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Vellore Institute of Technology

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School of Electronics Engineering (SENSE)

B. Tech – Electronics & Communication Engineering

BECE403E – EMBEDDED SYSTEMS DESIGN

LAB RECORD

(lab slot L27+L28)

Submitted By

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Submitted To

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LAB – 05: Working with an LCD

AIM: To understand the interfacing of a Liquid Crystal Display (LCD) with Nucleo64-STM32L152RE Board for various applications involving the display of texts as Outputs. We will also perform the following tasks:

Lab Task-1: Write a program for 16x2 LCD to display your register number (ex: "20BEC1001") at row-0 3rd position and your name (ex: "ABCDEFGH") at beginning of the row-1. Assume LCD operates in 4-bit with EN and RS active state. Design and verify this logic on the Nucleo-L152RE board using online Keil Studio platform.

Lab Task-2: Write a program that accepts a serial input character via the "Teraterm" software from a host computer and displays it on the LCD. Assume LCD operates in 4-bit with EN and RS active state. Design and verify this logic on Nucleo-152RE board using online Keil Studio platform.

Lab Task-3: Write a program to display the potentiometer value with 4 decimal places on the LCD display on row-1 5th position. Assume LCD operates in 4 bit with EN and RS active state. Design and verify this logic on Nucleo-L152RE board using online Keil Studio Platform.

SOFTWARE REQUIRED: ARM Keil Studio (Mbed Online Compiler), Tera Term

HARDWARE REQUIRED: Micro USB cable, NUCLEO64-STM32L152 Board, Potentiometer, Jumper Wires (M-F and M-M), Breadboard, LCD

PROCEDURE:

1. Go to ARM Keil Studio (https://studio.keil.arm.com) and log in
2. Select File → New → Mbed Project
3. Click the Example project drop-down list and select "mbed2-example-blinky"
4. In Project name field, provide the name of the new project and click Add project
5. Double click on the "main.cpp" file from the newly created project folder
6. Modify the code in the editor window as per the logic of your application
7. Check for any errors in the program under the "Problems" tab of the panels window
8. If no errors, connect the Nucleo Board to the computer using Micro USB Cable
9. Click Play icon (Run project) to upload and start the code execution on the board.

PROGRAMS:

Lab Task 1: Write a program for 16x2 LCD to display your register number (ex: “20BEC1001”) at row-0 3rd position and your name (ex: “ABCDEFGH”) at beginning of the row-1. Assume LCD operates in 4-bit with EN and RS active state. Design and verify this logic on the Nucleo-L152RE board using online Keil Studio platform.

Code:

```
#include "mbed.h"
#include "TextLCD.h"
TextLCD lcd(PC_0,PC_1,PB_0,PA_4, PA_1, PA_0); // rs, e, d4-d7
int main() {
lcd.locate(3,0);
lcd.printf("22BEC1205\n");
lcd.locate(0,1);
lcd.printf("Jayakrishnan M\n");
}
```

Output:

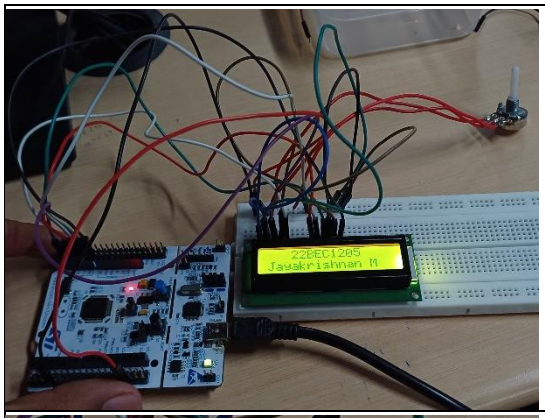


Fig. 1.1: The LCD displays the Register Number and the Name in the prescribed format

Fig. 1.2: Close up image of the LCD, displaying the Register number and the Name

Lab Task 2: Write a program that accepts a serial input character via the "Teraterm" software from a host computer and displays it on the LCD. Assume LCD operates in 4-bit with EN and RS active state. Design and verify this logic on Nucleo-152RE board using online Keil Studio platform.

Code:

```
#include "mbed.h"
#include "TextLCD.h"
TextLCD lcd(PC_0,PC_1,PB_0,PA_4,PA_1,PA_0); // rs, e, d4-d7
Serial pc(USBTX,USBRX);
int main(){
while(1){
pc.printf("\nPress a Character: ");
char y=pc.getc();
lcd.locate(3,0);
lcd.putc(y);
pc.putc(y);
}
}
```

Output:

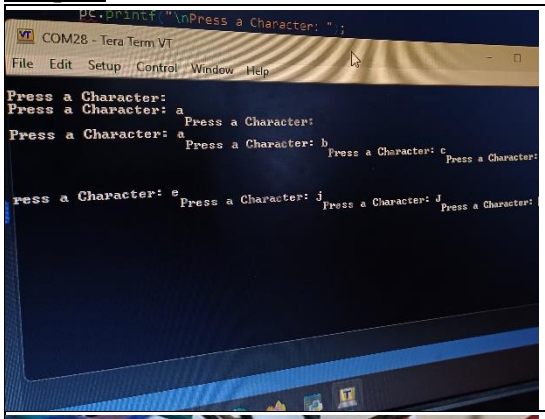


Fig. 2.1: Characters were typed individually on the Teraterm application, which works like a serial monitor

Fig. 2.2: On entering the character "a" to the serial window, the same character appears on the LCD screen as well

Fig. 2.3: On entering the character "b" to the serial window, the same character appears on the LCD screen as well

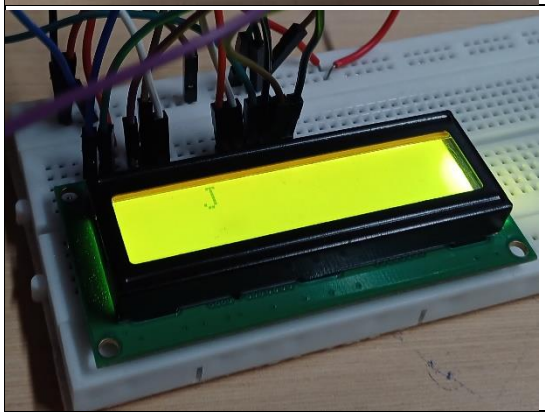


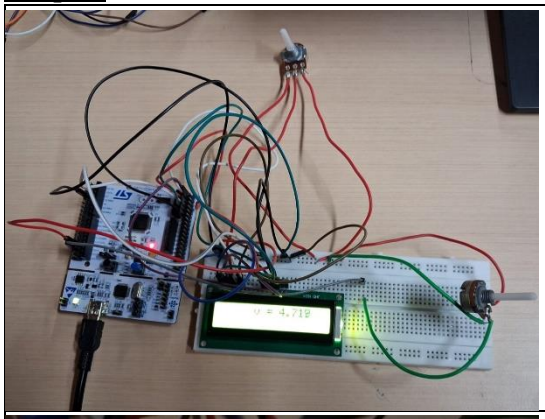
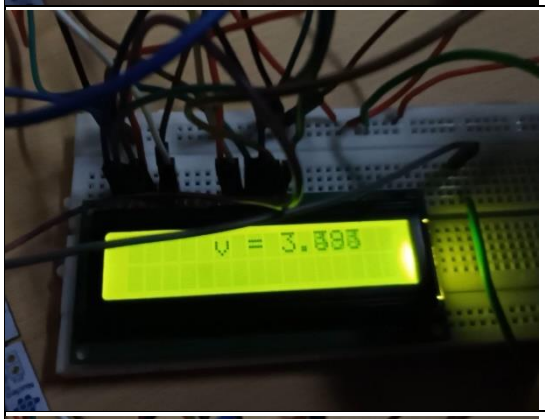
Fig. 2.4: On entering the character "J" to the serial window, the same character appears on the LCD screen as well

Lab Task 3: Write a program to display the potentiometer value with 4 decimal places on the LCD display on row-1 5th position. Assume LCD operates in 4 bit with EN and RS active state. Design and verify this logic on Nucleo-L152RE board using online Keil Studio Platform.

