ECE 320 - Homework #8

Schmitt Triggers, Boolean Logic, DTL Logic. Due Monday, October 15th, 2018

Comparitors and Schmitt Triggers

A temperature sensor has the following characteristics:

$$R = 1000 \cdot \exp\left(\frac{3905}{T} - \frac{3905}{298}\right)\ \Omega$$

where T is the temperture in degrees Kelvin.

1) Design a circuit which outputs
   - V2 = 0V for T < 15C
   - V2 = 5V for T > 15C

At 15C (288K),

R = 1576 Ohms

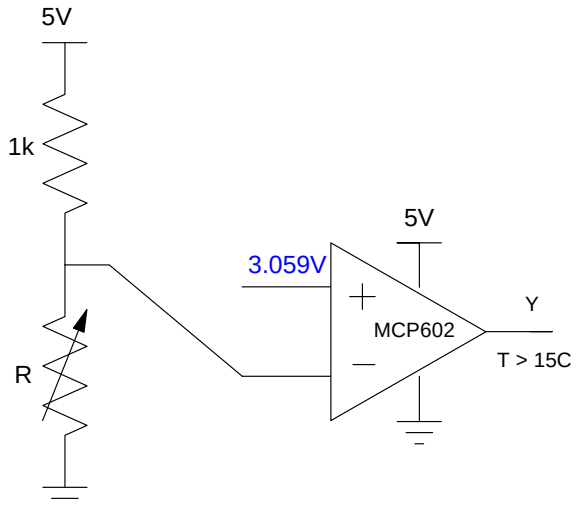
Using a 1k resistor for a voltage divider results in

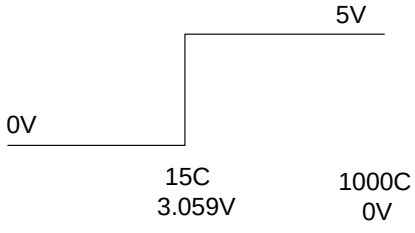
$$V_a = \left(\frac{R}{R+1000}\right) \cdot 5V = 3.059V$$

When temperature goes to infinity

- $R \to 0$
- $V_a \to 0$
- $V_{out} \to 5V$

Connect to the - input for the inverse correlation





2) Design a circuit with hysteresis which outputs

- V2 = 0V for T < 15C
- V2 = 5V for T > 20C
- No change for 15C < T < 20C

At 15C (288K)

- R = 1576 Ohms
- Va = 3.059V
- Vo = 0V

At 20C (293K)

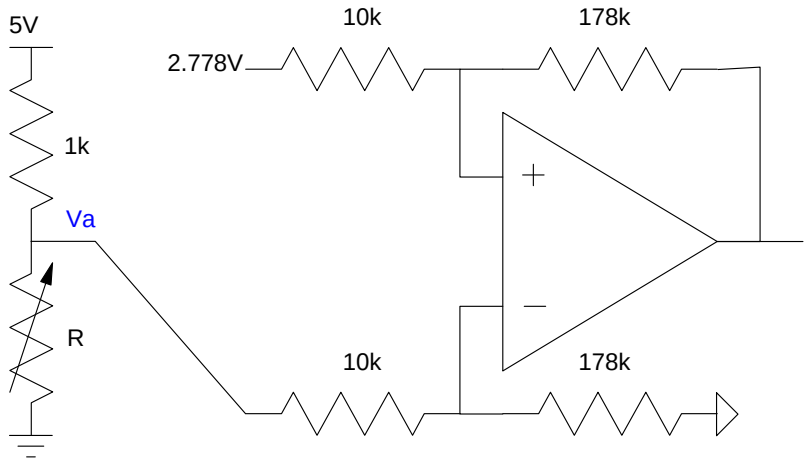
- R = 1250 Ohms
- Va = 2.778V
- Vo = 5V

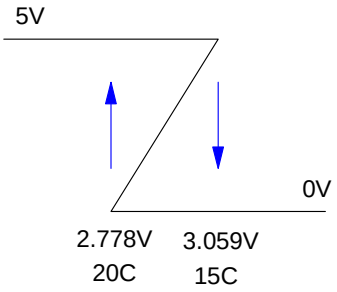
The output increases when the input decreases. Connect to the - input to provide this negative correlation.

