NOTRE DAME UNIVERSITY-LOUAIZE

Faculty of Engineering

ECCE Department

EEN 425

Microprocessor Laboratory

Section A

Final Project Report

Class Attendance

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Presented to:

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I- Introduction:

The objective of this project is to design and implement an automated classroom access and attendance verification system using a PIC16F877A microcontroller and a computer-based authentication program written in Python. Instead of relying on manual attendance sheets, the system allows each student to identify themselves electronically before entering the classroom by entering a unique 6 digits ID code.

The code is entered through a 4×4 matrix keypad connected to the PIC microcontroller. The PIC reads the values, assembles them into a full ID, and transmits this code to a computer over a UART serial link using a PL2303 USB-to-TTL converter. On the computer side, a Python program receives the ID, compares it with a stored list of registered students, and checks whether the entry time falls within the allowed class period. Based on this verification, the program sends an authorization message back to the microcontroller, which then displays “Access Granted”, “Access Denied”, or “Late” on an LCD and also displays it on the computer of the Dr/teacher.

This system contributes to solving human and organizational problems by reducing the time and effort required for attendance taking, minimizing human error. It also has a positive environmental impact by reducing the need for paper-based attendance logs. Furthermore, the digital nature of the system allows attendance data to be stored, processed, and analyzed more easily, supporting future extensions such as automatic reporting or integration with university databases.

The project is organized into four main functional blocks:

- **Input Block**: A 4×4 keypad used by students to enter their six-digit ID.
- **Control Block**: The PIC16F877A microcontroller, which scans the keypad, formats and sends the ID over UART, receives the verification result, and manages the LCD output.
- **Verification Block**: A Python application running on a PC, responsible for validating the received ID against a stored list and checking the time constraints.
- **Output Block**: An LCD that displays system prompts and the final access decision for each student.

Together, these blocks form an integrated attendance and access control solution that is low-cost, scalable, and suitable as a foundation for more advanced classroom management systems, such as door locking control, RFID integration, or networked attendance logging.

II- General Description:

The automated classroom attendance and access verification system is designed to simplify and secure the process of student identification at the classroom entrance. From the user's point of view, the system operates in a simple and intuitive manner. Each student enters a personal six-digit identification code using a keypad placed at the entrance. The system then verifies this code automatically and immediately displays the result on a screen, informing the student whether access is granted, denied, or granted with a late status.

At the center of the system is the PIC16F877A microcontroller, which acts as the main controller, is responsible for reading the keypad input, sending the entered ID to the computer, receiving the verification result, and displaying the corresponding message on the LCD. The computer runs a Python program that performs the actual identity verification and time validation. Communication between the PIC and the computer is achieved through a USB-to-UART interface (PL2303), enabling bidirectional serial data transfer.

The logic of operation of the system is summarized by the flowchart shown in Figure 1 and can be described as follows:

1. When the system is powered on, the PIC initializes all peripherals.
2. The student enters the digits one by one using the keypad. Each key press is detected and processed by the PIC.
3. After the sixth digit is entered, the PIC sends the complete ID to the computer through the UART serial link using the PL2303 interface.
4. The Python program receives the ID, checks it against the stored list of valid students, and verifies whether the current time falls within the allowed class time window.
5. Based on the verification result, the Python program sends a response code back to the PIC.
6. The PIC decodes this response and displays the corresponding message on the LCD:
    - Access granted
    - Access denied
    - Late
7. After displaying the result for a short duration, the system resets and returns to the initial state, ready to process the next student.

