ELP305: DESIGN AND SYSTEM LABORATORY

EXPERIMENT 2: CALCULATOR

GROUP NUMBER: 21
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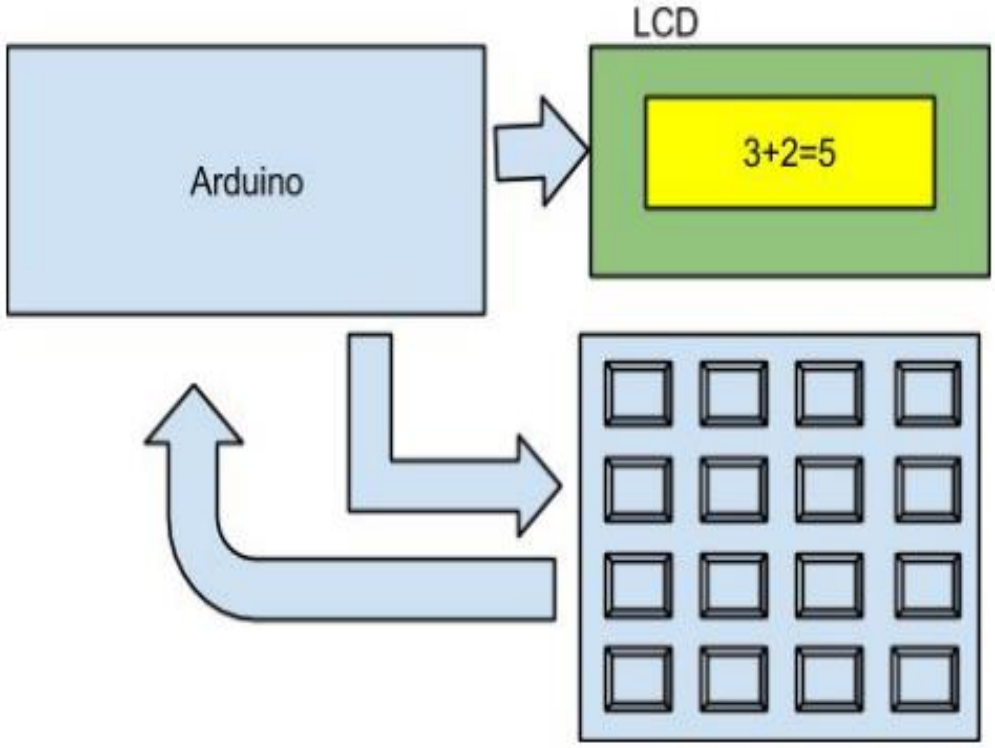
Objective: Designing a simple digital system using a microcontroller.

Apparatus Required: Arduino, 4X4 keypad, 2X16 LCD display, potentiometer, resistor, jumper wires, breadboard

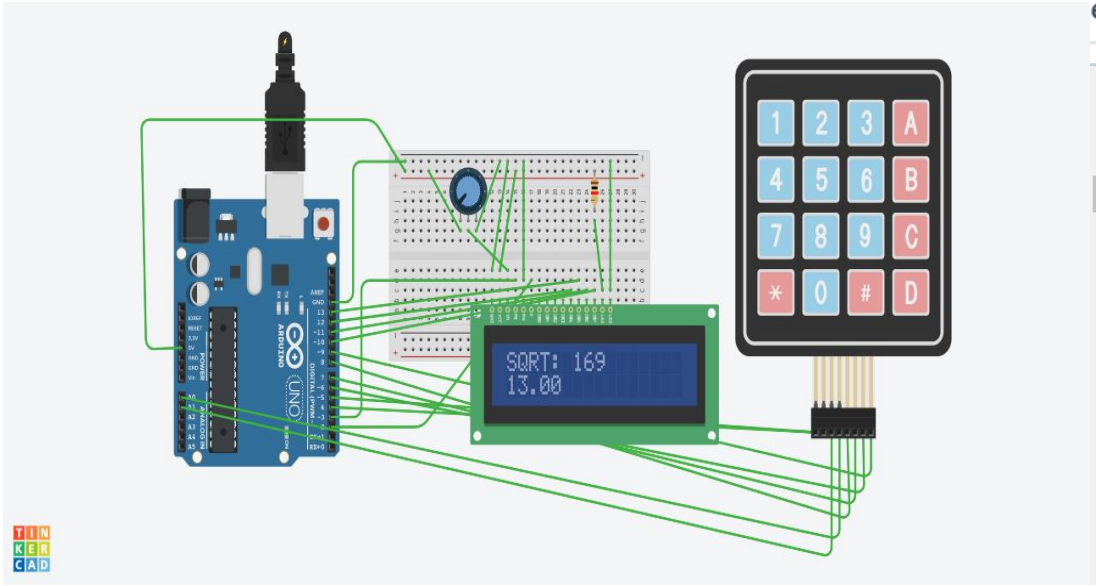
Challenges Faced: Due to the absence of sufficient digital pins in the arduino to connect both the keypad and LCD,we used the analog pins in place of digital pins for some connections of keypad.

