ECE 320 - Homework #8

Competitors, Schmitt Triggers, Boolean Logic. Due Monday, March 4th, 2019

Assume a thermistor with

$$R = 1000 \cdot \exp\left(\frac{3905}{T} - \frac{3905}{278}\right)\Omega$$

where T is the temperature in degrees Kelvin (C + 273).

Comparitors

1) Design a circuit to

- Turn on a fan when the temperature is more than 20C, and
- Turn off the fan when the temperature is less than 20C

Assume the fan draws 200mA @ 10V DC. (note: you'll need to use a TIP112 transistor)

20C has a resistance of 1250 Ohms.

Choose a 1k resistor for the voltage divider. This results in the voltage being

$$V_a = \left(\frac{1250}{1k+1250}\right)10V = 5.557V$$

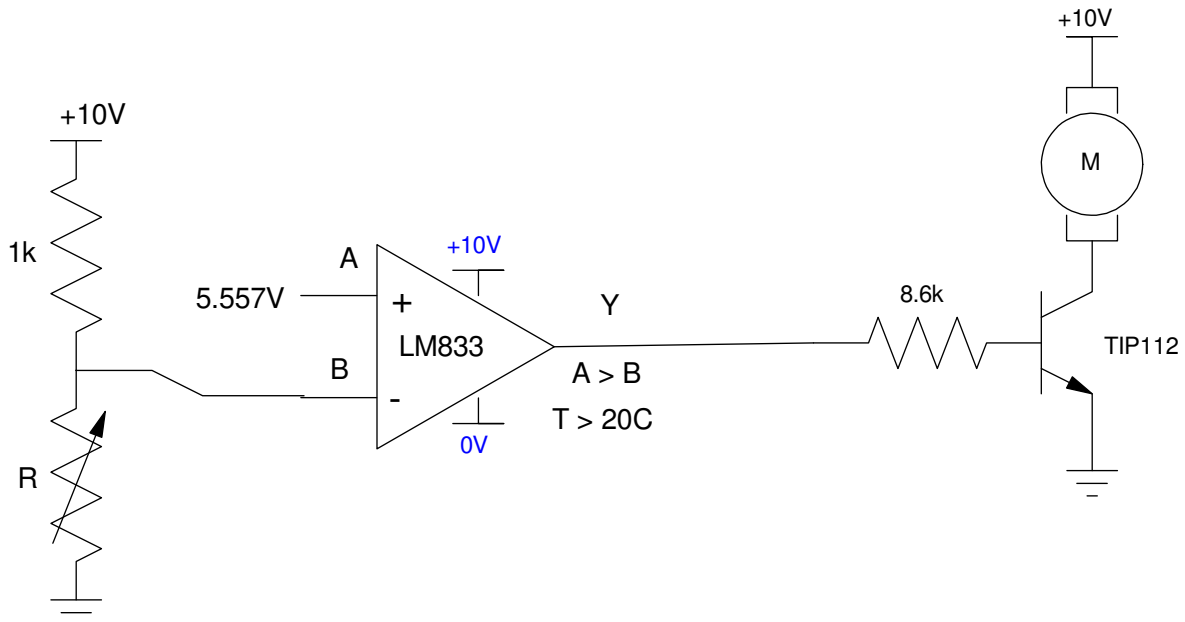
To saturate the fan,

$$\beta I_b > I_c$$

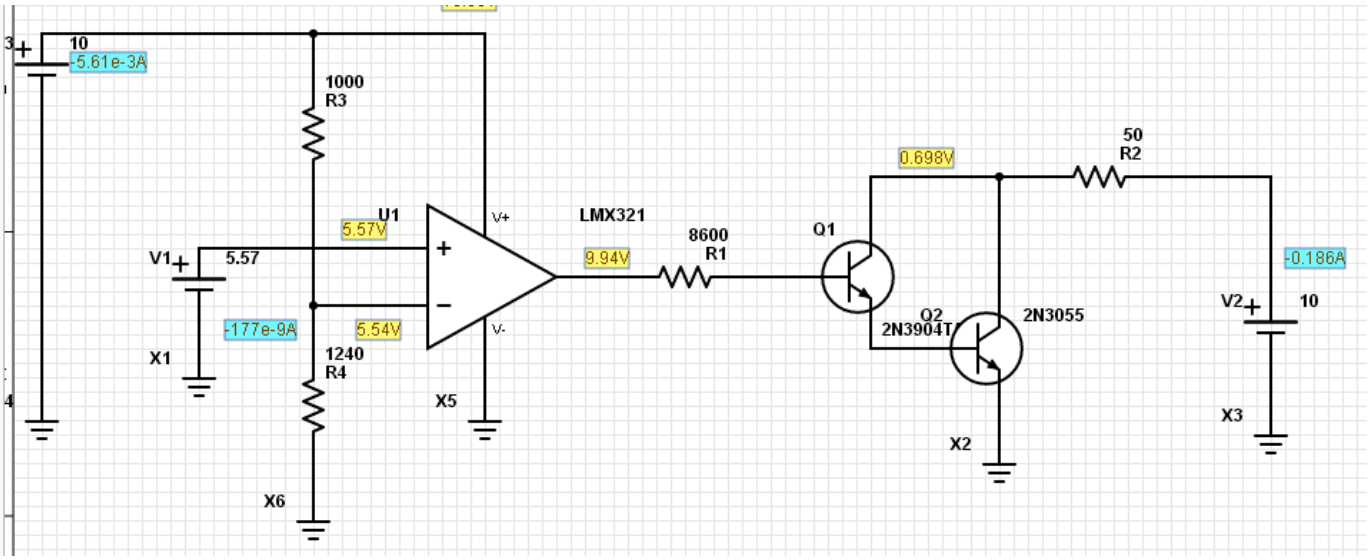
$$I_b > \frac{200mA}{1000} = 200\mu A$$

Let Ib = 1mA (overkill)

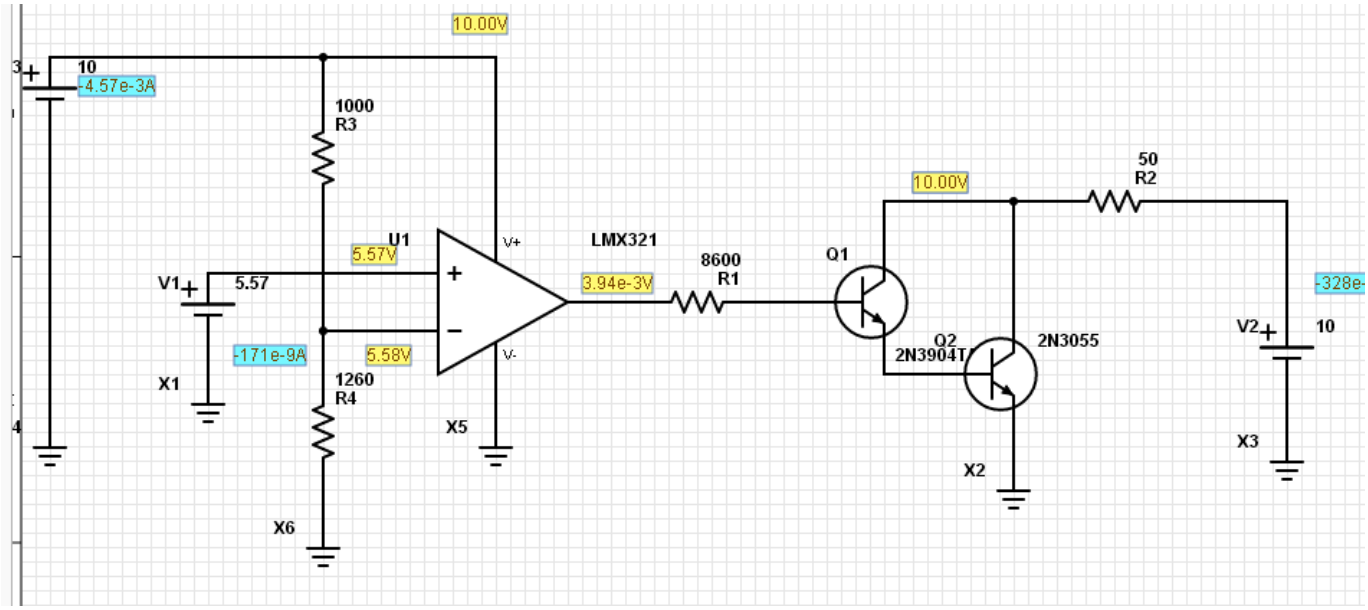
$$R_b = \left(\frac{10V-1.4V}{1mA}\right) = 8600\Omega$$



2) Check your design in PartSim



At 1240 Ohms (slightly hotter than 20C) the fan is on



At 1260 Ohms (slightly colder than 20C) the fan is off

3 (lab) Check your design in lab.

