Scientific Calculator

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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:

- Standard arithmetic operations (+, , *, /)
- Trigonometric functions (sin, cos, tan)
- Logarithmic calculations (log, ln)
- Exponentiation and square root
- Factorial calculations
- Modular arithmetic
- Shift functionality for inverse trigonometric functions, hyperbolic functions, and mathematical constants

II. Hardware Components

- **Arduino Uno** - Microcontroller for processing inputs and outputs
- **16x2 LCD Display** - Displays user input and results
- **5x4 Button Matrix Keypad** - Used for user input (numbers, functions, operations)
- **10kΩ Potentiometer** - Adjusts LCD contrast
- **Breadboard and Jumper Wires** - For making circuit connections
- **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 **5x4 keypad matrix** consists of **5 rows (outputs)** and **4 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)

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.