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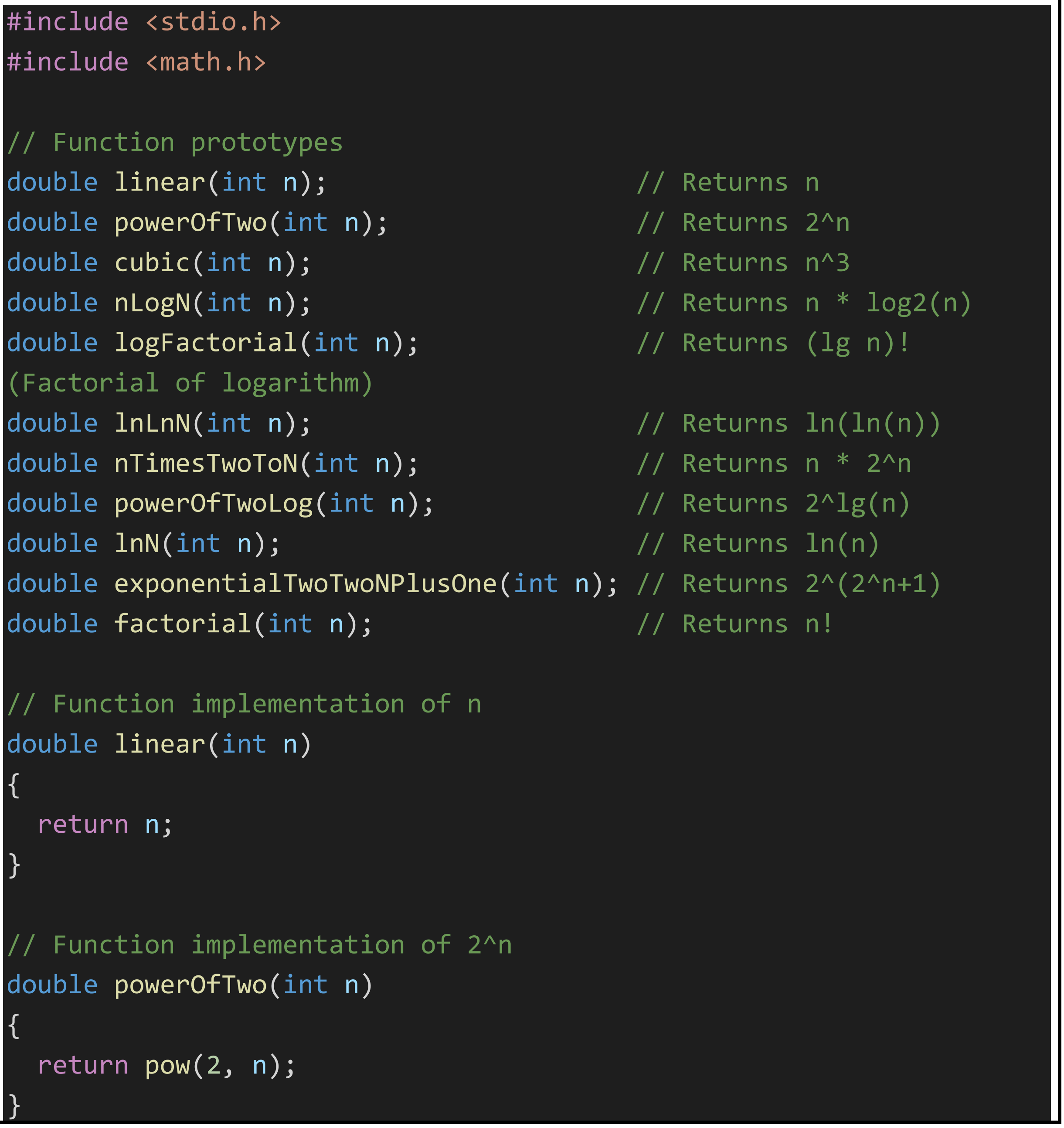
Department Of Computer Engineering

Name	Manish Shashikant Jadhav
UID	2023301005
Subject	Design and Analysis of Algorithms.
Experiment No.	1.A
Aim	To implement the various functions e.g. linear, non-linear, quadratic, exponential etc.

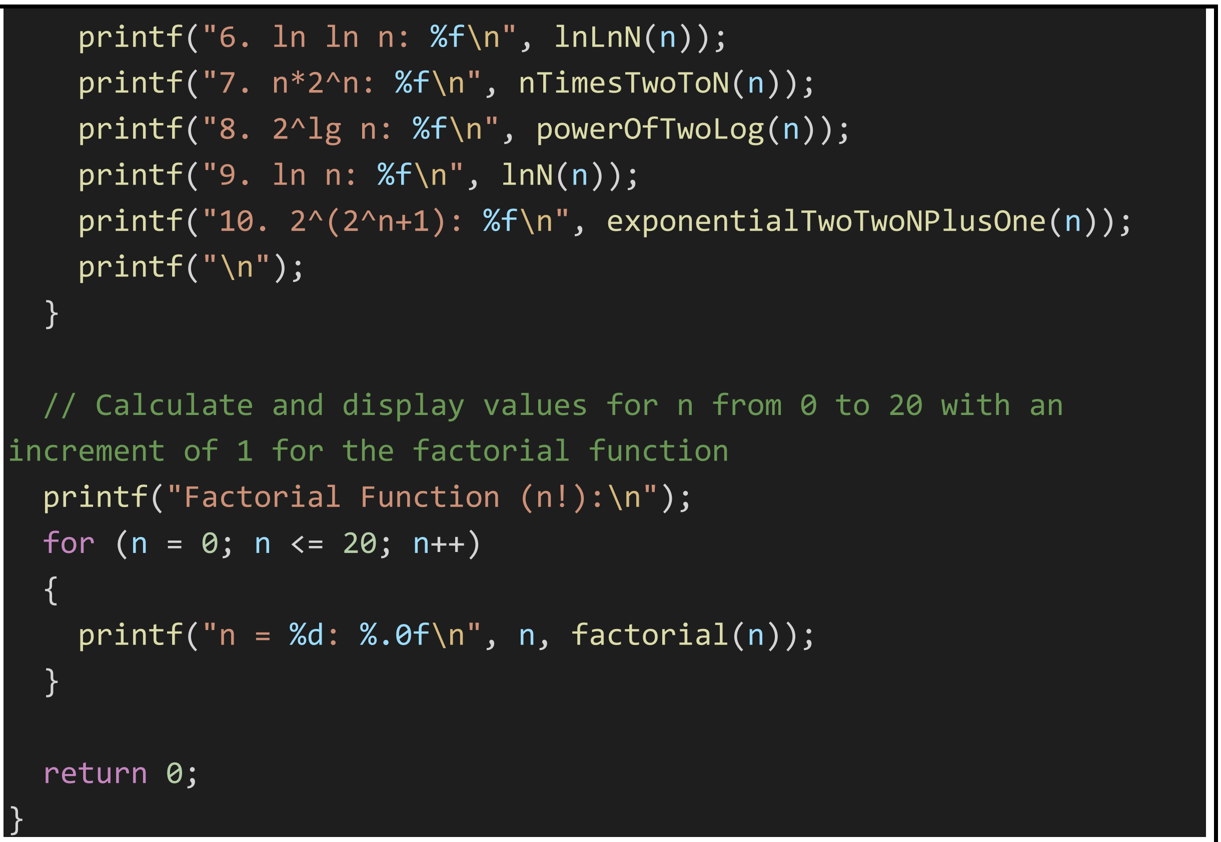
Code



```c
#include <stdio.h>
#include <math.h>

// Function prototypes
double linear(int n);                    // Returns n
double powerOfTwo(int n);                // Returns 2^n
double cubic(int n);                     // Returns n^3
double nLogN(int n);                     // Returns n * log2(n)
double logFactorial(int n);              // Returns (lg n)!
(Factorial of logarithm)
double lnLnN(int n);                     // Returns ln(ln(n))
double nTimesTwoToN(int n);              // Returns n * 2^n
double powerOfTwoLog(int n);             // Returns 2^lg(n)
double lnN(int n);                       // Returns ln(n)
double exponentialTwoTwoNPlusOne(int n); // Returns 2^(2^n+1)
double factorial(int n);                 // Returns n!

// Function implementation of n
double linear(int n)
{
  return n;
}

// Function implementation of 2^n
double powerOfTwo(int n)
{
  return pow(2, n);
}
```

