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Lab Report:	lab 5
Course Name:	Conputer Architecture
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TASK : A

Task A — Coding: Use one button to cycle through LED modes (display the current state on the OLED):

1. Both OFF
2. Alternate blink
3. Both ON
4. PWM fade Use the second button to reset to OFF.

Link:

https://wokwi.com/projects/445861635944420353

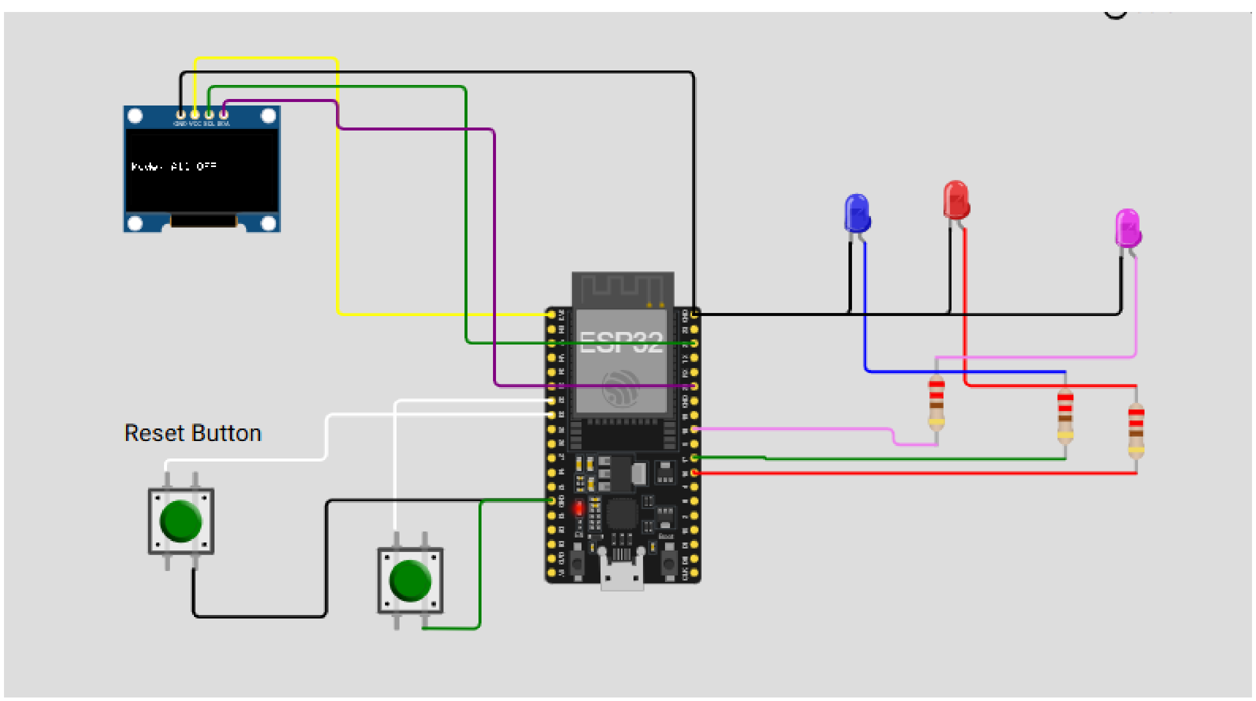
CODE:

```
//Assignment 1 Part A

//button to cycle through LED modes

//Embeded IOT FALL -2025

// Muhammad Umair Butt                    //REG 23-NTU-CS-1076

#include <Wire.h>

#include <Adafruit_GFX.h>

#include <Adafruit_SSD1306.h>


#define LED1 16

#define LED2 17

#define LED3 18

#define BTN_MODE 32

#define BTN_RESET 33


#define SCREEN_WIDTH 128

#define SCREEN_HEIGHT 64

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, -1);
```

