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## //1. i. Implement Insertion Sort (The program should report the number of comparisons)

//Test run the algorithm on 100 different inputs of sizes varying from
//30 to 1000. Count the number of comparisons and draw the graph.

```
#include<iostream>

#include<bits/stdc++.h>

using namespace std;

int y = 0;

void insertionsort(int arr[],int n){

  for(int i = 1;i<n;i++){

    int curr = arr[i];

    int prev = i-1;

    while(prev >= 0 && arr[prev]>curr){

      arr[prev+1] = arr[prev];

       prev--;

       y++;

    }
```

```
    arr[prev+1] = curr;
  }
}
void display(int array[], int size) {
  for(int i = 0; i<size; i++)
     cout << array[i] << " ";
  cout << endl;
}
void fun(int arr[],int s){
    int size = s;
    int u = 0;
    int b = 1000;
    arr[s];
 mt19937 num(random_device{}());
  uniform_int_distribution<int> dist(u,b);
for(int i= 0;i<s;i++){
    arr[i] = dist(num);
}
insertionsort(arr, size-1);     //(n-1) for last index
  cout << "Array after Sorting: ";
  display(arr, size);
}
int main(){
    int ub = 30;
```

```
 int lb = 1000;
 int size = 100;
int u = 0;
int arr[size] ;
mt19937
 num(random_device{}());
uniform_int_distribution<int> dist(ub, lb);
for (auto& i : arr) {
  i = dist(num);
}
 for (auto i : arr) {
  cout << i << " ";
}
cout << endl;
int c = 0;
 cout<<"No. of comparisons = "<<y<<endl;
ofstream myfile;
  myfile.open ("kartik.csv");
   myfile <<"Iteration No.,Array Size,Time ,Comparisons " <<" \n";
for(int j=0;j<100;j++){
  int s = arr[j];
  int ar[s];
  cout<<endl;
  cout<<"size of array  = "<<s<<endl;
```

```
  c++;
   clock_t time_req;
   time_req = clock();
 fun(ar,s);
time_req = clock()- time_req;
  cout << "Processor time taken for iteration "<<j+1<<" : "
      << (float)time_req/CLOCKS_PER_SEC << " seconds" << endl;
u = y - u;
 cout<<"No. of comparisons = "<<u<<endl;
  myfile <<j+1<<","<<s<<","<<(float)time_req/CLOCKS_PER_SEC<<","<<u<<" \n";
u = y;}
myfile.close();
cout<<endl;
cout<<"number of inputs sorted = "<<c;
}
```

kartik.csv

| Iteration No. | Array Size | Time | Comparisons |
|---|---|---|---|
| 1 | 575 | 0.14 | 84053 |
| 2 | 735 | 0.15 | 141331 |
| 3 | 368 | 0.08 | 34059 |
| 4 | 918 | 0.19 | 217476 |
| 5 | 35 | 0.01 | 326 |
| 6 | 607 | 0.13 | 92527 |
| 7 | 876 | 0.19 | 194681 |
| 8 | 530 | 0.12 | 71871 |
| 9 | 961 | 0.2 | 235020 |
| 10 | 976 | 0.2 | 241619 |
| 11 | 194 | 0.05 | 9419 |
| 12 | 672 | 0.14 | 117017 |
| 13 | 337 | 0.07 | 29288 |
| 14 | 543 | 0.11 | 75017 |
| 15 | 710 | 0.14 | 133121 |
| 16 | 795 | 0.15 | 163947 |
| 17 | 277 | 0.06 | 19711 |
| 18 | 101 | 0.02 | 2453 |
| 19 | 587 | 0.12 | 86694 |
| 20 | 350 | 0.07 | 31100 |
| 21 | 358 | 0.08 | 32749 |
| 22 | 596 | 0.13 | 89141 |
| 23 | 261 | 0.05 | 17353 |
| 24 | 60 | 0.01 | 844 |
| 25 | 197 | 0.04 | 9486 |
| 26 | 931 | 0.19 | 220456 |

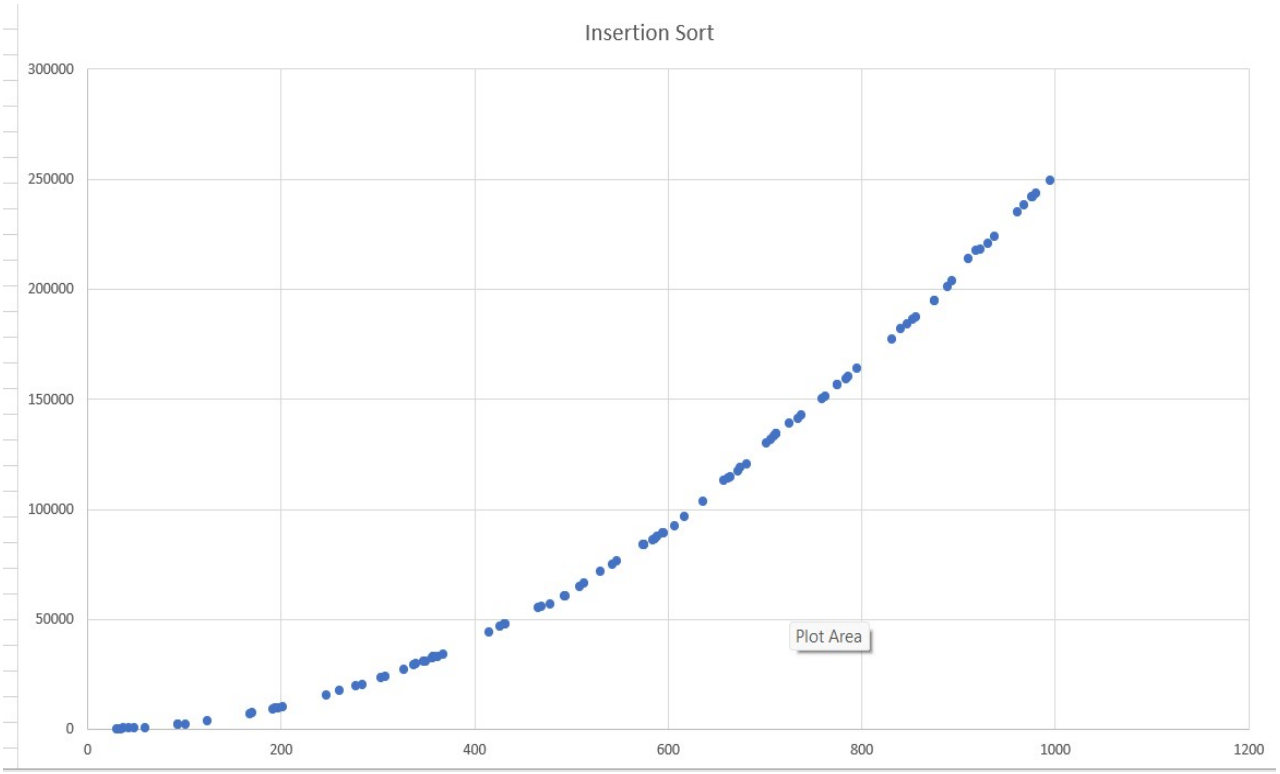
kartik.csv

| Iteration No. | Array Size | Time | Comparisons |
|---|---|---|---|
| 27 | 968 | 0.28 | 238246 |
| 28 | 49 | 0.01 | 579 |
| 29 | 664 | 0.16 | 114541 |
| 30 | 786 | 0.17 | 160191 |
| 31 | 493 | 0.11 | 60718 |
| 32 | 356 | 0.07 | 32225 |
| 33 | 94 | 0.02 | 2082 |
| 34 | 362 | 0.07 | 33136 |
| 35 | 43 | 0.01 | 454 |
| 36 | 432 | 0.09 | 47878 |
| 37 | 847 | 0.3 | 184169 |
| 38 | 911 | 0.19 | 213855 |
| 39 | 304 | 0.06 | 23375 |
| 40 | 662 | 0.14 | 113979 |
| 41 | 923 | 0.19 | 217862 |
| 42 | 584 | 0.12 | 85899 |
| 43 | 853 | 0.17 | 185951 |
| 44 | 37 | 0.01 | 378 |
| 45 | 574 | 0.13 | 83722 |
| 46 | 308 | 0.06 | 23800 |
| 47 | 893 | 0.18 | 203567 |
| 48 | 738 | 0.15 | 142613 |
| 49 | 31 | 0.01 | 238 |
| 50 | 712 | 0.14 | 134349 |
| 51 | 284 | 0.06 | 20356 |
| 52 | 469 | 0.1 | 55704 |

