Algorithm & Research Computing

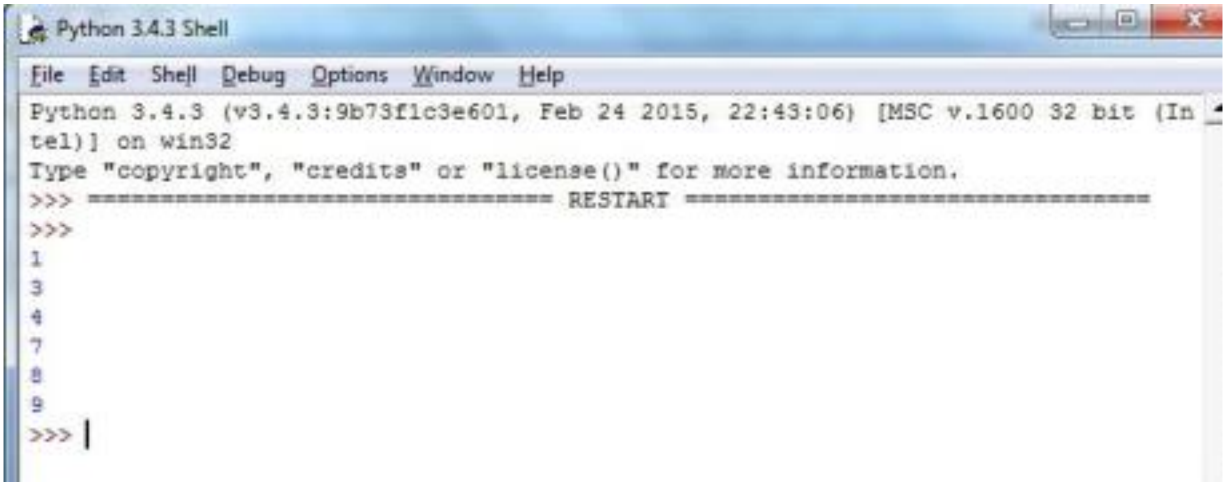
Q.1) Write a Program for Randomized Selection

Algorithm from random import randrange

```
def partition(x, pivot_index = 0):
    i = 0
    if pivot_index !=0: x[0],x[pivot_index] =
    x[pivot_index],x[0] for j in range(len(x)-1):
        if x[j+1] < x[0]:
            x[j+1],x[i+1] = x[i+1],x[j+1]
            i += 1
    x[0],x[i] = x[i],x[0]
    return x,i
def RSelect(x,k):
    if len(x) == 1:
        return x[0]
    else:
        xpart = partition(x,randrange(len(x)))
        x = xpart[0] # partitioned array
        j = xpart[1] # pivot index
        if j == k:
            return x[j]
        elif j > k:
            return RSelect(x[:j],k)
        else:
```

```
k = k - j - 1

return RSelect(x[(j+1):], k)

x = [3,1,8,4,7,9]

for i in range(len(x)):

print (RSelect(x,i))
```

Output:



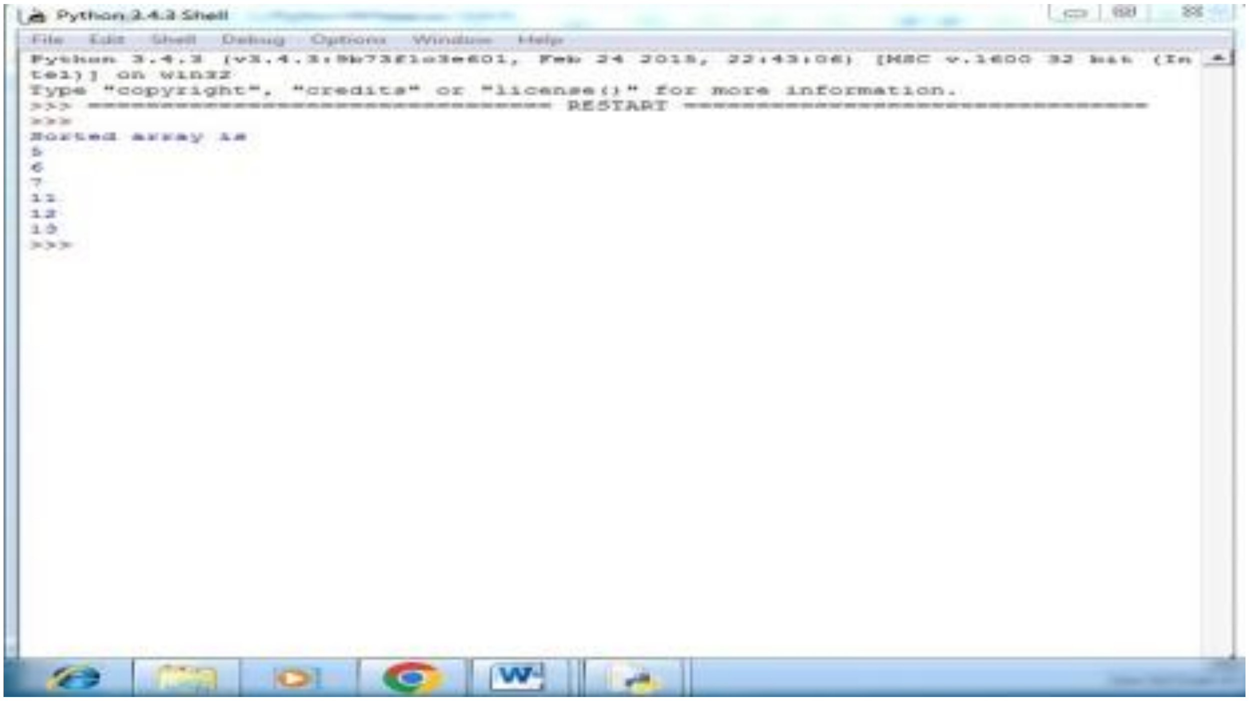
```
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (In
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>>
1
3
4
7
8
9
>>> 
```

Q.2) Write a Program for Heap Sort Algorithm

```
# To heapify subtree rooted at index i.
# n is size of heap
def heapify(arr, n, i):
    largest = i # Initialize largest as root
    l = 2 * i + 1 # left = 2*i + 1
    r = 2 * i + 2 # right = 2*i + 2

    # See if left child of root exists and is
    # greater than root
    if l < n and arr[i] < arr[l]:
        largest = l

    # See if right child of root exists and is
    # greater than root
    if r < n and arr[largest] < arr[r]:
        largest = r

    # Change root, if needed
    if largest != i:
        arr[i],arr[largest] = arr[largest],arr[i] # swap

        # Heapify the root.
        heapify(arr, n, largest)

# The main function to sort an array of given size def heapSort(arr):
    n = len(arr)

    # Build a maxheap.
    for i in range(n, -1, -1):
        heapify(arr, n, i)

    # One by one extract elements
    for i in range(n-1, 0, -1):
        arr[i], arr[0] = arr[0], arr[i] # swap
        heapify(arr, i, 0)

# Driver code to test above
arr = [ 12, 11, 13, 5, 6, 7]
heapSort(arr)
n = len(arr)
```

```
print ("Sorted array is")
for i in range(n):
        print ("%d" %arr[i])
```

Output:



```
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (In
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>>
Sorted array is
5
6
7
11
12
13
>>>
```

Q.3) Write a Program to perform Radix Sort Algorithm

```
# A function to do counting sort of arr[] according to # the digit represented
by exp.
def countingSort(arr, exp1):

    n = len(arr)

    # The output array elements that will have sorted arr output = [0] * (n)

    # initialize count array as 0
    count = [0] * (10)

    # Store count of occurrences in count[]
    for i in range(0, n):
        index = (arr[i]/exp1)
        count[ (index)%10 ] += 1

    # Change count[i] so that count[i] now contains actual # position of this digit
    in output array
    for i in range(1,10):
        count[i] += count[i-1]

    # Build the output array
    i = n-1
    while i>=0:
        index = (arr[i]/exp1)
        output[ count[ (index)%10 ] - 1] = arr[i]
        count[ (index)%10 ] -= 1
        i -= 1

    # Copying the output array to arr[],
    # so that arr now contains sorted numbers
    i = 0
    for i in range(0,len(arr)):
        arr[i] = output[i]

# Method to do Radix Sort
def radixSort(arr):

    # Find the maximum number to know number of digits max1 =
    max(arr)

    # Do counting sort for every digit. Note that instead # of passing digit number,
    exp is passed. exp is 10^i # where i is current digit number
    exp = 1
    while max1/exp > 0:
        countingSort(arr,exp)
        exp *= 10

# Driver code to test above
arr = [ 170, 45, 75, 90, 802, 24, 2, 66]
```

