MICROCRONTROLLER

Milestone 1

Task 1-5

Documentation
https://github.com/MoeezMufti/Microcontroller--Moeez-Mufti

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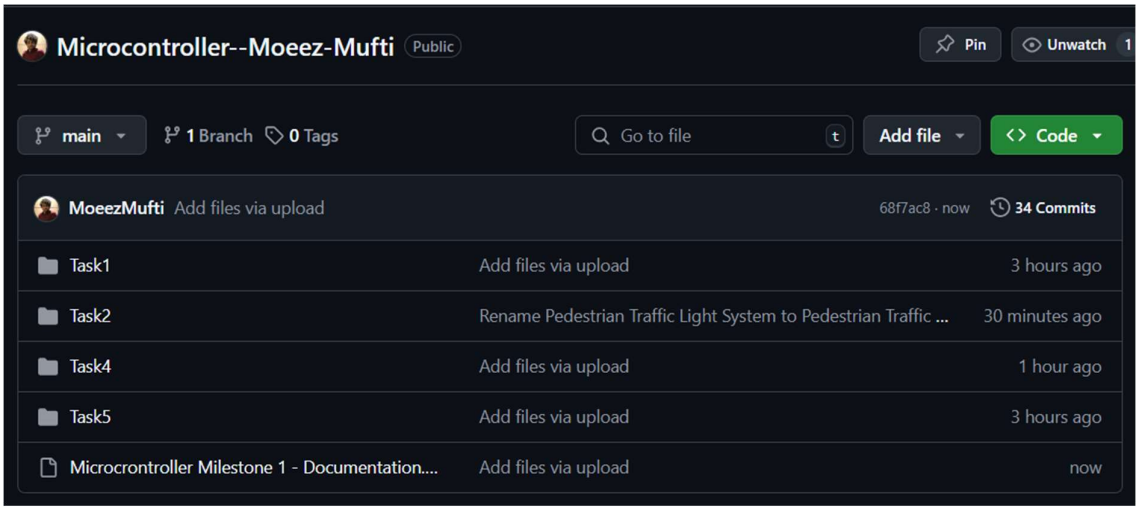
GitHub:

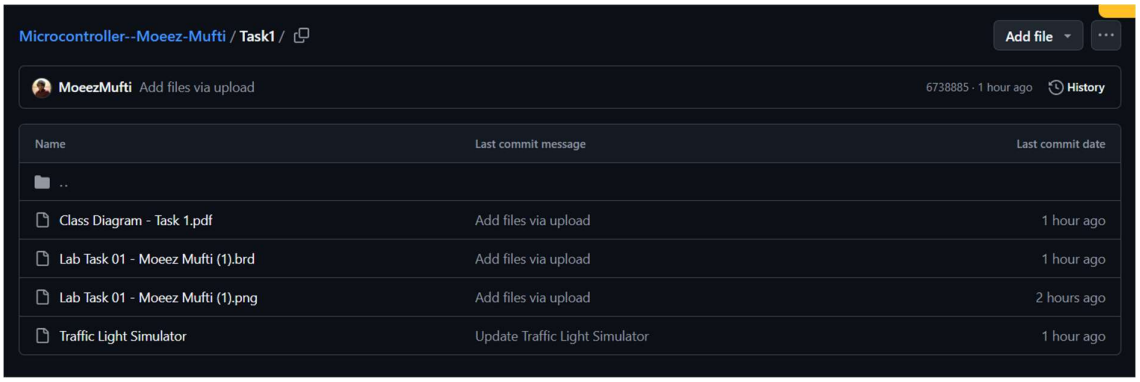
Link:

https://github.com/MoeezMufti/Microcontroller--Moeez-Mufti

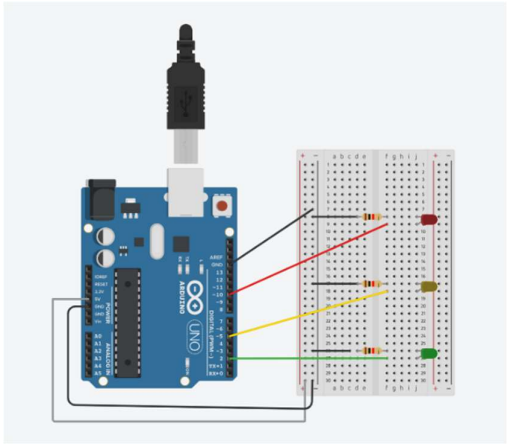


Task 1

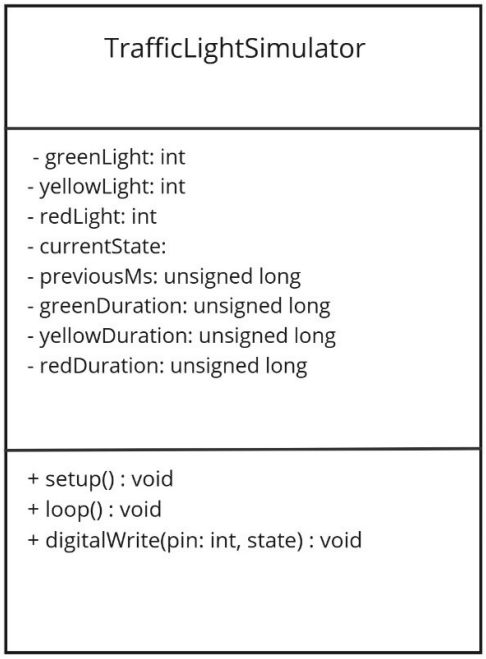
GitHub:



TinkerCAD Simulation:



State Machine Diagram:



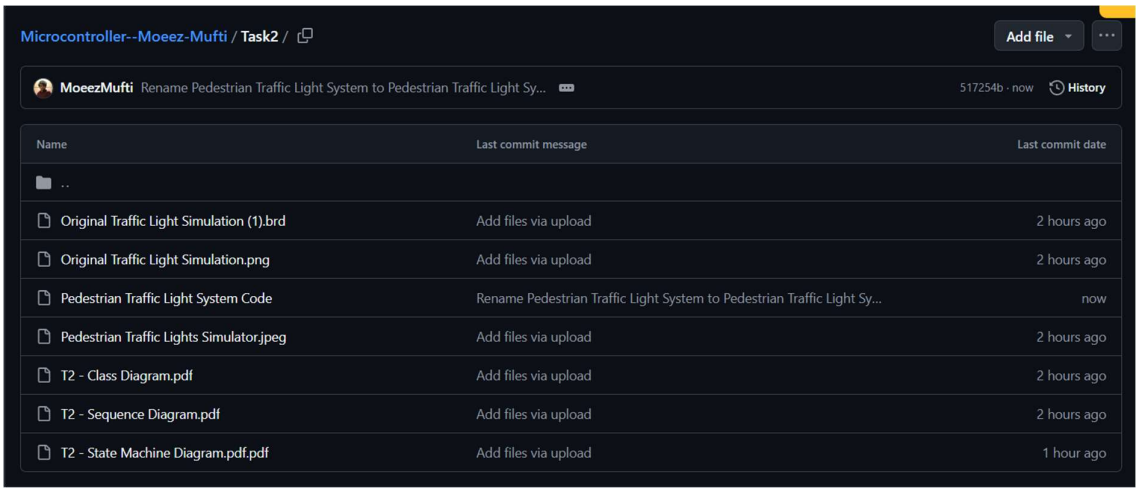
Code:

```
// Pin delegations
const int greenLight = 2;
const int yellowLight = 3;
const int redLight = 4;

// State definitions
enum TrafficState { Green, Yellow, Red };
TrafficState currentState = Green;

/*setting durations as constant so that they
don't change with with other condition*/
unsigned long previousMs = 0;
const unsigned long greenDuration = 10000; //in ms
const unsigned long yellowDuration = 3000;
const unsigned long redDuration = 5000;

void setup() {
  // Set variables to their modes
  pinMode(greenLight, OUTPUT);
  pinMode(yellowLight, OUTPUT);
  pinMode(redLight, OUTPUT);

  // System always comes back to Green Light
  digitalWrite(greenLight, HIGH);
```

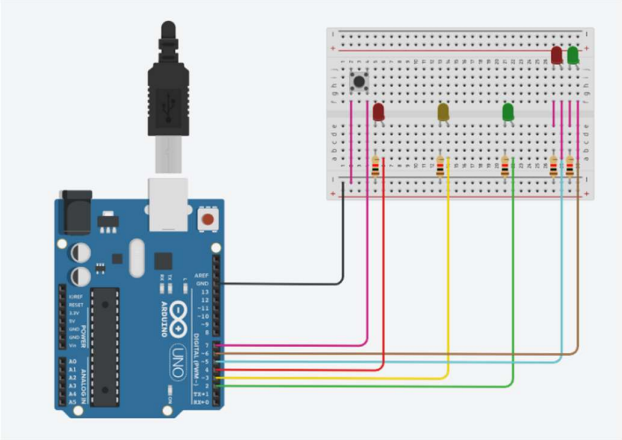
```
  previousMs = millis(); //tells how much ms has passed since beginning
}
void loop() {
  unsigned long currentMs = millis();

  switch (currentState) {
    case Green:
      // Green light is on for 10s
      if (currentMs - previousMs >= greenDuration) {
        //how much time has passed from beginning to current
        digitalWrite(greenLight, LOW);
        digitalWrite(yellowLight, HIGH);
        currentState = Yellow;
        previousMs = currentMs;
      }
      break;

    case Yellow:
      // Yellow light is on for 3s
      if (currentMs - previousMs >= yellowDuration) {
        digitalWrite(yellowLight, LOW);
        digitalWrite(redLight, HIGH);
        currentState = Red;
        previousMs = currentMs;
      }
      break;

    case Red:
      // Red light is on for 5s
      if (currentMs - previousMs >= redDuration) {
        digitalWrite(redLight, LOW);
        digitalWrite(greenLight, HIGH);
        currentState = Green;
        previousMs = currentMs;
      }
      break;
  }
}
```