Block Diagram:



Circuit Diagram:

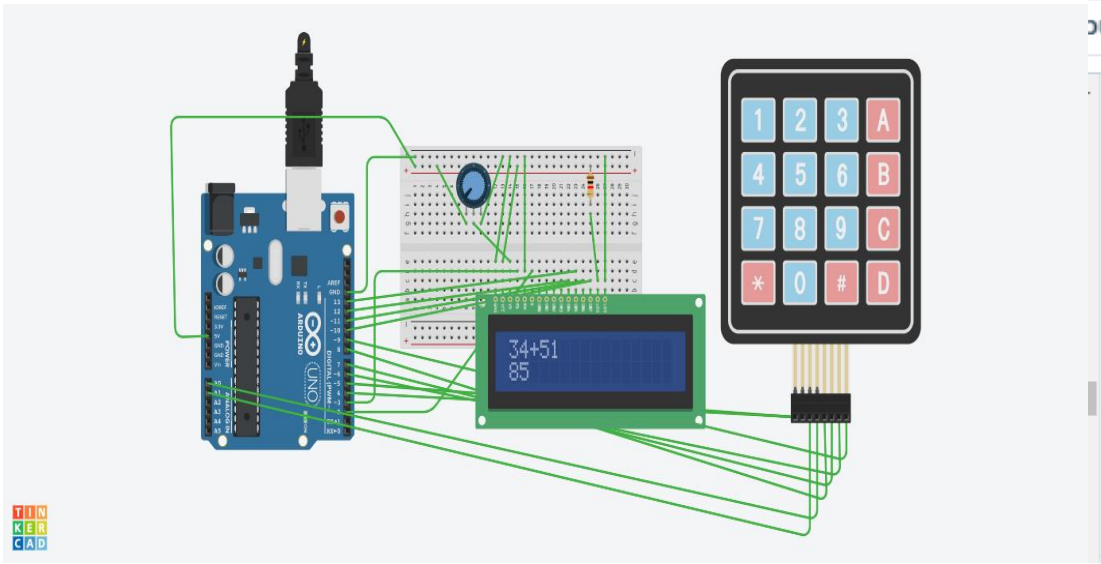
An example for square root operation is shown below



ebugger Serial Monitor

```
Choose the option:
1.ADD
2.SUB
3.MULT
4.DIV
5.ABS
6.SIN
7.COS
8.MOD
9.SQRT
You have chosen:9
SQRT:
Enter the number.
169
Result is:
13.00
```