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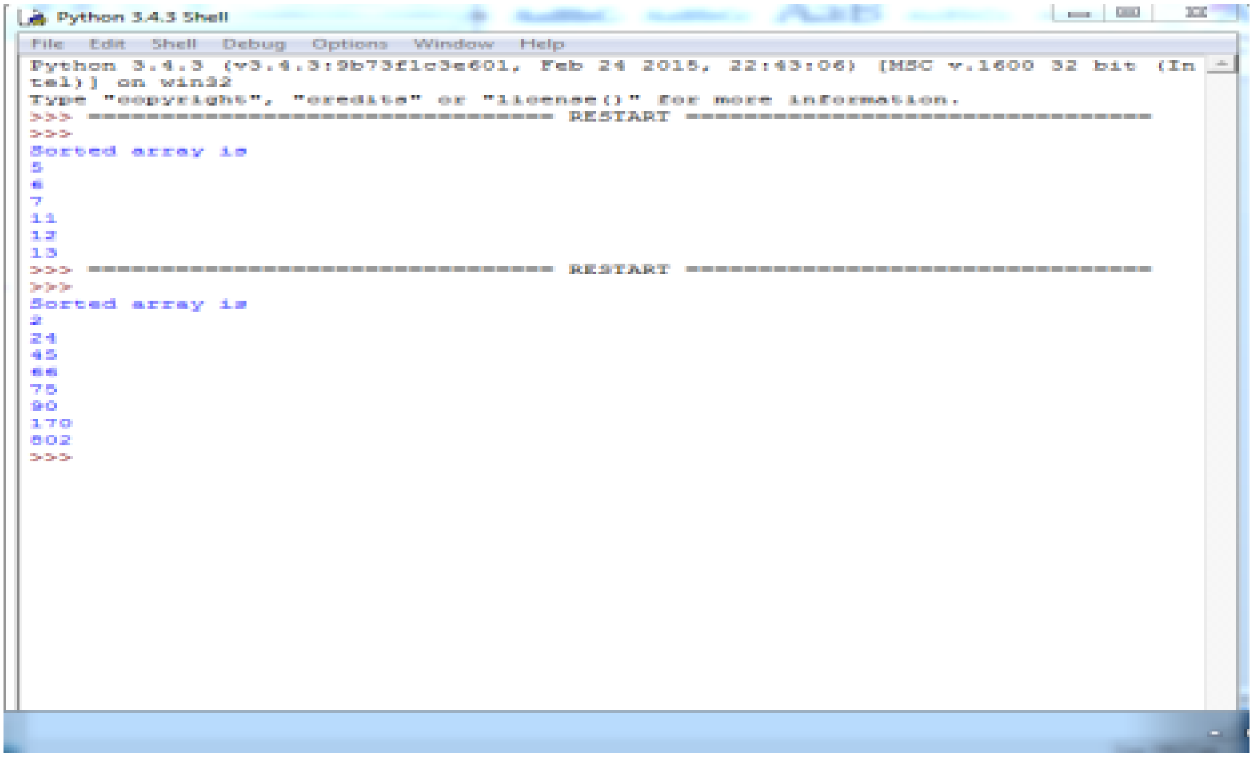
```
radixSort(arr)

for i in range(len(arr)):
print(arr[i])
```

Output:

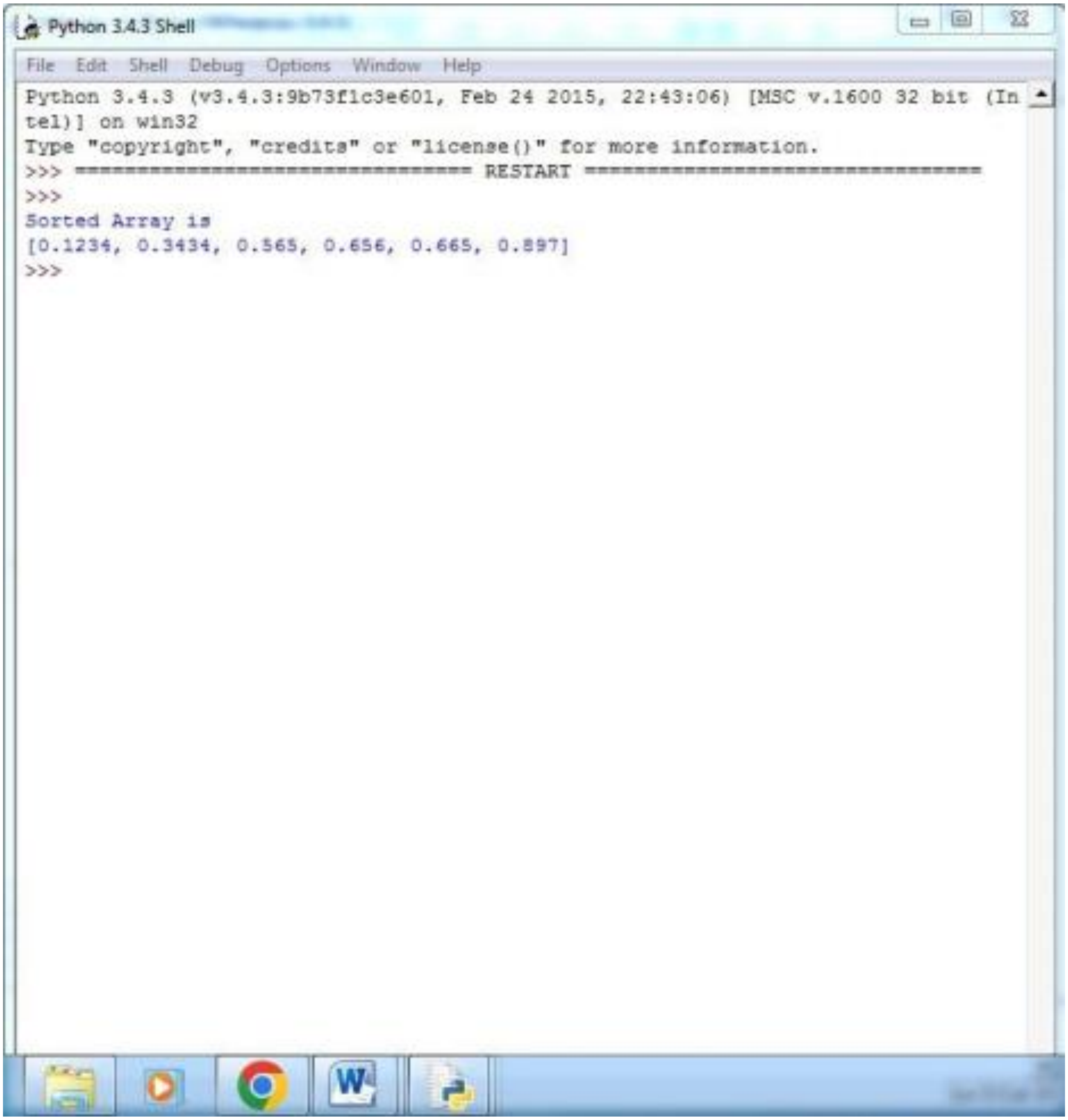


```
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (In
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>> 
Sorted array is
5
6
7
11
12
13
>>> ================================ RESTART ================================
>>> 
Sorted array is
2
24
45
66
75
90
170
802
>>> 
```

Q.4) Write a Program to Perform Bucket Sort Algorithm

```
# Python3 program to sort an array # using
bucket sort

def insertionSort(b):

    for i in range(1, len(b)):

        up = b[i]

        j = i - 1

        while j >=0 and b[j] > up:

            b[j + 1] = b[j]

            j -= 1

        b[j + 1] = up

    return b

def bucketSort(x):

    arr = []

     slot_num = 10 # 10 means 10 slots, each # slot's size
                                              is 0.1

    for i in range(slot_num):

        arr.append([])

    # Put array elements in different buckets for j in x:

        index_b = int(slot_num * j)

        arr[index_b].append(j)

    # Sort individual buckets

    for i in range(slot_num):

        arr[i] = insertionSort(arr[i])

    # concatenate the result

    k = 0

    for i in range(slot_num):

        for j in range(len(arr[i])):

            x[k] = arr[i][j]

            k += 1

    return x

# Driver Code

x = [0.897, 0.565, 0.656,

          0.1234, 0.665, 0.3434]

print("Sorted Array is")

print(bucketSort(x))
```

Output:



```
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (In
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>>
Sorted Array is
[0.1234, 0.3434, 0.565, 0.656, 0.665, 0.897]
>>>
```

