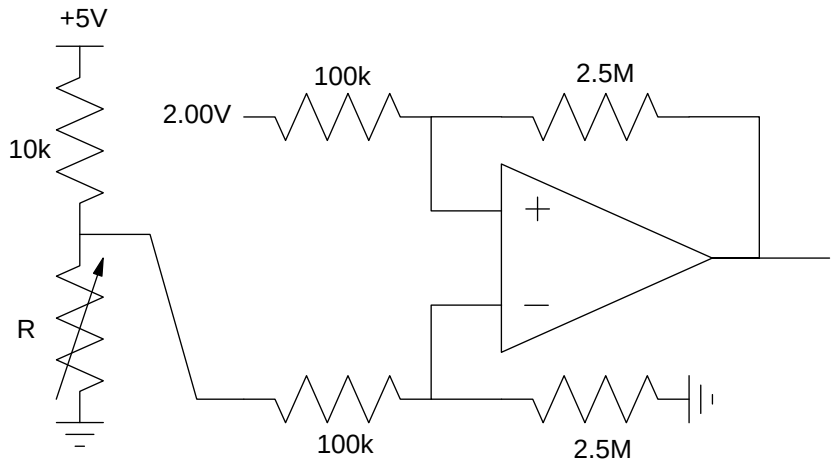
Vo goes high

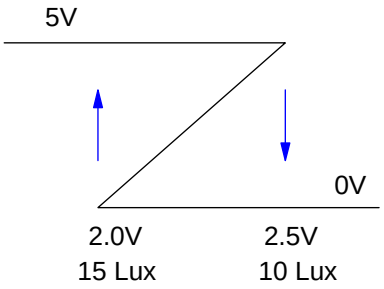
The gain you need is

$$gain = \left(\frac{5V-0V}{2.5V-2.0V}\right) = 25$$

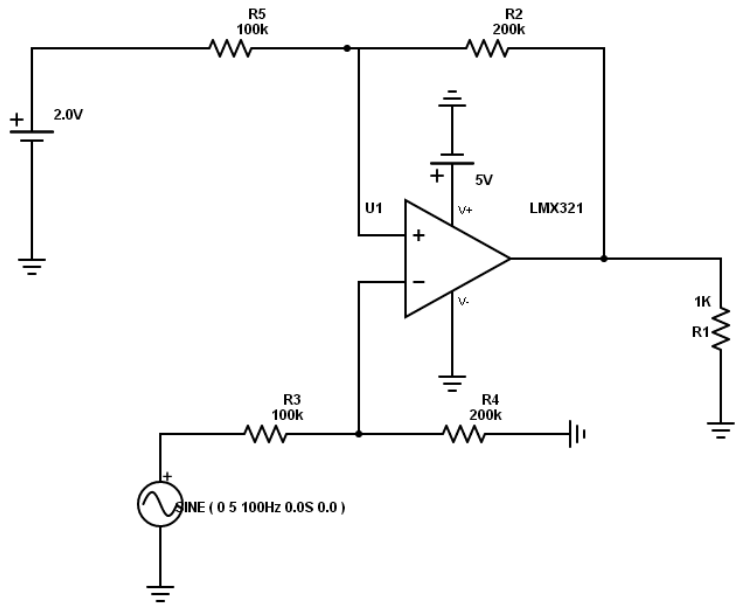
As Va increases, Vo decreases. Connect the divider to the - input

When Vo = 0V, the output switches at 2.00V. Connect the offset to 2.00V

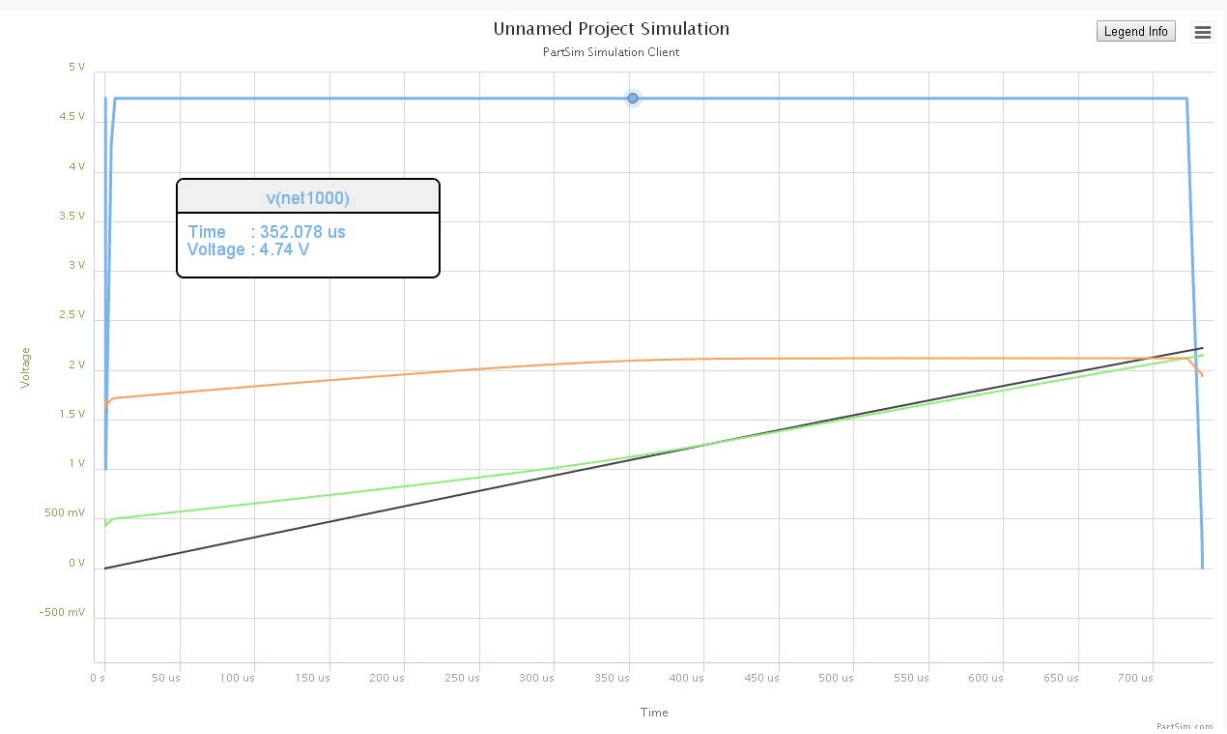




4) Verify your design in PartSim



PartSim dies when the Schmitt Trigger switches



Lab

5) Build the circuit for problem #3. Verify that

- The output (A) is 5V when the light level is less than 10 Lux (10k Ohms)
- The output (A) is 0V when the light level is more than 15 Lux (6666 Ohms)
- The output switches at 10 Lux and 15 Lux (100k and 6666 Ohms)

note: The lab is a little more fun if you add in a transistor switch to turn on and off a DC motor....