The gain you need is

$$gain = \left(\frac{\text{change in output}}{\text{change in input}}\right) = \left(\frac{5V-0V}{3.059V-2.778V}\right) = 17.8$$

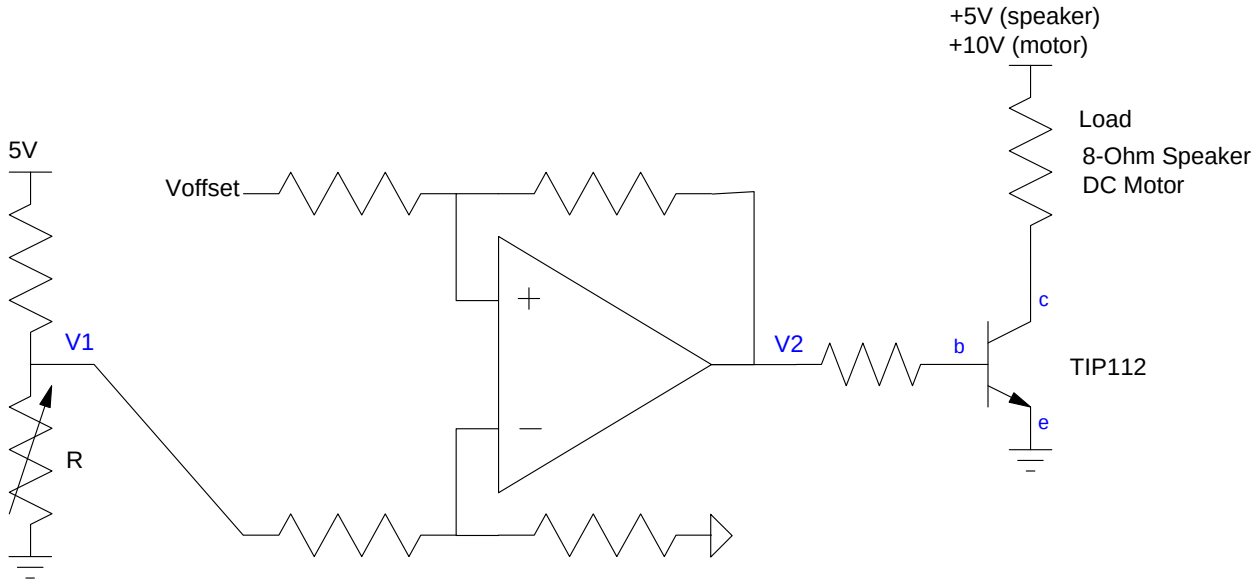
When the output is 0V, you switch when the input is 2.778V. Connect the offset to 2.778V





3) Build these two circuits in lab connected to a TIP112 NPN transistor to turn on and off a DC motor or 8 Ohm speaker (your pick). Using a potentiometer intead of the thermistor, (easier to adjust), determine the following for the compatitor and Schmitt Trigger:

- What resistance (or voltage) does the output jump to +5V?
- What resistance (or voltage) does the output jump to -5V

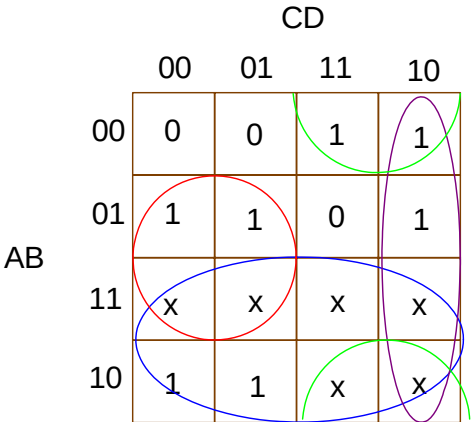


Problem 1-3: Turn on and off a speaker and/or DC motor using a comparitor and Schmitt Trigger.

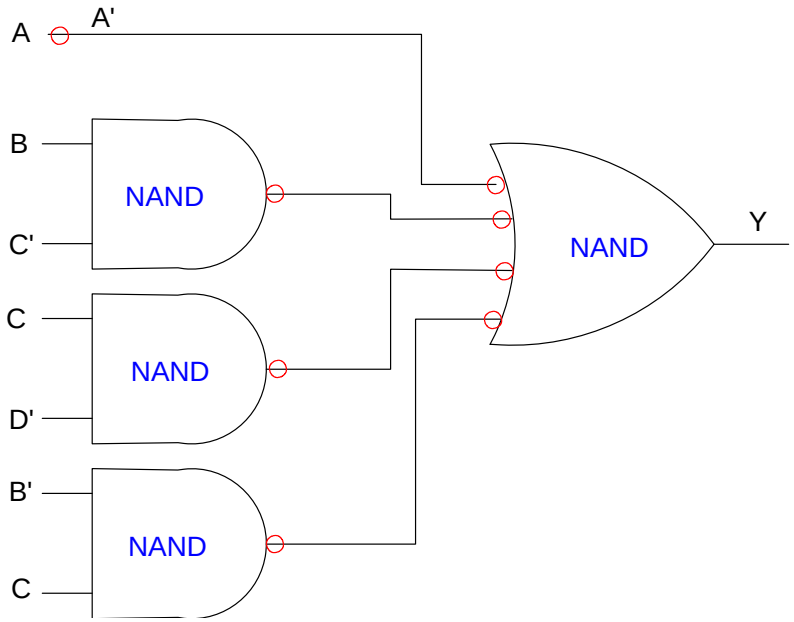
	Calculations	Measured
V1 when V2 goes to +5V	2.778V	
V1 when V2 goes to 0V	3.059V	

