Institute of
Space Technology

LAB PROJECT PROPOSAL
DIGITAL LOGIC DESIGN
‘”CODE LOCK”

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Project Proposal

Project: Code Lock

1) Introduction:

The **Digital Combinational Code Lock** project presents a simple yet effective approach to implementing a basic security system using only hardware components, without involving any microcontrollers, software, or memory elements**.** At its core, the system accepts a **4-bit binary** input from the user, which is then compared bit-by-bit against a fixed, predefined secret combination using **XNOR** logic gates**.** XNOR gates are ideal for this application because they output a logic HIGH (1) only when both inputs are identical, which makes them perfect for bit-level equality checking**.**

When all the four input bits matches exactly the code which is stored, the output of all **XNOR gates** becomes **HIGH**. After that these outputs are then combined using **AND gates**, ensuring that only when all comparisons succeed does the circuit activate a **green LED** to indicate that access is granted. If even a single input bit does not match the expected value, one or more **XNOR** outputs will be **LOW**, causing the AND gate to output LOW as well. In that case, a **NOT gate** inverts the LOW signal to turn ON a **red LED**, clearly indicating access is denied.

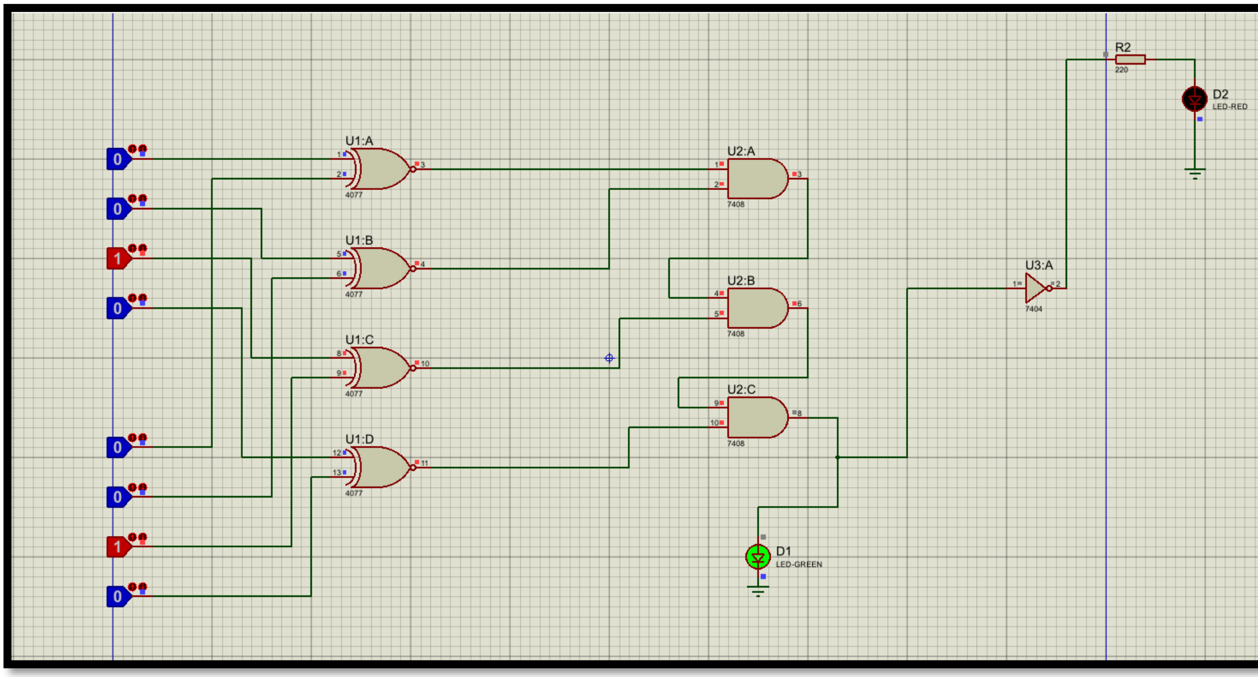
2) Project Vision:

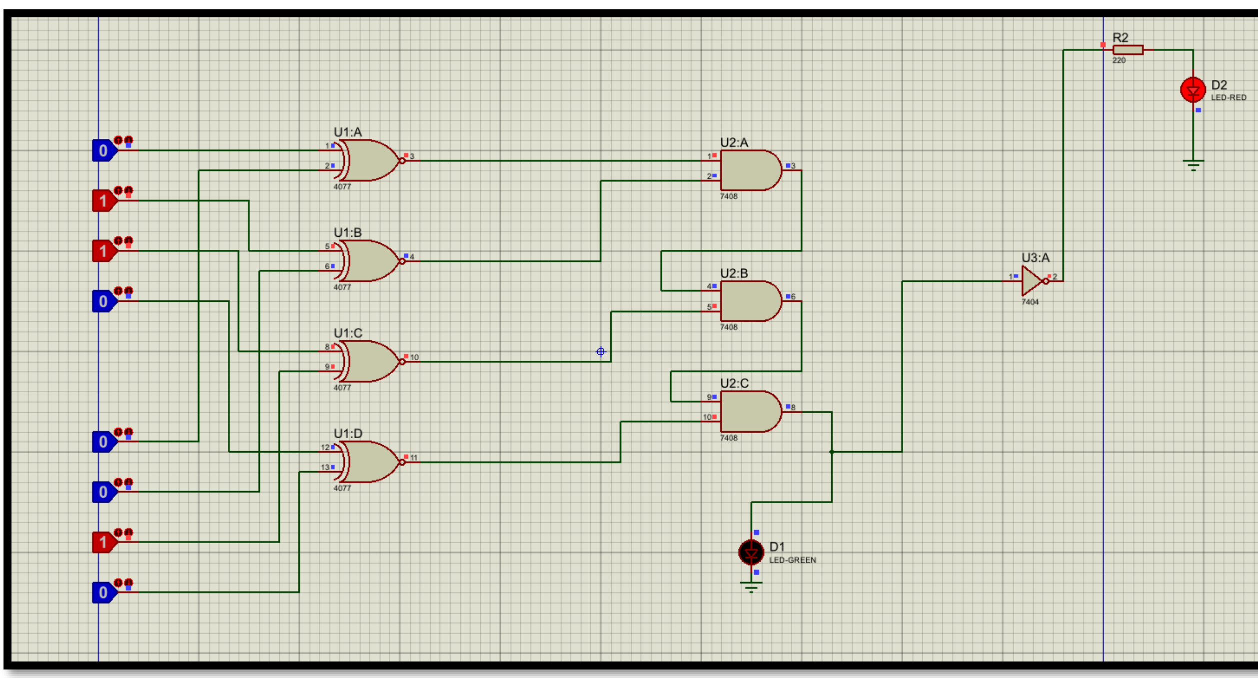
The big dream for this project is to whip up a super affordable and easy-to-build lock that keeps things secure without needing complicated programming. We're tapping into the power of logic gates, IC 4077 for XNOR, IC 7408 for AND, and IC 7404 for NOT, to show how digital logic can tackle real-life security challenges. Think of it as a learning adventure! It's not just about locking a door or a box; it's a chance to explore how combinational logic and error checking work, making it a fantastic tool for students like us in electronics or computer engineering. We want to spark that "I can do this!" feeling and get more people excited about creating their own security gadgets.

3) Project Design:

3.1 Circuit Design

The circuit is engineered to compare a 4-bit binary input provided by the user (configured via the last four switches of an 8-bit DIP switch, labeled E, F, G, H) with a preset secret code (established via the first four switches, labeled A, B, C, D). Each input bit is evaluated against its corresponding preset code bit using XNOR gates from the IC 4077, which produce a HIGH (1) output only when the inputs are identical. The outputs from all four XNOR gates are then directed to AND gates from the IC 7408, which generates a HIGH output solely when all inputs are HIGH, signifying a complete match across all four bits. A HIGH output from the AND gate activates the green LED (through a 220-ohm current-limiting resistor) to indicate access is granted. Conversely, if any bit is mismatched, the AND gate output becomes LOW, which is inverted by a NOT gate from the IC 7404 to activate the red LED, signaling access denial. The design incorporates 4.7k-ohm pull-down resistors on the DIP switch lines to prevent floating inputs, ensuring stable logic levels, and employs combinational logic to deliver instantaneous responses without the need for memory or timing elements.