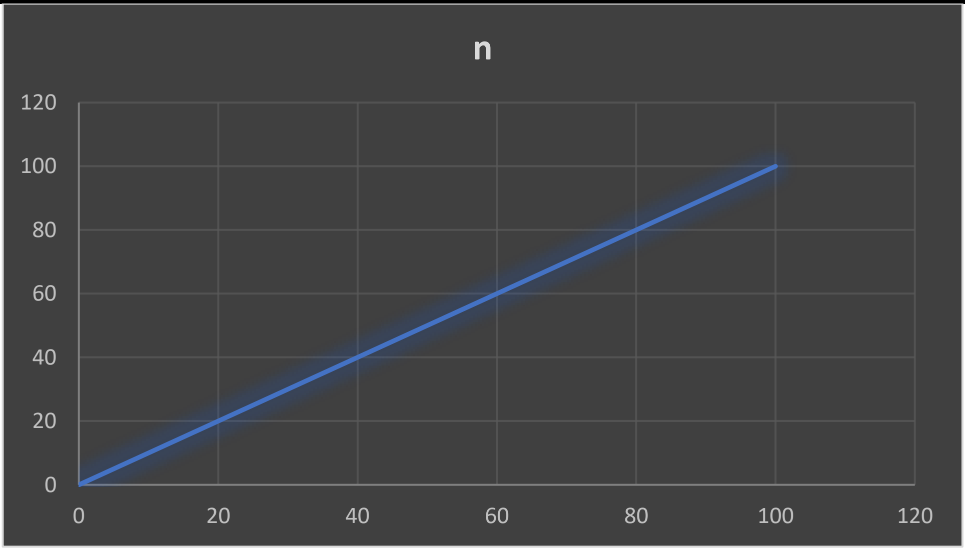
```
// Function implementation of n^3
double cubic(int n)
{
  return pow(n, 3);
}

// Function implementation of n * log2(n)
double nLogN(int n)
{
  return n * log2(n);
}

// Function implementation of (lg n)! (Factorial of logarithm)
double logFactorial(int n)
{
  return tgamma(log2(n) + 1); // Using tgamma for gamma function (factorial )
}

// Function implementation of ln(ln(n))
double lnLnN(int n)
{
  return log(log(n));
}

// Function implementation of n * 2^n
double nTimesTwoToN(int n)
{
  return n * pow(2, n);
}

// Function implementation of 2^lg(n)
double powerOfTwoLog(int n)
{
  return pow(2, log2(n));
}
```

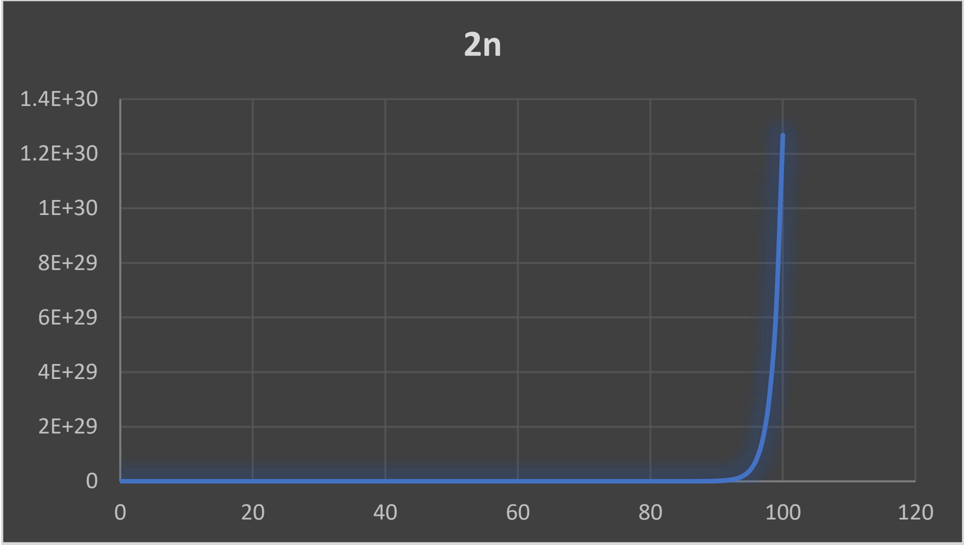
```

// Function implementation of ln(n)
double lnN(int n)
{
  return log(n);
}

// Function implementation of 2^(2^n+1)
double exponentialTwoTwoNPlusOne(int n)
{
  return pow(2, pow(2, n) + 1);
}

// Function implementation of n!
double factorial(int n)
{
  if (n == 0 || n == 1)
    return 1;
  else
    return n * factorial(n - 1);
}

int main()
{
  int n;

  // Calculate and display values for n from 0 to 100 with an increment of 1
  for (n = 0; n <= 100; n++)
  {
    printf("n = %d:\n", n);
    printf("1. n: %d\n", (int)linear(n));
    printf("2. 2^n: %f\n", powerOfTwo(n));
    printf("3. n^3: %f\n", cubic(n));
    printf("4. n lg n: %f\n", nLogN(n));
    printf("5. (lg n)! (Factorial of logarithm): %f\n", logFactorial(n));
```