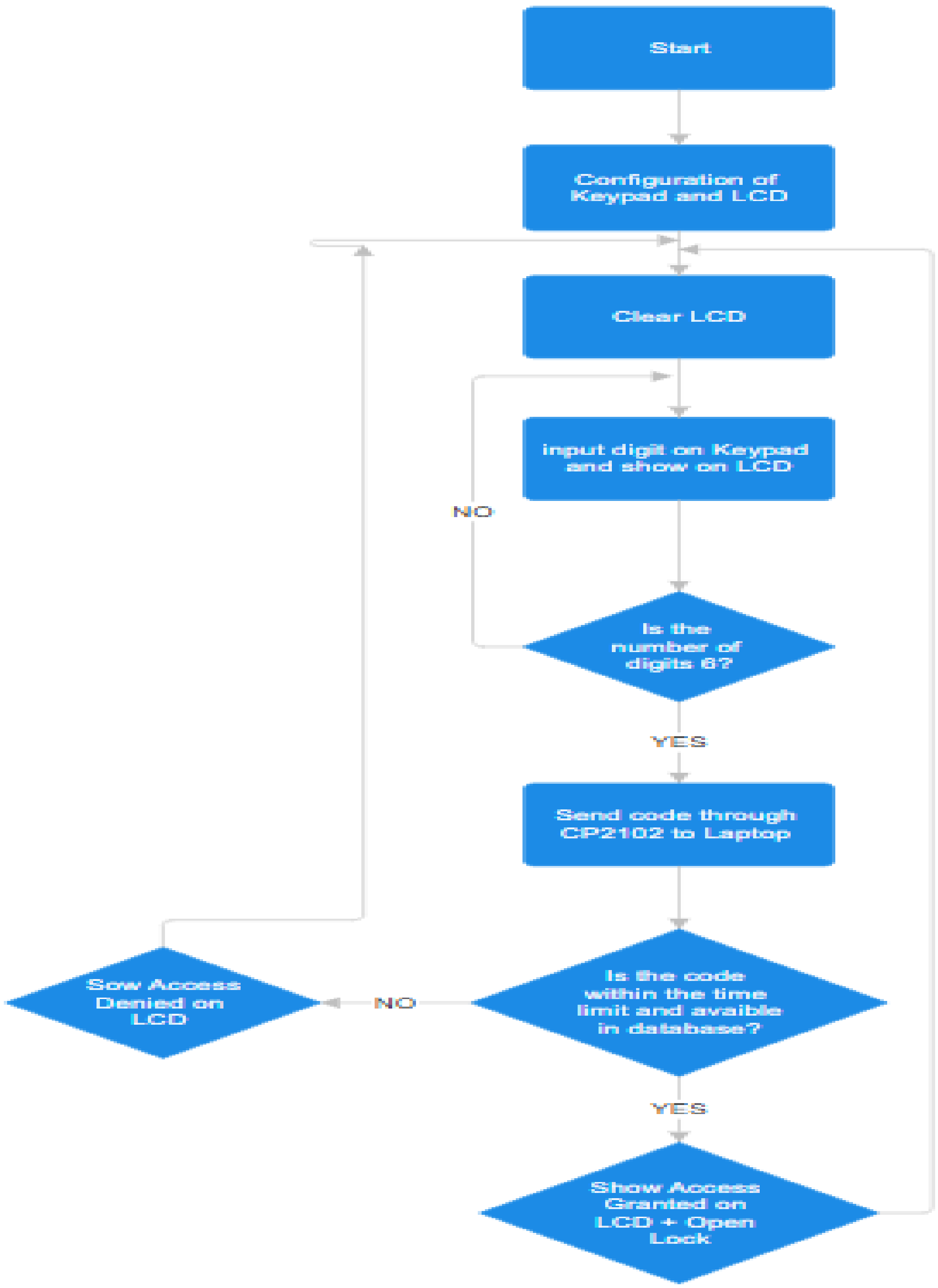
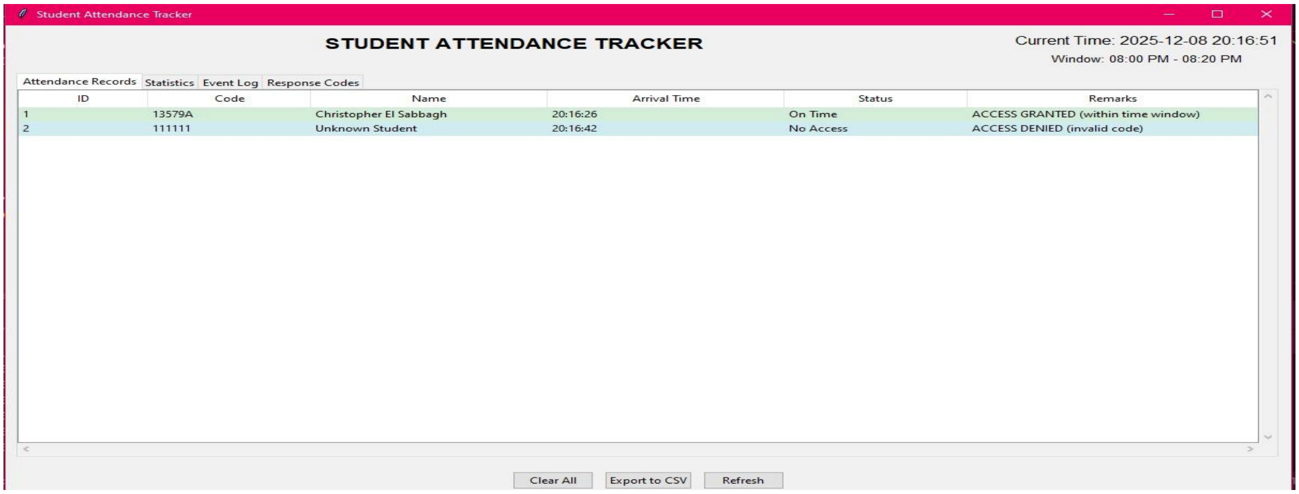