3.2 Equipment Required

- **1 × 8-bit DIP Switch**: For manually setting the preset code (A, B, C, D) and user input (E, F, G, H).
- **1 × IC 4077 (Quad 2-Input XNOR Gate)**: For bit-by-bit comparison of the input and preset code.
- **1 × IC 7408 (Quad 2-Input AND Gate)**: To combine XNOR outputs and verify a full code match.
- **1 × IC 7404 (Hex Inverter)**: To invert the AND gate output for red LED activation on mismatch.
- **2 × LEDs**: 1 green LED (access granted) and 1 red LED (access denied).
- **2 × 220-ohm Resistors**: For current limiting with the green and red LEDs.
- **4 × 4.7k-ohm Resistors**: As pull-down resistors for DIP switch inputs.
- **1 × 9V Battery**: To power the circuit.
- **1 × 9V Battery Clip**: For connecting the battery to the breadboard.
- **1 × 830-pin Breadboard**: For prototyping the circuit.
- **AWG 24/0.6mm Single-Stranded Wire**: For establishing connections.

3.3 Brief Working of Each Equipment with Safety Measures

1. **Connecting Wires / Jumper Wires**
    - **Working**: Facilitate electrical connections between components on the breadboard.
    - **Safety Measures**: Ensure secure connections to prevent short circuits; use appropriate wire gauge for current requirements.
2. **Breadboard (830-pin)**
    - **Working**: Serves as a temporary prototyping platform, allowing easy insertion and removal of components without soldering.
    - **Safety Measures**: Avoid loose connections; prevent overcurrent through power rails to avoid heating or melting.
3. **9V Battery & Clip**
    - **Working**: Provides power to the circuit; the clip connects the battery terminals to the breadboard.
    - **Safety Measures**: Prevent short circuits; disconnect the battery when not in use to avoid drainage or leakage.
4. **IC 4077 (XNOR Gate)**
    - **Working**: Contains four 2-input XNOR gates; outputs HIGH when inputs are identical.
    - **Safety Measures**: Do not exceed a 15V supply voltage; employ anti-static precautions to protect CMOS circuitry.
5. **IC 7408 (AND Gate)**
    - **Working**: Contains four 2-input AND gates; outputs HIGH only when both inputs are HIGH.
    - **Safety Measures**: Avoid static discharge; ensure correct pin orientation during insertion.
6. **IC 7404 (NOT Gate)**
    - **Working**: Contains six inverters; inverts input logic (0 to 1, 1 to 0).
    - **Safety Measures**: Connect unused inputs to GND or Vcc; handle to avoid static damage.

7. **8-bit DIP Switch**
   - **Working**: Provides manual binary input; switches toggle between HIGH (ON) and LOW (OFF) with pull-down resistors.
   - **Safety Measures**: Ensure proper connection to avoid floating inputs; verify switch ratings.
8. **LEDs (Green and Red)**
   - **Working**: Emit light when forward biased to indicate access status.
   - **Safety Measures**: Use 220-ohm resistors to limit current; avoid reverse connection or overvoltage (maximum 3V).
9. **470-ohm & 4.7k-ohm Resistors**
   - **Working**: Limit current (220-ohm for LEDs) and pull inputs LOW (4.7k-ohm for DIP switches).
   - **Safety Measures**: Match wattage to the application; avoid exceeding voltage ratings.

Conclusion

The Code Lock System project will enhance the comprehension of digital circuits through practical design and testing. By employing combinational logic to develop a functional security lock, it fulfills its educational objectives and fosters problem-solving skills. Upon successful implementation, as outlined, the project will achieve its goal of providing a simple yet effective security solution.

Future Improvements

Future enhancements may involve integrating a microcontroller (e.g., Arduino) to facilitate dynamic code updates, incorporating an LCD for visual feedback, or adding a buzzer for incorrect attempts. Transitioning the design to a printed circuit board (PCB) could enhance compactness and reliability, broadening its applicability in real-world scenarios.