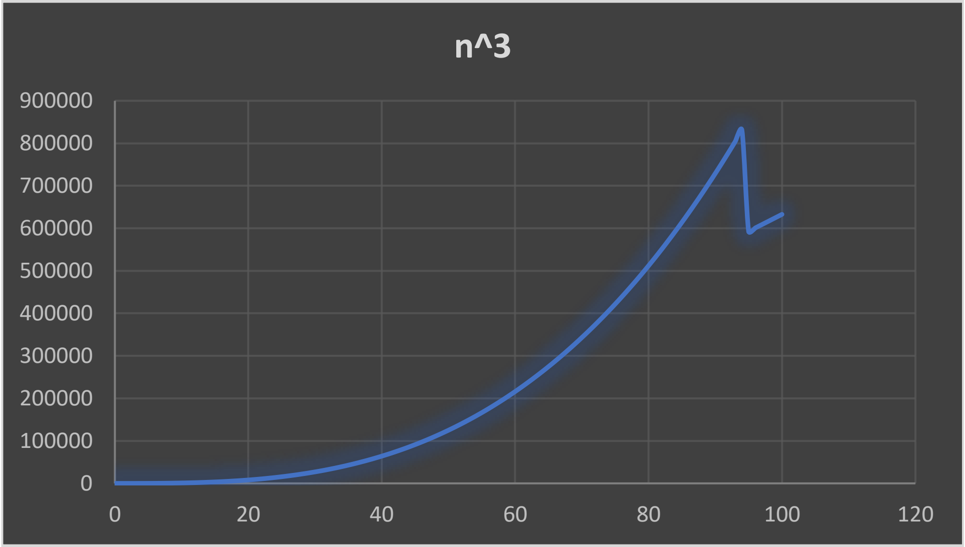


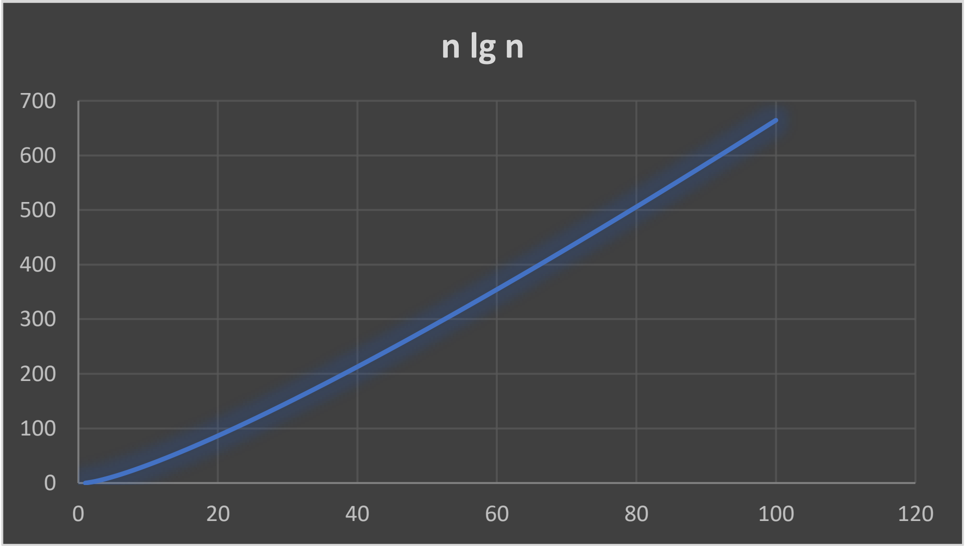
```
    printf("6. ln ln n: %f\n", lnLnN(n));
    printf("7. n*2^n: %f\n", nTimesTwoToN(n));
    printf("8. 2^lg n: %f\n", powerOfTwoLog(n));
    printf("9. ln n: %f\n", lnN(n));
    printf("10. 2^(2^n+1): %f\n", exponentialTwoTwoNPlusOne(n));
    printf("\n");
  }

  // Calculate and display values for n from 0 to 20 with an increment of 1 for the factorial function
  printf("Factorial Function (n!):\n");
  for (n = 0; n <= 20; n++)
  {
    printf("n = %d: %.0f\n", n, factorial(n));
  }

  return 0;
}
```

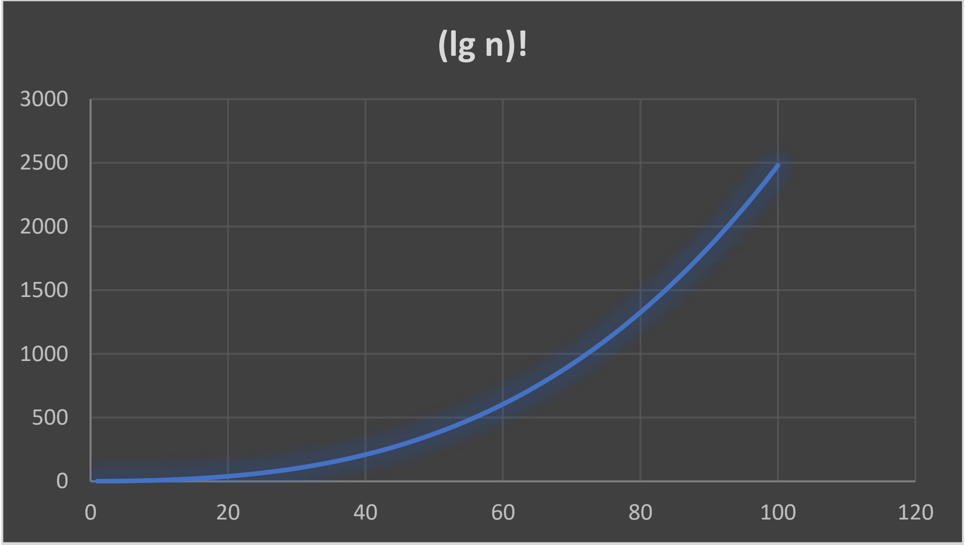
Graph

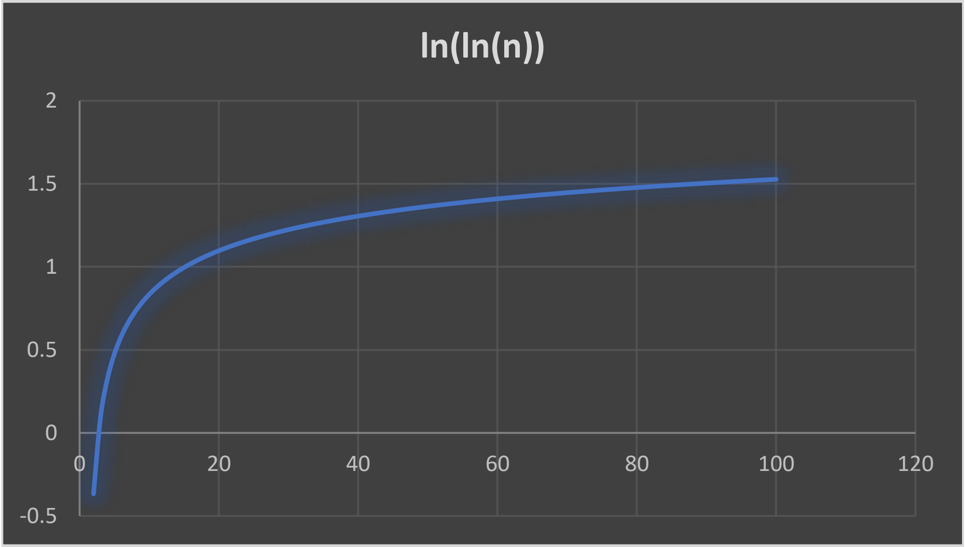


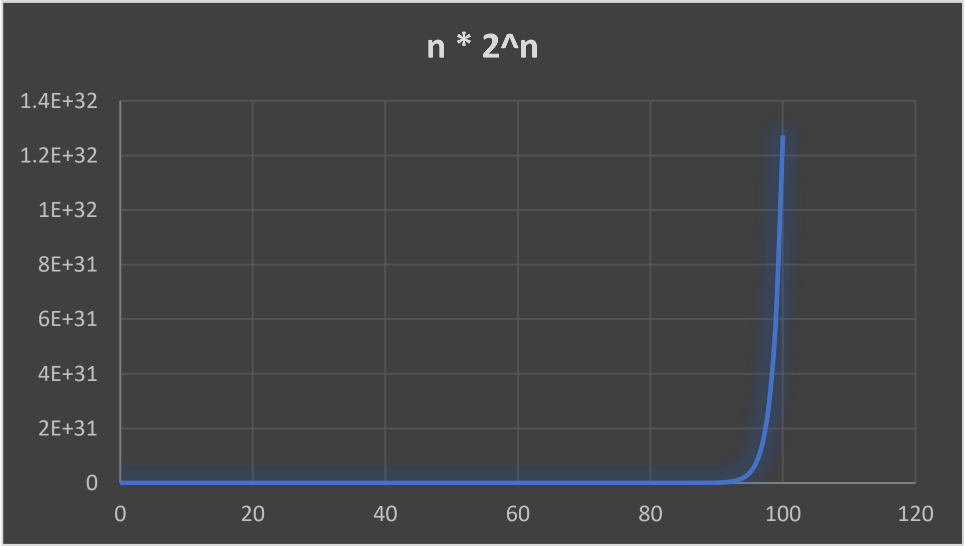

2n
1.4E+30
1.2E+30
1E+30
8E+29
6E+29
4E+29
2E+29
0
0
20
40
60
80
100
120

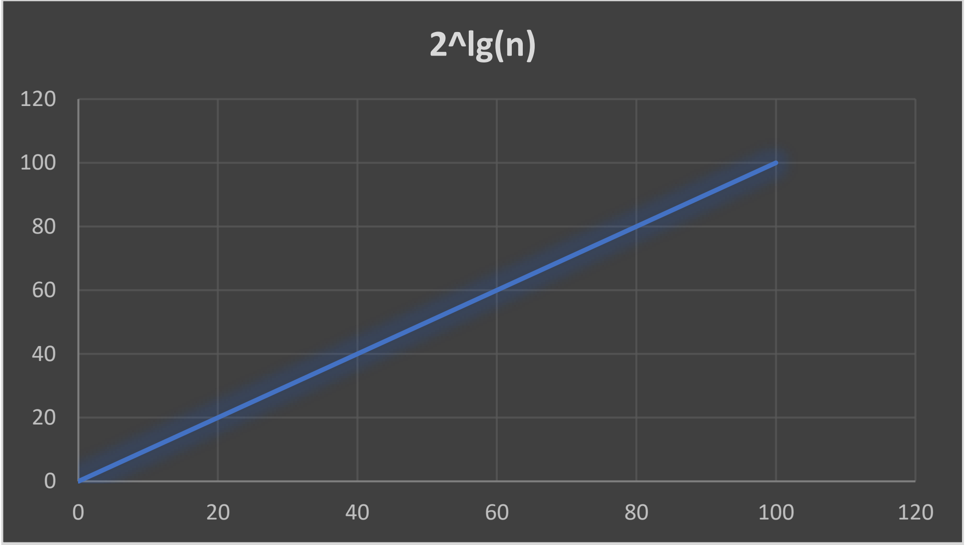

n^3
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
0
20
40
60
80
100
120

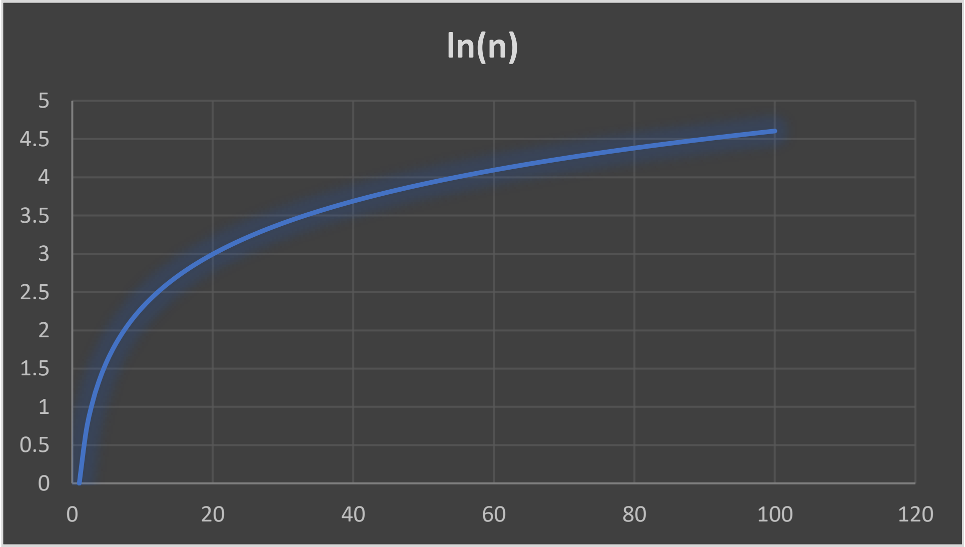

n lg n
700
600
500
400
300
200
100
0
0
20
40
60
80
100
120

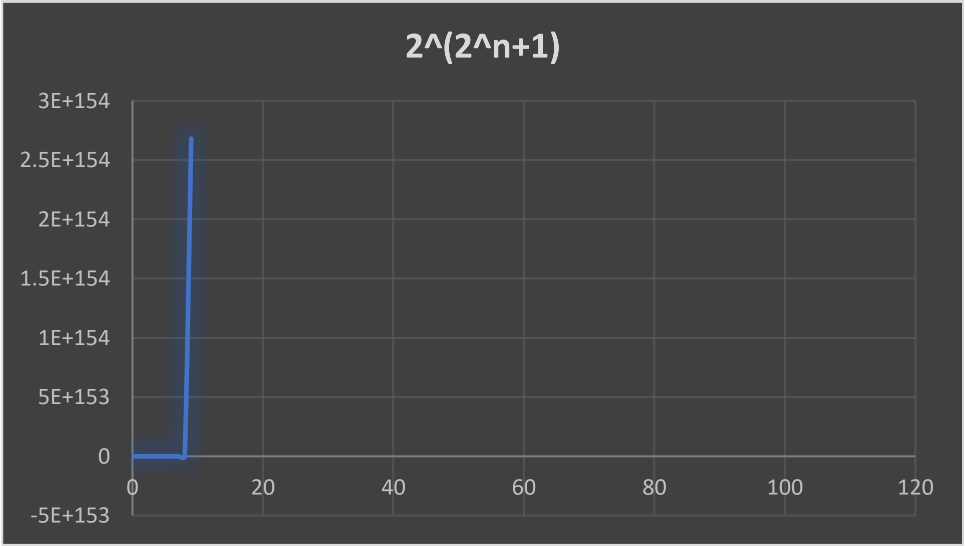

(lg n)!
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120

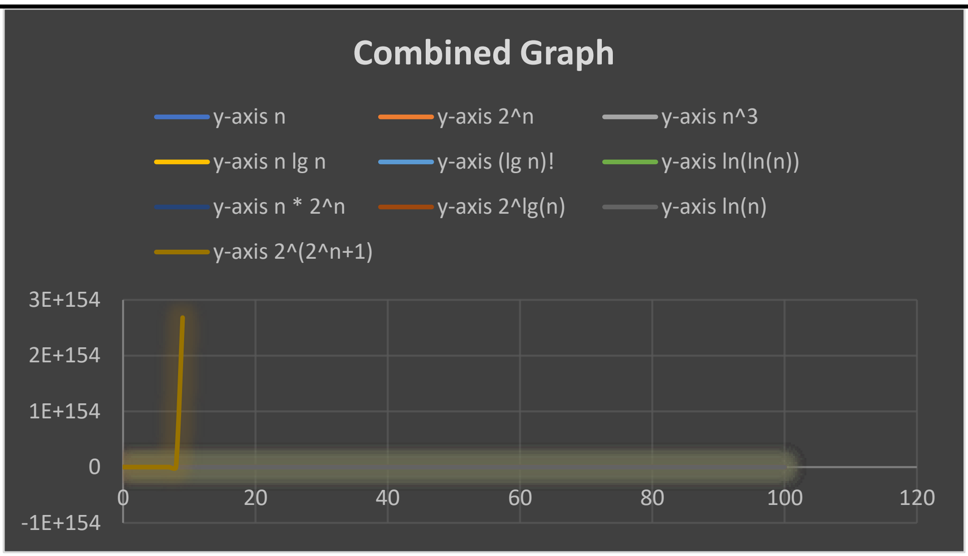

ln(ln(n))
2
1.5
1
0.5
0
-0.5
0
20
40
60
80
100
120


n * 2^n
1.4E+32
1.2E+32
1E+32
8E+31
6E+31
4E+31
2E+31
0
0
20
40
60
80
100
120

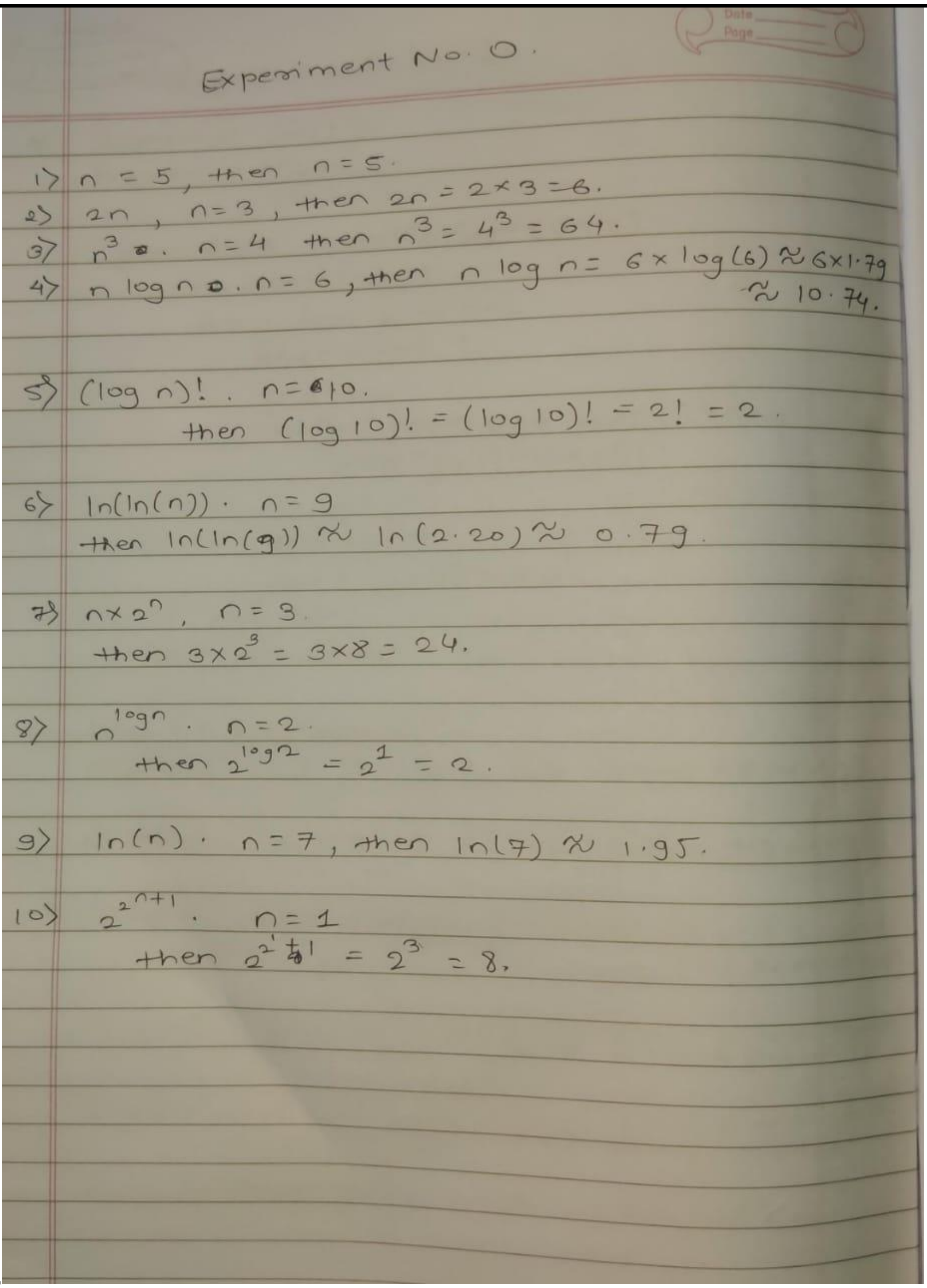

2^lg(n)
120
100
80
60
40
20
0
0
20
40
60
80
100
120

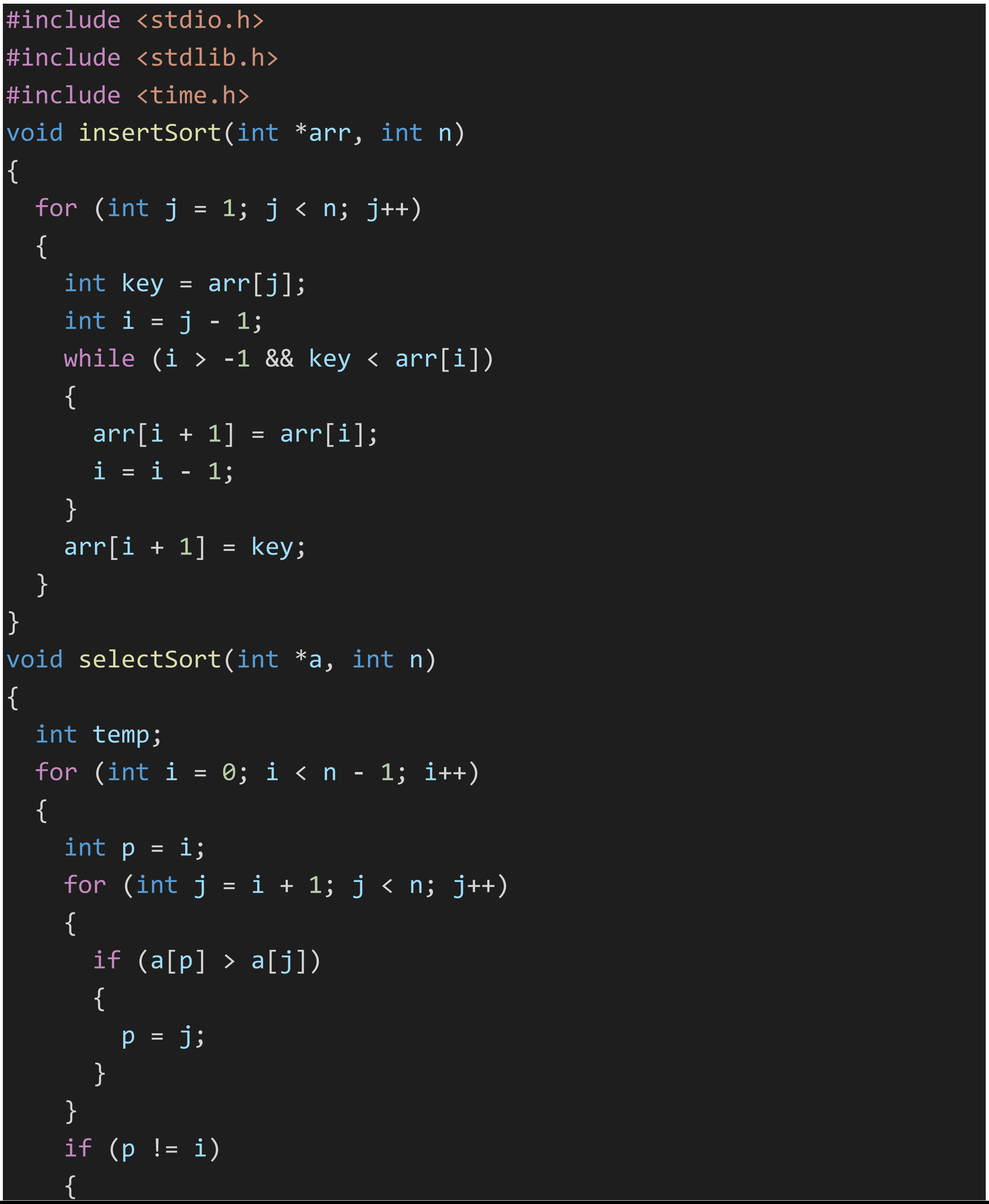

ln(n)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120


2^(2^n+1)
3E+154
2.5E+154
2E+154
1.5E+154
1E+154
5E+153
0
-5E+153
0
20
40
60
80
100
120

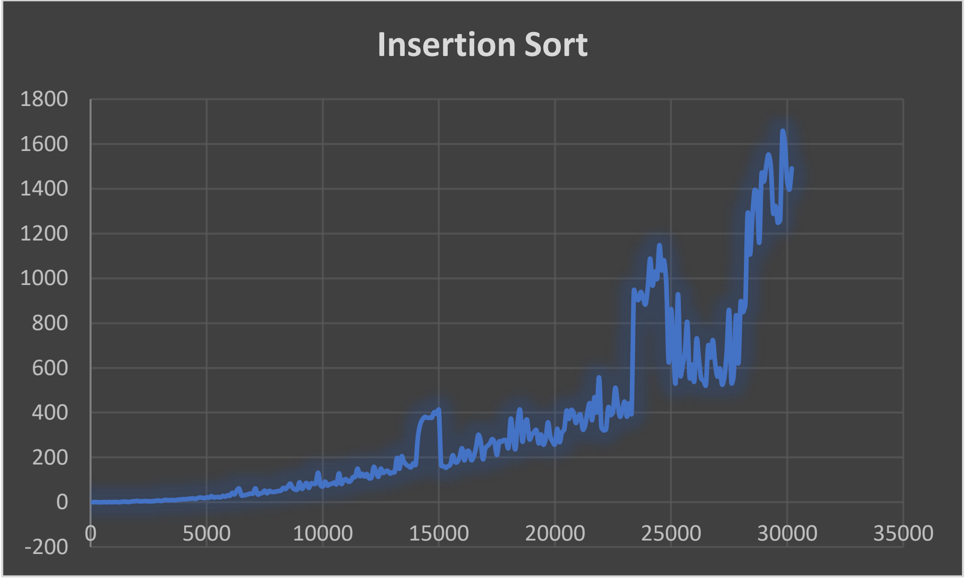
Combined Graph
y-axis n
y-axis 2^n
y-axis n^3
y-axis n lg n
y-axis (lg n)!
y-axis ln(ln(n))
y-axis n * 2^n
y-axis 2^lg(n)
y-axis ln(n)
y-axis 2^(2^n+1)
3E+154
2E+154
1E+154
0
-1E+154
0
20
40
60
80
100
120

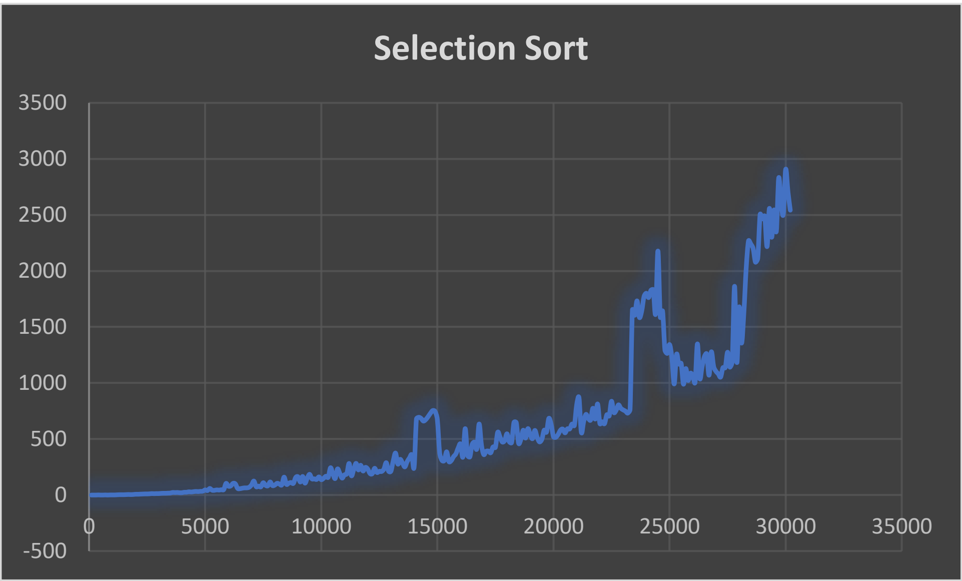
Solved Problem:	 Date Page Experiment No. 0. 1> $n = 5$, then $n = 5$. 2> $2n$, $n = 3$, then $2n = 2 \times 3 = 6$. 3> n^3. $n = 4$ then $n^3 = 4^3 = 64$. 4> $n \log n$. $n = 6$, then $n \log n = 6 \times \log(6) \approx 6 \times 1.79$ ≈ 10.74. 5> $(\log n)!$. $n = 10$. then $(\log 10)! = (\log 10)! = 2! = 2$. 6> $\ln(\ln(n))$. $n = 9$ then $\ln(\ln(9)) \approx \ln(2.20) \approx 0.79$. 7> $n \times 2^n$, $n = 3$. then $3 \times 2^3 = 3 \times 8 = 24$. 8> $n^{\log n}$. $n = 2$. then $2^{\log 2} = 2^1 = 2$. 9> $\ln(n)$. $n = 7$, then $\ln(7) \approx 1.95$. 10> 2^{2^n+1}. $n = 1$ then $2^{2^1+1} = 2^3 = 8$.
Conclusion	Hence, by completing this experiment I came to know about to implement the various functions e.g. linear, non-linear, quadratic, exponential etc.