kartik.csv

| Iteration No. | Array Size | Time | Comparisons |
|---|---|---|---|
| 53 | 358 | 0.07 | 32749 |
| 54 | 247 | 0.05 | 15523 |
| 55 | 937 | 0.19 | 223776 |
| 56 | 876 | 0.18 | 194681 |
| 57 | 494 | 0.1 | 60765 |
| 58 | 726 | 0.3 | 139269 |
| 59 | 980 | 0.19 | 243408 |
| 60 | 889 | 0.18 | 201179 |
| 61 | 775 | 0.15 | 156627 |
| 62 | 356 | 0.07 | 32225 |
| 63 | 712 | 0.14 | 134349 |
| 64 | 681 | 0.14 | 120530 |
| 65 | 192 | 0.04 | 9242 |
| 66 | 617 | 0.12 | 96540 |
| 67 | 513 | 0.1 | 66564 |
| 68 | 94 | 0.02 | 2082 |
| 69 | 658 | 0.13 | 112892 |
| 70 | 775 | 0.15 | 156627 |
| 71 | 675 | 0.14 | 118662 |
| 72 | 832 | 0.18 | 177262 |
| 73 | 856 | 0.17 | 187285 |
| 74 | 170 | 0.03 | 7338 |
| 75 | 547 | 0.11 | 76323 |
| 76 | 32 | 0.01 | 256 |
| 77 | 327 | 0.07 | 27340 |
| 78 | 509 | 0.1 | 64995 |

| | | | | |
|---|---|---|---|---|
| | 79 | 348 | 0.19 | 30594 |
| | 80 | 124 | 0.03 | 3936 |
| | 81 | 431 | 0.08 | 47557 |
| | 82 | 702 | 0.14 | 129953 |
| | 83 | 575 | 0.11 | 84053 |
| | 84 | 636 | 0.14 | 103509 |
| | 85 | 706 | 0.15 | 131770 |
| | 86 | 763 | 0.16 | 151363 |
| | 87 | 589 | 0.12 | 87376 |
| | 88 | 478 | 0.1 | 56845 |
| | 89 | 340 | 0.06 | 29596 |
| | 90 | 784 | 0.15 | 159091 |
| | 91 | 995 | 0.2 | 249351 |
| | 92 | 759 | 0.15 | 150298 |
| | 93 | 595 | 0.12 | 88996 |
| | 94 | 977 | 0.2 | 241657 |
| | 95 | 415 | 0.09 | 44022 |
| | 96 | 202 | 0.04 | 9933 |
| | 97 | 427 | 0.09 | 46787 |
| | 98 | 466 | 0.1 | 54983 |
| | 99 | 168 | 0.04 | 7196 |
| | 100 | 841 | 0.29 | 181827 |




// ii. Implement Merge Sort (The program should report the number of comparisons)

```
#include<iostream>
#include<bits/stdc++.h>
#include <random>
using namespace std;
int y = 0;
void display(int arr[], int s) {
  for(int i = 0; i<s; i++)
    cout << arr[i] << " ";
  cout << endl;
}
```

```
void merge(int arr[], int si, int mid, int ei) {
  int i, j, k, nl, nr;
  nl = mid-si+1; nr = ei-mid;
  int larr[nl], rarr[nr];
  for(i = 0; i<nl; i++)
    larr[i] = arr[si+i];
  for(j = 0; j<nr; j++)
    rarr[j] = arr[mid+1+j];
  i = 0; j = 0; k = si;
  while(i < nl && j<nr) {
    if(larr[i] <= rarr[j]) {
      arr[k] = larr[i];
      i++;
    }else{
      arr[k] = rarr[j];
      j++;
    }
    k++;
   y++;
  }
  while(i<nl) {
    arr[k] = larr[i];
    i++; k++;
  }
```

```
  while(j<nr) {
    arr[k] = rarr[j];
    j++; k++;
  }
}
void mergeSort(int arr[], int si, int r) {
  int mid;
  if(si < r) {
    int mid = si+(r-si)/2;
    mergeSort(arr, si, mid);
    mergeSort(arr, mid+1, r);
    merge(arr, si, mid, r);
  }
}
void fun(int arr[],int s){
   int size = s;
   int u = 0;
   int b = 1000;
   arr[s];
 mt19937 pr(random_device{}());
  uniform_int_distribution<int> dist(u,b);
for(int i= 0;i<s;i++){
   arr[i] = dist(pr);
}
```

```
 mergeSort(arr, 0, size-1);
   cout << "Array after Sorting: ";
   display(arr, size);
}
int main() {
    int ub = 30;
   int lb = 1000;
   int size = 100;
  int u = 0;
  int arr[size] ;
  mt19937
   num(random_device{}());
  uniform_int_distribution<int> dist(ub, lb);
  for (auto& i: arr) {
    i = dist(num);
  }
   for (auto i: arr) {
    cout << i << " ";
  }
  cout << endl;
   int c = 0;
    ofstream myfile;
    myfile.open ("kartikey.csv");
     myfile <<"Iteration No.,Array Size,Time ,Comparisons " <<" \n";
```

```
    clock_t time_req;
for(int j=0;j<100;j++){
    int s = arr[j];
    int ar[s];
    cout<<endl;
    cout<<"size of array  = "<<s<<endl;
    c++;
     time_req = clock();
   fun(ar,s);
  time_req = clock()- time_req;
    cout << "Processor time taken for iteration "<<j+1<<" : "
        << (float)time_req/CLOCKS_PER_SEC << " seconds" << endl;
  u = y - u;
   cout<<"No. of comparisons = "<<u<<endl;
    myfile <<j+1<<","<<s<<","<<(float)time_req/CLOCKS_PER_SEC<<","<<u<<" \n";
  u = y;
}
myfile.close();
cout<<endl;
cout<<"number of inputs sorted = "<<c;
}
```

kartikey.csv

| Iteration No. | Array Size | Time | Comparisons |
|---|---|---|---|
| 1 | 575 | 0.07 | 4549 |
| 2 | 735 | 0.09 | 6070 |
| 3 | 368 | 0.05 | 2682 |
| 4 | 918 | 0.11 | 7868 |
| 5 | 35 | 0.01 | 139 |
| 6 | 607 | 0.07 | 4852 |
| 7 | 876 | 0.11 | 7482 |
| 8 | 530 | 0.07 | 4143 |
| 9 | 961 | 0.12 | 8307 |
| 10 | 976 | 0.12 | 8419 |
| 11 | 194 | 0.02 | 1214 |
| 12 | 672 | 0.07 | 5460 |
| 13 | 337 | 0.04 | 2397 |
| 14 | 543 | 0.06 | 4269 |
| 15 | 710 | 0.08 | 5823 |
| 16 | 795 | 0.12 | 6670 |
| 17 | 277 | 0.13 | 1894 |
| 18 | 101 | 0.01 | 543 |
| 19 | 587 | 0.08 | 4661 |
| 20 | 350 | 0.05 | 2513 |
| 21 | 358 | 0.05 | 2586 |
| 22 | 596 | 0.08 | 4731 |
| 23 | 261 | 0.03 | 1756 |
| 24 | 60 | 0.01 | 286 |
| 25 | 197 | 0.02 | 1242 |
| 26 | 931 | 0.11 | 8012 |