Boolean Logic:

4) Determine a circuit using NAND gates to implement the following function (i.e. circle the ones)



$$Y = A + BC' + CD' + B'C$$



5) Determine a circuit using NOR gates to implement the following function (i.e. circle the zeros)

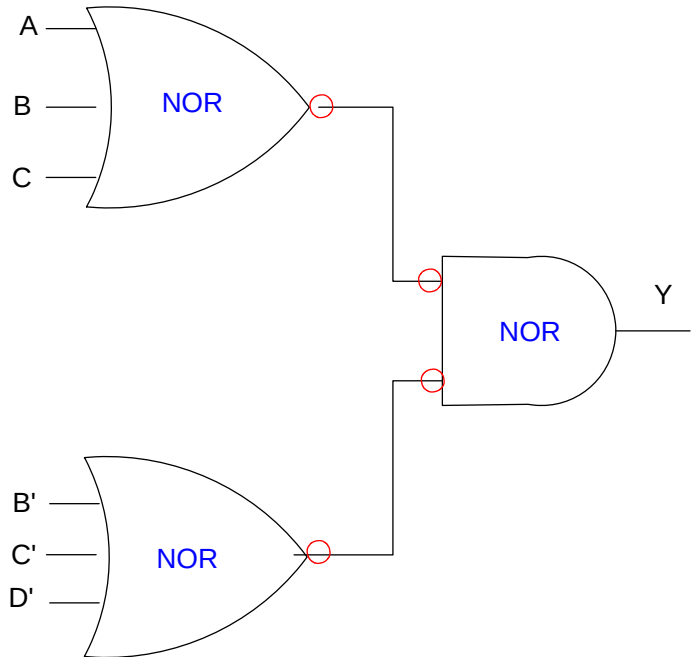
AB \ CD	00	01	11	10
00	0	0	1	1
01	1	1	0	1
11	x	x	x	x
10	1	1	x	x