Task 2

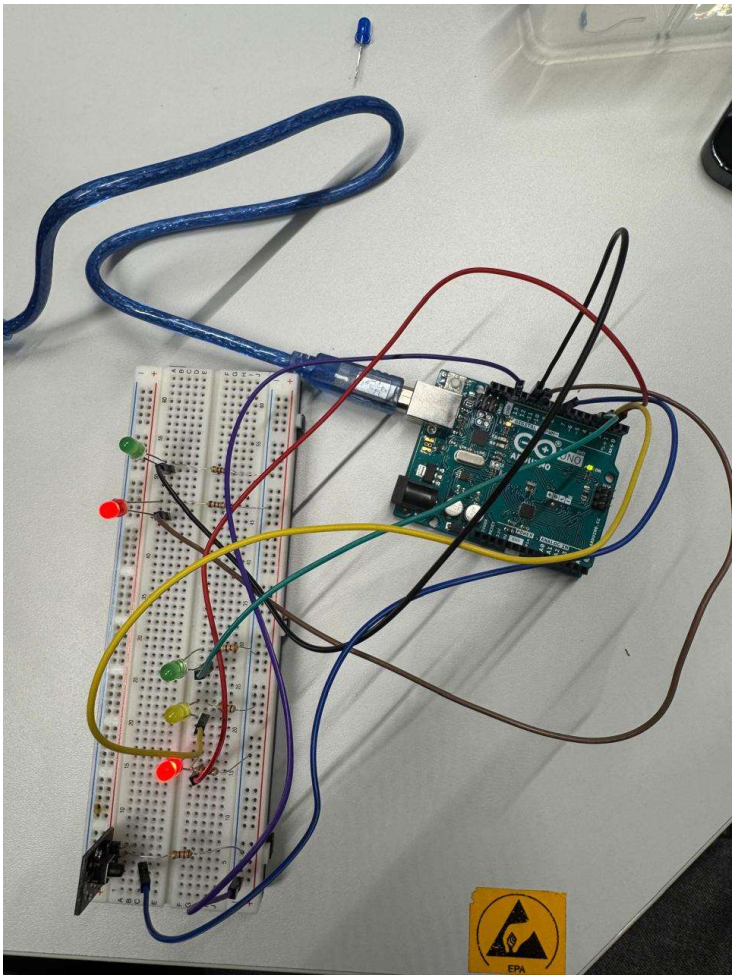
GitHub:



TinkerCAD Simulation:



Physical Simulation:

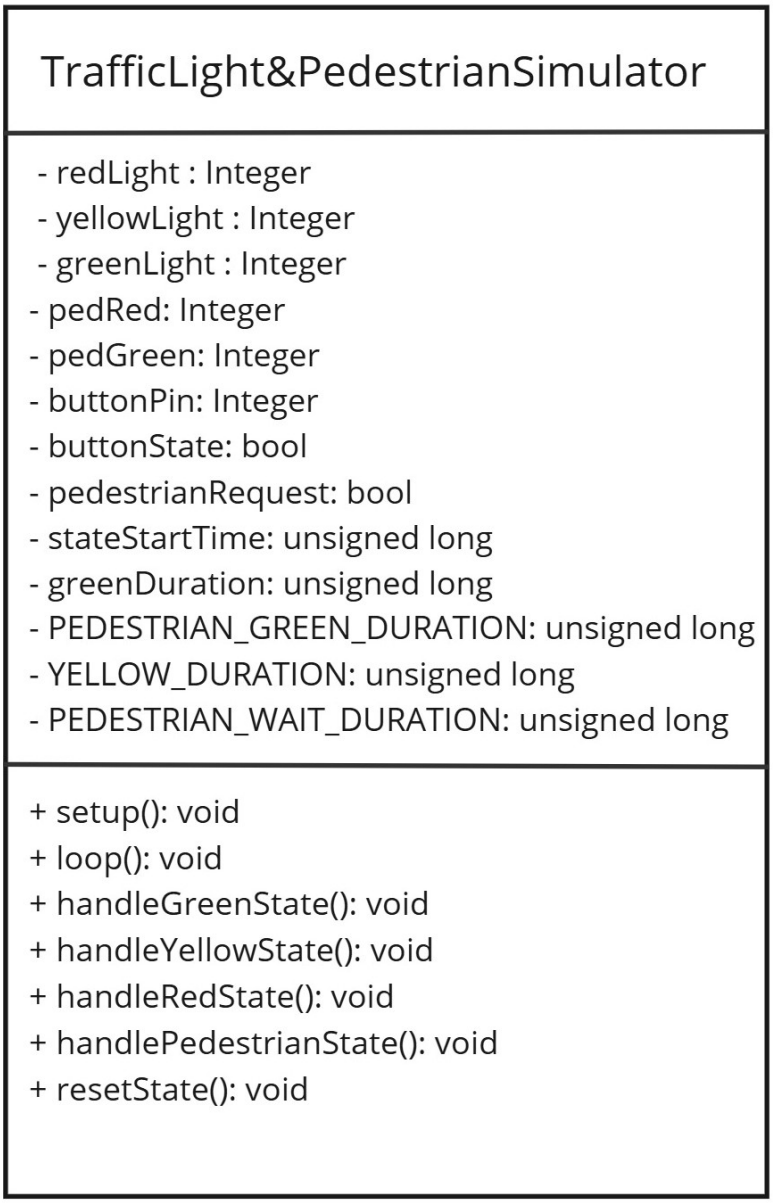


Code:

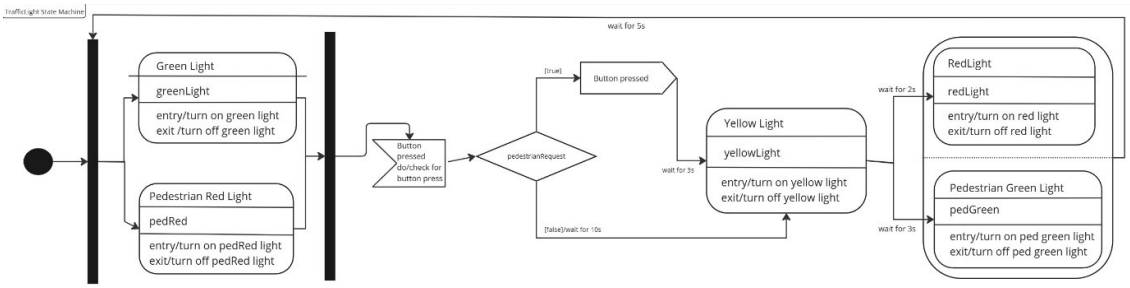
```
// Pin definitions
const int greenLight = 2;
const int yellowLight = 3;
const int redLight = 4;
const int pedRed = 5;
const int pedGreen = 6;
const int button = 7;

// State definitions
enum TrafficState { GREEN, YELLOW, RED, RESET };
TrafficState currentState = GREEN;

//setting timer to zero for initi setup and button to false
unsigned long greenTimer = 0;
bool buttonPressed = false;

void setup() {
  // Set pin AND modes
  pinMode(greenLight, OUTPUT);
  pinMode(yellowLight, OUTPUT);
  pinMode(redLight, OUTPUT);
  pinMode(pedRed, OUTPUT);
  pinMode(pedGreen, OUTPUT);
  pinMode(button, INPUT_PULLUP);

  // Always start and loop back to Green
  digitalWrite(greenLight, HIGH);
  digitalWrite(pedRed, HIGH);
  greenTimer = millis();
}

void loop() {
  // Check whether or not the button is pressed
  if (digitalRead(button) == LOW) {
    buttonPressed = true;
  }

  // State machine for traffic light control
  switch (currentState) {
    case GREEN:
      // Stay in GREEN state until 10 seconds pass or button is pressed
      if ((buttonPressed && digitalRead(greenLight) == HIGH) ||
          (millis() - greenTimer >= 10000)) {
        if (buttonPressed) {
          delay(3000);  // Green light will stay on for 3s after button press
        }
        currentState = YELLOW;
```

```
      }
      break;

    case YELLOW:
      digitalWrite(greenLight, LOW);
      digitalWrite(yellowLight, HIGH);
      delay(2000);
      digitalWrite(yellowLight, LOW);
      currentState = RED;
      break;

    case RED:
      // Red light and pedestrian crossing sequence
      digitalWrite(redLight, HIGH);
      digitalWrite(pedRed, LOW);
      digitalWrite(pedGreen, HIGH);
      delay(5000);
      currentState = RESET;
      break;

    case RESET:
      // Reset to initial state
      digitalWrite(pedGreen, LOW);
      digitalWrite(pedRed, HIGH);
      digitalWrite(redLight, LOW);
      digitalWrite(greenLight, HIGH);
      buttonPressed = false;
      greenTimer = millis();
      currentState = GREEN;
      break;
  }
}
```