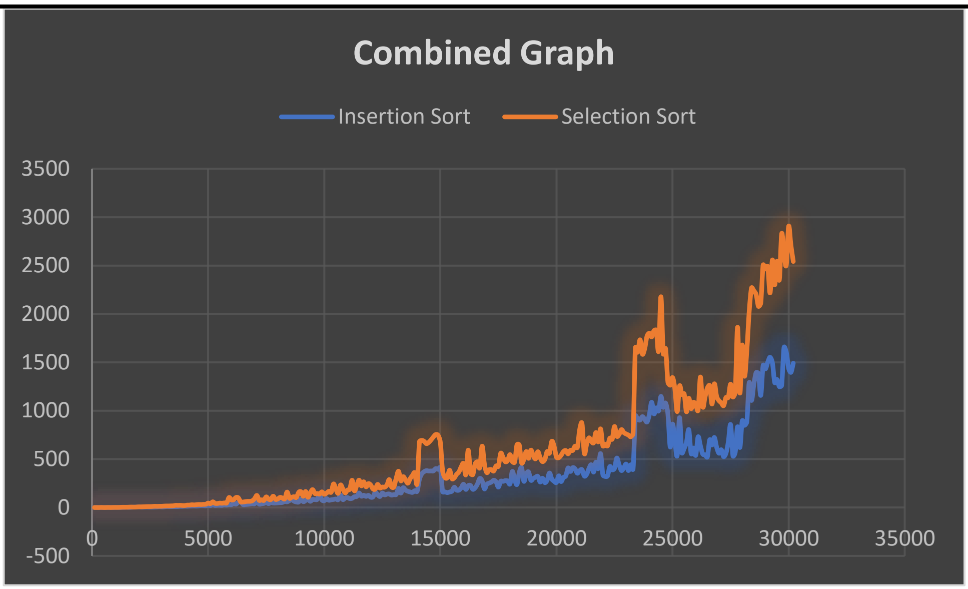
Experiment No.	1.B
Aim	Experiment on finding the running time of an algorithm(Insertion Sort and Selection Sort).
Code	

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
void insertSort(int *arr, int n)
{
  for (int j = 1; j < n; j++)
  {
    int key = arr[j];
    int i = j - 1;
    while (i > -1 && key < arr[i])
    {
      arr[i + 1] = arr[i];
      i = i - 1;
    }
    arr[i + 1] = key;
  }
}
void selectSort(int *a, int n)
{
  int temp;
  for (int i = 0; i < n - 1; i++)
  {
    int p = i;
    for (int j = i + 1; j < n; j++)
    {
      if (a[p] > a[j])
      {
        p = j;
      }
    }
    if (p != i)
    {
      temp = a[i];
      a[i] = a[p];
      a[p] = temp;
    }
  }
}
void main()
{
  srand(time(NULL));
  FILE *fileptr;
  FILE *fileptr1;
  int n = 100000;
  fileptr = fopen("inp.txt", "w");
  int arr[n];
  for (int j = 0; j < n; j++)
  {
    arr[j] = rand() % 100000 + 1;
    fprintf(fileptr, "%d\n", arr[j]);
  }
  fclose(fileptr);

  fileptr1 = fopen("time.csv", "w");
  printf("Block Size\tInsertion Sort\tSelection sort\n");

  fileptr = fopen("inp.txt", "r");
  for (int p = 99; p < n; p = p + 100)
  {
    int array[p + 1];
    int array1[p + 1];
    for (int j = 0; j < p; j++)
    {
      array[j] = arr[j];
      fscanf(fileptr, "%1d", &array1[j]);
    }
    clock_t begin = clock();
    insertSort(array, p + 1);
    clock_t mid = clock();
    selectSort(array1, p + 1);
    clock_t end = clock();
    double time_spent = (double)(mid - begin);
    double time_spent1 = (double)(end - mid);
    printf("%d\t%lf\t%lf\n", p + 1, time_spent, time_spent1);
    fprintf(fileptr1, "%d,%lf,%lf\n", p + 1, time_spent,
time_spent1);
  }
  printf("\n");
}
```

Graph:





Combined Graph
Insertion Sort
Selection Sort
3500
3000
2500
2000
1500
1000
500
0
-500
0
5000
10000
15000
20000
25000
30000
35000

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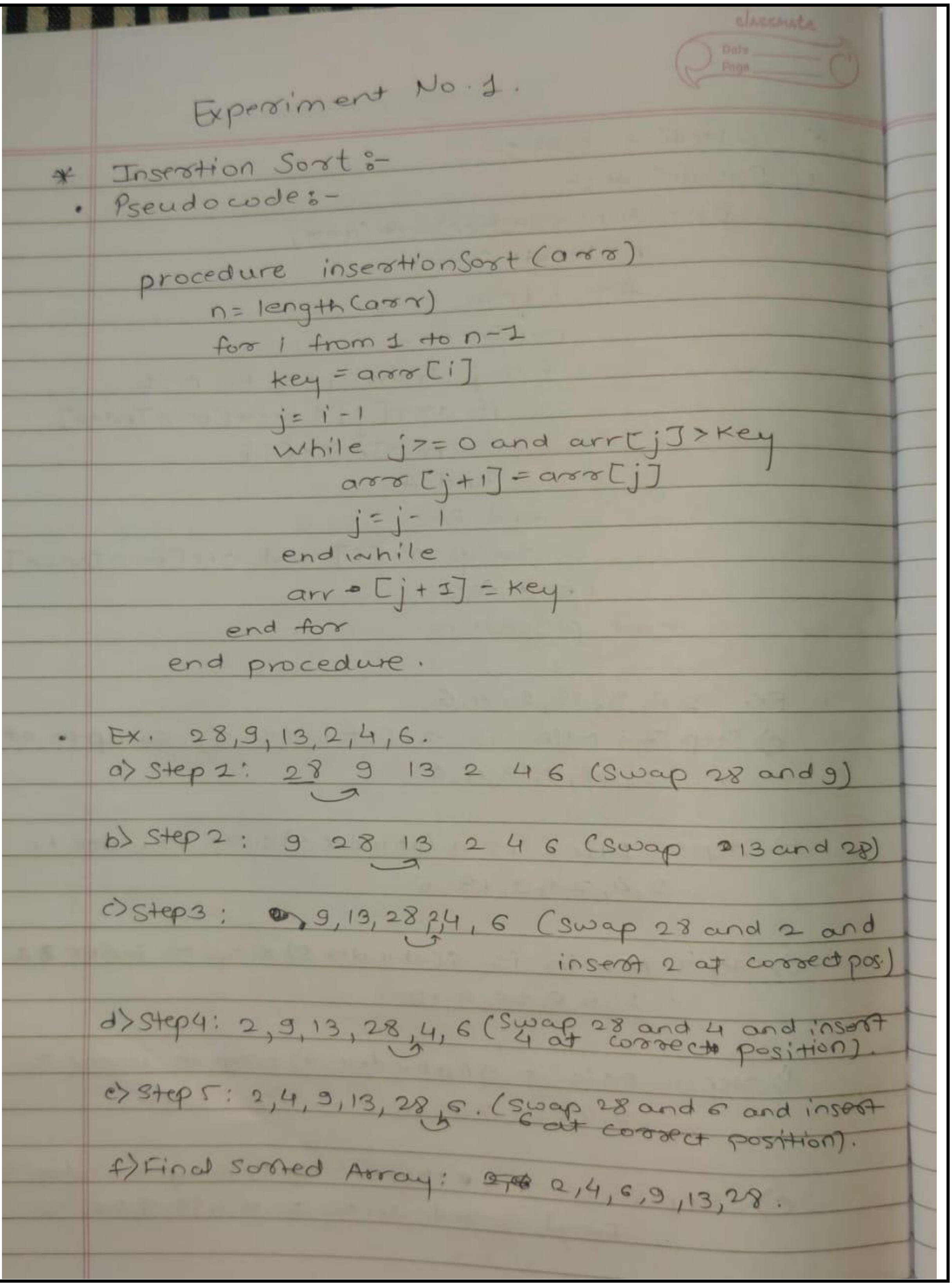
Insertion Sort Pseudocode and example:



Experiment No. 1.

* Insertion Sort :-

- Pseudocode:-