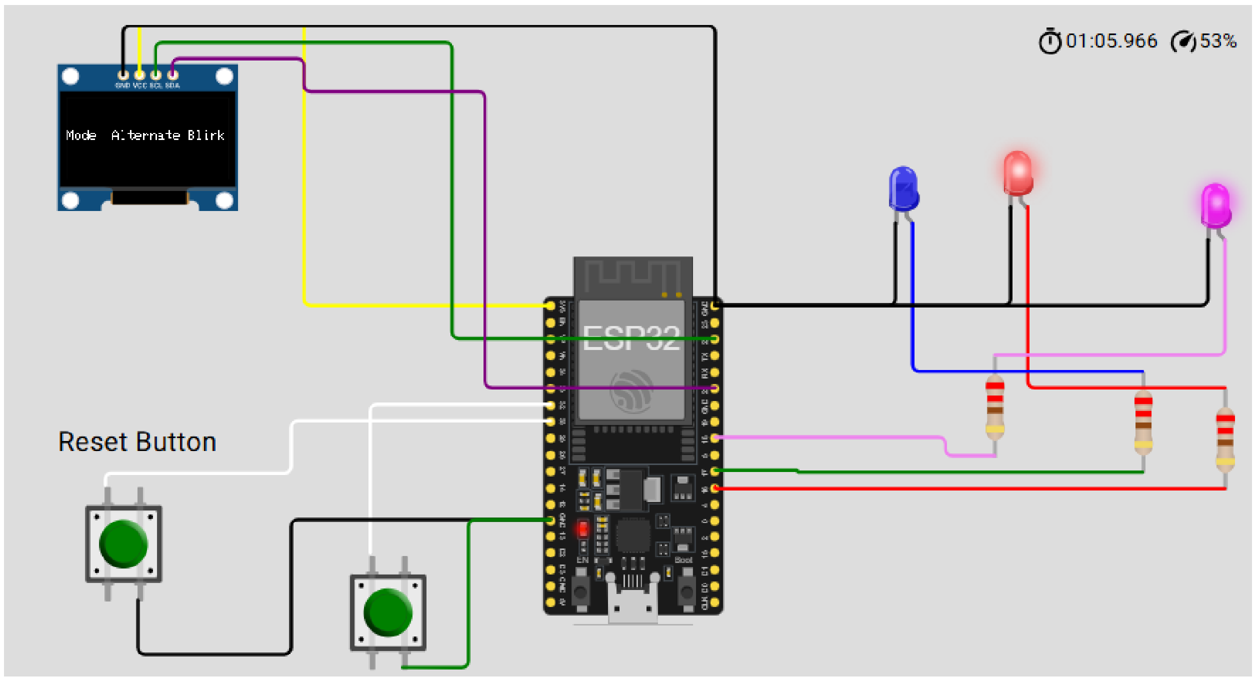
```
int mode = 0;
int brightness = 0;
int fadeAmount = 5;

// Timing variables for non-blocking delays
unsigned long previousBlinkMillis = 0;
unsigned long previousFadeMillis = 0;
unsigned long previousButtonMillis = 0;
unsigned long previousResetMillis = 0;

const long blinkInterval = 200;
const long fadeInterval = 15;
const long buttonInterval = 300;
const long resetDebounce = 200; // debounce for reset button

// Software PWM settings (works in Wokwi)
const unsigned long pwmPeriod = 10; // ms per PWM cycle (~100 Hz)
                                    // lower value -> smoother PWM but more CPU usage

// Blink state variables
int blinkState = 0;

void setup() {
  pinMode(LED1, OUTPUT);
  pinMode(LED2, OUTPUT);
  pinMode(LED3, OUTPUT);
  pinMode(BTN_MODE, INPUT_PULLUP);
  pinMode(BTN_RESET, INPUT_PULLUP);
  if (!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) while (1);
  display.clearDisplay();
  display.setTextSize(1);
  display.setTextColor(SSD1306_WHITE);
  showMode("All OFF");

  // ensure LEDs are off
  digitalWrite(LED1, LOW);
  digitalWrite(LED2, LOW);
  digitalWrite(LED3, LOW);
}

void showMode(const char *text) {
  display.clearDisplay();
  display.setCursor(0, 25);
  display.print("Mode: ");
  display.println(text);
  display.display();
}

void resetToMode0() {
  mode = 0;
  brightness = 0;
  fadeAmount = 5;
  blinkState = 0;
  digitalWrite(LED1, LOW);
  digitalWrite(LED2, LOW);
  digitalWrite(LED3, LOW);
  showMode("Reset to OFF");
```

```
}

void loop() {
  unsigned long currentMillis = millis();

  // --- RESET BUTTON (HIGH PRIORITY) with debounce ---
  if (digitalRead(BTN_RESET) == LOW && (currentMillis - previousResetMillis >= resetDebounce)) {
    previousResetMillis = currentMillis;
    resetToMode0();
    delay(50); // small pause to avoid immediate retrigger
    return; // Exit so reset takes effect immediately
  }

  // --- MODE BUTTON with debounce ---
  if (digitalRead(BTN_MODE) == LOW && (currentMillis - previousButtonMillis >= buttonInterval)) {
    previousButtonMillis = currentMillis;

    mode++;
    if (mode > 3) mode = 0;

    // Reset LEDs when changing modes
    digitalWrite(LED1, LOW);
    digitalWrite(LED2, LOW);