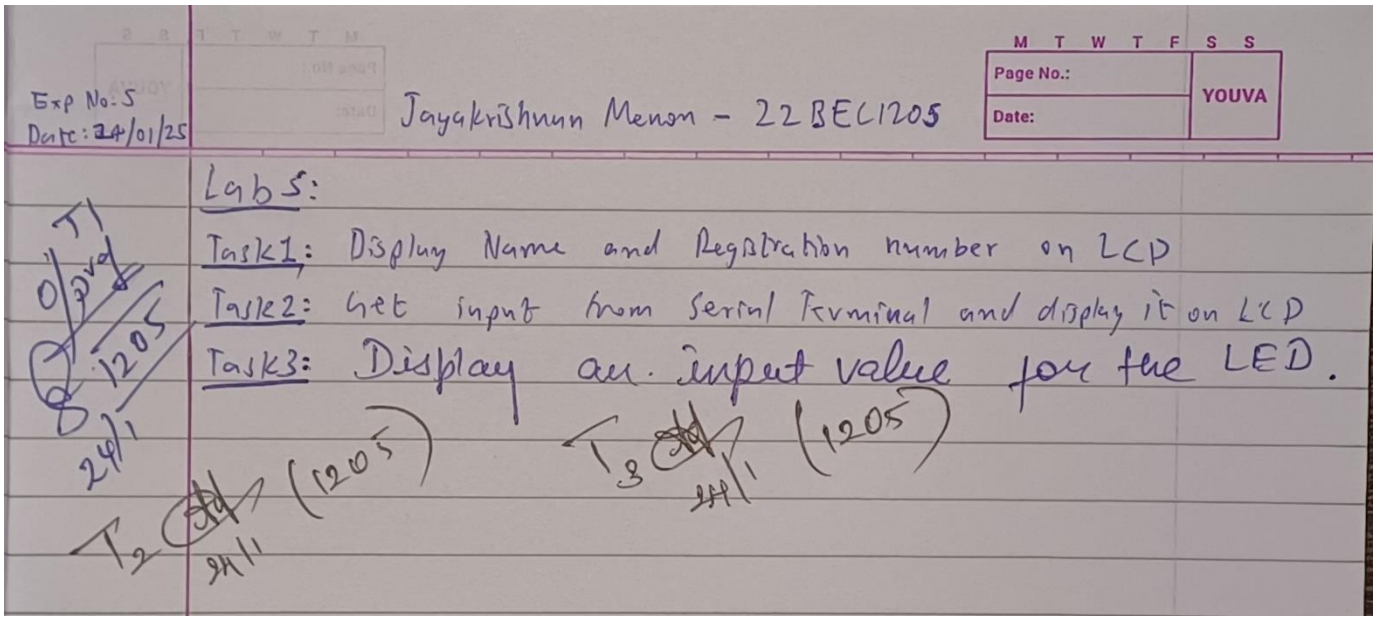
Code:

```
#include "mbed.h"
#include "TextLCD.h"
AnalogIn ain(PC_5);
TextLCD lcd(PC_0,PC_1,PB_0,PA_4,PA_1,PA_0); // rs,e,d4-d7
int main(){
lcd.cls();
while(1) {
float value = ain*5;
lcd.locate(5,0);
lcd.printf("v = %0.3f",value);
wait(2);
lcd.cls();
wait(1);
}
}
```

Output:

	**Fig. 3.1:** Image of the entire setup is shown. Here, 2 potentiometers will be used. One for controlling the contrast of the LCD display, which will be left untouched after the desired contrast is achiever and the other one will be continuously varied to produce a range of analog values
	**Fig. 3.2:** The Potentiometer's wiper is on one extreme and hence, at the maximum voltage value is achieved. The corresponding voltage value to this resistance is read using the AnalogIn API. Turning the wiper of the potentiometer leads to decrease in input analog voltage, which gets reflected on the LCD
	**Fig. 3.3:** Turning of the wiper of the potentiometer leads to decrease in input analog voltage and the corresponding value gets displayed on the LCD
	**Fig. 3.4:** Turning of the wiper of the potentiometer leads to decrease in input analog voltage and the corresponding value gets displayed on the LCD

OUTPUT VERIFICATION:



INFERENCE:

1. The TextLCD library allows a Nucleo board to control Liquid Crystal Displays (LCDs) based on the Hitachi HD44780 chipset in 4-bit mode. It can be used by including the header file, "TextLCD.h". The mbed TextLCD library performs the laborious LCD setup routines and also tells the LCD object which pins are used for which functions.
2. The Syntax for using this API is: “TextLCD lcd(rs, enable, d4, d5, d6, d7)”.
3. It also provides 4 main useful functions. The cls() function clears the screen and locates the cursor to 0,0. The locate() function can be used to move the cursor to any of the 16x2 positions available on the LCD. The putc() function writes a character to the LCD. The printf() function writes a formatted string to the LCD.
4. The “Serial” API in mbed provides a mechanism for serial communication, enabling the microcontroller to send and receive data over a serial interface. Its Syntax is: “Serial Identifier(PinName tx, PinName rx, int baud)”.
5. The Serial API provides two methods, getc and putc. The getc() function is used to receive a single character from the serial interface. It returns the received character. The putc() function is used to transmit a single character over the serial interface. It takes the character to be transmitted as its argument.
6. The USBTX, USBRX arguments (in “Serial Identifier(USBTX, USBRX)”) allow Serial communications to happen through the micro USB cable on the Development board (“USB Virtual Serial Port”). Hence, serial communication doesn’t require any additional pins to be configured.

7. The “AnalogIn” API in mbed allows you to read analog signals from an analog input pin. This is useful for interfacing with sensors that produce analog outputs, such as potentiometers, light sensors, and temperature sensors. Its Syntax is: “AnalogIn Identifier(PinName)”.
8. The “read()” function in the AnalogIn API reads the analog value from the specified pin. It returns a value representing the analog reading, typically in the range of 0 to 1.
9. Programmable Delays can be implemented through the use of the “wait()” function.
10. A program can be set to run indefinitely using the “while(1)” loop

RESULT:

Thus, the interfacing of a Liquid Crystal Display (LCD) with Nucleo64-STM32L152RE Board for various applications involving the display of texts as Outputs was understood and the tasks were also performed successfully.