Q.5) Write a Program to Perform Folyd-Warshall algorithm

```
# Python Program for Floyd Warshall Algorithm

# Number of vertices in the graph
V = 4

# Define infinity as the large enough value. This value will be # used for vertices not
connected to each other
INF = 99999

# Solves all pair shortest path via Floyd Warshall Algorithm def floydWarshall(graph):

    """ dist[][] will be the output matrix that will finally have the shortest distances between every
    pair of vertices """ """ initializing the solution matrix same as input graph matrix OR we can
    say that the initial values of shortest distances are based on shortest paths considering no
    intermediate vertices """
    dist = map(lambda i : map(lambda j : j , i) , graph)

    """ Add all vertices one by one to the set of intermediate vertices.
      ---> Before start of an iteration, we have shortest distances between all pairs of
      vertices such that the shortest
      distances consider only the vertices in the set
    {0, 1, 2, .. k-1} as intermediate vertices.
        ----> After the end of a iteration, vertex no. k is
      added to the set of intermediate vertices and the
    set becomes {0, 1, 2, .. k}
    """
    for k in range(V):

        # pick all vertices as source one by one
        for i in range(V):

            # Pick all vertices as destination for the
            # above picked source
            for j in range(V):

                # If vertex k is on the shortest path from
                # i to j, then update the value of dist[i][j]
                dist[i][j] = min(dist[i][j] ,
                                                    dist[i][k]+ dist[k][j]
                                        )
    printSolution(dist)


# A utility function to print the solution
```

```
def printSolution(dist):
    print "Following matrix shows the shortest distances\ between every pair of
  vertices"
    for i in range(V):

        for j in range(V):
            if(dist[i][j] == INF):
                print "%7s" %("INF"),
            else:
                print "%7d\t" %(dist[i][j]),
            if j == V-1:
                print ""



# Driver program to test the above program
# Let us create the following weighted graph
"""
            10
       (0)->(3)
         | /|\
      5 | |
         | | 1
       \|/ |
       (1)->(2)
            3 """
graph = [[0,5,INF,10],
             [INF,0,3,INF],
             [INF, INF, 0, 1],
             [INF, INF, INF, 0]
        ]
# Print the solution
floydWarshall(graph);
```

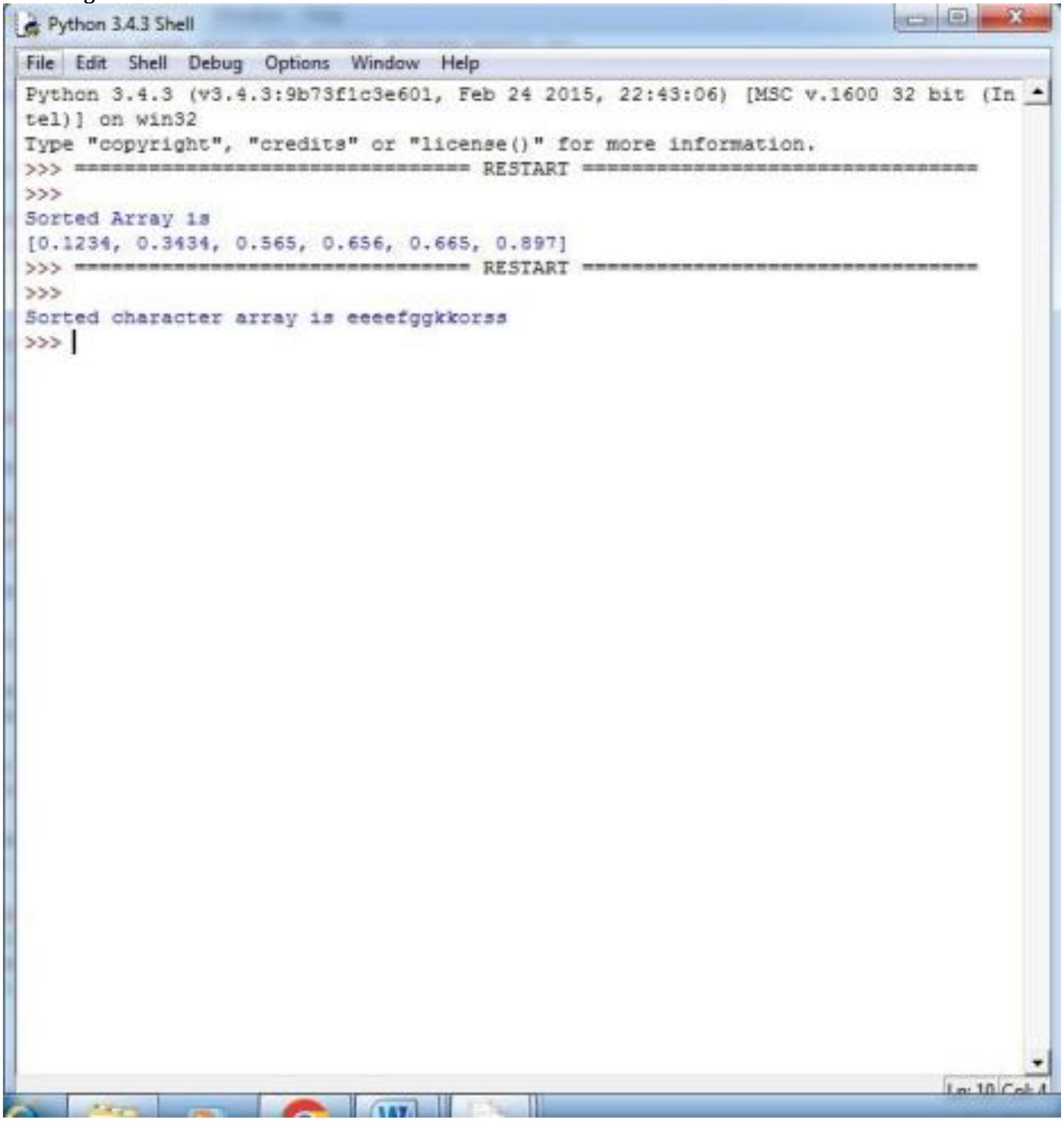
Output:

```
Following matrix shows the shortest distances between every pair
of vertices
    0      INF    0      8
    INF    5      INF    3
    INF           INF    0
INF   9 4 1 0
```

Q.6) Write a Program for Counting Sort Algorithm in python

```
# The main function that sort the given string arr[] in # alphabetical order
def countSort(arr):

    # The output character array that will have sorted arr output = [0 for i in
    range(256)]

    # Create a count array to store count of inidividul # characters and
    initialize count array as 0 count = [0 for i in range(256)]

    # For storing the resulting answer since the # string is
    immutable
    ans = ["" for _ in arr]

    # Store count of each character
    for i in arr:
        count[ord(i)] += 1

    # Change count[i] so that count[i] now contains actual # position of this
    character in output array for i in range(256):
        count[i] += count[i-1]

    # Build the output character array
    for i in range(len(arr)):
        output[count[ord(arr[i])]-1] = arr[i]
        count[ord(arr[i])] -= 1

    # Copy the output array to arr, so that arr now # contains sorted
    characters
    for i in range(len(arr)):
        ans[i] = output[i]
    return ans

# Driver program to test above function
arr = "geeksforgeeks"
ans = countSort(arr)
print "Sorted character array is %s" %("".join(ans))
```

Output:

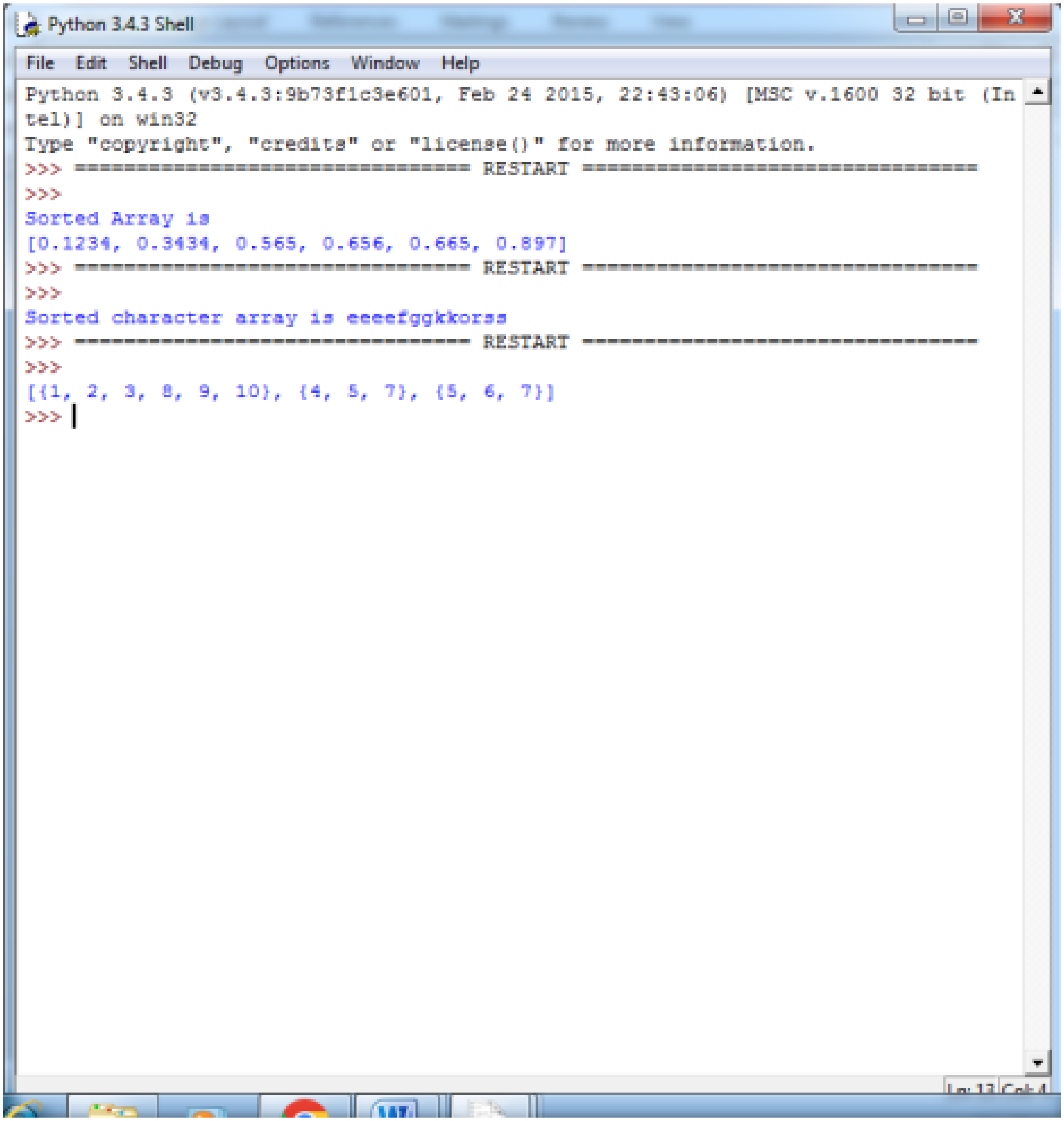


```
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (In
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>> 
Sorted Array is
[0.1234, 0.3434, 0.565, 0.656, 0.665, 0.897]
>>> ================================ RESTART ================================
>>> 
Sorted character array is eeeefggkkorss
>>> 
```

Q.7) Write a program for Set Covering Problem

```
def set_cover(universe, subsets):
    """Find a family of subsets that covers the universal set""" elements = set(e for s in
    subsets for e in s)

    # Check the subsets cover the universe

    if elements != universe:

        return None

    covered = set()

    cover = []

    # Greedily add the subsets with the most uncovered points while covered !=
    elements:

        subset = max(subsets, key=lambda s: len(s - covered))
        cover.append(subset)

        covered |= subset


    return cover

def main():

    universe = set(range(1, 11))

    subsets = [set([1, 2, 3, 8, 9, 10]),

        set([1, 2, 3, 4, 5]),

        set([4, 5, 7]),

        set([5, 6, 7]),

        set([6, 7, 8, 9, 10])]

    cover = set_cover(universe, subsets)

    print(cover)

if name == ' main_':

    main()
```

Output:

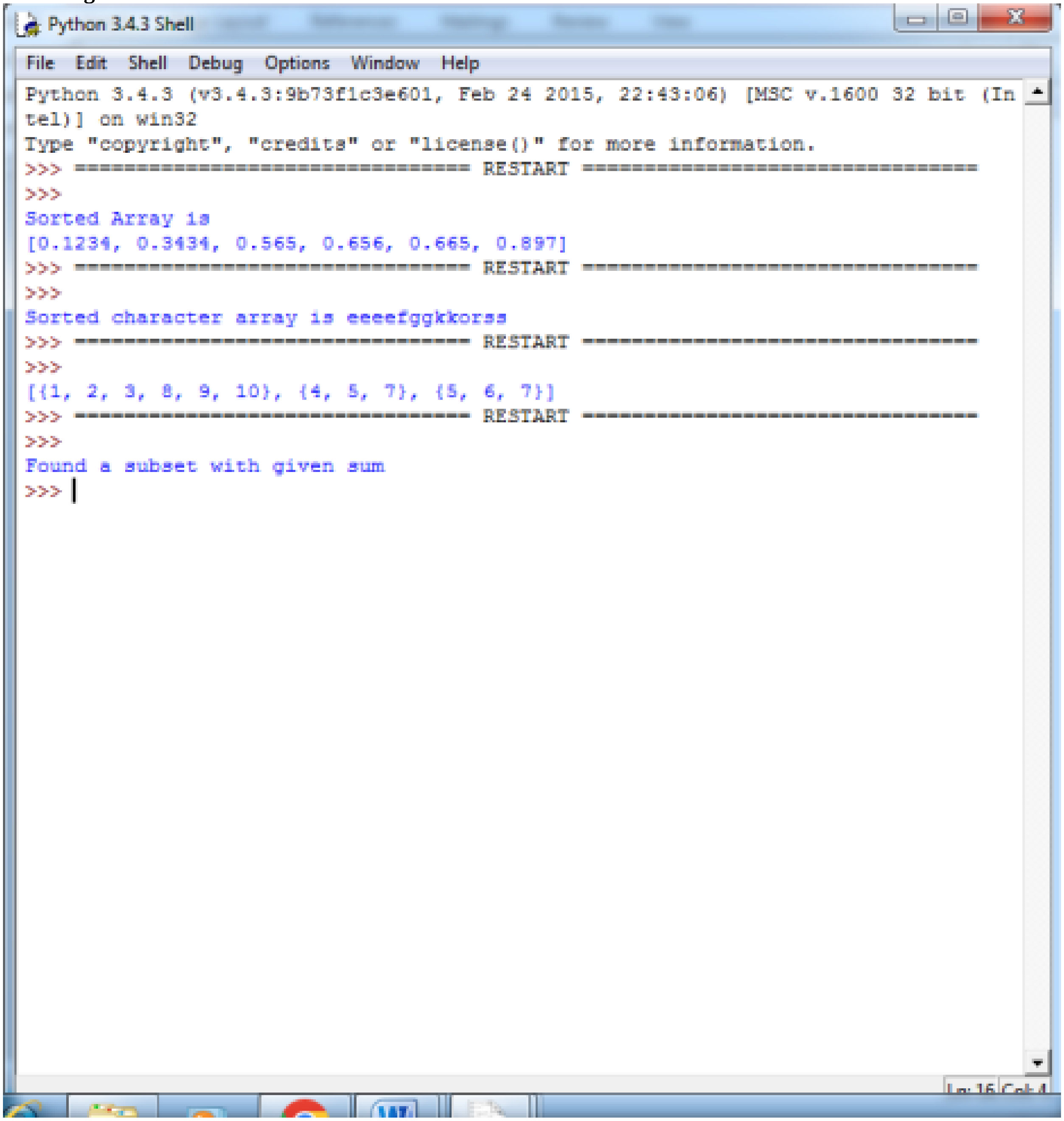


```
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (In
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>> 
Sorted Array is
[0.1234, 0.3434, 0.565, 0.656, 0.665, 0.897]
>>> ================================ RESTART ================================
>>> 
Sorted character array is eeeefggkkorss
>>> ================================ RESTART ================================
>>> 
[{1, 2, 3, 8, 9, 10}, {4, 5, 7}, {5, 6, 7}]
>>> 
```

8) Write a Program for found a subset with given sum

```
# A recursive solution for subset sum
# problem

# Returns true if there is a subset
# of set[] with sun equal to given sum
def isSubsetSum(set,n, sum) :

    # Base Cases
    if (sum == 0) :
        return True
    if (n == 0 and sum != 0) :
        return False

    # If last element is greater than
    # sum, then ignore it
    if (set[n - 1] > sum) :
        return isSubsetSum(set, n - 1, sum);

    # else, check if sum can be obtained
    # by any of the following
    # (a) including the last element
    # (b) excluding the last element
                        return isSubsetSum(set, n-1, sum) or isSubsetSum(set, n-1, sum-set[n-1])


# Driver program to test above function
set = [3, 34, 4, 12, 5, 2]
sum = 9
n = len(set)
if (isSubsetSum(set, n, sum) == True) :
    print("Found a subset with given sum")
else :
    print("No subset with given sum")
```

Output:



```
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (In
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>>
Sorted Array is
[0.1234, 0.3434, 0.565, 0.656, 0.665, 0.897]
>>> ================================ RESTART ================================
>>>
Sorted character array is eeeefggkkorss
>>> ================================ RESTART ================================
>>>
[{1, 2, 3, 8, 9, 10}, {4, 5, 7}, {5, 6, 7}]
>>> ================================ RESTART ================================
>>>
Found a subset with given sum
>>> 
```