Schmitt Triggers

4) Design a circuit to

- Turn on a fan when the temperature is more than 20C, and
- Turn off the fan when the temperature is less than 15C

Assume the fan draws 200mA @ 10V DC. (note: you'll need to use a TIP112 transistor)

Use a 1k resistor for the votlage divider like before.

At 20V (fan on)

- R = 1250 Ohms
- Va = 5.5567V

At 15C (fan off)

- R = 1576 Ohms
- Va = 6.1183V

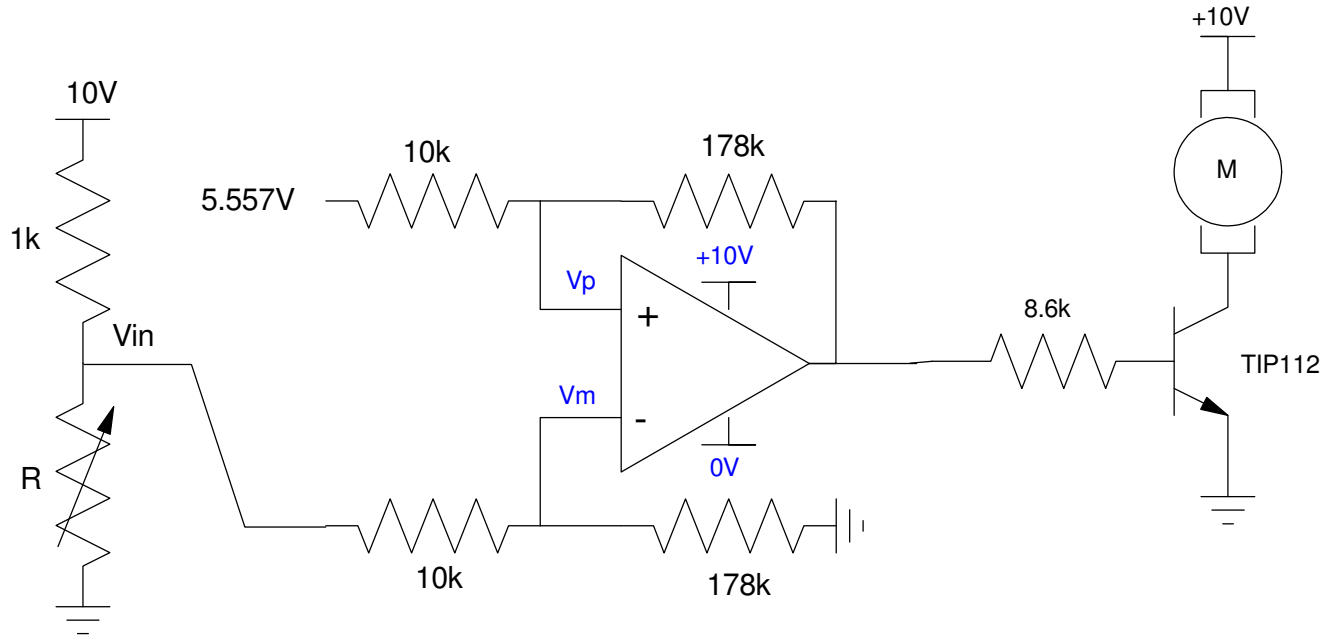
The output goes up as the input (Va) goes down. Connect to the minus input

