PH435 Lab 5

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1. Simple Square Pulse Generator

The following circuit was used to generate the square waves. The mismatched values were due to unavailability of matching capacitors. Resistors were adjusted accordingly. The time period is simply proportional to the capacitors and resistors connected together.

$$T = 0.69RC \tag{1}$$

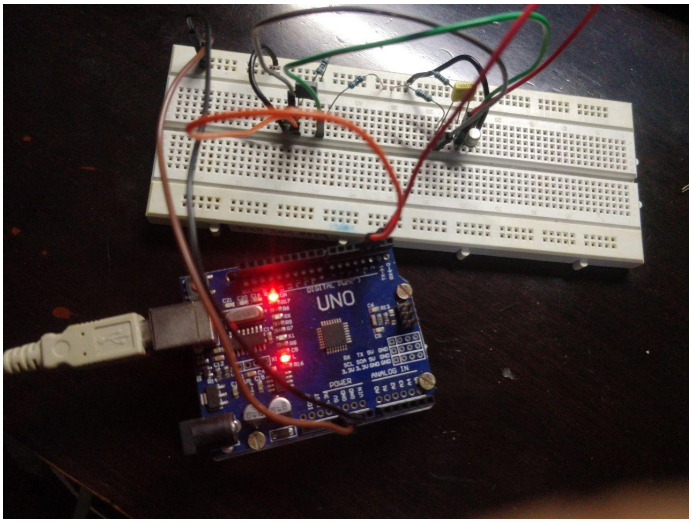

Figure 1: Connected Arduino

The circuit simulation is as in Figure 3

2. Average speed of a motor

Code works, see Figure 6. I observed a frequency of about **663 Hz**, which is reasonably close to the expected 720Hz from simulation.

The state transition diagram is as follows

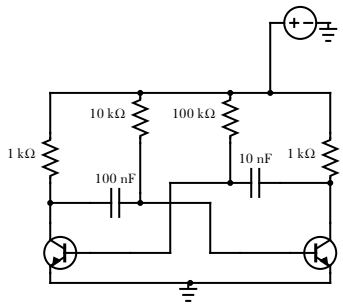

Figure 2: Oscillator

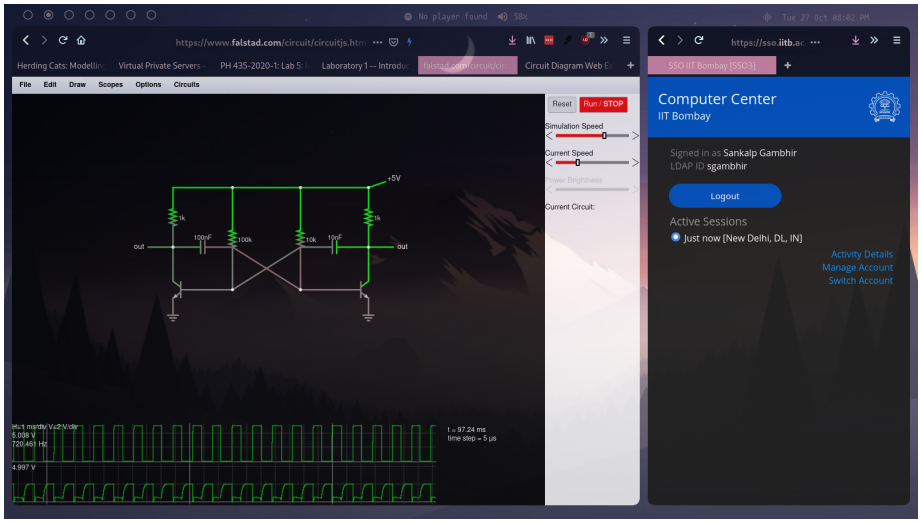

Figure 3: Circuit Simulation

3. Double speedmeter that also measures phase

Code uploaded is in the appendix. I measured the time difference between the two outputs from the square wave generator, flipped version of each other. The time difference observed, $740\,\mu s$ is in agreement with the expected value of $757\,\mu s$ as per the observed frequency in Part 2.