Start
Configuration of Keypad and LCD
Clear LCD
input digit on Keypad and show on LCD
NO
Is the number of digits 6?
YES
Send code through CP2102 to Laptop
Is the code within the time limit and avaible in database?
NO
Sow Access Denied on LCD
YES
Show Access Granted on LCD + Open Lock

Figure 1 Flowchart of the project(since we were using cp2102 initially but due to problems we switched to pl2303)

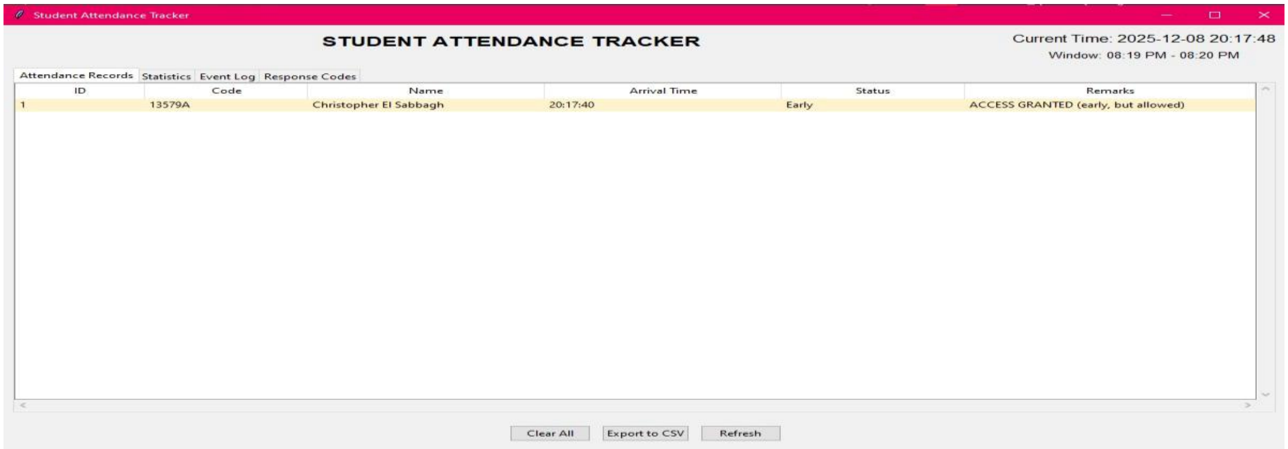


STUDENT ATTENDANCE TRACKER

Current Time: 2025-12-08 20:16:51
Window: 08:00 PM - 08:20 PM

ID	Code	Name	Arrival Time	Status	Remarks
1	13579A	Christopher El Sabbagh	20:16:26	On Time	ACCESS GRANTED (within time window)
2	111111	Unknown Student	20:16:42	No Access	ACCESS DENIED (invalid code)