    digitalWrite(LED3, LOW);
    brightness = 0;
    fadeAmount = 5;
    blinkState = 0;
    previousBlinkMillis = currentMillis;
    previousFadeMillis = currentMillis;
  switch (mode) {
    case 0:
      showMode("All OFF");
      break;
    case 1:
      showMode("Alternate Blink");
      break;
    case 2:
      digitalWrite(LED1, HIGH);
      digitalWrite(LED2, HIGH);
      digitalWrite(LED3, HIGH);
      showMode("All ON");
      break;
    case 3:
      showMode("PWM Fade");
      break;
  }
  delay(50); // tiny extra debounce gap
}

// --- MODE BEHAVIORS (NON-BLOCKING) ---
switch (mode) {
  case 1: // Alternate Blink
    if (currentMillis - previousBlinkMillis >= blinkInterval) {
      previousBlinkMillis = currentMillis;

      // Turn all LEDs off first
      digitalWrite(LED1, LOW);
      digitalWrite(LED2, LOW);
      digitalWrite(LED3, LOW);

      // Turn on the current LED in sequence
      switch (blinkState) {
        case 0:
          digitalWrite(LED1, HIGH);
          break;
        case 1:
          digitalWrite(LED2, HIGH);
          break;
        case 2:
          digitalWrite(LED3, HIGH);
          break;
      }

      blinkState = (blinkState + 1) % 3;
    }
    break;

  case 3: // PWM Fade (software PWM for Wokwi / no analogWrite)
    // update brightness at fadeInterval rate (non-blocking)
    if (currentMillis - previousFadeMillis >= fadeInterval) {
      previousFadeMillis = currentMillis;
      brightness += fadeAmount;
      // clamp/flip on edges for stable behaviour
      if (brightness <= 0) {
        brightness = 0;
        fadeAmount = abs(fadeAmount);
      } else if (brightness >= 255) {
        brightness = 255;
        fadeAmount = -abs(fadeAmount);
      }
    }

    // software PWM cycle: compute duty within pwmPeriod
    {
      unsigned long phase = currentMillis % pwmPeriod; // 0 .. pwmPeriod-1 ms
      unsigned int onTime = (unsigned long)brightness * pwmPeriod / 255u; // ms LED should be ON
this cycle
      bool on = (phase < onTime);

      digitalWrite(LED1, on ? HIGH : LOW);
      digitalWrite(LED2, on ? HIGH : LOW);
      digitalWrite(LED3, on ? HIGH : LOW);
    }
    break;

   // cases 0 and 2 don't need periodic work
   default:
    break;
 }
}
```