```
procedure insertionSort (arr)
    n= length(arr)
    for i from 1 to n-1
        key = arr[i]
        j= i-1
        while j>=0 and arr[j]>key
            arr [j+1] = arr[j]
            j=j-1
        end while
        arr [j+1] = key.
    end for
end procedure.
```

- Ex. 28,9,13,2,4,6.

a) Step 1: 28 9 13 2 4 6 (Swap 28 and 9)

b) Step 2 : 9 28 13 2 4 6 (Swap 13 and 28)

c) Step3 : 9,13,28,2,4, 6 (Swap 28 and 2 and insert 2 at correct pos.)

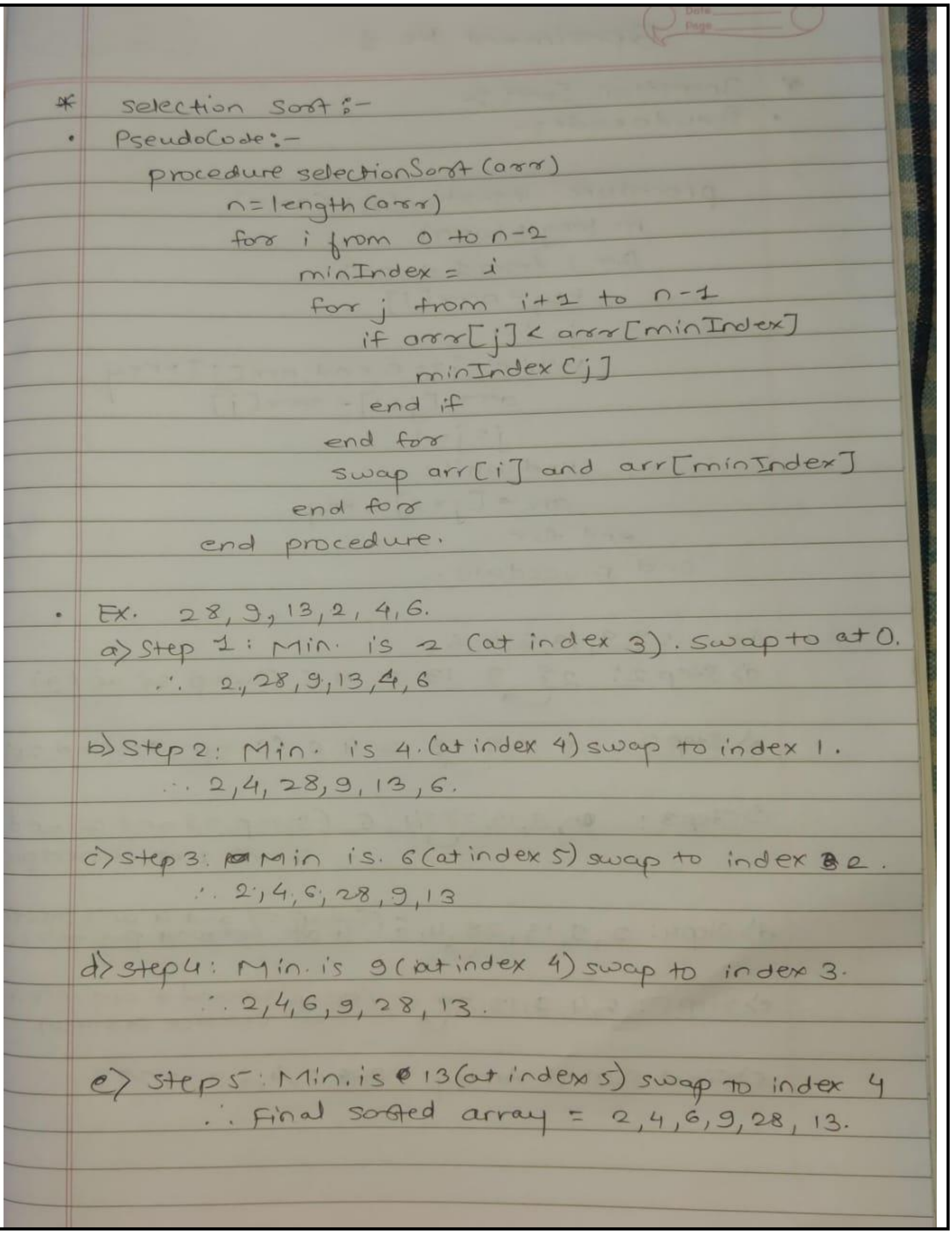
d) Step4: 2,9,13,28,4,6 (Swap 28 and 4 and insert 4 at correct position).

e) Step 5: 2,4,9,13,28,6. (Swap 28 and 6 and insert 6 at correct position).

f) Final sorted Array: 2,4,6,9,13,28.

Selection Sort

Pseudocode and example:



* Selection Sort :-

- PseudoCode :-

```
procedure selectionSort (arr)
    n= length (arr)
    for i from 0 to n-2
        minIndex = i
        for j from i+1 to n-1
            if arr[j] < arr[minIndex]
                minIndex [j]
            end if
        end for
        swap arr[i] and arr[minIndex]
    end for
end procedure.
```

- Ex. 28, 9, 13, 2, 4, 6.

a) Step 1: Min. is 2 (at index 3). Swap to at 0.
∴ 2, 28, 9, 13, 4, 6

b) Step 2: Min. is 4. (at index 4) swap to index 1.
∴ 2, 4, 28, 9, 13, 6.

c) Step 3: Min is. 6 (at index 5) swap to index 2.
∴ 2, 4, 6, 28, 9, 13

d) step 4: Min. is 9 (at index 4) swap to index 3.
∴ 2, 4, 6, 9, 28, 13.

e) step 5: Min. is 13 (at index 5) swap to index 4
∴ Final sorted array = 2, 4, 6, 9, 28, 13.

Conclusion	Hence, by completing this experiment I came to know about finding the running time of an algorithm(Insertion Sort and Selection Sort).