An example for addition operation is shown below



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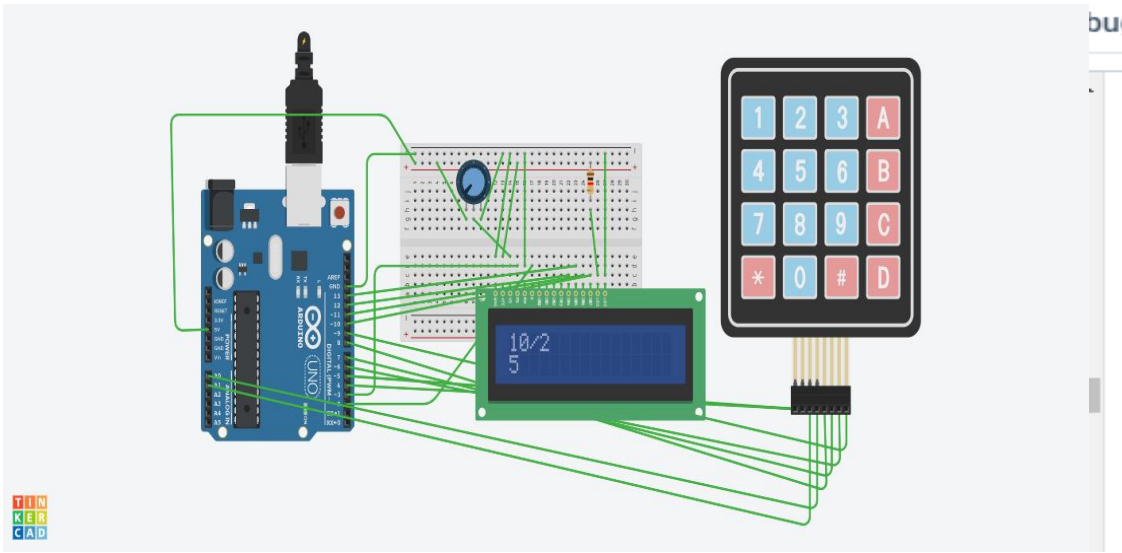
```
Choose the option:
1.ADD
2.SUB
3.MULT
4.DIV
5.ABS
6.SIN
7.COS
8.MOD
9.SQRT
You have chosen:1
Enter the first number.
34
+
Enter second number.
51
Result is:
85
```

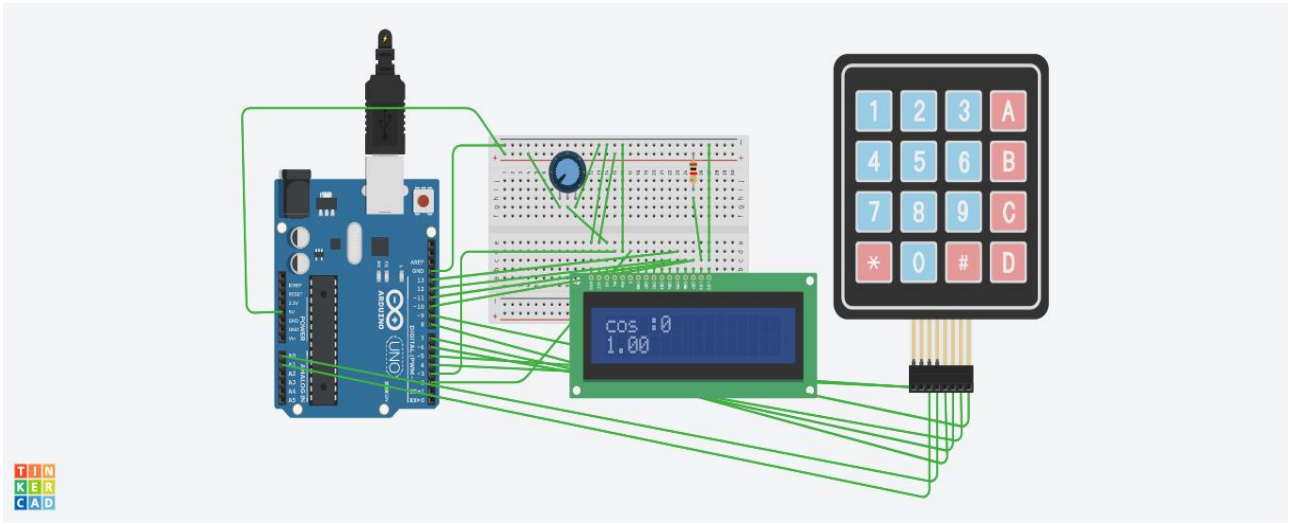
An example for division operation is shown below