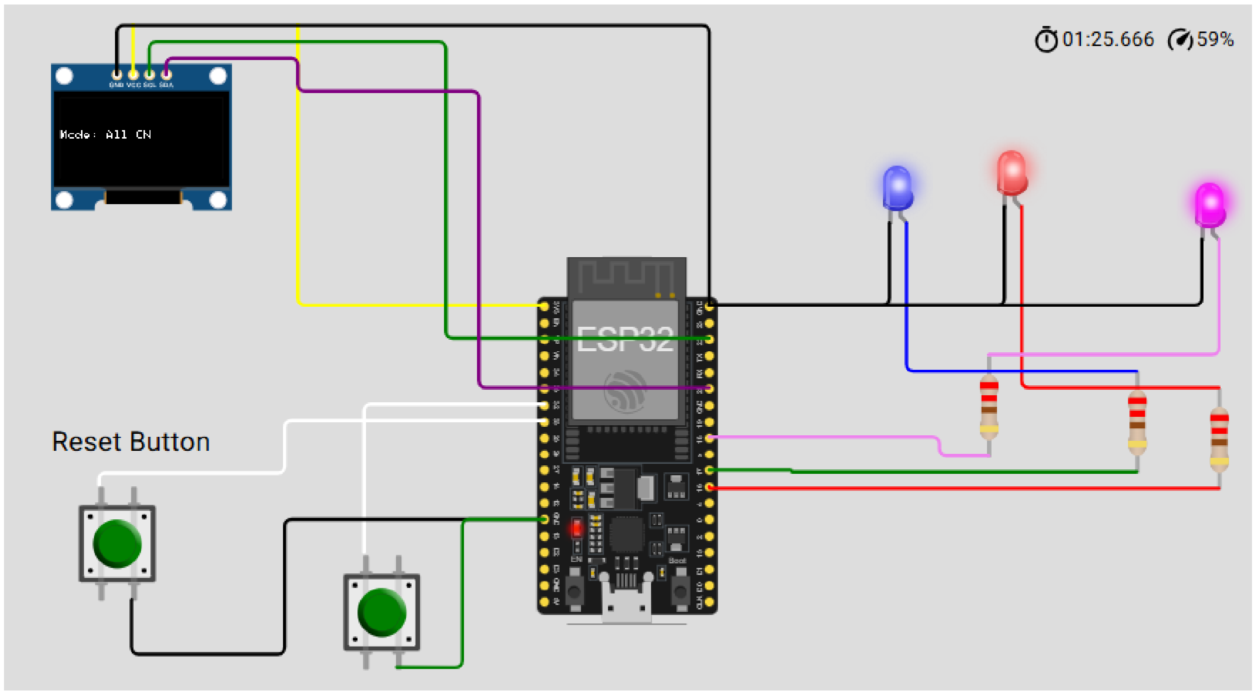
1. Both OFF



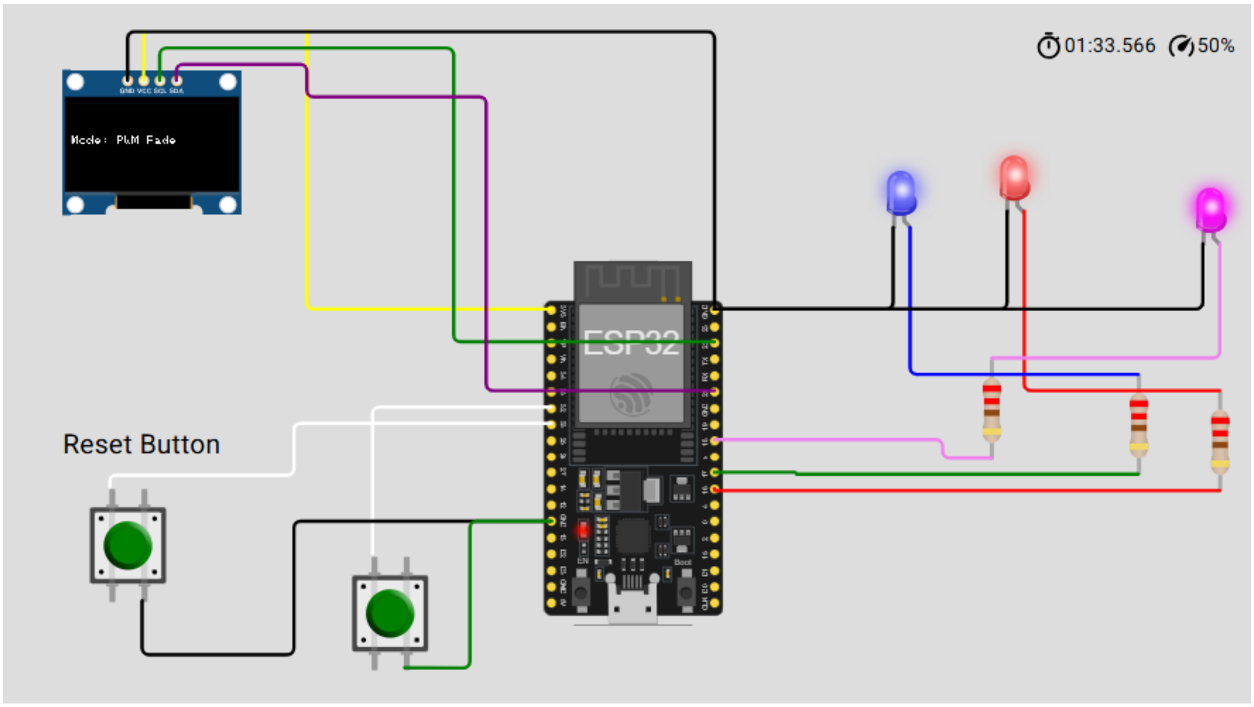
2. Alternate blink



3. Both ON



4. PWM fade



(Task B — Coding)

Use a single button with press-type detection (display the event on the OLED):

• Short press → toggle LED

• Long press (> 1.5 s) → play a buzzer tone

