

# National Textile University, Faisalabad



## Department of Computer Science

<b>Name:</b>	Hajra Ahmad
<b>Class:</b>	BS CS "A"
<b>Registration No:</b>	23-NTU-CS-1034
<b>Course Name:</b>	Embedded IOT System
<b>Submitted To:</b>	Sir Nasir Mahmood
<b>Submission Date:</b>	19 October ,2025

## **Title of the Project:**

ESP32-based Smart LED Control System with OLED Display

### **1. Overview**

In this project, an OLED display, push buttons, a buzzer, and an ESP32 microcontroller are used to create a Smart LED Control System. The system shows how several digital parts can work together effectively in an embedded setting. While showing the current mode on an OLED panel, it enables the user to switch between several LED operation modes, including ON, OFF, Alternate Blink, and PWM Fade.

Digital input/output, PWM (Pulse Width Modulation), debouncing, and user feedback via display and sound are among the fundamental embedded programming principles that are highlighted in this project.

### **2. Goals**

Our project's primary goals are:

1. To use ESP32 to create a straightforward and engaging LED control system.
2. To use an OLED panel to show the system status in real time.
3. To display the various LED modes (PWM fade, blinking, OFF, and ON).
4. To use software debouncing in conjunction with button-based input.
5. To elicit user input by use of a visual cue and buzzer.

### **3. Required Components: Description of Component Quantity**

1. ESP32 Development Module
2. OLED Display on the main microcontroller board (0.96" I2C)
3. One display with 128x64 pixels for visual feedback  
Red, green, and onboard LEDs3 Show the many modes of functioning.
4. Buttons for Push to Control of mode selection and reset
5. Audio feedback is provided by Buzzer.
6. As required, resistors ( $420\Omega$ )For LED current limitation and button pull-ups
7. For circuit assembly, use a breadboard and jumper wires.

### **4. Overview of the System**

Two push buttons are used to operate the system:

- Button 1: Switches between LED modes of operation.
- Button 2: Turns everything off and resets the system.
- The OLED display shows the current mode, while the buzzer provides short audio feedback for user actions.
- PWM (Pulse Width Modulation) is used by the LED3 (onboard LED) to exhibit gradual brightness fading.

## 5.Principle of Operation

System Initialization: The ESP32 initializes all pins and the OLED shows "System Ready" upon startup.

Control Mode:

- All of the LEDs are in the "OFF" mode.
- ALT BLINK MODE: Two LEDs alternately flash at a predetermined time.
- ON Mode: Both LEDs stay on all the time.
- PWM Mode: PWM is used by the onboard LED to progressively raise and reduce brightness.
- OLED Display: The OLED dynamically displays the operating mode at the moment.
- Buzzer Feedback: A brief sound indicates a system reset or mode change.

## 6. Design of Circuits

SDA → GPIO 21 and SCL → GPIO 22 for OLED (I2C)

Buttons: Attached to internal pull-ups on GPIO 25 and 26.

LEDs: onboard GPIOs 14, 27, and 2.

GPIO 33 is the buzzer.

The system employs PWM on GPIO 2 to regulate the brightness of the LEDs and software debouncing to provide stable button reading.

Reference circuit Picture:

