

# ECE 320 - Homework #5

555 Timers, Transistors used as a Switch, Schmitt Triggers. Due Monday, September 28th

Assume a 3904 transistor (NPN) and 3906 (PNP) (\$0.04 each)

$$\beta = 100 \quad \min(|V_{ce}|) = 0.2V \quad \max(I_c) = 200mA$$

Assume a thermistor with

$$R = 1000 \exp\left(\frac{3905}{T+273} - \frac{3905}{298}\right) \Omega$$

## Transistor Switch

1) For the circuit shown below

- Assume  $V_1 = 5V$ . Determine  $I_b$ ,  $I_c$ ,  $V_b$ , and  $V_c$ .
- Assume  $V_1 = 0V$ . Determine  $I_b$ ,  $I_c$ ,  $V_b$ , and  $V_c$ .

2) Using CircuitLab, determine  $\{I_b, I_c, V_b, \text{ and } V_c\}$  for

- $V_1 = 0V$
- $V_1 = 5V$

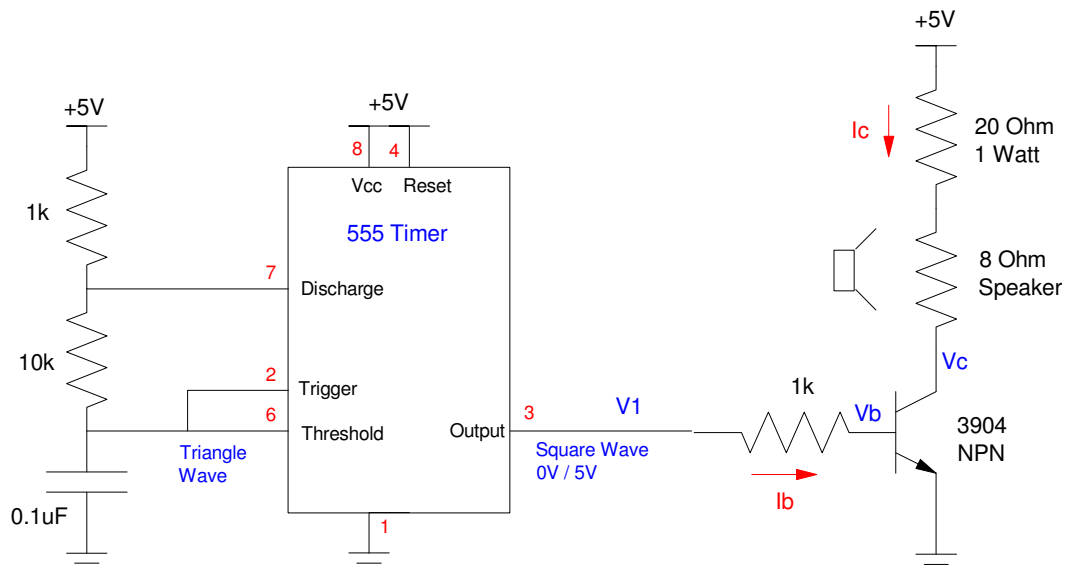
Is the transistor turning on ( $V_c = 0.2V$ ) and off ( $I_c = 0$ )?

3) Simulate the circuit with the 555 timer in CircuitLab.

- What frequency should you hear at the speaker?

4) Build this circuit with your lab kits and verify

- The frequency at  $V_1$
- That the transistor is off when  $V_1 = 0V$  (connect the 1k resistor to ground rather than the 555 timer)
- That the transistor is saturated when  $V_1 = 5V$  (connect the 1k resistor to +5V)
- That the speaker is loud and annoying (the transistor acts as an amplifier)



Circuit for problem 1 - 4

## Comparator

Add an electronic switch to turn the speaker on and off

- 5) Design a comparator (shown in blue - don't add the red resistors (they are for a Schmitt trigger) ) to
  - Turn on the speaker ( $V_2 = 5V$ ) when  $T < 40C$ , and
  - Turn off the speaker ( $V_2 = 0V$ ) when  $T > 40C$
- 6) Simulate the comparator in CircuitLab to verify the on / off temperature (or resistance or voltage)
- 7) Build this circuit and verify it's on and off temperature (or voltage or resistance. Replace R with a potentiometer for test purposes)

## Schmitt Trigger

Add an electronic switch to turn the speaker on and off

- 8) Design a Schmitt Trigger (modify section in blue) to
  - Turn on the speaker ( $V_2 = 5V$ ) when  $T < 40C$ , and
  - Turn off the speaker ( $V_2 = 0V$ ) when  $T > 45C$
- 9) Simulate the comparator in CircuitLab to verify the on / off temperature (or resistance or voltage)
- 10) Build this circuit and verify it's on and off temperature (or voltage or resistance. Replace R with a potentiometer for test purposes)

