CSCI 420: Lab 2

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Abstract

This lab introduces more components and involves making more complex circuits.

1 Introduction

This lab covers basic uses of NPN transistors and capacitors. As well this lab concentrates on showing us how to make our first complex circuits. A key part of this lab was correct identification of parts as well as careful reading of the circuit diagrams.

2 Background

In this lab I learned about transistors and capacitors. Transistors are small electronic components with three terminals and act as amplifiers for current passing through them. However if there is no current going to the pin designated as the "base" (which may be different on different models) no current will pass through them. Essentially a small current passed to the base acts as a stoplight at an intersection, if there is current to the base, the "light is green" and current may pass. If there is no current, then "the light is red" and no current can pass. Transistors are prone to overload (as I nearly found out) and resistors are required to limit the current and prevent an overload. Capacitors collect and store small amounts of electrical charge and can also rapidly release that energy. With both of these I also made my first sort of complex circuits.

3 Experimental setup

Here is a list of the parts used in this experiment

Familiar parts from previous experiments

1: 2 LEDs

2: 3 10kΩ resistor

3: 1 9v battery

4: wires

New parts for this experiment

1: 2x NPN Transistors (specifically 2222a model supplied in the kit)

2: 2x 220R resistors

3: 2x 100 υF Capacitor

4 Experiments

In this lab there were four experiments. The first involved setting up a circuit using a transistor and a pair of LEDs. This one proved kind of difficult at first as I mistakenly had the 10k resistor line leading into the collector and the 220R leading into the base. This is where I nearly had an overload as almost immediately my transistor became very hot and may or may not have smoked a little. I cut the power and corrected my mistake, using a different transistor I completed the experiment, but I tested the original later and it still functioned. Experiment 2 was very simple, and I actually had no issues with it. This experiment involved making two circuits, one which served to charge a capacitor, and the second which served to test using the capacitor as a power supply. When in the first circuit, the LED in it would remain lit until the capacitor was charged, then I would move the capacitor to the second circuit, where the LED would remain lit a proportional amount of time until the capacitor was discharged. The third circuit was more difficult and took a few hours of work to get somewhat operational, but even then I only got it really working in the demo itself. This experiment involves making an LED blink through the use of a capacitor, a transistor, and the switch action of flying leads. The idea for this one was that when you left the leads apart, the light would remain on until the capacitor was charged, then the leads would be touched, allowing the capacitor to be discharged and for the light to turn on again as power could flow to the transistor's base again. Experiment four was the largest and most complex of the four but after my difficulties with three, this wasn't as bad. This experiment is essentially two of three but acting on each other. When one side is off it is because the otherside has charged its capacitor and is preventing the off side's transistor from passing current. The capacitor will discharge and then current can resume flowing with causes the opposite side's capacitor to be charged, thus turning the other side off almost immediately.

4.1 Experiment1

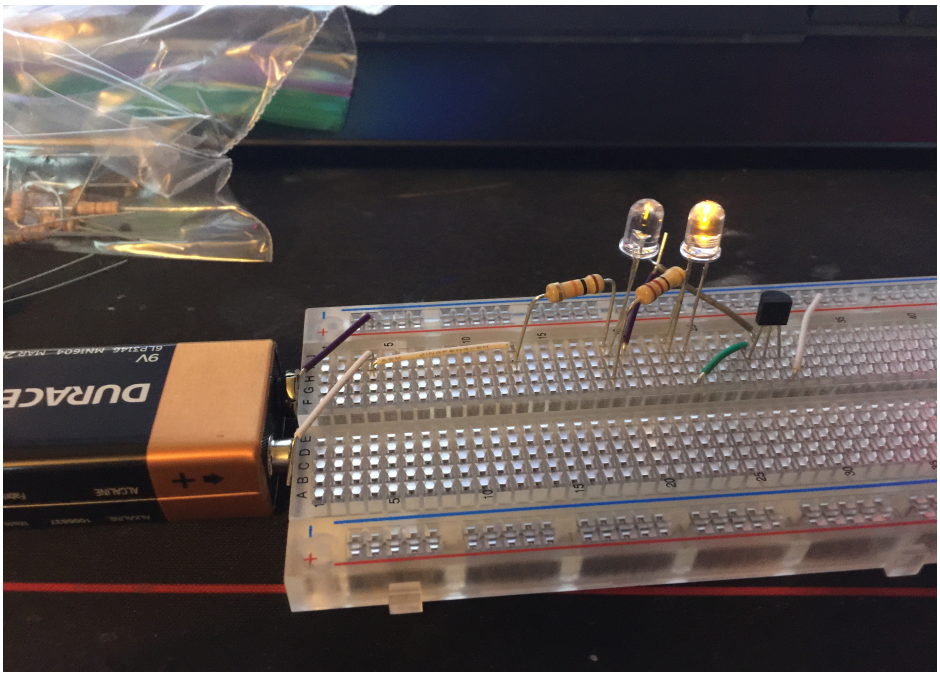

Figure 1: Photo of Experiment 1 bread board

4.1.1 Experiment 1 Questions

1) With the leads apart the transistor is recieving no current to its base, the LED on the 220R resistor is not lit, nor is the LED on the 10k because it's circuit is not complete.

