MALAD KANDIVALI EDUCATION SOCIETY'S

NAGINDAS KHANDWALA COLLEGE OF COMMERCE, ARTS & MANAGEMENT STUDIES & SHANTABEN NAGINDAS KHANDWALA COLLEGE OF SCIENCE

MALAD [W], MUMBAI – 64

AUTONOMOUS INSTITUTION

(Affiliated To University Of Mumbai)

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CERTIFICATE

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RollNo: 322 Programme: BScIT Semester: III

This is certified to be a bonafide record of practical works done by the above student in the college laboratory for the course **Data Structures (Course Code: 2032UISPR)** for thepartial fulfilment of Third Semester of BSc IT during the academic year2020-21.

The journal work is the original study work that has been duly approved in the year 2020-21 by the undersigned.

External Examiner

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(Subject-In-Charge)

Date of Examination: (College Stamp)

Class: S.Y. B.Sc. ITSem-III **Roll No: 322**

Subject: Data Structures

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DS repostries link ="https://github.com/PrabhatM123/DS"

Practical 1(a)

Aim: Implement the following for Array:

a) Write a program to store the elements in 1-D array and provide an option to perform the operations like searching, sorting, merging, reversing the elements.

Theory:

Storing Data in Arrays. Assigning values to an elementin an array is similar to assigning values to scalar variables. Simply reference an individual element of anarray using the array name and the index inside parentheses, then use the assignment operator (=) followed by a value.

Following are the basic operations supported by an array.

- Traverse − print all the array elements one byone.
- Insertion − Adds an element at the givenindex.
- Deletion − Deletes an element at the givenindex.
- Search − Searches an element using the given index or by thevalue

Code and Output:

main.py

```python
# Implement the following for Array:
# Write a program to store the elements in 1-D array and provide an option
# to perform the operations like searching, sorting, merging, reversing the elements.
arr1=[12,35,42,22,1,6,54]
arr2=['hello','world']
arr1.index(35)
print(arr1)
arr1.sort()
print(arr1)
arr1.extend(arr2)
print(arr1)
arr1.reverse()
print(arr1)
```

Shell

```
[12, 35, 42, 22, 1, 6, 54]
[1, 6, 12, 22, 35, 42, 54]
[1, 6, 12, 22, 35, 42, 54, 'hello', 'world']
['world', 'hello', 54, 42, 35, 22, 12, 6, 1]
>
```

Practical 1(b)

Aim: Implement the following for Array:

Write a program to perform the Matrix addition, Multiplication and Transpose Operation.

Theory:

- add() – add elements of twomatrices.
- subtract() – subtract elements of twomatrices.
- divide() – divide elements of twomatrices.
- multiply() – multiply elements of twomatrices.
- dot() – It performs matrix multiplication, does not element wisemultiplication.
- sqrt() – square root of each element ofmatrix.
- sum(x,axis) – add to all the elements in matrix. Second argument is optional, it is used when we want to compute the column sum if axis is 0 and row sum if axis is1.
- “T” – It performs transpose of the specified matrix.

Code and Output:

main.py

Run

```
result = [[0,0,0,0],
          [0,0,0,0],
          [0,0,0,0]]
 # iterate through rows of X
for i in range(len(X)):
# iterate through columns of Y
    for j in range(len(Y[0])):
# iterate through rows of Y
        for k in range(len(Y)):
            result[i][j] += X[i][k] * Y[k][j]
            for r in result:
                print(r)

# Program to transpose a matrix
X = [[12,7], [4 ,5], [3 ,8]]
result = [[0,0,0], [0,0,0]]
 # iterate through rows
for i in range(len(X)):
# iterate through columns
    for j in range(len(X[0])):
        result[j][i] = X[i][j]
        for r in result:
```

Shell

Clear

```
[16, 0, 0]
[0, 0, 0]
[0, 0, 0]
[16, 15, 0]
[0, 0, 0]
[0, 0, 0]
[16, 15, 4]
[0, 0, 0]
[0, 0, 0]
[16, 15, 4]
[10, 0, 0]
[0, 0, 0]
[16, 15, 4]
[10, 12, 0]
[0, 0, 0]
[16, 15, 4]
[10, 12, 9]
[0, 0, 0]
[16, 15, 4]
[10, 12, 9]
[11, 0, 0]
[16, 15, 4]
[10, 12, 9]
```

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Practical 2

Aim: Implement Linked List. Include options for insertion, deletion and search of a number, reverse the list and concatenate two linked lists.