bugger Serial Monitor

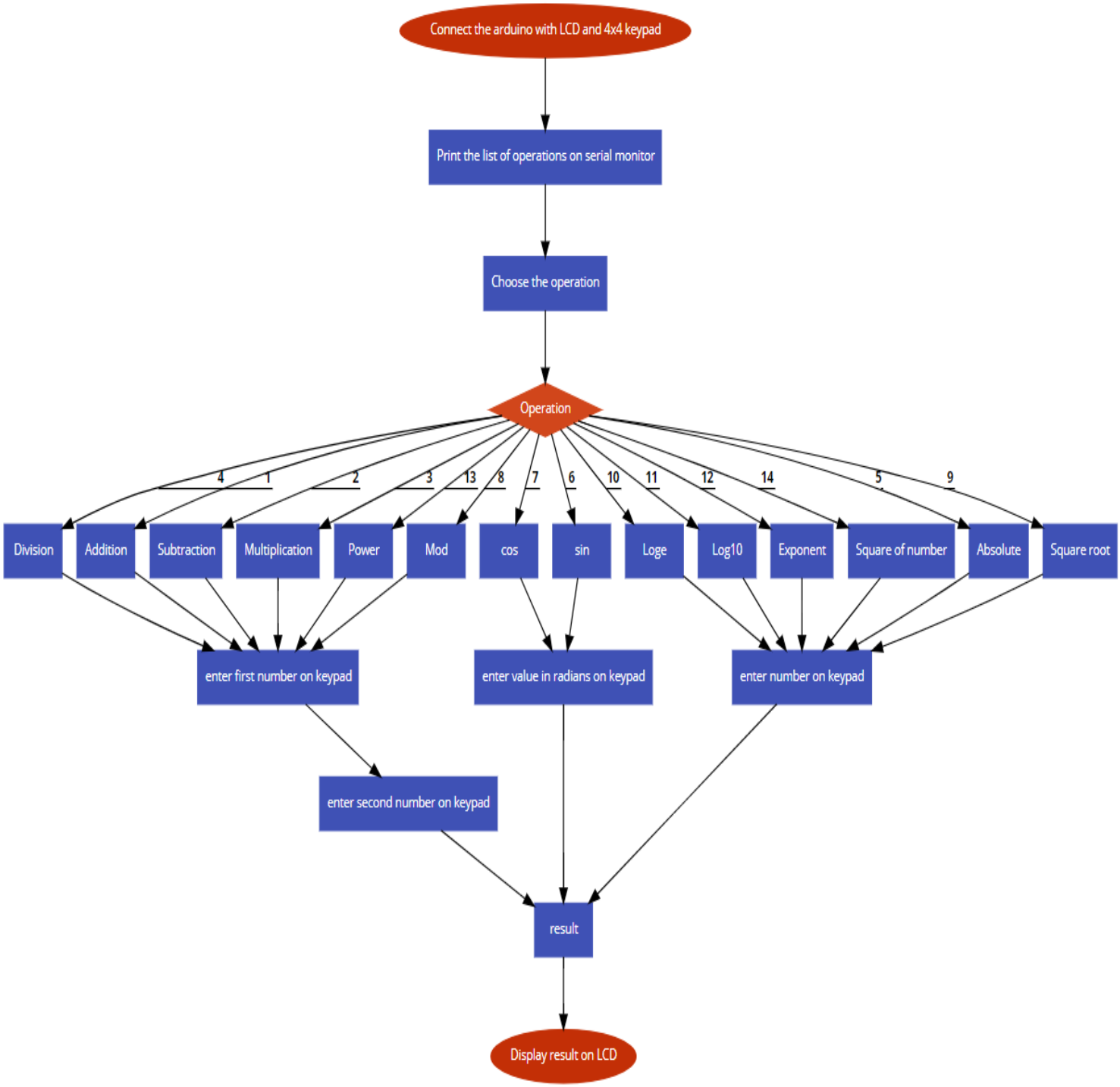
```
Choose the option:
1.ADD
2.SUB
3.MULT
4.DIV
5.ABS
6.SIN
7.COS
8.MOD
9.SQRT
You have chosen:4
Enter the first number.
10
/
Enter second number.
2
Result is:
5
```

An example for cos operation is shown below



We have added advanced operations like $\log_e$,$\log_{10}$,exponent, power etc.We have also improvised the calculator so that it can continuously perform operations one after the other on the answer obtained from one operation.

Flow-Chart for code:



Observations and Conclusion:

A list of operations is printed on the serial monitor. When you press the number associated to the required operation on the keypad, the serial monitor will ask you to enter the numbers. Then the result will be displayed on the LCD screen. We have built a basic calculator with operations like addition, subtraction, division, multiplication, modulus, sin, cos and square root function. In a similar way, it is possible to build very powerful and advanced devices for calculations and computations.

Results:

In this experiment we built a simple calculator which performs addition, subtraction, multiplication and division. Then we modified it to include sin, cos, absolute value, modulus and square root operator. We have also added advanced operations like $\log_e$,$\log_{10}$,exponent, power etc.We have also improvised the calculator so that it can continuously perform operations one after the other on the answer obtained from one operation.

The serial monitor displays the list of operations, the numbers are pressed in the keypad and the result is displayed on the LCD screen.

References:

- http://playground.arduino.cc/Main/KeypadTutorial
- https://www.arduino.cc/en/Tutorial/LiquidCrystalDisplay

Code:

```
#include <Keypad.h>
#include <LiquidCrystal.h>
#include <math.h>

//used 'D' for enter

LiquidCrystal lcd(3,2,12,13,11,10);

const byte ROWS = 4;
const byte COLS = 4;
char keys[ROWS][COLS] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'#','0','*','D'}
};
byte rowPins[ROWS] = {5, 4,15,14};
byte colPins[COLS] = {8, 7, 6,9};

String show_val = "";
double prev_val = 0;
bool status = false;
Keypad keypad = Keypad( makeKeymap(keys), rowPins,
colPins, ROWS, COLS );

void setup(){
  Serial.begin(9600);
  lcd.begin(16, 2);
  operation_information();
}

void loop(){

  status = false;
  long enter_val = getNumber();
  Serial.print("You have chosen:");
  Serial.print(enter_val);
  Serial.println();
```

```
  lcd.clear();
  lcd.print("you have chosen:");
  lcd.setCursor(0,2);
  lcd.print(enter_val);
  delay(2000);
  show_val = "";
  prev_val = process(enter_val,status);

  while(1){
     status = true;
     Serial.println("press only D to start new computation.");
     show_val = "";
     long enter_val1 = getNumber();
     if(enter_val1==0){
       Serial.println("starting new computation.");
              break;
     }
     else{
       Serial.print("you have chosen:");
       Serial.println(enter_val);
       lcd.clear();
       show_val = "";
       String myString = String(prev_val);
       getshow_val(myString);
       lcd.print(show_val);
       prev_val = process(enter_val1,status);
     }
   }

  delay(6000);
  lcd.clear();
  show_val = "";
}

 void operation_information(){
  Serial.println("Choose the option:");
  Serial.println("1.ADD");
  Serial.println("2.SUB");
  Serial.println("3.MULT");
  Serial.println("4.DIV");
  Serial.println("5.ABS");
  Serial.println("6.SIN");
  Serial.println("7.COS");
  Serial.println("8.MOD");
  Serial.println("9.SQRT");
  Serial.println("10.Loge");
  Serial.println("11.Log10");
  Serial.println("12.exp");
  Serial.println("13.pow");
  Serial.println("14.square of number");
}

 String operation(int num1)
 {
  String ret_val = "";
  while(1){
    if(num1==1){
      ret_val = "+";
    }
    else if(num1==2){
      ret_val = "-";
    }
    else if(num1==3){
      ret_val = "*";
    }
    else if(num1==4){
      ret_val = "/";
    }
    else if(num1==5){
      ret_val = "abs :";
    }
    else if(num1==6){
      ret_val = "sin :";
    }
    else if(num1==7){
      ret_val = "cos :";
    }
    else if(num1==8){
      ret_val = "Mod";
    }
    else if (num1==9){
      ret_val = "SQRT: ";
    }
    else if(num1==10){
      ret_val = "Loge:";
    }
    else if(num1==11){
      ret_val = "Log10:";
    }
    else if(num1==12){
      ret_val = "exp:";
    }
    else if(num1==13){
      ret_val = "pow:";
    }
    else if(num1==14){
      ret_val = "square of a number:";
    }