2) With the leads closed the transistor is recieving current to its base, both LEDs are lit.

3) The transistor's base appears to get some current but not as much as direct contact. The LEDs are lit, but only enought to say so. I tried this with several different kinds of graphite, 2B and HB art pencils, a mechanical pencil, and a HB No. 2 pencil with somewhat varied results, but not enough to be worth documenting as none of them altered the brightness of the LED much.

4) When I hold the leads to my skin the transistor's base doesn't get any current and neither of the LEDs are lit. Theoretically they should be (had both pressed to the same finger) but it is possible that my battery is weak, I have no idea on this one.

4.2 Experiment2

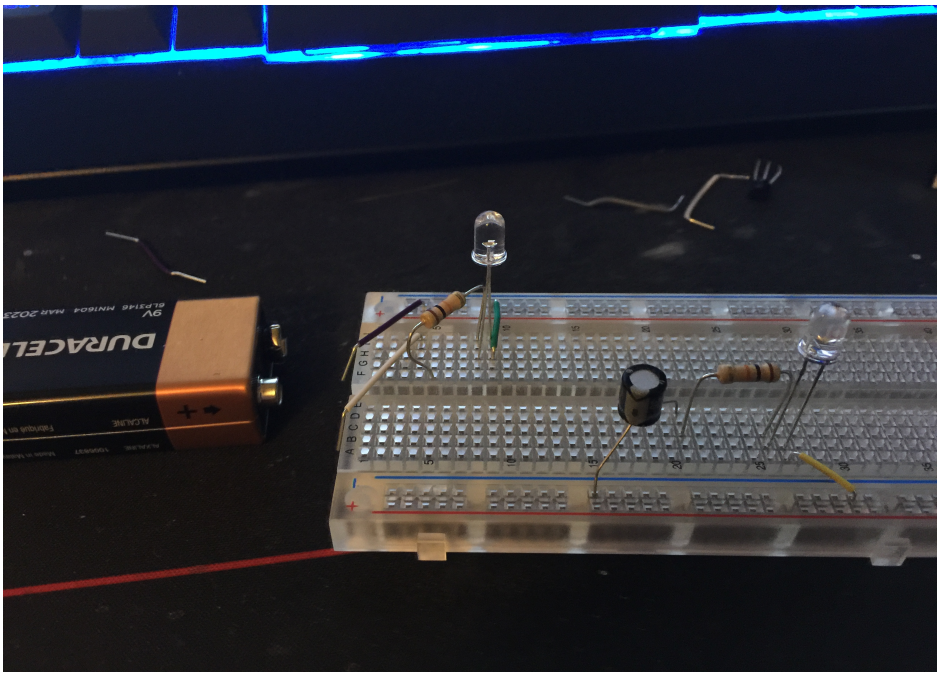

Figure 2: Photo of Experiment 2 bread board

4.2.1 Experiment 2 Questions

1) The LED on the first circuit took about 10 seconds to go ou after the battery's leads were connected to the circuit.

2) The LED went out as the capacitor became charged and current no longer flowed through it.

3) The LED on the second circuit stayed lit for about 9 seconds.

4) The transitions between LEDs being turned on and off was very gradual, taking place over several seconds.