Link:

https://wokwi.com/projects/445863410661551105

CODE:

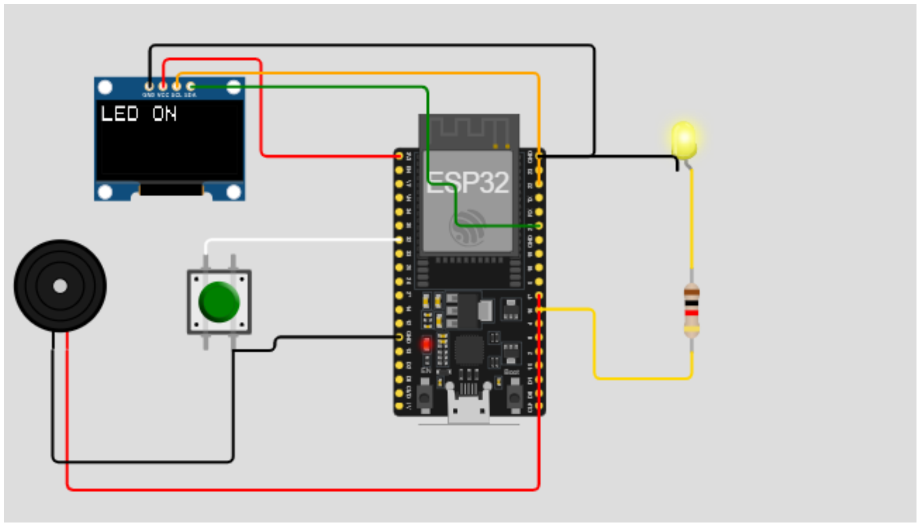
```
//Assignment 1 Part B
// long press buzzer
//Embeded IOT FALL -2025
// Muhammad Umair Butt                    //REG 23-NTU-CS-1076
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
```

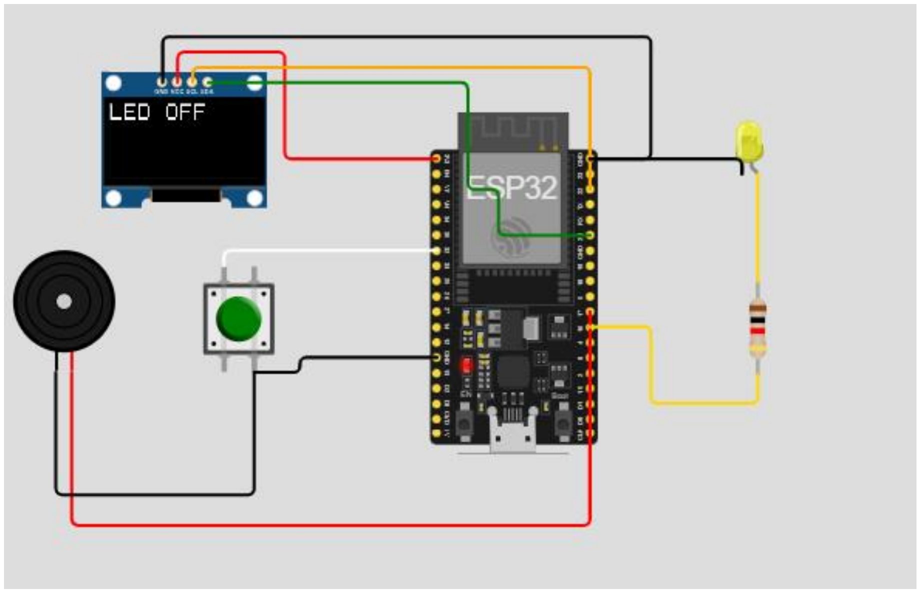
```
// Pin configuration
const int buttonPin = 32;  // single button
const int ledPin = 16;     // LED pin
const int buzzerPin = 17;  // buzzer pin

// OLED configuration
#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, -1);

// Variables for button timing
unsigned long buttonPressTime = 0;
bool isButtonPressed = false;
bool ledState = false;
bool longPressActive = false;
const unsigned long longPressDuration = 1500; // 1.5 seconds for long press
const unsigned long debounceDelay = 50;       // 50ms debounce time

void showOLED(const char *message) {
  display.clearDisplay();
  display.setTextSize(2);
  display.setTextColor(SSD1306_WHITE);
  display.setCursor(0, 0);
  display.println(message);
  display.display();
}

void setup() {
  pinMode(buttonPin, INPUT_PULLUP);
  pinMode(ledPin, OUTPUT);
  pinMode(buzzerPin, OUTPUT);

  Wire.begin(21, 22); // SDA = 21, SCL = 22 for ESP32
  Serial.begin(115200);

  if (!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) {
    Serial.println("❌ OLED init failed");
    while (true);
  }
  showOLED("Ready");

  // Initialize LED to OFF state
  digitalWrite(ledPin, LOW);
}

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

  // Button pressed (LOW because of INPUT_PULLUP)
  if (buttonState == LOW && !isButtonPressed) {
    // Wait for debounce period to confirm the press
    delay(debounceDelay);
    // Check button again after debounce
    if (digitalRead(buttonPin) == LOW) {
      isButtonPressed = true;
      buttonPressTime = millis();
      longPressActive = false;
      Serial.println("Button pressed - waiting for release");
    }
```

```
}

// Button is being held
if (buttonState == LOW && isButtonPressed) {
  if (!longPressActive && (millis() - buttonPressTime > longPressDuration)) {
    // Long press detected – activate buzzer
    longPressActive = true;
    tone(buzzerPin, 1000);
    showOLED("BUZZER");
    Serial.println("Long press activated - BUZZER ON");
  }
}

// Button released (HIGH because of INPUT_PULLUP)
if (buttonState == HIGH && isButtonPressed) {
  // Wait for debounce period to confirm the release
  delay(debounceDelay);
  // Check button again after debounce
  if (digitalRead(buttonPin) == HIGH) {
    noTone(buzzerPin); // stop buzzer immediately when released

    if (!longPressActive) {
      // Short press – toggle LED
      ledState = !ledState;
      digitalWrite(ledPin, ledState ? HIGH : LOW);
      showOLED(ledState ? "LED ON" : "LED OFF");
      Serial.println(ledState ? "LED turned ON" : "LED turned OFF");
    } else {
      // If long press happened
      showOLED("Stopped");
```