The state diagram is as follows

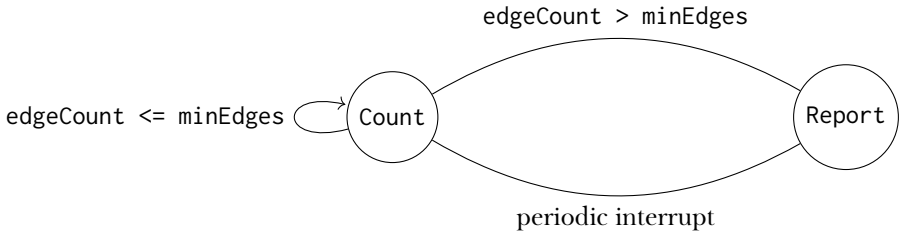

Figure 4: State Diagram for Frequency Measuring

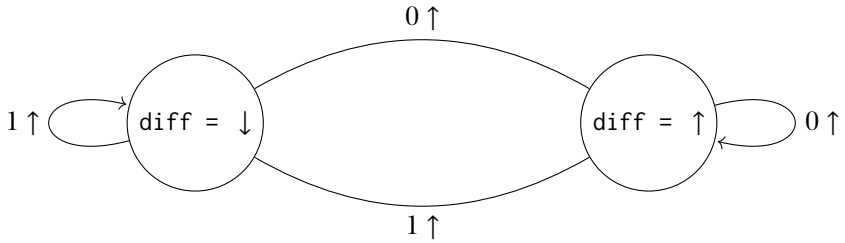

Figure 5: State Diagram for Phase Measuring

Appendix

I log in, therefore I am See Figure 6. **Measuring frequency**

The code uploaded to the arduino for measuring the frequency of an input square pulse train.

```
/*
Lab 5
Interrupt based DSO
*/

#include "TimerOne.h"

#define InPin(x) 3-x

// Declaring global variables
volatile float freq;
volatile int edgeCount;
long long int dt;
const int measureTime = 5000;
const int minEdges = 5000;
const int outTime = 500;

// functions
void checkFreq();

void setup() {

  Serial.begin(9600); // why not

  Timer1.initialize(measureTime);
  Timer1.attachInterrupt(checkFreq);
```

```

  pinMode(InPin(0), INPUT);
  pinMode(InPin(1), INPUT);

  attachInterrupt(digitalPinToInterrupt(InPin(0)),
                  [](void){edgeCount++;},
                  FALLING);

  freq = dt = edgeCount = 0;
}

void loop() {
    Serial.println(edgeCount);
    delay(outTime);
}

void checkFreq(){
  dt += measureTime/1000.0;
  if(edgeCount >= minEdges){
    freq = (edgeCount*1000.0)/(double)dt;
    edgeCount = 0;
    dt = 0;
  }
}
```

Measuring time difference

The code uploaded to the arduino for measuring the time difference between two edges.

```
/*
Lab 5.420
Delay measuring with interrupts
*/

#include "TimerOne.h"

#define InPin(x) 3-x

// Declaring global variables
long long dt;
long long diffMax;
const int measureTime = 10;

// functions
void phaseCheck();

void setup() {

  Serial.begin(9600); // why not

  Timer1.initialize(measureTime);
  Timer1.attachInterrupt(phaseCheck);

  pinMode(InPin(0), INPUT);
  pinMode(InPin(1), INPUT);

  attachInterrupt(digitalPinToInterrupt(InPin(0)),
                  [](void){edgeCount++;},
                  FALLING);
```

```

  attachInterrupt(digitalPinToInterrupt(InPin(0)),
                  [](void){diff = 1;},
                  FALLING); // edge counting
  attachInterrupt(digitalPinToInterrupt(InPin(1)),
                  [](void){diff = 0;},
                  FALLING);

  dt = diff = diffMax = 0;
}

void loop() {
    Serial.print("Max delay measured");
    Serial.print(diffMax);
    Serial.print(" uS\n");
}

void setup() {// put your setup code here, to run once:
  Serial.begin(9600);
  Timer1.initialize(t_period);
  Timer1.attachInterrupt(phase_detect);
  attachInterrupt(digitalPinToInterrupt(input_pin_1), [](){diff = 1;}, FALLING); //
    interrupt
  attachInterrupt(digitalPinToInterrupt(input_pin_2), [](){diff = 0;}, FALLING); //
    interrupt
  pinMode(input_pin_1, INPUT);
  pinMode(input_pin_2, INPUT);
  diff_count = 0;
  del_t = 0;

}

void loop() {
    Serial.print(diffMax);
    Serial.println(" uS");
    delay(output_period);

}

void checkPhase(){
  if( diff == 1 ){
    dt += measureTime;
  }
  if ( (diff == 0) && (del_t != 0) ){
    diffMax = diffMax > dt ? diffMax : dt;
    dt = 0;
  }

}
```

