Scientific Calculator

EE24BTECH11020 Ellanti Rohith

I. INTRODUCTION

This report details the implementation of a scientific calculator using an Arduino Uno, a 16x2 LCD display, and a 5x5 matrix keypad. The calculator supports:

1) Standard arithmetic operations (+,-, *, /)
2) Trigonometric functions (sin, cos, tan)
3) Logarithmic calculations (log, ln)
4) Exponentiation and square root
5) Factorial calculations
6) Modular arithmetic
7) Shift functionality for inverse trigonometric functions, and mathematical constants.

II. HARDWARE COMPONENTS

1) **Arduino Uno** - Microcontroller for processing inputs and outputs
2) **16x2 LCD Display** - Displays user input and results
3) **5x5 Button Matrix Keypad** - Used for user input (numbers, functions, operations)
4) **10kΩ Potentiometer** - Adjusts LCD contrast
5) **Breadboard and Jumper Wires** - For making circuit connections
6) **Power Supply** - Arduino powered via USB or external 5V source

III. CIRCUIT CONNECTIONS

A. LCD to Arduino Connections

The **16x2 LCD Display** is connected to the **Arduino Uno** in **4-bit mode**, using six digital/analog pins for communication.

LCD Pin	Arduino Pin	Function
VSS	GND	Ground
VDD	+5V	Power Supply
V0	Potentiometer (10kΩ)	Contrast Adjustment
RS	D12	Register Select
RW	GND	Always set to Ground (Write mode)
E	D13	Enable Signal
D4	A0	Data Line 4
D5	A1	Data Line 5
D6	A2	Data Line 6
D7	A3	Data Line 7
A (LED +)	+5V	LCD Backlight Positive
K (LED -)	GND	LCD Backlight Negative

The **10kΩ potentiometer** is used to adjust the contrast of the LCD. One terminal of the potentiometer is connected to +5V, the other to GND, and the middle pin is connected to V0 on the LCD.

B. Keypad to Arduino Connections

The **5x5 keypad matrix** consists of **5 rows (outputs)** and **5 columns (inputs)**. The Arduino scans the keypad by driving rows LOW and checking which column reads LOW.

Keypad Pin	Arduino Pin	Function
Row 1 (R1)	D2	Output
Row 2 (R2)	D3	Output
Row 3 (R3)	D4	Output
Row 4 (R4)	D5	Output
Row 5 (R5)	D6	Output
Column 1 (C1)	D7	Input (Pull-up)
Column 2 (C2)	D8	Input (Pull-up)
Column 3 (C3)	D9	Input (Pull-up)
Column 4 (C4)	D10	Input (Pull-up)
Column 5 (C5)	D11	Input (Pull-up)

C. Keypad Operation

The Arduino scans the keypad using the following steps:

1) The **Arduino sets one row LOW** at a time while keeping others HIGH.
2) It checks which **column reads LOW**, indicating a pressed key.
3) Once detected, the Arduino determines which key was pressed using the **row-column mapping**.
4) The **Shift key (S)** toggles alternate functions, and results are displayed on the LCD.

IV. KEYPAD LAYOUT

A. Standard Mode

```
{'7', '8', '9', '/', 's'},  // s = sin
{'4', '5', '6', '*', 'c'},  // c = cos
{'1', '2', '3', ' ', 't'},  // t = tan
{'0', '.', '=', '+', 'l'},  // l = log
{'C', 'S', '^', 'R', 'e'}   // S = Shift, R = sqrt, e = exp
```

B. Shift Mode

```
{'P', 'E', '!', 'm', 'S'},  // P = pi, E = Euler, ! = factorial, m = mod
{'a', 'b', 'c', 'd', 'C'},  // Unused characters
{'s', 'c', 't', ' ', 'I'},  // s = asin, c = acos, t = atan, I = inverse
{'n', 'L', 'X', '+', 'h'},  // n = ln, L = log10, X = e^x
{'C', 'S', '^', 'R', 'e'}   // S = Shift, R = sqrt, e = exp
```

V. CODE IMPLEMENTATION

The code for the calculator is available at: https://github.com/ellantirohith/EE1003/blob/main/Reports/Calc/codes/main.c

VI. CONCLUSION

This scientific calculator effectively handles standard and advanced functions using a matrix keypad. The shift key extends its capability without requiring extra buttons.