4.3 Experiment3

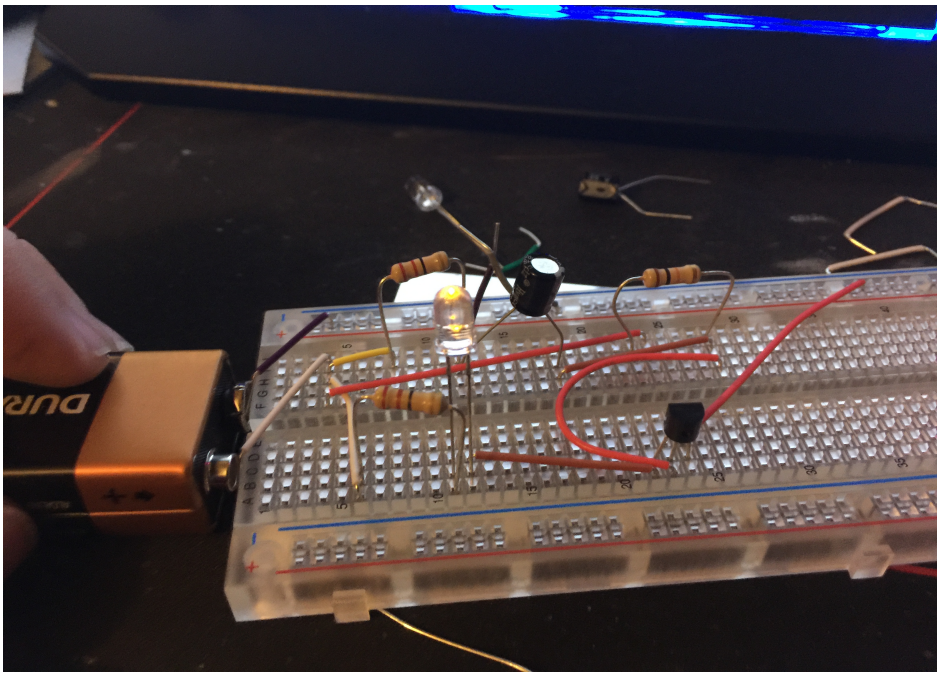

Figure 3: Photo of Experiment 3 bread board

4.3.1 Experiment 3 Questions

1) The LED is cuts off immediately and then comes back on when the leads are connected.

2) The LED stays off for several seconds, three at most, and then comes back on.

3) The timing is much shorter, only a second or two rather than upwards of ten. I would guess this is because the capacitor both isn't receiving all of the current, some will go through the 10k, and because once the leads are touched the capacitor is essentially bipassed, some current from the 10k will try to go to the capacitor, but can't charge it from that direction (or maybe the 10k charges it faster than the 220R with the capacitor eventually charging and blocking current from going that direction, I am not sure here) and after a few seconds will go to the base of the transistor, turning the LED on.

4) The LED is very bright red in this experiment, but is a pale orange after touching the leads together. My best theory on the color change is because of the amount of current reaching the LED, which tells me there is a distinct difference in how the LED reacts with different levels of current beyond growing brighter and dimmer. In earlier experiments, the LED seemed to red-shift as more current was applied (at least I think that terminology is correct).

5) The transistor is acting almost as a water tap, allowing the changes in current between when the capacitor is charged and discharged to determine the brightness of the LED. The best theory I have is that the greater the current applied to the LED, the greater the "red shift" of it, which can be seen in some of my pictures. In some the LED is a pale yellow or orange (which seems to be the low power state) and in others it is a bright almost cherry red. In this case, when the LED is orange, like after the leads have been connected and the light has come back on, less current is reaching the LED than when they are unconnected and it is bright red.

4.4 Experiment4

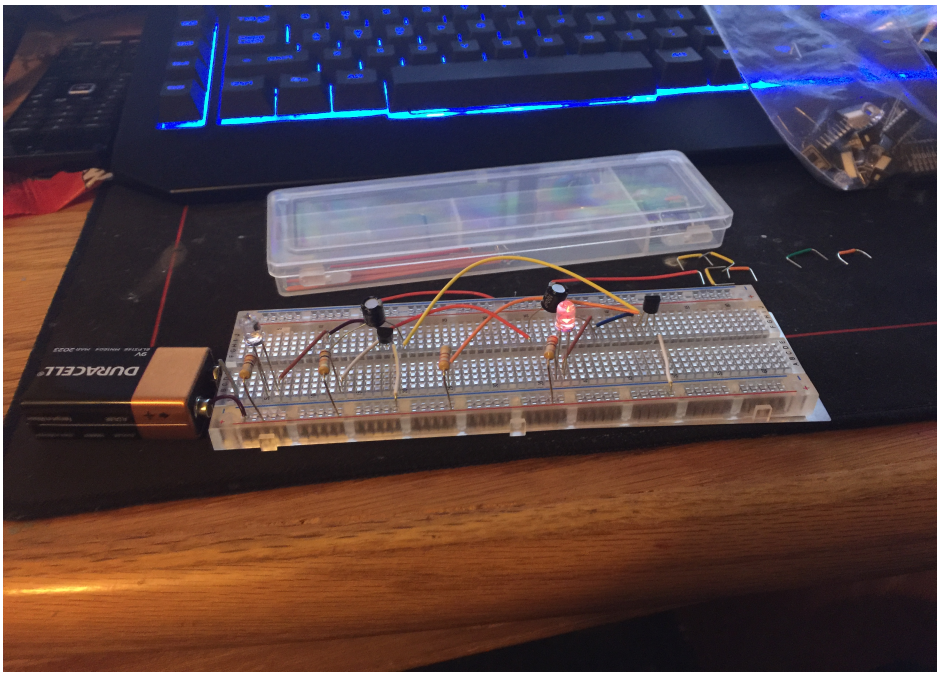

Figure 4: Photo of Experiment 4 bread board

4.4.1 Experiment 4 Questions

1) No, only one light at a time can be on because the capacitor attached to the lit LED is still charging and is preventing current from the 10k past the capacitor from reaching the base of the transistor of the other light due it its charging. Once the capacitor is charged, it prevents further current from flowing through it from the LED and forces the 10k to provide current to the base of the transistor, allowing the other LED to be lit while the capacitor is discharged into the base as well.

2) Each light only stays on for a second and it comes from the charge time of the capacitors.

3) It changes the charge time of the nearer capacitor, shortening it, making the LED conencted to that capacitor blink faster.