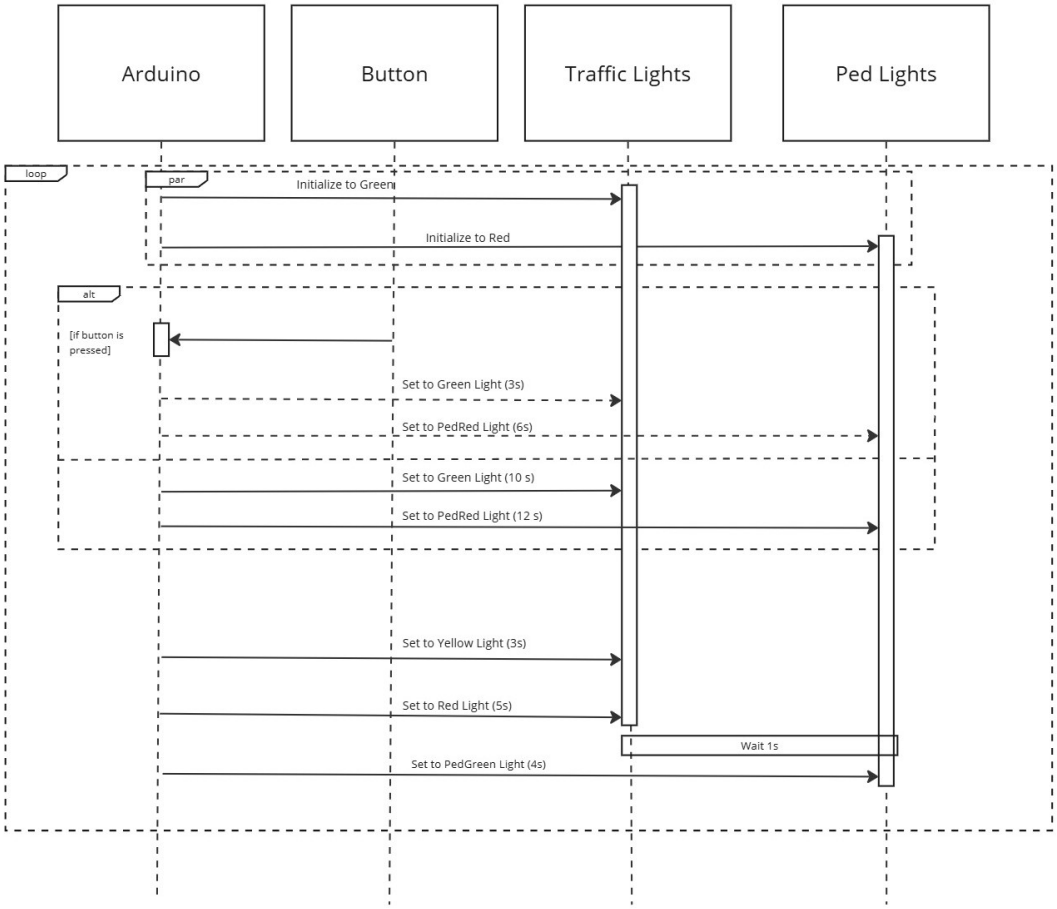
Class Machine Diagram:



State Machine:

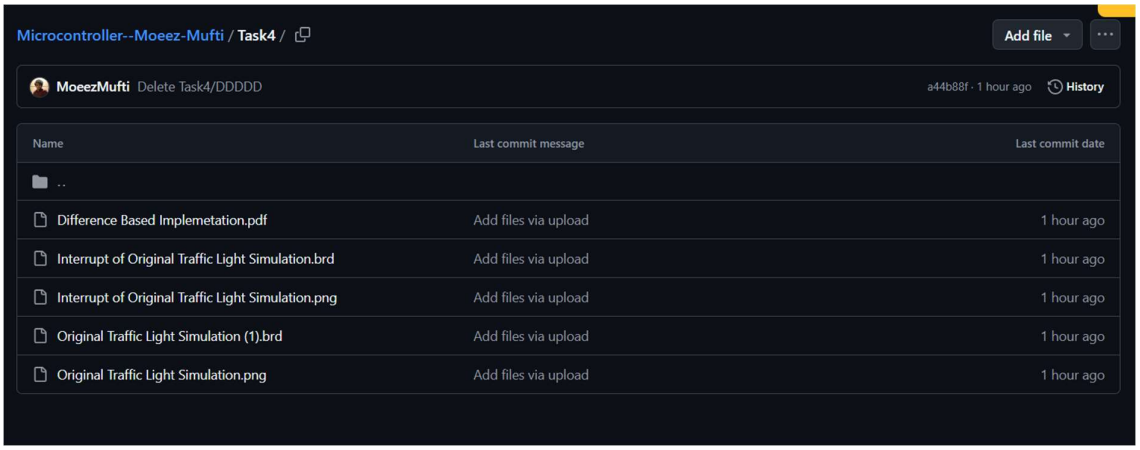


Sequence Diagram:

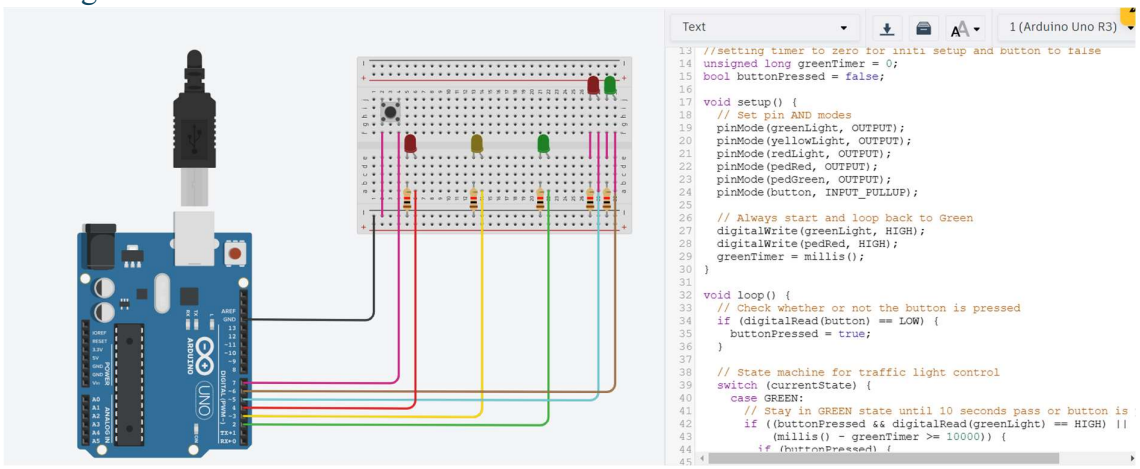


Task 4:

Github:

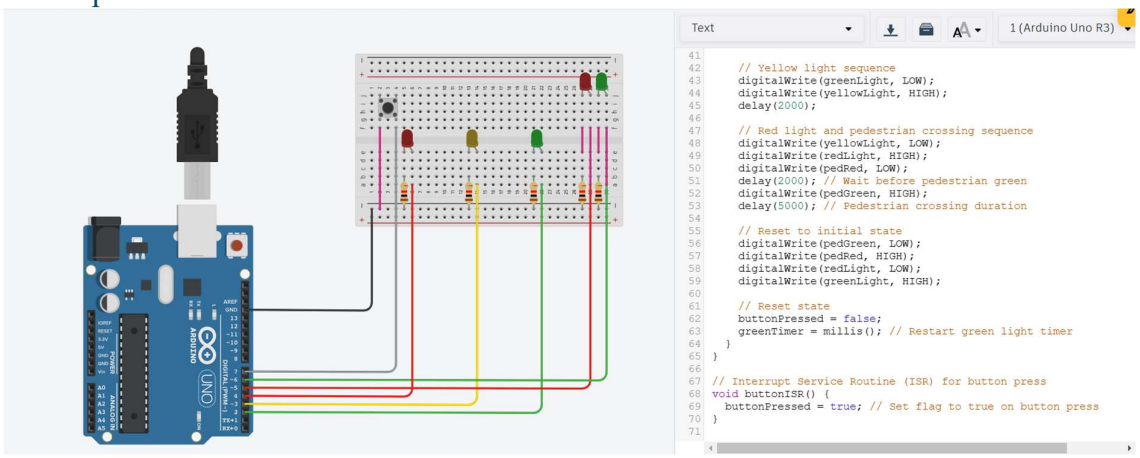


Polling-Based:



```
//setting timer to zero for initi setup and button to false
unsigned long greenTimer = 0;
bool buttonPressed = false;

void setup() {
  // Set pin AND modes
  pinMode(greenLight, OUTPUT);
  pinMode(yellowLight, OUTPUT);
  pinMode(redLight, OUTPUT);
  pinMode(pedRed, OUTPUT);
  pinMode(pedGreen, OUTPUT);
  pinMode(button, INPUT_PULLUP);

  // Always start and loop back to Green
  digitalWrite(greenLight, HIGH);
  digitalWrite(pedRed, HIGH);
  greenTimer = millis();
}

void loop() {
  // Check whether or not the button is pressed
  if (digitalRead(button) == LOW) {
    buttonPressed = true;
  }

  // State machine for traffic light control
  switch (currentState) {
    case GREEN:
      // Stay in GREEN state until 10 seconds pass or button is
      if ((buttonPressed && digitalRead(greenLight) == HIGH) ||
          (millis() - greenTimer >= 10000)) {
        if (buttonPressed) {
```

Interrupt-based:

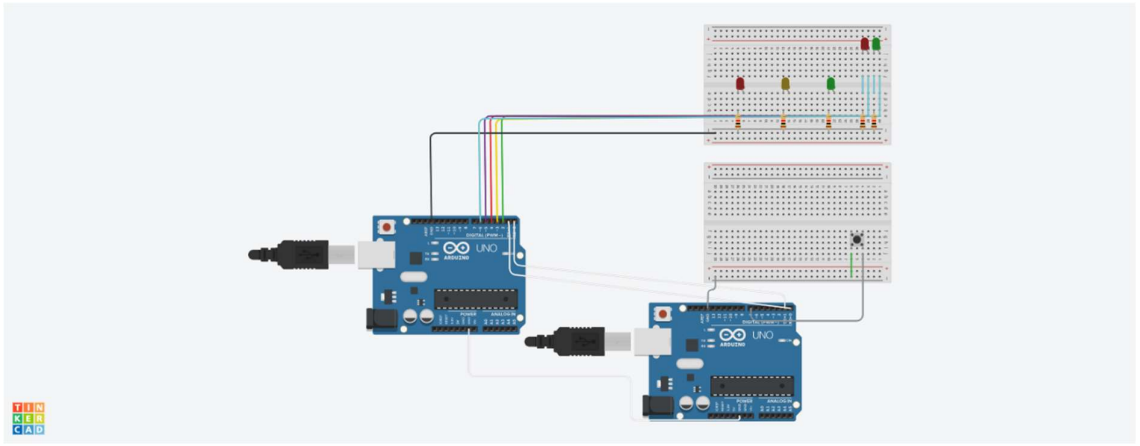


```
    // Yellow light sequence
    digitalWrite(greenLight, LOW);
    digitalWrite(yellowLight, HIGH);
    delay(2000);

    // Red light and pedestrian crossing sequence
    digitalWrite(yellowLight, LOW);
    digitalWrite(redLight, HIGH);
    digitalWrite(pedRed, LOW);
    delay(2000); // Wait before pedestrian green
    digitalWrite(pedGreen, HIGH);
    delay(5000); // Pedestrian crossing duration

    // Reset to initial state
    digitalWrite(pedGreen, LOW);
    digitalWrite(pedRed, HIGH);
    digitalWrite(redLight, LOW);
    digitalWrite(greenLight, HIGH);

    // Reset state
    buttonPressed = false;
    greenTimer = millis(); // Restart green light timer
  }
}

// Interrupt Service Routine (ISR) for button press
void buttonISR() {
  buttonPressed = true; // Set flag to true on button press
}
```

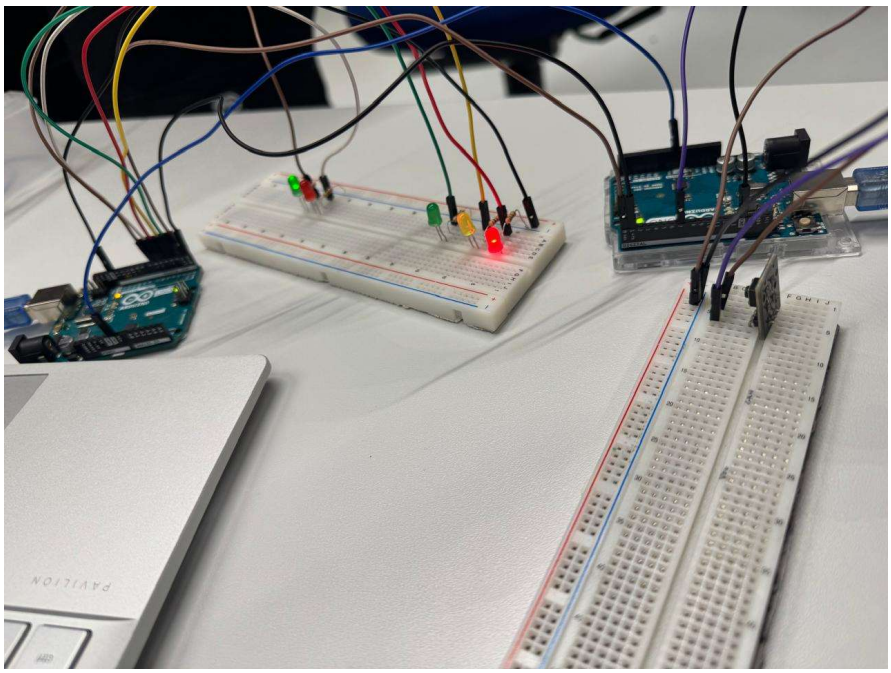
Task 5

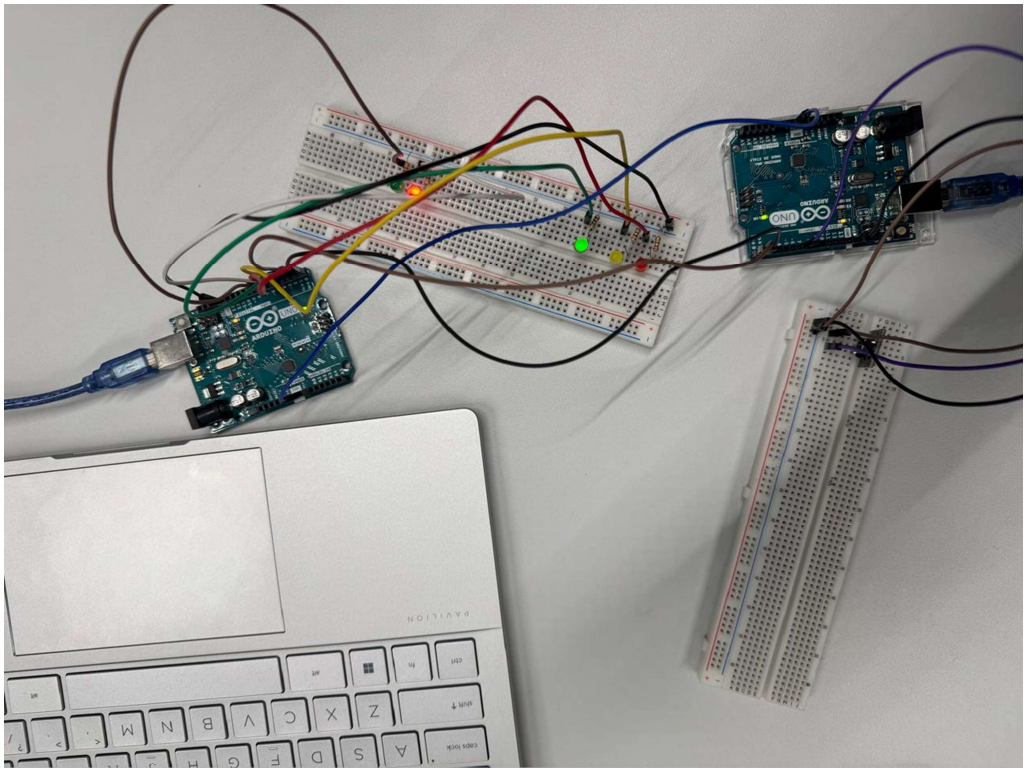
GitHub:

TinkerCAD Simulation:



Physical Simulation:





Code:

Master Code (Pedestrian Button):

```
const int buttonPin = 7;
int buttonState = 0;

void setup() {
  Serial.begin(9600); // Start serial communication
  pinMode(buttonPin, INPUT_PULLUP); // Use internal pull-up resistor for the
button
}

void loop() {
  buttonState = digitalRead(buttonPin);

  if (buttonState == LOW) { // if Button is pressed
    Serial.println(1); // Send signal "1" to the Slave to communicate
    delay(500); // Debounce delay
  }
}
```

Slave Code (Traffic Lights):

```
const int greenLight = 2;
const int yellowLight = 3;
const int redLight = 4;
const int pedRed = 5;
const int pedGreen = 6;

enum TrafficState { GREEN, YELLOW, RED, PEDESTRIAN, RESET };
TrafficState currentState = GREEN;

bool pedestrianRequest = false;
unsigned long stateStartTime = 0;
unsigned long greenDuration = 10000;  // Default green light duration
const unsigned long PEDESTRIAN_GREEN_DURATION = 5000; //ms
const unsigned long YELLOW_DURATION = 3000;
const unsigned long PEDESTRIAN_WAIT_DURATION = 1000;

void setup() {
  Serial.begin(9600);
  pinMode(greenLight, OUTPUT);
  pinMode(yellowLight, OUTPUT);
  pinMode(redLight, OUTPUT);
  pinMode(pedRed, OUTPUT);
  pinMode(pedGreen, OUTPUT);

  // Start with green light and pedestrian red
  digitalWrite(greenLight, HIGH);
```

```
  digitalWrite(pedRed, HIGH);
  stateStartTime = millis();
}

void loop() {
  // Check for pedestrian request via serial input
  if (Serial.available() > 0) {
    char signal = Serial.read();
    if (signal == '1') {
      pedestrianRequest = true;
      // Adjust green duration to extend by 3 seconds from the moment of
button press
      unsigned long currentTime = millis();
      if (currentTime - stateStartTime < greenDuration - 3000) {
        greenDuration = (currentTime - stateStartTime) + 3000;
      }
    }
  }

  unsigned long currentTime = millis();

  switch (currentState) {
    case GREEN:
      if (currentTime - stateStartTime >= greenDuration) {
        currentState = YELLOW;
        stateStartTime = currentTime;
      }
      break;

    case YELLOW:
      digitalWrite(greenLight, LOW);
      digitalWrite(yellowLight, HIGH);
      if (currentTime - stateStartTime >= YELLOW_DURATION) {
        digitalWrite(yellowLight, LOW);
        digitalWrite(redLight, HIGH);
        currentState = RED;
        stateStartTime = currentTime;
      }
      break;

    case RED:
      // Handle pedestrian request in RED state
      if (pedestrianRequest) {
        if (currentTime - stateStartTime >= PEDESTRIAN_WAIT_DURATION) {
          digitalWrite(pedRed, LOW);
          digitalWrite(pedGreen, HIGH);
          currentState = PEDESTRIAN;
          stateStartTime = currentTime;
```

```
        }
      } else {
        currentState = RESET;
        stateStartTime = currentTime;
      }
      break;

    case PEDESTRIAN:
      if (currentTime - stateStartTime >= PEDESTRIAN_GREEN_DURATION) {
        digitalWrite(pedGreen, LOW);
        digitalWrite(pedRed, HIGH);
        pedestrianRequest = false; // Reset pedestrian request
        currentState = RESET;
        stateStartTime = currentTime;
      }
      break;

    case RESET:
      digitalWrite(redLight, LOW);
      digitalWrite(greenLight, HIGH);
      greenDuration = 10000; // Reset green duration to default timing
      currentState = GREEN;
      stateStartTime = currentTime;
      break;
  }
}
```