Figure 2 Terminal seen by the Dr when student arrives on time

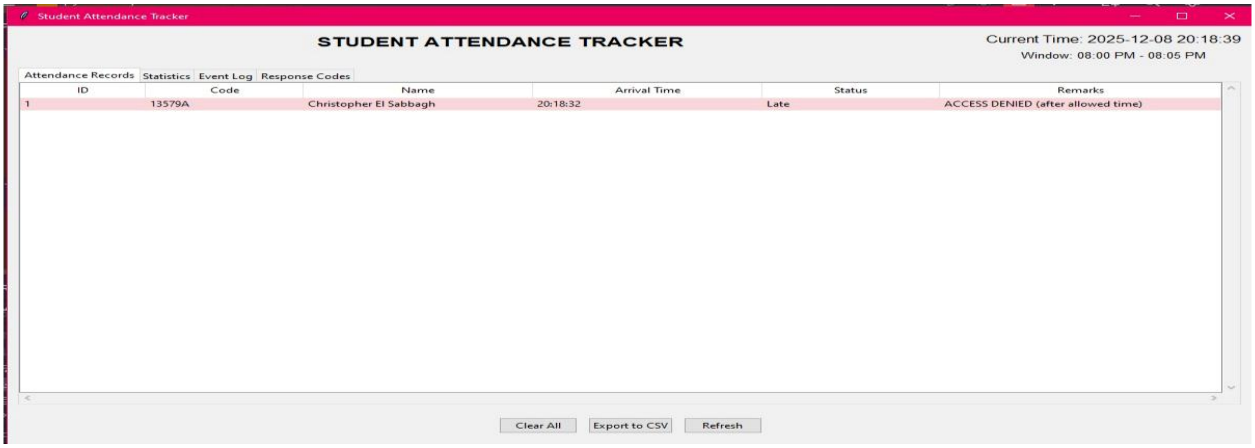


STUDENT ATTENDANCE TRACKER

Current Time: 2025-12-08 20:17:48
Window: 08:19 PM - 08:20 PM

ID	Code	Name	Arrival Time	Status	Remarks
1	13579A	Christopher El Sabbagh	20:17:40	Early	ACCESS GRANTED (early, but allowed)

Figure 3 Terminal seen by the Dr when student arrives early



STUDENT ATTENDANCE TRACKER

Current Time: 2025-12-08 20:18:39
Window: 08:00 PM - 08:05 PM

ID	Code	Name	Arrival Time	Status	Remarks
1	13579A	Christopher El Sabbagh	20:18:32	Late	ACCESS DENIED (after allowed time)

Figure 4 Terminal seen by the Dr when student arrives late

III- Implementation:

The system is built using the following main electronic components:

- **PIC16F877A Microcontroller:**
  The PIC16F877A is the main controller of the system. It is responsible for reading the keypad inputs, assembling the six-digit identification code, transmitting the data to the computer through UART communication, receiving the verification response, and controlling the LCD display.
- **4×4 Matrix Keypad:**
  The keypad serves as the input interface for students. It allows the entry of the six-digit identification code. The PIC continuously scans the keypad to detect key presses and stores the entered digits in sequence until the full code is completed.
- **LCD Display:**
  The LCD is used to display system messages and verification results. It shows the id entered for each student and also the final status messages such as “Access Granted”, “Access Denied”, or “Late”.
- **PL2303 USB-to-UART Converter:**
  The PL2303 module acts as a communication bridge between the PIC microcontroller and the PC. Since the PIC uses TTL-level UART signals while the PC communicates through USB, the PL2303 converts USB signals into UART signals and vice versa. This enables reliable two-way serial communication between the microcontroller and the Python program.
- **Computer with Python Software:**
  The computer runs a Python program that receives the student ID from the PIC, checks it against a predefined list of valid students, verifies the entry time, and sends the appropriate authorization response back to the PIC.

All system components are interconnected as follows:

- **Keypad Connections**
  The keypad is connected to **PORTB** of the PIC microcontroller through an appropriate keypad encoding and scanning method (74922 encoder). This allows the PIC to detect and decode each pressed key accurately.
- **LCD Connections**
  The LCD is connected to **PORTD** of the PIC. These pins are configured as outputs and are used to send data and control signals to the display.
- **PL2303 Connections**
  - **TX (PL2303) → RC7 (RX of PIC)**
  - **RX (PL2303) → RC6 (TX of PIC)**
  - **GND (PL2303) → GND (PIC)**

  These connections allow bidirectional UART communication between the PIC and the computer.

- **Power Supply and Grounding**
  All components share a common ground reference. The PIC, LCD, and keypad are powered using a regulated 5V power supply to ensure correct and stable operation.

The system software is divided into two main parts:

- **PIC Firmware (Assembly/C Language)**
  The PIC firmware performs the following tasks:
  - Initializes all ports, UART module, and LCD.
  - Scans the keypad and captures six-digit student IDs.
  - Sends the completed ID to the PC through UART.
  - Waits for the verification response from the PC.
  - Interprets the received response and displays the appropriate message on the LCD.
  - Resets the system for the next student.
- **Python Program (PC Side)**
  The Python program continuously listens to the serial port for incoming IDs. Once an ID is received, the program:
  - Compares the ID with a predefined internal list of registered students.
  - Checks the real-time system clock to determine whether the entry is on time or late.
  - Sends a corresponding response code back to the PIC through the same serial connection.