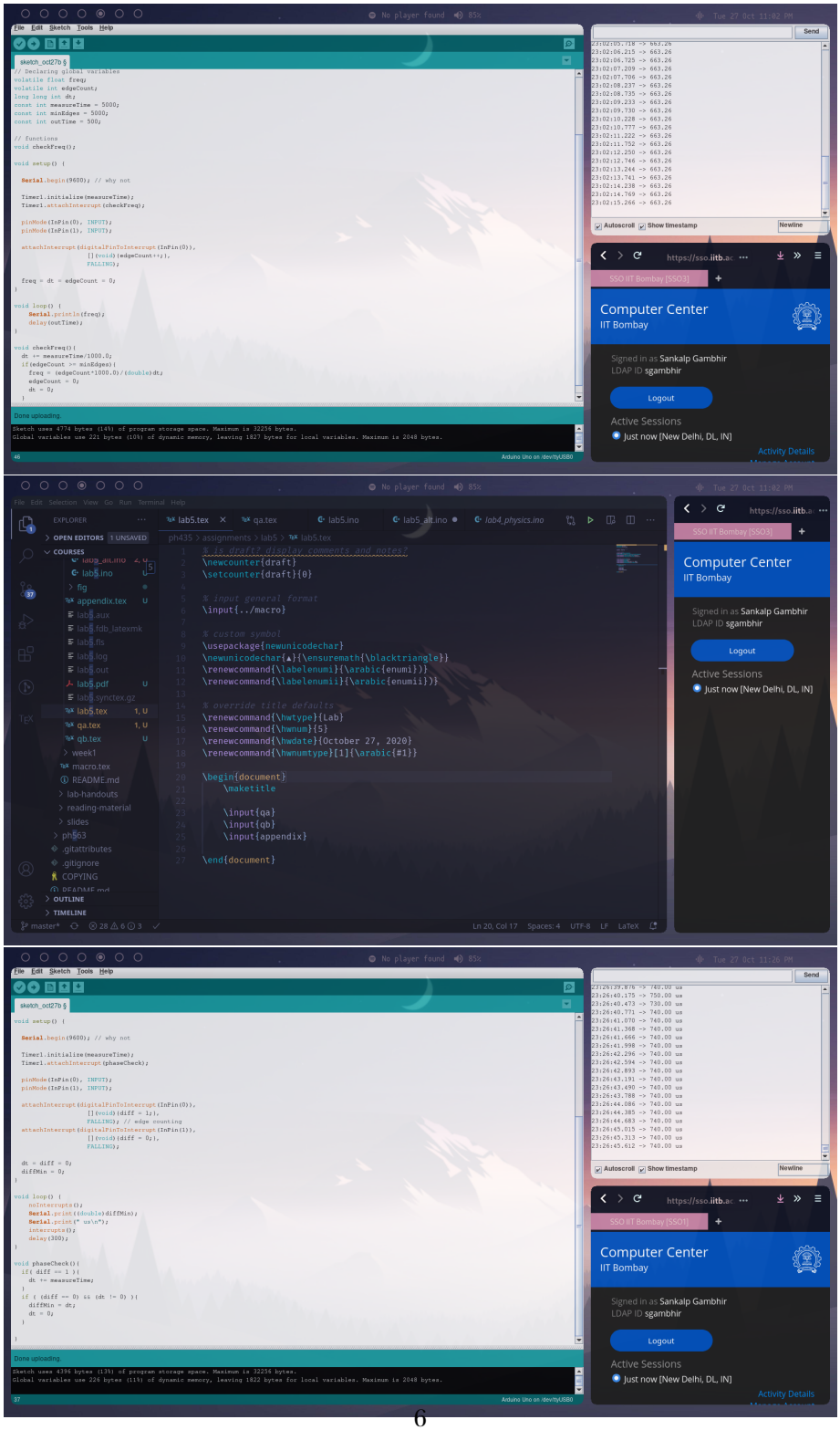

Figure 6: Me logged in, with results