    break;
  }
  getshow_val(ret_val);
  return ret_val;
 }

 double process(int num,bool status){
  double val1 = prev_val;
  if(num==1){
    if(status==true){
    }
    else{
          lcd.clear();
          Serial.println("Enter the first number.");
          val1 = (double)getNumber();
          Serial.println(val1);
```

```
 }
 String oper = operation(num);
 lcd.clear();
 lcd.print(show_val);
            Serial.println(oper);
            Serial.println("Enter second number.");
            double val2 = (double)getNumber();
            Serial.println(val2);
            lcd.clear();
            lcd.print(show_val);
 lcd.setCursor(0,2);
 double result = val1 + val2;
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
 return result;
}
else if(num==2){
 if(status==true){
 }
 else{
   lcd.clear();
   Serial.println("Enter the first number.");
   val1 = (double)getNumber();
             Serial.println(val1);
 }
 String oper = operation(num);
            lcd.clear();
            lcd.print(show_val);
            Serial.println(oper);
            Serial.println("Enter second number.");
            double val2 = (double)getNumber();
            Serial.println(val2);
            lcd.clear();
            lcd.print(show_val);
 lcd.setCursor(0,2);
 double result = val1 - val2;
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
 return result;
}
else if(num==3){
 if(status==true){
 }
 else{
  lcd.clear();
  Serial.println("Enter the first number.");
  val1 = (double)getNumber();
             Serial.println(val1);
 }
 String oper = operation(num);
            lcd.clear();
            lcd.print(show_val);
            Serial.println(oper);
            Serial.println("Enter second number.");
            double val2 = (double)getNumber();
            Serial.println(val2);
            lcd.clear();
            lcd.print(show_val);
 lcd.setCursor(0,2);
 double result = val1 * val2;
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
 return result;
}
 else if(num==4){
 if(status==true){
 }
 else{
  lcd.clear();
  Serial.println("Enter the first number.");
  val1 = getNumber();
             Serial.println(val1);
 }
 String oper = operation(num);
            lcd.clear();
            lcd.print(show_val);
            Serial.println(oper);
            Serial.println("Enter second number.");
            long val2 = getNumber();
            Serial.println(val2);
            lcd.clear();
            lcd.print(show_val);
 lcd.setCursor(0,2);
 double result = val1 / val2;
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
  return result;
}
 else if(num==8){
 if(status==true){
 }
 else{
  lcd.clear();
  Serial.println("Enter the first number.");
  val1 = getNumber();
             Serial.println(val1);
 }
 String oper = operation(num);
            lcd.clear();
            lcd.print(show_val);
            Serial.println(oper);
            Serial.println("Enter second number.");
            long val2 = getNumber();
            Serial.println(val2);
            lcd.clear();
            lcd.print(show_val);
 lcd.setCursor(0,2);
 long result = ((long)val1) % val2;
 lcd.print(result);
 Serial.println("Result is:");
```

```
 Serial.println(result);
 return result;
}
 else if(num==5){
 lcd.clear();
 show_val = "";
 String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
 if(status==true){
  String myString = String(val1);
  getshow_val(myString);
  lcd.print(show_val);
 }
 else{
  Serial.println("Enter the number.");
  val1 = (double)getNumber();
             Serial.println(val1);
 }
 lcd.setCursor(0,2);
 double result = abs(val1);
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
  return result;
}
else if(num==6){
 lcd.clear();
 show_val = "";
 String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
 if(status==true){
  String myString = String(val1);
  getshow_val(myString);
  lcd.print(show_val);
 }
 else{
  Serial.println("Enter the number.");
  val1 = (double)getNumber();
             Serial.println(val1);
 }
 lcd.setCursor(0,2);
 double result = sin(val1);