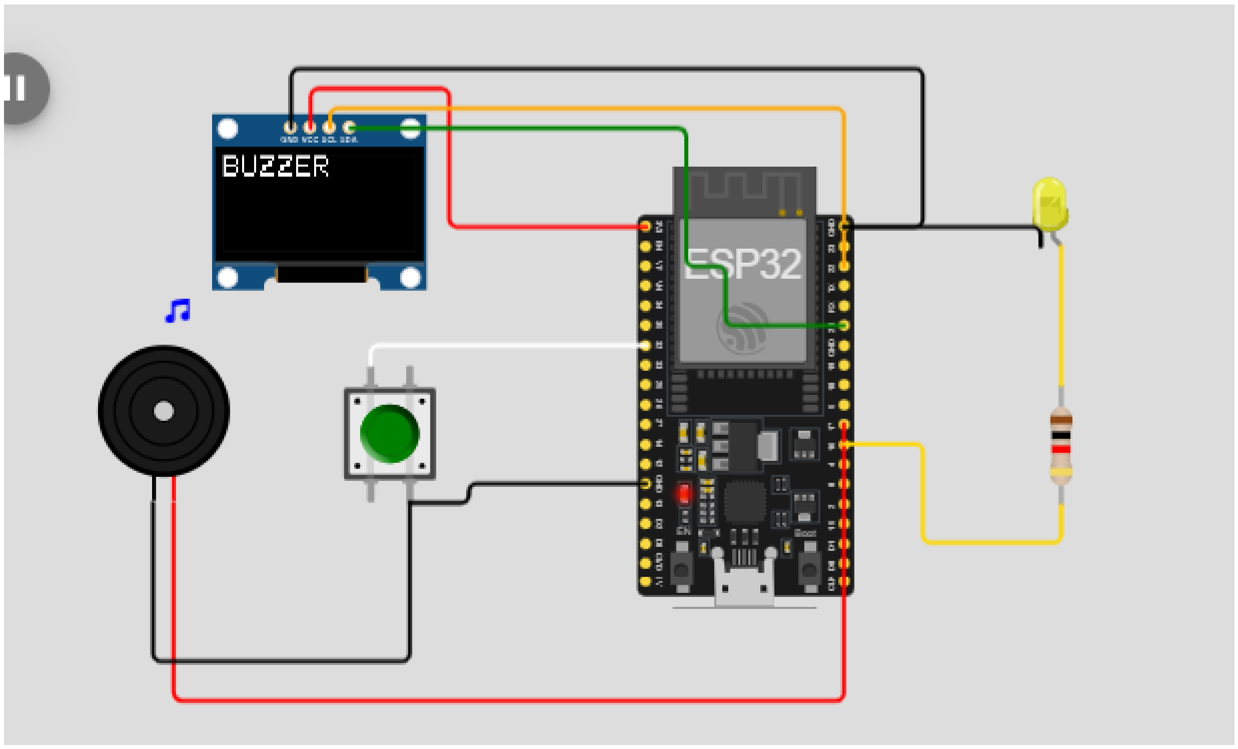
```
        Serial.println("Long press stopped");
      }

      // Reset state
      isButtonPressed = false;
      longPressActive = false;
    }
  }
}
```

Short press → toggle LED





Long press (> 1.5 s) → play a buzzer tone


BUZZER
ESP32
GND VCC SCL SDA