Communication between the PIC microcontroller and the computer is achieved using **asynchronous UART serial communication** with the following parameters:

- Baud Rate: **9600 bps**
- Data Bits: **8**
- Parity: **None**
- Stop Bits: **1**
- Communication Mode: **Full duplex**

The PIC initiates the communication by transmitting the six-digit student ID as an ASCII string. The Python program receives this string, performs verification, and sends back a single ASCII character as a response according to the following protocol:

Response Character	**Meaning**
‘1’	Early
‘2’	On Time
‘0’	Late or Invalid ID

Upon receiving the response:

- The PIC immediately decodes the character.
- It displays the corresponding message on the LCD.
- After a short delay, the system resets and becomes ready to accept the next student’s ID.

This simple and reliable communication protocol ensures fast system response and clear separation between the control tasks handled by the PIC and the decision-making tasks handled by the computer.

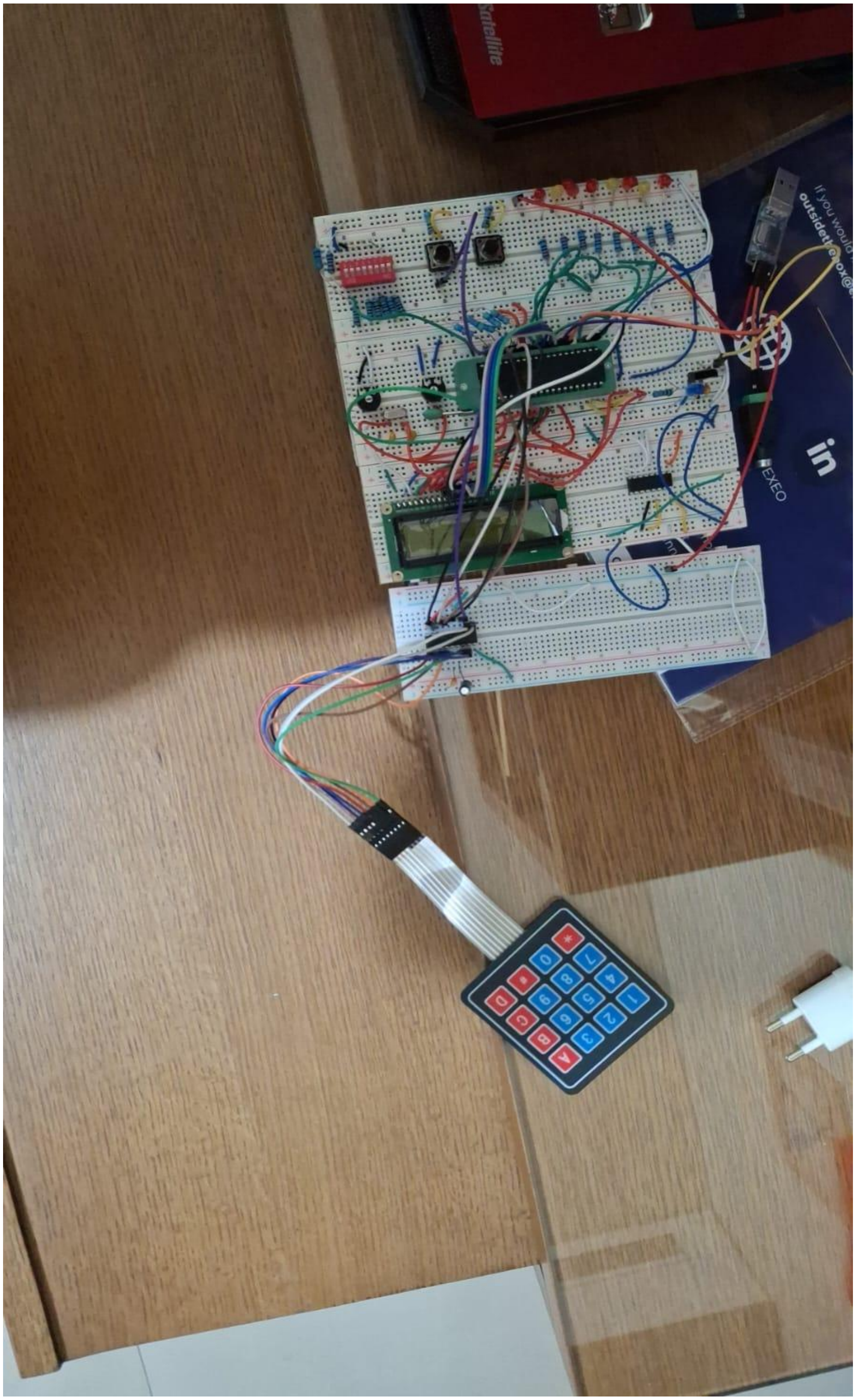


Figure 5 Circuit Wiring

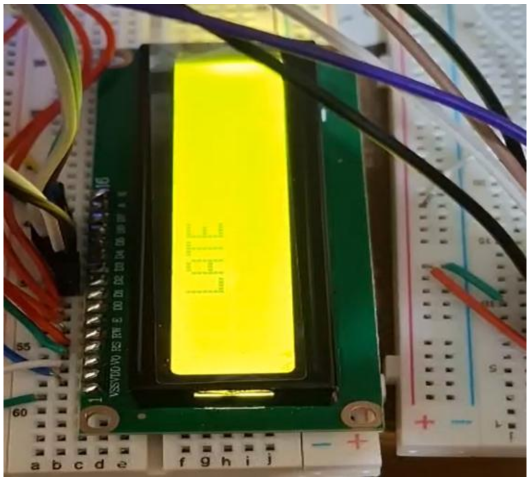


Figure 6 LCD displaying LATE for a student

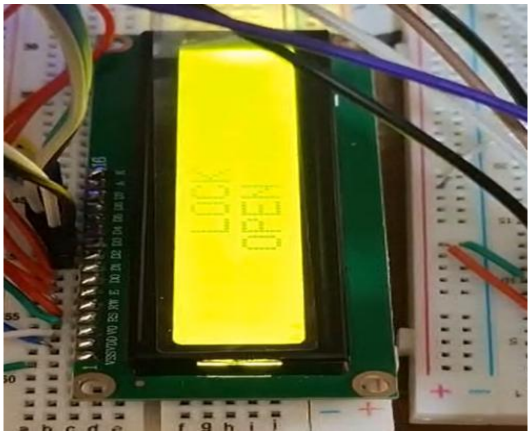


Figure 7 LCD displaying LOCK OPEN for the LATE student(Dr allowed him to enter class)

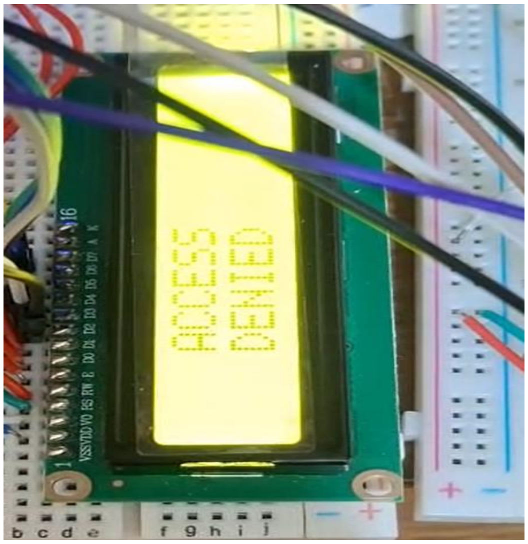


Figure 8 LCD displaying ACCESS DENIED after user entered wrong ID or was disallowed to enter by the Dr

IV- CONCLUSION:

This project successfully demonstrates the design and implementation of an automated classroom attendance and access control system based on microcontroller and PC communication. The system accurately verifies student identity and arrival time using keypad input, UART communication, and Python-based verification. The final implementation also includes physical access control through door lock activation.

One of the main strengths of the system is its ability to classify students as early, on time, late, or unauthorized while automatically storing all attendance records digitally. The Python graphical interface provides real-time monitoring, logging, and statistical analysis of attendance.

However, the project has certain limitations. The system relies on a computer running Python, which prevents it from being fully standalone. Additionally, keypad-based authentication alone is vulnerable to code sharing between students. The current database is local and not network-based.

Future improvements may include:

- RFID-based student authentication
- Cloud database integration
- Face recognition verification
- Smart door motor control with safety sensors
- Mobile application connectivity

Overall, this project provides a strong and expandable foundation for modern smart classroom access systems.