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
 return result;
}
 else if(num==7){
 lcd.clear();
 show_val = "";
 String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
 if(status==true){
  String myString = String(val1);
  getshow_val(myString);
  lcd.print(show_val);
 }
 else{
  Serial.println("Enter the number.");
  val1 = (double)getNumber();
             Serial.println(val1);
 }
 lcd.setCursor(0,2);
 double result = cos(val1);
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
  return result;
}
 else if(num==9){
 lcd.clear();
 show_val = "";
 String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
 if(status==true){
  String myString = String(val1);
  getshow_val(myString);
  lcd.print(show_val);
 }
 else{
  Serial.println("Enter the number.");
  val1 = (double)getNumber();
             Serial.println(val1);
 }
 lcd.setCursor(0,2);
 double result = sqrt(val1);
 lcd.print(result);
 Serial.println("Result is:");
 Serial.println(result);
  return result;
}
else if(num==10){
 lcd.clear();
 show_val = "";
 String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
 if(status==true){
  String myString = String(val1);
  getshow_val(myString);
  lcd.print(show_val);
 }
 else{
  Serial.println("Enter the number.");
  val1 = (double)getNumber();
             Serial.println(val1);
 }
 lcd.setCursor(0,2);
 double result = log(val1);
 lcd.print(result);
```

```
  Serial.println("Result is:");
  Serial.println(result);
   return result;
}
else if(num==11){
  lcd.clear();
  show_val = "";
  String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
  if(status==true){
    String myString = String(val1);
    getshow_val(myString);
    lcd.print(show_val);
  }
  else{
    Serial.println("Enter the number.");
    val1 = getNumber();
             Serial.println(val1);
  }
  lcd.setCursor(0,2);
  double result = log10((double)val1);
  lcd.print(result);
  Serial.println("Result is:");
  Serial.println(result);
   return result;
}
else if(num==12){
  lcd.clear();
  show_val = "";
  String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
  if(status==true){
    String myString = String(val1);
    getshow_val(myString);
    lcd.print(show_val);
  }
  else{
    Serial.println("Enter the number.");
    val1 = getNumber();
             Serial.println(val1);
  }
  lcd.setCursor(0,2);
  double result = exp((double)val1);
  lcd.print(result);
  Serial.println("Result is:");
  Serial.println(result);
   return result;
}
else if(num==14){
  lcd.clear();
  show_val = "";
  String oper = operation(num);
            lcd.clear();
            Serial.println(oper);
  if(status==true){
    String myString = String(val1);
    getshow_val(myString);
    lcd.print(show_val);
  }
  else{
    Serial.println("Enter the number.");
    val1 = getNumber();
             Serial.println(val1);
  }
  lcd.setCursor(0,2);
  double result = square((double)val1);
  lcd.print(result);
  Serial.println("Result is:");
  Serial.println(result);
   return result;
 }
 if(num==13){
  if(status==true){
  }
  else{
            lcd.clear();
            Serial.println("Enter the first number.");
            val1 = (double)getNumber();
            Serial.println(val1);
  }
  String oper = operation(num);
  lcd.clear();
  lcd.print(show_val);
            Serial.println(oper);
            Serial.println("Enter second number.");
            long val2 = getNumber();
            Serial.println(val2);
            lcd.clear();
            lcd.print(show_val);
  lcd.setCursor(0,2);
  double result = pow(val1,(double)val2);
  lcd.print(result);
  Serial.println("Result is:");
  Serial.println(result);
  return result;
 }


}


void getshow_val(String str){
 show_val = show_val + str;
}


long getNumber()
{
 long second = 0;
 while(1)
 {
  char Key = keypad.getKey();
```

```
if(Key >= '0' && Key <= '9')
{
  second = second * 10 + (Key - '0');
  lcd.clear();
  String myString = String(Key);
  getshow_val(myString);
  lcd.print(show_val);
 }
```

```
   if(Key == 'D') {
     break;
    }

  }
   return second;
}
```