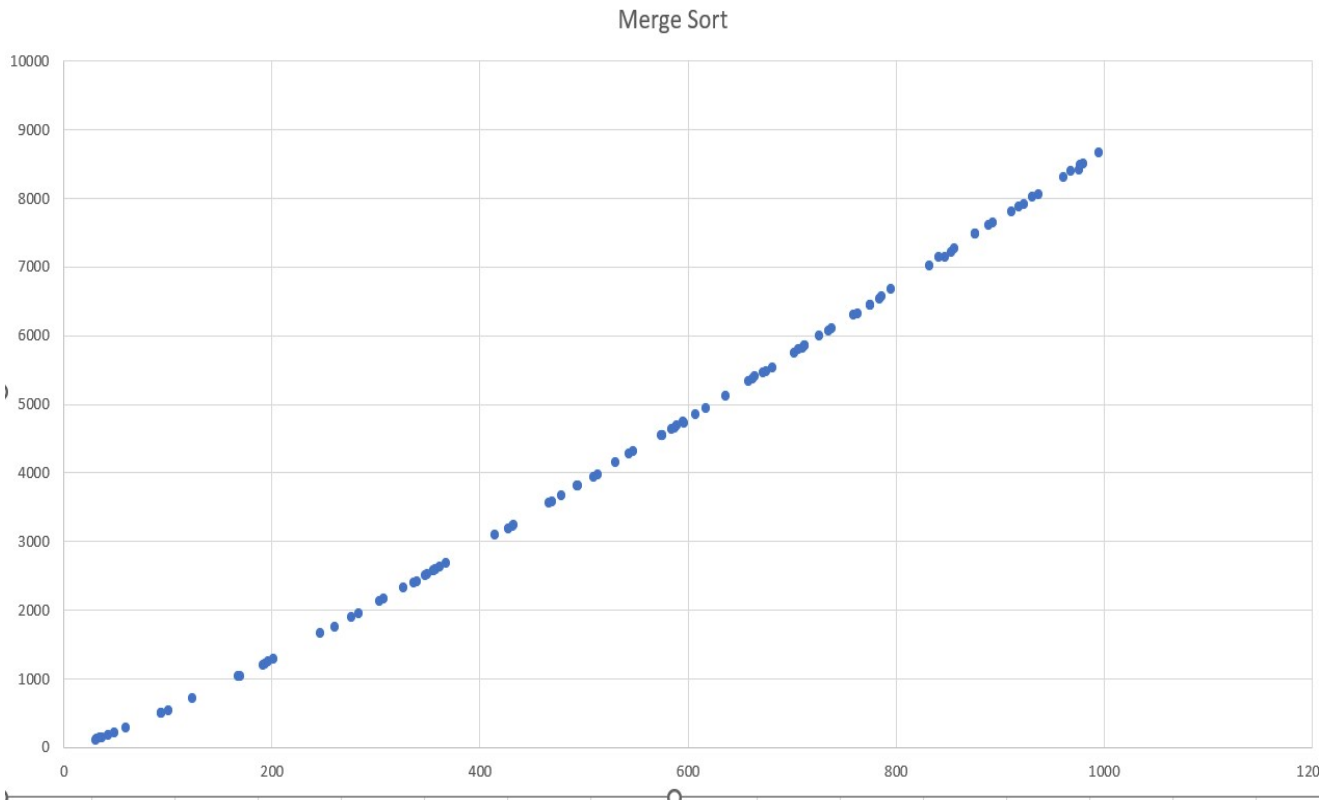
kartikey.csv

| Iteration No. | Array Size | Time | Comparisons |
|---|---|---|---|
| 27 | 968 | 0.11 | 8394 |
| 28 | 49 | 0.01 | 213 |
| 29 | 664 | 0.08 | 5401 |
| 30 | 786 | 0.09 | 6568 |
| 31 | 493 | 0.06 | 3812 |
| 32 | 356 | 0.04 | 2574 |
| 33 | 94 | 0.01 | 490 |
| 34 | 362 | 0.04 | 2626 |
| 35 | 43 | 0.01 | 178 |
| 36 | 432 | 0.05 | 3238 |
| 37 | 847 | 0.09 | 7146 |
| 38 | 911 | 0.1 | 7805 |
| 39 | 304 | 0.04 | 2126 |
| 40 | 662 | 0.08 | 5366 |
| 41 | 923 | 0.1 | 7915 |
| 42 | 584 | 0.07 | 4639 |
| 43 | 853 | 0.1 | 7221 |
| 44 | 37 | 0 | 144 |
| 45 | 574 | 0.13 | 4553 |
| 46 | 308 | 0.04 | 2157 |
| 47 | 893 | 0.1 | 7635 |
| 48 | 738 | 0.08 | 6094 |
| 49 | 31 | 0 | 113 |
| 50 | 712 | 0.08 | 5852 |
| 51 | 284 | 0.03 | 1956 |
| 52 | 469 | 0.05 | 3585 |

kartikey.csv

| Iteration No. | Array Size | Time | Comparisons |
|---|---|---|---|
| 53 | 358 | 0.04 | 2586 |
| 54 | 247 | 0.03 | 1660 |
| 55 | 937 | 0.11 | 8047 |
| 56 | 876 | 0.1 | 7482 |
| 57 | 494 | 0.06 | 3818 |
| 58 | 726 | 0.08 | 5993 |
| 59 | 980 | 0.11 | 8496 |
| 60 | 889 | 0.11 | 7607 |
| 61 | 775 | 0.09 | 6440 |
| 62 | 356 | 0.06 | 2574 |
| 63 | 712 | 0.11 | 5852 |
| 64 | 681 | 0.1 | 5536 |
| 65 | 192 | 0.03 | 1202 |
| 66 | 617 | 0.14 | 4945 |
| 67 | 513 | 0.07 | 3974 |
| 68 | 94 | 0.01 | 490 |
| 69 | 658 | 0.08 | 5336 |
| 70 | 775 | 0.09 | 6440 |
| 71 | 675 | 0.08 | 5473 |
| 72 | 832 | 0.1 | 7012 |
| 73 | 856 | 0.1 | 7259 |
| 74 | 170 | 0.02 | 1031 |
| 75 | 547 | 0.06 | 4314 |
| 76 | 32 | 0 | 118 |
| 77 | 327 | 0.04 | 2324 |
| 78 | 509 | 0.06 | 3941 |

| | | | | |
|---|---|---|---|---|
| | 79 | 348 | 0.04 | 2504 |
| | 80 | 124 | 0.02 | 713 |
| | 81 | 431 | 0.05 | 3227 |
| | 82 | 702 | 0.08 | 5740 |
| | 83 | 575 | 0.07 | 4549 |
| | 84 | 636 | 0.08 | 5114 |
| | 85 | 706 | 0.08 | 5796 |
| | 86 | 763 | 0.09 | 6325 |
| | 87 | 589 | 0.07 | 4686 |
| | 88 | 478 | 0.06 | 3672 |
| | 89 | 340 | 0.04 | 2414 |
| | 90 | 784 | 0.15 | 6533 |
| | 91 | 995 | 0.12 | 8654 |
| | 92 | 759 | 0.08 | 6296 |
| | 93 | 595 | 0.07 | 4734 |
| | 94 | 977 | 0.11 | 8477 |
| | 95 | 415 | 0.05 | 3094 |
| | 96 | 202 | 0.02 | 1289 |
| | 97 | 427 | 0.05 | 3192 |
| | 98 | 466 | 0.05 | 3558 |
| | 99 | 168 | 0.02 | 1031 |
| | 100 | 841 | 0.1 | 7137 |




# //same for heap sort

```
#include<iostream>

#include<bits/stdc++.h>

#include <random>

using namespace std;

int y = 0;

void heapify(int arr[],int i,int size){

 int left = 2*i + 1;

 int right = 2*i + 2;

 int maxidx = i;

 if(left<size && arr[left]>arr[maxidx]){
```

```
    maxidx = left;
    y++;
  }
  if(right<size && arr[right]>arr[maxidx]){
    maxidx = right;
    y++;
  }
  if( maxidx != i){
    int temp = arr[i];
    arr[i] = arr[maxidx];
    arr[maxidx] = temp;

heapify(arr,maxidx,size);
  }
}
void display(int arr[], int s) {
   for(int i = 0; i<s; i++)
      cout << arr[i] << " ";
   cout << endl;
}
void heapsort(int arr[],int n){
   // Build heap (rearrange array)
    for(int i=n/2;i>=0;i--){
        heapify(arr,i,n);
```

```
    }
     // One by one extract an element from heap and Moving current root to end
    for(int i=n-1;i>=0;i--){
      int temp = arr[0];
      arr[0] = arr[i];
      arr[i] = temp;
     // heapify on the reduced heap
        heapify(arr,0,i);
    }
}
void fun(int arr[],int s){
    int size = s;
    int u = 0;
    int b = 1000;
    arr[s];
    //generating random numbers and string them in the arr[s]
    // where s is the particular index of another 100 size array
 mt19937 pr(random_device{}());
  uniform_int_distribution<int> dist(u,b);
for(int i= 0;i<s;i++){
    arr[i] = dist(pr);
}
 heapsort(arr, size-1);
   cout << "Array after Sorting: ";
```

```
  display(arr, size);
}
int main(){
  int ub = 30;
   int lb = 1000;
   int size = 100;
  int u = 0;
  int arr[size] ;
//generating 100 random numbers and storing them in an array
  mt19937 num(random_device{}());
  uniform_int_distribution<int> dist(ub, lb);
  for (auto& i: arr) {
    i = dist(num);
  }
   for (auto i: arr) {
    cout << i << " ";
  }
  cout << endl;
   int c = 0;
    ofstream myfile;
    myfile.open ("kartikeyh.csv");
     myfile <<"Iteration No.,Time,Array Size ,Comparisons " <<" \n";
    clock_t time_req;
for(int j=0;j<100;j++){
```

```
  int s = arr[j];
  int ar[s];
  cout<<endl;
  cout<<"size of array  = "<<s<<endl;
  c++;
   time_req = clock();
 fun(ar,s);
time_req = clock()- time_req;
  cout << "Processor time taken for iteration "<<j+1<<" : "
      << (float)time_req/CLOCKS_PER_SEC << " seconds" << endl;
u = y - u;
 cout<<"No. of comparisons = "<<u<<endl;
  myfile <<j+1<<","<<(float)time_req/CLOCKS_PER_SEC<<","<<s<<","<<u<<" \n";
u = y;
}
myfile.close();
cout<<endl;
cout<<"number of inputs sorted = "<<c;
}
```

