ECE 206 Lab – NE555 and STEMTera

Challenge: 555 Timer, RC circuits review, and STEMTera

Since we will be working from home, you will not have access to the usual lab instruments. Fortunately, the STEMTera allows you to emulate some lab equipment functionality. The STEMTera is a device which combines a Arduino UNO compatible microcontroller with a breadboard and power supplies and supports the standard Arduino software: https://learn.stemtera.com/en/begin/. To start, install the recommended version of the Arduino IDE according to the instructions. Make sure you can correctly run the basic LED blink test as in the tutorial on the STEMTera website. In this lab, we will be using the STEMTera as a simple oscilloscope to plot the discharge curve of a 555 timer.

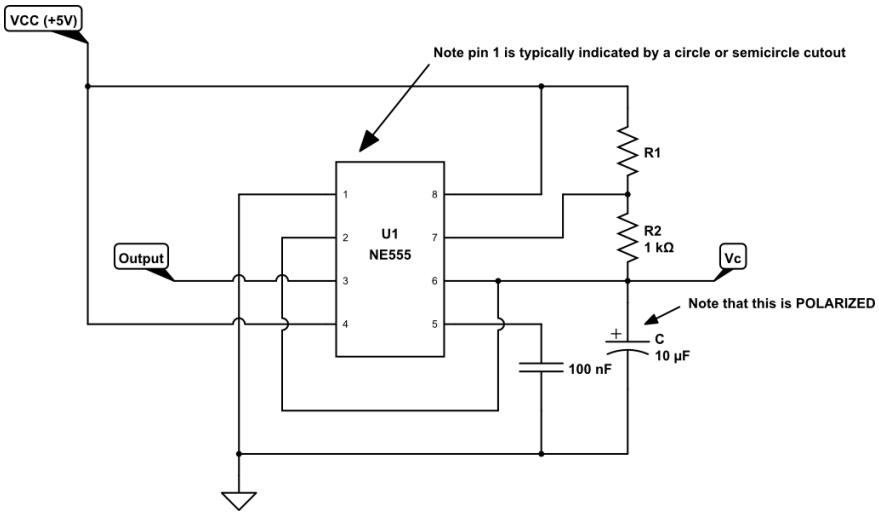
One of the oldest integrated circuits which remains popular today (40+ years after it was introduced) is the "555" timer. Try searching on "555" in Google-Images, and you will get an idea of how popular this device is.

The specific part number of 555 chip in our Kit is the LM555, and we have both Texas Instruments (LM555) and STMicroelectronics (NE555) datasheets on our Resources page on the course website.

Operation of the circuit:
The NE555 integrates the following components. First, there is an internal transistor which allows an external capacitor (denoted C) to charge and discharge. Second, there is an input called threshold to discharge the capacitor. When the voltage on the threshold surpasses .67*Vcc (where Vcc is the STEMTera 5V output), the transistor is put into discharge mode. Finally, there is an input called the trigger to charge the capacitor. When the voltage on the trigger is below .33*Vcc, the transistor is put into charge mode.

The NE555 when operating in astable multivibrator mode it works as follows:

Initially the capacitor is at 0 V. Because this is below the trigger voltage (.33*Vcc), the internal transistor in the 555 will start charging the capacitor through R1+R2. This forms an R-C circuit with C and Req=R1+R2. The capacitor continues to charge until it hits the threshold voltage (.67*Vcc), upon which time the 555 will start discharging. The discharge also forms a R-C circuit, but the Req in this case is only R2. When the capacitor has discharged to below the trigger voltage, the process repeats.



Students who took the ECE 205 lab in-person will have done a similar lab in person using the lab oscilloscopes, students who took ECE 205 lab online will have done a simulation of the NE555 timer for a lab. Please also refer to your ECE 205 lab report.

It is important to note that C (which you will use to be 10uF in this lab) is a <u>polarized</u> electrolytic capacitor. You must be sure the longer terminal (which is the + terminal) is connected to pin 6, while the shorter terminal (which has the – stripe) is connected to ground. An electrolytic capacitor which is connected in backwards <u>may explode</u> due to the electrolyte boiling off.

<u>Challenge</u>: Construct an <u>astable multivibrator</u> (oscillator) circuit and use the STEMTera to confirm/deny that R2 determines the discharge time, but R1+R2 determines the charge time.

- use fixed values for R2 (10k), and C (10μF, within 20%)
- use **<u>at least two</u>** different values for R1: 10K and 20K – you may use multiple 10K resistors for this. Record the waveform(s): $V_C(t)$ (from Pin 6, to GND), and Vout (Pin 3, to GND)
- Use the STEMTera A0 and A1 analog inputs to read $V_C(t)$ and Vout. Why do we need to use analog inputs? What would be different if we used digital inputs?

<u>Resources required for this lab</u>:

- STEMTera board
- Components required to create the astable multivibrator circuit
    - NE555 Timer chip
    - 3 * 10K resistor (R1, R2, R2')
    - .1uF capacitor (non polarized)
    - 10uF capacitor (polarized)

<u>Prelab Deliverables</u>:

- No prelab for Lab 1
- Make sure you have a working install of Arduino IDE
- Find your ECE 205 NE555 timer lab report to use as a reference

<u>Required Deliverables:</u>

- Obtain sufficient data from the STEMTera plot to be able to confirm that the discharge time depends on R2, while the charge time depends on both R1 and R2.
    - Make measurements for **<u>at least two</u>** different values of R1.
- TA signoffs (from showing your graphs - at least 4 – two sets of charge/discharge curves, and two sets of output waveforms from the oscilloscope – you can use two channels (A0 and A1) to capture output and discharge onto the same screen)