When the output is 0V, you switch at 5.55V. Make the offset 5.55V

The gain is

$$gain = \left(\frac{10V - 0V}{6.118V - 5.556V}\right) = 17.8$$

Pick the resistors in a 17.8 : 1 ration

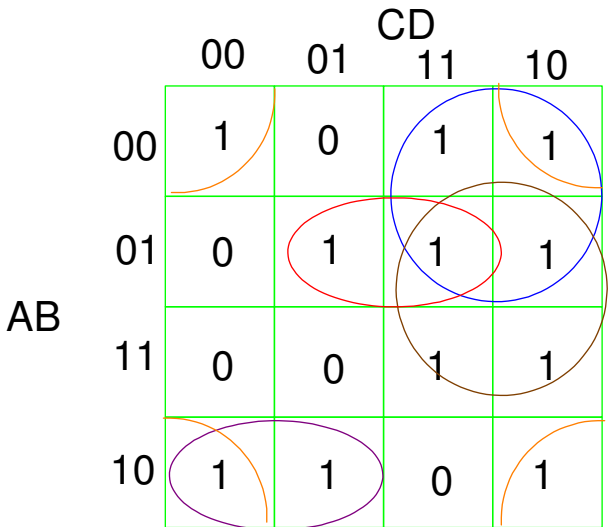


5 (lab) Check your design in lab.

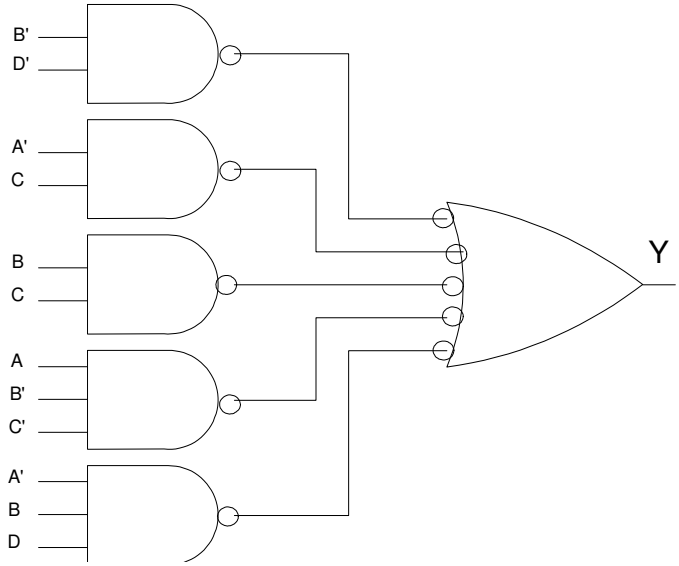
(note: PartSim doesn't like Schmitt Triggers...)

Boolean Logic

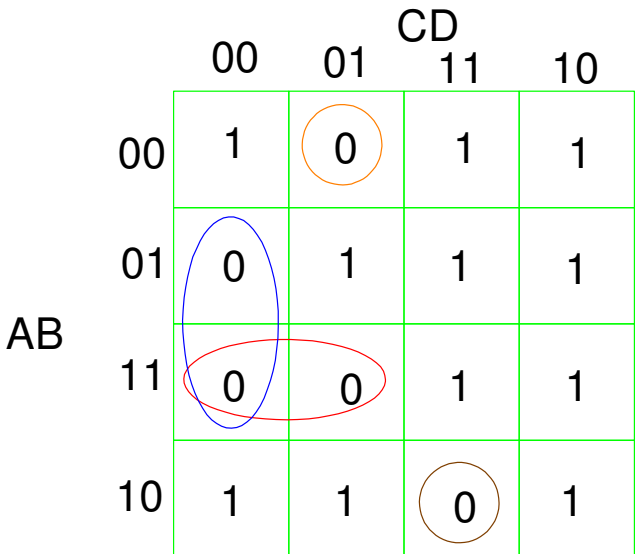
6) Implement the following function using NAND gates



$$Y = \overline{B}\overline{D} + \overline{A}C + BC + A\overline{B}\overline{C} + \overline{A}BD$$



7) Implement the following function using NOR gates



$$\overline{Y} = \overline{A}\overline{B}\overline{C}D + A\overline{B}CD + B\overline{C}\overline{D} + AB\overline{C}$$

Using DeMorgan's theroem

$$Y = \left(A + B + C + \overline{D}\right)\left(\overline{A} + B + \overline{C} + \overline{D}\right)\left(\overline{B} + C + D\right)\left(\overline{A} + \overline{B} + C\right)$$