kartikeyh.csv

| Iteration No. | Time | Array Size | Comparisons |
|---|---|---|---|
| 1 | 0.15 | 575 | 5986 |
| 2 | 0.26 | 735 | 7976 |
| 3 | 0.25 | 368 | 3498 |
| 4 | 0.28 | 918 | 10480 |
| 5 | 0.02 | 35 | 151 |
| 6 | 0.14 | 607 | 6416 |
| 7 | 0.15 | 876 | 9905 |
| 8 | 0.1 | 530 | 5416 |
| 9 | 0.18 | 961 | 11111 |
| 10 | 0.18 | 976 | 11285 |
| 11 | 0.04 | 194 | 1567 |
| 12 | 0.13 | 672 | 7232 |
| 13 | 0.06 | 337 | 3154 |
| 14 | 0.1 | 543 | 5603 |
| 15 | 0.14 | 710 | 7731 |
| 16 | 0.14 | 795 | 8848 |
| 17 | 0.06 | 277 | 2480 |
| 18 | 0.02 | 101 | 691 |
| 19 | 0.1 | 587 | 6138 |
| 20 | 0.07 | 350 | 3285 |
| 21 | 0.07 | 358 | 3357 |
| 22 | 0.1 | 596 | 6226 |
| 23 | 0.15 | 261 | 2272 |
| 24 | 0.01 | 60 | 336 |
| 25 | 0.04 | 197 | 1616 |
| 26 | 0.17 | 931 | 10627 |
| 27 | 0.17 | 968 | 11151 |
| 28 | 0.02 | 49 | 249 |
| 29 | 0.12 | 664 | 7139 |
| 30 | 0.14 | 786 | 8746 |
| 31 | 0.1 | 493 | 4981 |
| 32 | 0.06 | 356 | 3324 |
| 33 | 0.02 | 94 | 617 |

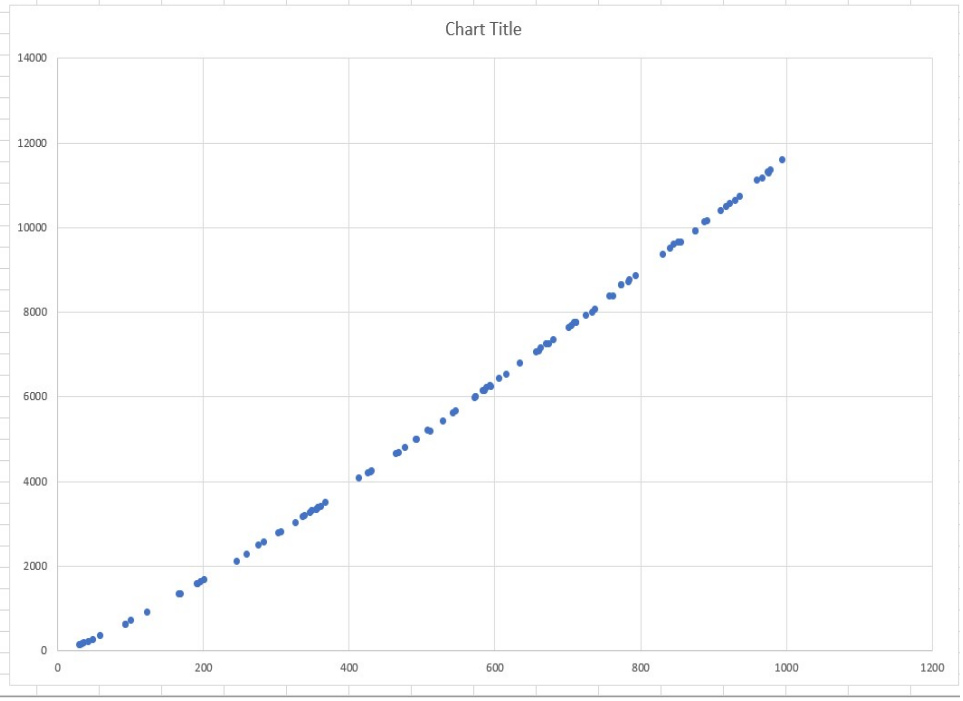
kartikeyh.csv

| Iteration No. | Time | Array Size | Comparisons |
|---|---|---|---|
| 34 | 0.06 | 362 | 3396 |
| 35 | 0.01 | 43 | 210 |
| 36 | 0.07 | 432 | 4227 |
| 37 | 0.16 | 847 | 9586 |
| 38 | 0.17 | 911 | 10393 |
| 39 | 0.06 | 304 | 2758 |
| 40 | 0.12 | 662 | 7064 |
| 41 | 0.18 | 923 | 10556 |
| 42 | 0.1 | 584 | 6133 |
| 43 | 0.17 | 853 | 9641 |
| 44 | 0.01 | 37 | 175 |
| 45 | 0.19 | 574 | 5957 |
| 46 | 0.06 | 308 | 2801 |
| 47 | 0.15 | 893 | 10141 |
| 48 | 0.14 | 738 | 8044 |
| 49 | 0.01 | 31 | 119 |
| 50 | 0.13 | 712 | 7732 |
| 51 | 0.05 | 284 | 2542 |
| 52 | 0.09 | 469 | 4660 |
| 53 | 0.06 | 358 | 3357 |
| 54 | 0.05 | 247 | 2101 |
| 55 | 0.18 | 937 | 10724 |
| 56 | 0.16 | 876 | 9905 |
| 57 | 0.09 | 494 | 4984 |
| 58 | 0.13 | 726 | 7906 |
| 59 | 0.18 | 980 | 11338 |
| 60 | 0.16 | 889 | 10108 |
| 61 | 0.14 | 775 | 8618 |
| 62 | 0.06 | 356 | 3324 |
| 63 | 0.13 | 712 | 7732 |
| 64 | 0.12 | 681 | 7342 |
| 65 | 0.04 | 192 | 1558 |
| 66 | 0.2 | 617 | 6508 |
| 67 | 0.09 | 513 | 5179 |

kartikeyh.csv

| Iteration No. | Time | Array Size | Comparisons |
|---|---|---|---|
| 68 | 0.02 | 94 | 617 |
| 69 | 0.12 | 658 | 7036 |
| 70 | 0.14 | 775 | 8618 |
| 71 | 0.12 | 675 | 7246 |
| 72 | 0.16 | 832 | 9348 |
| 73 | 0.15 | 856 | 9639 |
| 74 | 0.02 | 170 | 1323 |
| 75 | 0.1 | 547 | 5653 |
| 76 | 0.01 | 32 | 132 |
| 77 | 0.06 | 327 | 3020 |
| 78 | 0.1 | 509 | 5187 |
| 79 | 0.06 | 348 | 3244 |
| 80 | 0.02 | 124 | 884 |
| 81 | 0.08 | 431 | 4215 |
| 82 | 0.13 | 702 | 7610 |
| 83 | 0.1 | 575 | 5986 |
| 84 | 0.12 | 636 | 6782 |
| 85 | 0.14 | 706 | 7672 |
| 86 | 0.14 | 763 | 8372 |
| 87 | 0.1 | 589 | 6209 |
| 88 | 0.09 | 478 | 4790 |
| 89 | 0.16 | 340 | 3166 |
| 90 | 0.14 | 784 | 8691 |
| 91 | 0.18 | 995 | 11596 |
| 92 | 0.14 | 759 | 8369 |
| 93 | 0.11 | 595 | 6263 |
| 94 | 0.17 | 977 | 11276 |
| 95 | 0.07 | 415 | 4061 |
| 96 | 0.03 | 202 | 1660 |
| 97 | 0.07 | 427 | 4176 |
| 98 | 0.09 | 466 | 4647 |
| 99 | 0.03 | 168 | 1317 |
| 100 | 0.14 | 841 | 9488 |

| | A | B |
|---|---|---|
| 1 | 575 | 5986 |
| 2 | 735 | 7976 |
| 3 | 368 | 3498 |
| 4 | 918 | 10480 |
| 5 | 35 | 151 |
| 6 | 607 | 6416 |
| 7 | 876 | 9905 |
| 8 | 530 | 5416 |
| 9 | 961 | 11111 |
| 10 | 976 | 11285 |
| 11 | 194 | 1567 |
| 12 | 672 | 7232 |
| 13 | 337 | 3154 |
| 14 | 543 | 5603 |
| 15 | 710 | 7731 |
| 16 | 795 | 8848 |
| 17 | 277 | 2480 |
| 18 | 101 | 691 |
| 19 | 587 | 6138 |
| 20 | 350 | 3285 |
| 21 | 358 | 3357 |
| 22 | 596 | 6226 |
| 23 | 261 | 2272 |
| 24 | 60 | 336 |
| 25 | 197 | 1616 |
| 26 | 931 | 10627 |
| 27 | 968 | 11151 |
| 28 | 49 | 249 |
| 29 | 664 | 7139 |
| 30 | 786 | 8746 |
| 31 | 493 | 4981 |
| 32 | 356 | 3324 |
| 33 | 94 | 617 |