$$Y' = A'B'C' + BCD$$

Use DeMorgain's theorem

$$Y = (A + B + C)(B' + C' + D')$$

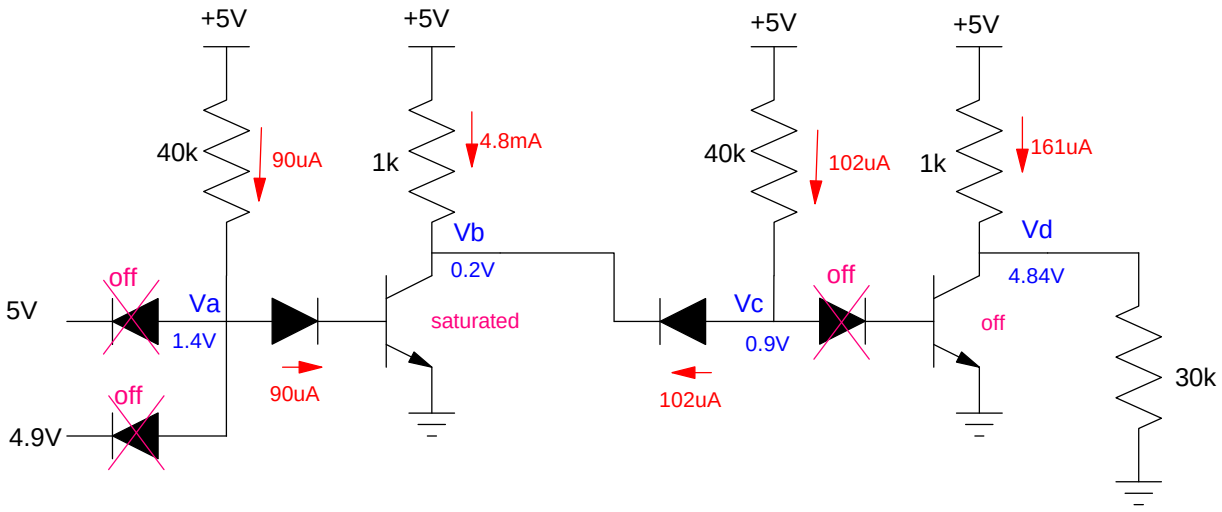
Implement with NOR gates



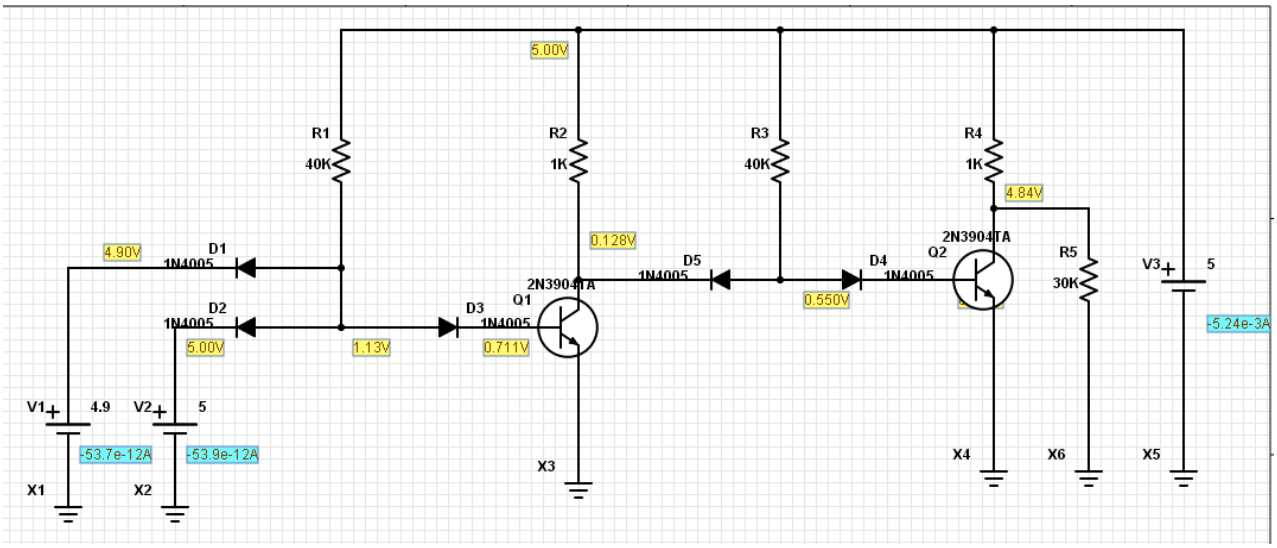
DTL Logic:

6) Determine the voltages and currents for the following DTL AND gate. Assume 3904 transistors

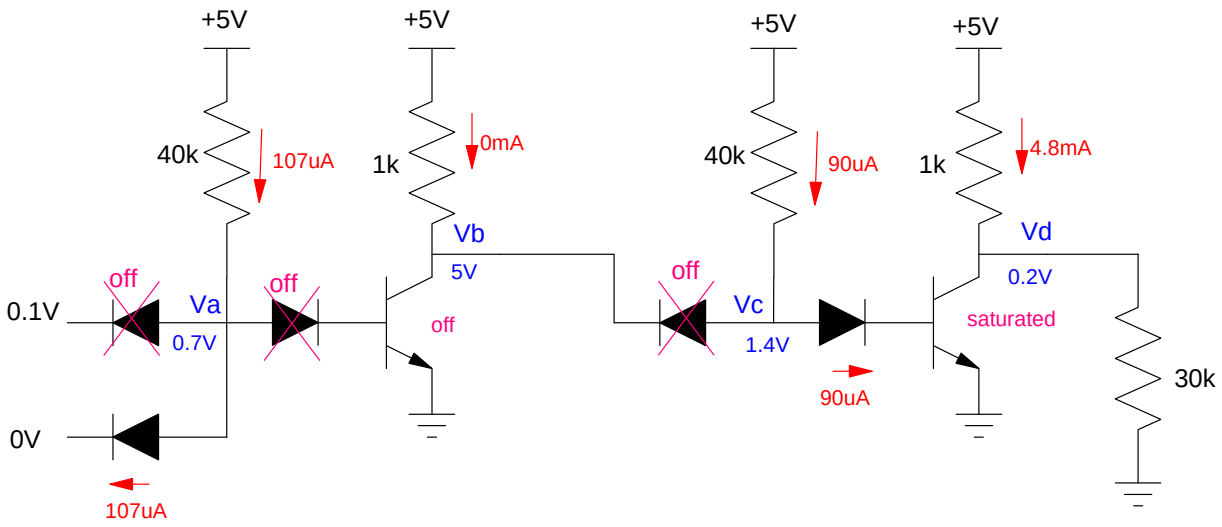
- $\beta = 200$
- $V_{ce(sat)} = 0.2V$
- $V_{be} = 0.7V$



8) Checking in PartSim



7) Determine the voltages and currents for the previous circuit when the input voltages (on the left) are 0.1V and 0.0V



8) Check your results for problem 6 and 7 using PartSim.