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Lab 1 Manual

EECE1195: Digital Electronics II

3-digits Digital Lock

Objectives

Design and implement a **3-digit digital combination lock** using **only combinational logic circuits**.

The system compares a **user-entered 3-digit BCD code** (via DIP switches) with a **hard-wired secret code** (derived from your student ID).

When the entered code matches the secret and the **Test pushbutton** is pressed, the **lock opens**, indicated by both an **LED** and a **7-segment display**.

Overview

Each student will design a **digital combination lock** that unlocks only when the correct **3-digit secret code** is entered.

The secret code corresponds to the **last three digits of your student ID** and is **hard-wired** into the circuit.

Each digit of the code is entered using a **4-bit DIP switch**, representing a **decimal digit (0–9)** in binary.

A **push button** is used to validate the entered code and simulate the unlock action.

Functional Requirements

Inputs

1. **Three sets of 4-bit DIP switches (SW1, SW2, SW3):**
 - o Each set represents one decimal digit (0–9) using binary encoding.
Example:
 - $0101 = 5$
 - $0111 = 7$
2. **Test Push Button (PB1):**
 - o Used to validate the entered code and trigger the unlock action.

Secret Code

- The secret code is **hard-wired** using logic constants (e.g., connected to VCC or GND).

- Each student's code equals the **last three digits** of their student ID.
Example: If your student ID is **8799753**, your code is **753**.

Outputs

1. **Match LED (LED1):**
 - **ON (1):** The entered 3-digit code matches the secret code.
 - **OFF (0):** The entered code does not match.
2. **Unlock LED (LED2):**
 - **ON (1):** The entered code matches, *and* the **Test Push Button** is pressed.
This LED can also be used to **drive a relay or buzzer** (through a transistor if needed).
 - **OFF (0):** The code is incorrect, or the button is not pressed.
3. **7-Segment Display:**
 - Displays “–” when the system is locked or before validation.
 - Displays “U” (for “Unlocked”) when the correct code is entered **and** validated by the push button.

Deliverables

A) Simulation File

1. Multisim (.ms14) or equivalent
2. Fully labeled schematic

B) Demonstration Video (1–3 minutes) (**MUST** with verbal description)

Must include:

1. Incorrect code
2. Correct code before validation
3. Correct code after validation (Unlock)

C) Report (PDF)

Must include:

1. **Circuit schematic** with labeled components.
2. **Truth table** for all logic outputs.
3. **Simplified Boolean expressions** for logic outputs.
4. **Simulation screenshots.**

Due date is January 29, 2026.

Bonus (+25%) — Hardware Implementation

1. Build the complete circuit on a **breadboard or PCB**.
 2. In this case, **two students may work together** on one physical prototype and submit one report.
 3. You may use **any student ID** for the group's secret code.
 4. **Optional:** Use the **Unlock LED output** to drive a **relay module** with **normally open (NO) contact**.
 5. The relay will simulate the lock's opening or activation of an external circuit.
 6. Ensure proper **transistor driver**, **base resistor**, and **flyback diode** are included.

Extra Notes Paper