# Q3)//implementing randomized quicksort :-

```
#include<iostream>

#include<bits/stdc++.h>

using namespace std;

int y=0;

int partition(int arr[],int left,int right){

   int p = arr[right];

   int i = left-1; //holding elements smaller then pivot

   for(int j=left;j<right;j++){

      if( arr[j]<=p){

       i++;

       y++;
```

```
        int temp = arr[j];
        arr[j] = arr[i];
        arr[i] = temp;
       }
     }
      i++;
        int temp = p;
        arr[right] = arr[i];
        arr[i] = temp;
        return i;
        }
int partition_r(int arr[], int left, int right)
{
    // Generate a random number in between
    // low .. high
    srand(time(NULL));
    int random = left + rand() % (right - left);

    // Swap A[random] with A[high]
    swap(arr[random], arr[right]);

    return partition(arr, left, right);
}
```

```
void display(int arr[], int s) {
  for(int i = 0; i<s; i++)
     cout << arr[i] << " ";
  cout << endl;
}
void quicksort(int arr[],int left,int right){
   if(left>=right){
       return;
   }
  int pivot_index =  partition_r(arr,left,right);
  //cout<<pivot_index<<endl;
   quicksort(arr,left,pivot_index-1);
   quicksort(arr,pivot_index+1,right);
  }
  void fun(int arr[],int s){
   int size = s;
   int u = 0;
   int b = 1000;
   arr[s];
   //generating random numbers and string them in the arr[s]
   // where s is the particular index of another 100 size array
mt19937 pr(random_device{}());
 uniform_int_distribution<int> dist(u,b);
for(int i= 0;i<s;i++){
```

```
  arr[i] = dist(pr);
}
quicksort(arr,0,s-1);
  cout << "Array after Sorting: ";
  display(arr, size);
}
int main(){
  int ub = 30;
  int lb = 1000;
  int size = 100;
 int u = 0;
 int arr[size] ;
//generating 100 random numbers and storing them in an array
 mt19937 num(random_device{}());
 uniform_int_distribution<int> dist(ub, lb);
 for (auto& i: arr) {
   i = dist(num); }
  for (auto i: arr) {
   cout << i << " "; }
 cout << endl;
  int c = 0;
   ofstream myfile;
   myfile.open ("quick.csv");
    myfile <<"Iteration No.,Time,Array Size ,Comparisons " <<" \n";
```

```
  clock_t time_req;
for(int j=0;j<100;j++){
  int s = arr[j];
  int ar[s];
  cout<<endl;
  cout<<"size of array  = "<<s<<endl;
  c++;
   time_req = clock();
 fun(ar,s);
 time_req = clock()- time_req;
  cout << "Processor time taken for iteration "<<j+1<<" : "
      << (float)time_req/CLOCKS_PER_SEC << " seconds" << endl;
 u = y - u;
  cout<<"No. of comparisons = "<<u<<endl;
  myfile <<j+1<<","<<(float)time_req/CLOCKS_PER_SEC<<","<<s<<","<<u<<" \n";
 u = y; }
myfile.close();
cout<<endl;
cout<<"number of inputs sorted = "<<c; }
```

quick.csv

| Iteration No. | Time | Array Size | Comparisons |
|---|---|---|---|
| 1 | 0.42 | 575 | 2785 |
| 2 | 0.3 | 735 | 4154 |
| 3 | 0.1 | 368 | 1818 |
| 4 | 0.19 | 918 | 5267 |
| 5 | 0.01 | 35 | 129 |
| 6 | 0.12 | 607 | 2802 |
| 7 | 0.16 | 876 | 4097 |
| 8 | 0.1 | 530 | 2209 |
| 9 | 0.19 | 961 | 6120 |
| 10 | 0.17 | 976 | 5312 |
| 11 | 0.04 | 194 | 736 |
| 12 | 0.12 | 672 | 3294 |
| 13 | 0.06 | 337 | 1849 |
| 14 | 0.1 | 543 | 2374 |
| 15 | 0.13 | 710 | 3998 |
| 16 | 0.14 | 795 | 4562 |
| 17 | 0.06 | 277 | 1289 |
| 18 | 0.02 | 101 | 338 |
| 19 | 0.11 | 587 | 2602 |
| 20 | 0.06 | 350 | 1794 |
| 21 | 0.06 | 358 | 1453 |
| 22 | 0.1 | 596 | 4115 |
| 23 | 0.05 | 261 | 1134 |
| 24 | 0.01 | 60 | 198 |
| 25 | 0.04 | 197 | 753 |
| 26 | 0.17 | 931 | 5863 |

4

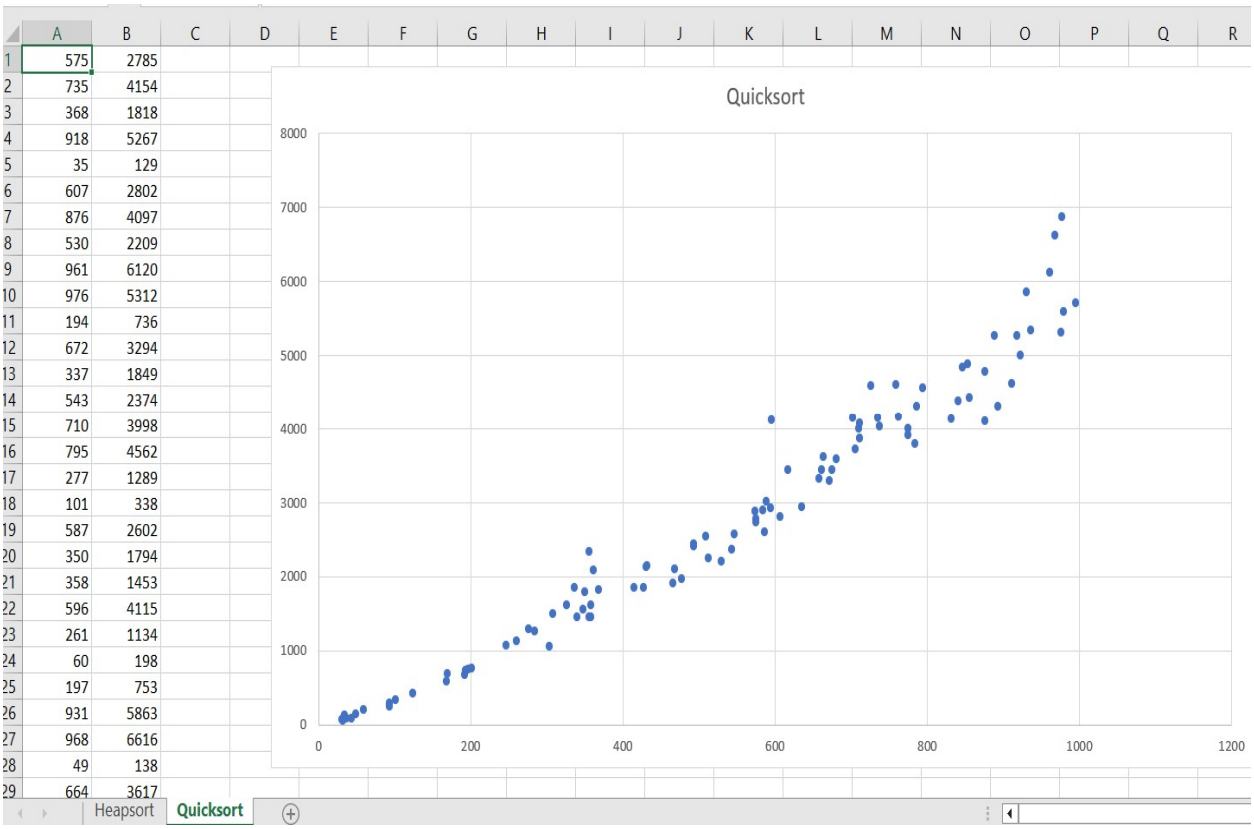
quick.csv

| Iteration No. | Time | Array Size | Comparisons |
|---|---|---|---|
| 53 | 0.06 | 358 | 1618 |
| 54 | 0.12 | 247 | 1077 |
| 55 | 0.16 | 937 | 5343 |
| 56 | 0.16 | 876 | 4787 |
| 57 | 0.09 | 494 | 2410 |
| 58 | 0.13 | 726 | 4589 |
| 59 | 0.18 | 980 | 5596 |
| 60 | 0.16 | 889 | 5271 |
| 61 | 0.14 | 775 | 3914 |
| 62 | 0.06 | 356 | 2344 |
| 63 | 0.13 | 712 | 3868 |
| 64 | 0.12 | 681 | 3586 |
| 65 | 0.03 | 192 | 668 |
| 66 | 0.11 | 617 | 3439 |
| 67 | 0.09 | 513 | 2248 |
| 68 | 0.02 | 94 | 298 |
| 69 | 0.12 | 658 | 3326 |
| 70 | 0.14 | 775 | 4006 |
| 71 | 0.11 | 675 | 3441 |
| 72 | 0.14 | 832 | 4132 |
| 73 | 0.24 | 856 | 4432 |
| 74 | 0.03 | 170 | 686 |
| 75 | 0.1 | 547 | 2568 |
| 76 | 0 | 32 | 62 |
| 77 | 0.06 | 327 | 1618 |
| 78 | 0.1 | 509 | 2549 |

mergesort.cpp heapsort.cpp heapoperations.cpp

quick.csv

| Iteration No. | Time | Array Size | Comparisons |
|---|---|---|---|
| 75 | 0.1 | 547 | 2568 |
| 76 | 0 | 32 | 62 |
| 77 | 0.06 | 327 | 1618 |
| 78 | 0.1 | 509 | 2549 |
| 79 | 0.06 | 348 | 1555 |
| 80 | 0.02 | 124 | 430 |
| 81 | 0.07 | 431 | 2135 |
| 82 | 0.12 | 702 | 4144 |
| 83 | 0.11 | 575 | 2741 |
| 84 | 0.11 | 636 | 2947 |
| 85 | 0.12 | 706 | 3728 |
| 86 | 0.14 | 763 | 4157 |
| 87 | 0.1 | 589 | 3018 |
| 88 | 0.09 | 478 | 1968 |
| 89 | 0.06 | 340 | 1451 |
| 90 | 0.15 | 784 | 3794 |
| 91 | 0.18 | 995 | 5705 |
| 92 | 0.14 | 759 | 4610 |
| 93 | 0.11 | 595 | 2929 |
| 94 | 0.18 | 977 | 6876 |
| 95 | 0.14 | 415 | 1853 |
| 96 | 0.04 | 202 | 761 |
| 97 | 0.07 | 427 | 1859 |
| 98 | 0.08 | 466 | 1906 |
| 99 | 0.03 | 168 | 586 |
| 100 | 0.15 | 841 | 4380 |




| | A | B |
|---|---|---|
| 1 | 575 | 2785 |
| 2 | 735 | 4154 |
| 3 | 368 | 1818 |
| 4 | 918 | 5267 |
| 5 | 35 | 129 |
| 6 | 607 | 2802 |
| 7 | 876 | 4097 |
| 8 | 530 | 2209 |
| 9 | 961 | 6120 |
| 10 | 976 | 5312 |
| 11 | 194 | 736 |
| 12 | 672 | 3294 |
| 13 | 337 | 1849 |
| 14 | 543 | 2374 |
| 15 | 710 | 3998 |
| 16 | 795 | 4562 |
| 17 | 277 | 1289 |
| 18 | 101 | 338 |
| 19 | 587 | 2602 |
| 20 | 350 | 1794 |
| 21 | 358 | 1453 |
| 22 | 596 | 4115 |
| 23 | 261 | 1134 |
| 24 | 60 | 198 |
| 25 | 197 | 753 |
| 26 | 931 | 5863 |
| 27 | 968 | 6616 |
| 28 | 49 | 138 |
| 29 | 664 | 3617 |

# Q4) Implement Radix Sort :-

```
#include<iostream>

using namespace std;


int getmax(int arr[],int n){

   int m = arr[0];

  for(int i=1;i<n;i++){

   if(arr[i]>m){

       m = arr[i];

   }

  }
```

```
  return m;
}

void countsort(int arr[],int n,int p){
     int b[n];
   int c[10] = {0};
   for(int i=0;i<n;i++){
    ++c[(arr[i]/p)%10];
   }
   for(int i=1;i<=n;i++){
    c[i]=c[i]+c[i-1];
   }
   for(int i=n-1;i>=0;i--){
     b[--c[(arr[i]/p)%10]] = arr[i];
   }
   for(int i=0;i<n;i++){
    arr[i]=b[i];

   }

}

void radixsort(int arr[],int n){
    int m = getmax(arr,n);
```

```
    for(int i=1;m/i>0;i*=10){
        countsort(arr,n,i);
    }
    for(int i=0;i<n;i++){
    cout<<arr[i]<<" ";
   }
}
int main(){
   int arr[] = {663,562,385,211,906,328};
   int n = 6;
   radixsort(arr,n);
}
```

```
PROBLEMS    OUTPUT    TERMINAL    DEBUG CONSOLE

Windows PowerShell
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Install the latest PowerShell for new features and improvements

PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>  & 'c:
gLauncher.exe' '--stdin=Microsoft-MIEngine-In-be0xwjii.kdc' '--
pid=Microsoft-MIEngine-Pid-53ksteil.44p' '--dbgExe=C:\Program F
32 32 211 385 562 663
PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>
```

# Q5) Implement Bucket Sort :-

```
#include <algorithm>
#include <iostream>
#include <vector>
using namespace std;
void bucketSort(float arr[], int n)
{
    vector<float> b[n];
    for (int i = 0; i < n; i++) {
        int bi = n * arr[i];
        b[bi].push_back(arr[i]);
    }
    for (int i = 0; i < n; i++)
        sort(b[i].begin(), b[i].end());
    int index = 0;
    for (int i = 0; i < n; i++)
        for (int j = 0; j < b[i].size(); j++)
            arr[index++] = b[i][j];
}
int main()
{
    float arr[]
        = { 0.837, 0.565, 0.65, 0.124, 0.065, 0.344 };
    int n = sizeof(arr) / sizeof(arr[0]);
```

```
    bucketSort(arr, n);


    cout << "Sorted array is \n";
    for (int i = 0; i < n; i++)
        cout << arr[i] << " ";
    return 0;
}
```

```
PROBLEMS    OUTPUT    TERMINAL    DEBUG CONSOLE

Windows PowerShell
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Install the latest PowerShell for new features and improvements! https:/

PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>  & 'c:\Users\AS
gLauncher.exe' '--stdin=Microsoft-MIEngine-In-41tc0o2n.sjb' '--stdout=Mi
pid=Microsoft-MIEngine-Pid-cepter0m.anw' '--dbgExe=C:\Program Files (x86
Sorted array is
0.065 0.124 0.344 0.565 0.65 0.837
PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>
```

# Q6) Implement Randomized Select :-

```
#include<iostream>
#include<time.h>
#include<ctime>
using namespace std;
```

```
// Creating the Exchange function :
void exchange(int &a,int &b){
   int temp=a;
   a=b;
   b=temp;
}



// function to select a random number between two given numbers :
/*int Random(int p,int r){
   srand(time(NULL));
   int x= rand()%r;
   return x;
}*/
// Creating the Partition Function :
int Partiton(int A[], int p,int r){
int x=A[r];
int i=(p-1);
for(int j=p;j<=r-1;j++){
if(A[j] <=x){
   i=i+1;
   exchange(A[i],A[j]);
```

```
}
}
exchange(A[i+1],A[r]);
return (i+1);
}

// Creating the random partiton function :
int Randomized_Partiton(int A[],int p,int r){
   int i=r;
   exchange(A[r],A[i]);
   return Partiton(A,p,r);
}

// Randomized Select :
int Randomized_Select(int A[],int p,int r,int i){
   if(p==r)
      return A[p];
   int q=Randomized_Partiton(A,p,r);
   int k=q-p+1;
   if (i==k){
      return A[q];
   }
```

```
    else if (i<k){
        return Randomized_Select(A,p,q-1,i);
    }
    else{
        return Randomized_Select(A,q+1,r,i-k);
    }
}
//Driver Code :
int main(){
   int A[]={5,2,7,9,6,12,4,3,16,14};
   cout<<"\nThe array is :  ";
   for(int e:A){
    cout<<e<<"  ";
   }
   cout<<endl;
    cout<<"The 1 st order statistics is :
"<<Randomized_Select(A,0,9,1)<<endl;
    cout<<"The 3 th order statistics is :
"<<Randomized_Select(A,0,9,3)<<endl;
    cout<<"The 10 th order statistics is
:"<<Randomized_Select(A,0,9,10)<<endl<<endl;
    return 0;
}
```

```
The array is :  5  2  7  9  6  12  4  3  16  14
The 1 st order statistics is : 2
The 3 th order statistics is : 4
The 10 th order statistics is :16

PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>
```

# Q7) Implement Breadth-First Search in a graph :-

```
#include <bits/stdc++.h>

#include <iostream>

#include<algorithm>

#include <iomanip>

using namespace std;

const int s = 100;

void bfs(queue<int>b){

   while(!b.empty()){

      cout<<b.front()<<" ";

      b.pop();

   }

}

void visited(vector<int>& v,queue<int>& b,int admatrrix[][s],int size){

   int c=0;

   for(int i=1;i<=size;i++){

      for (int j=1;j<=size;j++)
```

```
        if(admatrrix[i][j]!=0 && c==0){

            v.push_back(i);
            b.push(i);
            v.push_back(j);
            b.push(j);
            c++;
        }
       else  if(admatrrix[i][j]!=0){
            int c=count(v.begin(),v.end(),j);
            if(c==0){
                v.push_back(j);
                b.push(j);
            }
        }
    }

}
int main()
{
    int size, size1, size2;

    cout << "Enter the number of verteces";
    cin >> size;
```

```
cout << endl;
int admattrix[s][s];
for (int i = 1; i <= size; i++)
{
   for (int j = 1; j <= size; j++)
   {
      admattrix[i][j] = 0;
   }
}
cout << "Enter the number of edges ";
cin >> size1;
int s1, s2, w;

int w1, u, v;
queue<int>b;
vector<int>v1;
cout << "Enter the vertex1 and vertex2";
for (int i = 1; i <= size1; i++)
{
   cin >> u >> v;

   admattrix[u][v] = 1;
   admattrix[v][u] = 1;
```

```
    }
    cout<<"\n adjacency matrix \n";
    cout << " ";
    for (int i = 1; i <= size; i++)
    {
        cout << setw(4) << " " << i;
    }
    cout << endl;
    for (int i = 1; i <= size; i++)
    {
        cout << i;
        for (int j = 1; j <= size; j++)
        {
            cout << setw(5) << admattrix[i][j];
        }
        cout << endl;
    }cout<<"\nbfs of graph :  ";
visited(v1,b,admattrix,size);

bfs(b);
    return 0;
}
```

```
Enter the number of verteces4

Enter the number of edges 4
Enter the vertex1 and vertex22 3

4

5
6
7
8
9

 adjacency matrix
     1    2    3    4
1    0    0    0    0
2    0    0    1    0
3    0    1    0    0
4    0    0    0    0

bfs of graph :  2 3
```

# Q8) Implement Depth-First Search in a graph :-

```
#include <bits/stdc++.h>

#include <iostream>

#include<algorithm>

#include <iomanip>

using namespace std;

const int s = 100;

void dfs(queue<int>b){

   while(!b.empty()){

      cout<<b.front()<<" ";
```

```
        b.pop();
    }
}
void visited(vector<int>& v,queue<int>& b,stack<int>& s1,int admatrrix[][s],int
size){
    int c=0;
    for(int i=1;i<=size;i++){
        for (int j=1;j<=size;j++){
        if(admatrrix[i][j]!=0 && c==0){

            s1.push(i);
            s1.push(j);
            v.push_back(i);
            b.push(i);
            b.push(j);
            v.push_back(j);

            i=j;
            j=0;
            c++;
        }
       else  if(admatrrix[i][j]!=0){
            int c=count(v.begin(),v.end(),j);
            if(c==0){
```

```
            v.push_back(j);

            b.push(j);
            s1.push(j);
            i=j;
            j=0;
        }
    }
    if(j==size && !s1.empty()){

        int p=s1.top();
        s1.pop();
        i=p;
        j=0;
    }
  }
  }

}
int main()
{
  int size, size1, size2;

  cout << "Enter the number of verteces";
```

```
cin >> size;
cout << endl;
int admattrix[s][s];
for (int i = 1; i <= size; i++)
{
   for (int j = 1; j <= size; j++)
   {
      admattrix[i][j] = 0;
   }
}
cout << "Enter the number of edges ";
cin >> size1;
int w1, u, v;
queue<int>b;
vector<int>v1;
stack<int>s1;
cout << "Enter the vertex1 and vertex2";
for (int i = 1; i <= size1; i++)
{
   cin >> u >> v;

   admattrix[u][v] = 1;
   admattrix[v][u] = 1;
```

```
    }
    cout<<"\n adjacency matrix \n";
    cout << " ";
    for (int i = 1; i <= size; i++)
    {
        cout << setw(4) << " " << i;
    }
    cout << endl;
    for (int i = 1; i <= size; i++)
    {
        cout << i;
        for (int j = 1; j <= size; j++)
        {
            cout << setw(5) << admattrix[i][j];
        }
        cout << endl;
    }cout<<"\nDFS of graph :  ";
visited(v1,b,s1,admattrix,size);
     dfs(b);

    return 0;
}
```

```
Enter the number of verteces3

Enter the number of edges 4
Enter the vertex1 and vertex22
3
4
5
1
6
7
4

 adjacency matrix
     1    2    3
1    0    0    0
2    0    0    1
3    0    1    0
```

Q9) Write a program to determine the minimum spanning tree of a graph using both Prims and Kruskals algorithm :-

Prims :-

```
#include <iostream>

using namespace std;


class Edge

{

public:

  int src;
```

```
  int dest;
  int weight;
};

class Subset
{
public:
  int p;
  int rank;
};

int compEdges(const void *a, const void *b)
{
  return ((Edge *)(a))->weight > ((Edge *)(b))->weight;
}

class Graph
{
public:
  int V, E;
  Edge *edges;
  Subset *subsets;

  Graph(int V, int E)
```

```
{
  this->V = V;
  this->E = E;
  this->edges = new Edge[E];

  for (int i = 0; i < E; i++)
  {
    int src, dest, weight;
    cout << "Edge " << (i + 1)
        << "\n=============\n";
    cout << "Source Node: ";
    cin >> src;
    cout << "Destination Node: ";
    cin >> dest;
    cout << "Edge Weight: ";
    cin >> weight;
    cout << endl;

    if (src < 1 || src > V || dest < 1 || dest > V)
    {
      cout << "Invalid Node" << endl;
      exit(-1);
    }
```

```
    this->edges[i].src = src - 1;
    this->edges[i].dest = dest - 1;
    this->edges[i].weight = weight;
  }
}

void makeSet()
{
  this->subsets = new Subset[(this->V * sizeof(Subset))];

  for (int v = 0; v < this->V; ++v)
  {
    this->subsets[v].p = v;
    this->subsets[v].rank = 0;
  }
}

int findSet(int i)
{
  if (this->subsets[i].p != i)
  {
    this->subsets[i].p = this->findSet(this->subsets[i].p);
  }
```

```
  return this->subsets[i].p;
}

void link(int x, int y)
{
  if (this->subsets[x].rank > this->subsets[y].rank)
  {
    this->subsets[y].p = x;
  }
  else
  {
    this->subsets[x].p = y;

    if (this->subsets[x].rank == this->subsets[y].rank)
    {
      this->subsets[y].rank++;
    }
  }
}

void Union(int x, int y)
{
  this->link(this->findSet(x), this->findSet(y));
}
```

```
void KruskalMST()
{
  int e = 0, i = 0;
  Edge next, result[this->V];

  qsort(this->edges, this->E, sizeof(Edge), compEdges);

  this->makeSet();

  while (e < this->V - 1 && i < this->E)
  {
    next = this->edges[i++];

    int x = this->findSet(next.src);
    int y = this->findSet(next.dest);

    if (x != y)
    {
      result[e++] = next;
      this->Union(x, y);
    }
  }
  qsort(result, this->V - 1, sizeof(Edge), compEdges);
```

```
    cout << "Edges in Minimum Spanning Tree:"
        << "\n==============================\n";

    for (i = 0; i < e; ++i)
    {
      cout << "Edge (" << (result[i].src + 1)
          << ", " << (result[i].dest + 1)
          << ") ==> " << result[i].weight
          << endl;
    }

    return;
  }
};
int main()
{
  int V, E;
  cout << "Enter Number of Vertices: ";
  cin >> V;
  cout << "Enter Number of Edges: ";
  cin >> E;
  cout << endl;
  Graph graph(V, E);
```

```
  graph.KruskalMST();
  return 0;
}
```

```
Enter Number of Vertices: 3
Enter Number of Edges: 4

Edge 1
=============
Source Node: 2
Destination Node: 4
Edge Weight: 3

Invalid Node
```

# Krushkals :-

```
#include <algorithm>
#include <iostream>
#include <vector>
using namespace std;
#define edge pair<int, int>
class Graph {
   private:
  vector<pair<int, edge> > G;  // graph
  vector<pair<int, edge> > T;  // mst
  int *parent;
  int V;  // number of vertices/nodes in graph
   public:
  Graph(int V);
  void AddWeightedEdge(int u, int v, int w);
```

```
  int find_set(int i);
  void union_set(int u, int v);
  void kruskal();
  void print();
};
Graph::Graph(int V) {
  parent = new int[V];

  //i 0 1 2 3 4 5
  //parent[i] 0 1 2 3 4 5
  for (int i = 0; i < V; i++)
    parent[i] = i;

  G.clear();
  T.clear();
}
void Graph::AddWeightedEdge(int u, int v, int w) {
  G.push_back(make_pair(w, edge(u, v)));
}
int Graph::find_set(int i) {
  if (i == parent[i])
    return i;
  else
    return find_set(parent[i]);
```

```
}

void Graph::union_set(int u, int v) {
  parent[u] = parent[v];
}
void Graph::kruskal() {
  int i, uRep, vRep;
  sort(G.begin(), G.end());
  for (i = 0; i < G.size(); i++) {
    uRep = find_set(G[i].second.first);
    vRep = find_set(G[i].second.second);
    if (uRep != vRep) {
      T.push_back(G[i]);
      union_set(uRep, vRep);
    }
  }
}
void Graph::print() {
  cout << "Edge :"
     << " Weight" << endl;
  for (int i = 0; i < T.size(); i++) {
    cout << T[i].second.first << " - " << T[i].second.second << " : "
       << T[i].first;
    cout << endl;
```

```
  }
}
int main() {
  Graph g(6);
  g.AddWeightedEdge(0, 1, 4);
  g.AddWeightedEdge(0, 2, 4);
  g.AddWeightedEdge(1, 2, 2);
  g.AddWeightedEdge(1, 0, 4);
  g.AddWeightedEdge(2, 0, 4);
  g.AddWeightedEdge(2, 1, 2);
  g.AddWeightedEdge(2, 3, 3);
  g.AddWeightedEdge(2, 5, 2);
  g.AddWeightedEdge(2, 4, 4);
  g.AddWeightedEdge(3, 2, 3);
  g.AddWeightedEdge(3, 4, 3);
  g.AddWeightedEdge(4, 2, 4);
  g.AddWeightedEdge(4, 3, 3);
  g.AddWeightedEdge(5, 2, 2);
  g.AddWeightedEdge(5, 4, 3);
  g.kruskal();
  g.print();
  return 0;
}
```

```
PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>  & 'c:\
gLauncher.exe' '--stdin=Microsoft-MIEngine-In-pagtxtld.ly0' '--s
pid=Microsoft-MIEngine-Pid-mssqeeqt.a3p' '--dbgExe=C:\Program Fi
Edge : Weight
1 - 2 : 2
2 - 5 : 2
2 - 3 : 3
3 - 4 : 3
0 - 1 : 4
PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>
```

## Q10) Write a program to solve the weighted interval scheduling problem :-

```
#include<iostream>
using namespace std;
#define MAX 20
int M[MAX];

struct Interval
{
   int startTime;
   int finishTime;
   int weight;
};

class WIS{
   Interval I[MAX];
```

```
    public:
    int n;
    WIS(){
        for(int i=0;i<=MAX;i++)
        M[i]= 0;
    }
    void sortIntervals();
    int mComputeOpt(int);
    void input();
    int p(int);
};

int WIS::p(int j)
{
    for(int i=j-1;i>0;i--){
        if(I[i].finishTime <= I[j].startTime)
        return i;
    }
    return 0;
}
void WIS::input(){
    cout<<"enter number of intervals: ";
    cin>>n;
    cout<<"Enter the starting time ,finishing rime and weight value for the
intervals : ";
```

```
    cout<<"\n\nSi Fi Vi\n";
    for(int i=1;i<=n;i++){
        cin>>I[i].startTime;
        cin>>I[i].finishTime;
        cin>>I[i].weight;
    }
}

void WIS::sortIntervals(){
    int i,flag=1;
    Interval temp;

    for(i=1;(i<=n)&&flag;i++){
        flag =0 ;
        for(int j=1;j<n;j++){
            if(I[j+1].finishTime < I[j].finishTime){
                temp = I[j];
                I[j]=I[j+1];
                I[j+1]=temp;
                flag = 1;
            }
        }
    }
    for(i=1;i<=n;i++){
```

```
            for(int j=i+1;j<=n;j++){
                if(I[i].finishTime == I[j].finishTime &&  I[i].startTime>I[j].startTime)
                {
                    temp=I[i];
                    I[i] = I[j];
                    I[j]=temp;
                }
            }
        }
        cout<<"I<i>\t\ts<i>\t\tF<i>\t\tv<i>\n";
        for(int i=1;i<=n;i++){

cout<<"\t\t"<<i<<"\t\t"<<I[i].startTime<<"\t\t"<<I[i].finishTime<<"\t\t"<<I[i].weig
ht<<"\n";
        }
    }


    int WIS::mComputeOpt(int j){
        if(j==0){
            return 0;
        }else if(M[j]){
            return M[j];
        }
        else{
            M[j]=max((I[j].weight+mComputeOpt(p(j))),mComputeOpt(j-1));
```

```
    }
    return M[j];
}

int main(){
    WIS job;
    job.input();
    cout<<"\nSorted input: ";
    job.sortIntervals();
     cout<<endl;
     for(int i=1;i<=job.n;i++)
     cout<<"opt["<<i<<"]\t";

     cout<<endl;
     for(int i=1;i<=job.n;i++){
       cout<<job.mComputeOpt(i)<<"\t";
       if(i==job.n){
           cout<<endl;
           cout<<"max = "<<job.mComputeOpt(i);
       }
     }

     return 0;
}
```

```
enter number of intervals: 4
Enter the starting time ,finishing rime and weight value for the intervals :

Si Fi Vi
1 2 3
2 4 5
3 4 5
4 6 7

Sorted input: I<i>            s<i>          F<i>          v<i>
               1              1             2             3
               2              2             4             5
               3              3             4             5
               4              4             6             7

opt[1]  opt[2]  opt[3]  opt[4]
3       8       8       15
max = 15
```

# Q11) Write a program to solve the 0-1 knapsack problem :-

```
#include <bits/stdc++.h>

using namespace std;

int max(int a, int b) { return (a > b) ? a : b; }

int knapSack(int W, int wt[], int val[], int n)

{

if (n == 0 || W == 0)

 return 0;

if (wt[n - 1] > W)

return knapSack(W, wt, val, n - 1);

else

return max(val[n - 1] + knapSack(W - wt[n - 1], wt, val, n - 1),knapSack(W, wt, val, n - 1));

}

int main()
```

```
{
int profit[] = { 90, 20, 40 };
int weight[] = { 10, 30, 30 };
int W = 50;
int n = sizeof(profit) / sizeof(profit[0]);
cout << knapSack(W, weight, profit, n);
return 0;
}
```

```
PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>  & 'c:\Users\ASUS\.vscode\extens
gLauncher.exe' '--stdin=Microsoft-MIEngine-In-c3wthtwk.5ku' '--stdout=Microsoft-MIEngine-
pid=Microsoft-MIEngine-Pid-kw04dmzq.rkz' '--dbgExe=C:\Program Files (x86)\mingw-w64\i686-
130
PS C:\Users\ASUS\OneDrive\Desktop\Algorithms Practicals>
```