Theory:

A linked list is a sequence of data elements, which are connected together via links. Each data element contains a connection to another data element in form of a pointer. Python does not have linked lists in its standard library. We implement the concept of linked lists using the concept of nodes as discussed in the previous chapter. We have already seen how we create a node class and how to traverse the elements of a node. In this chapter we are going to study the types of linked lists known as singly linked lists. In this type of data structure there is only one link between any two data elements. We create such a list and create additional methods to insert, update and remove elements from the list.

- Insertion in a Linked list: Inserting element in the linked list involves reassigning the pointers from the existing nodes to the newly inserted node. Depending on whether the new data elementisgetting insertedatthebeginningoratthemiddleorattheendofthelinkedlist.

- Deleting an Item form a Linked List: We can remove an existing node using the key for that node. In the below program we locate the previous node of the node which is to be deleted. Then point the next pointer of this node to the next node of the node to bedeleted.

- Searching in linked list: Searching is performed in order to find the location of a particular element in the list. Searching any element in the list needs traversing through the list and make the comparison of every element of the list with the specified element. If the element is matched with any of the list element then the location of the element is returned from the function.

- Reversing a Linked list: To reverse a Linked List recursively we need to divide theLinked List into two parts: head and remaining. Head points to the first element initially. Remaining points to the next element from the head. We traverse the Linked List recursively until the second last element.

- Concatenating Linked lists: Concatenate the two lists by traversing the first list until we reach it’s a tail node and then point the next of the tail node to the head node of the second list. Store this concatenated list in the firstlist

Code and Output:

main.py

```python
class Node:

    def __init__ (self, element, next = None ):
        self.element = element
        self.next = next
        self.previous = None
    def display(self):
        print(self.element)

class LinkedList:

    def __init__(self):
        self.head = None
        self.size = 0



    def _len_(self):
        return self.size

    def get_head(self):
        return self.head
```

Shell

```
element 8
element 7
element 6
element 5
element 4
element 3
element 2
element 1
Searching at 0 and value is element 1
Searching at 1 and value is element 2
Searching at 2 and value is element 3
Searching at 3 and value is element 4
Searching at 4 and value is element 5
Searching at 5 and value is element 6
Found value at 5 location
>
```

Practical 3(a)

Aim: Implement the following for Stack:

a) Perform Stack operations using Array implementation.

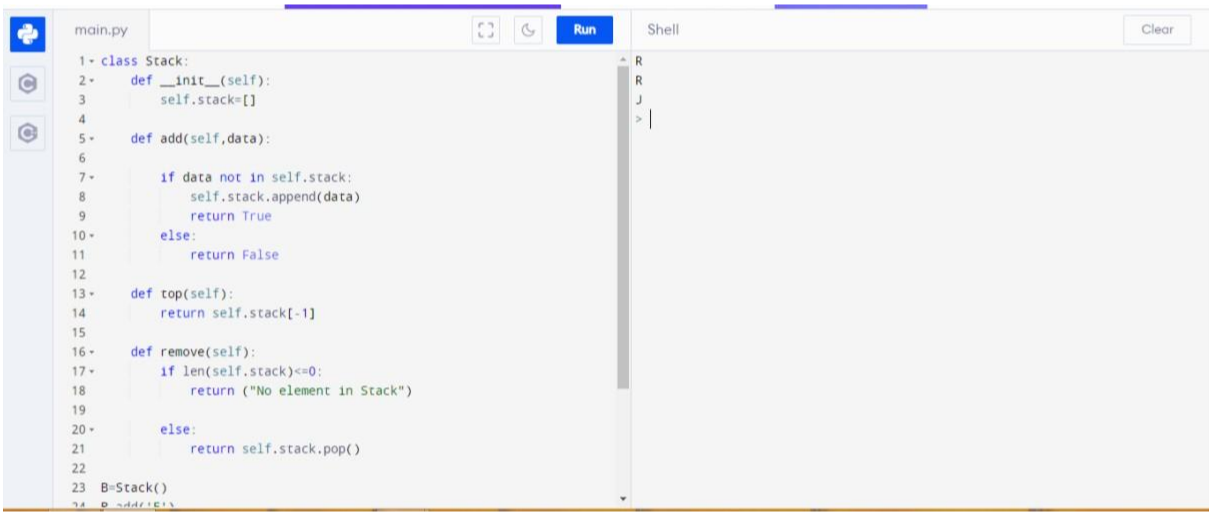
Theory:

Stacks is one of the earliest data structures defined in computer science. In simple words, Stack is a linear collection of items. It is a collection of objectsthat supports fast last-in, first-out (LIFO) semantics for insertion and deletion. It is an array or list structure of function calls and parameters used in modern computer programming and CPU architecture. Similar to a stack of plates at a restaurant, elements in a stack are added or removed from the top of the stack, in a "last in, first out" order. Unlike lists or arrays, random access is not allowed for the objects contained in the stack.

There are two types of operations in Stack:

- Push– To add data into thestack.
- Pop– To remove data from the stack

Code andOuput:



Practical 3(b)

Aim: Implement Tower of Hanoi.

Theory:

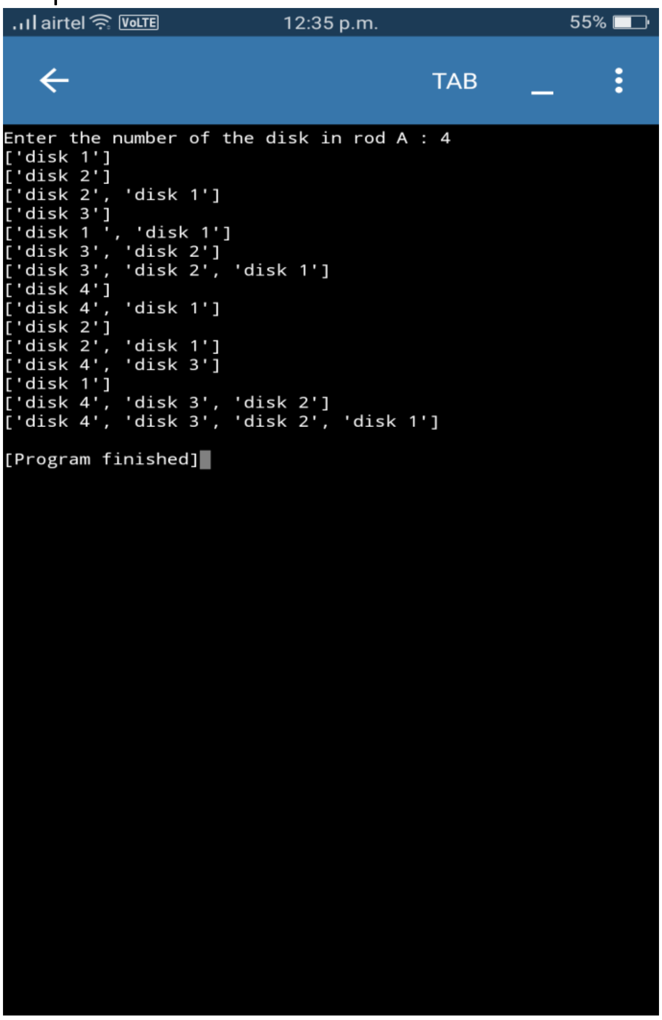
- We are given n disks and a series of rods, we need to transfer all the disks to the final rod under the givenconstraints
- We can move only one disk at atime.
- Only the uppermostdisk.

Code:

```
class Stack:

   def __init__(self):
      self.stack_arr = []

   def push(self,value):
      self.stack_arr.append(value)

   def pop(self):
      if len(self.stack_arr) == 0:
         print('Stack is empty!')
         return None
      else:
         self.stack_arr.pop()

   def get_head(self):
      if len(self.stack_arr) == 0:
         print('Stack is empty!')
         return None
      else:
         return self.stack_arr[-1]

   def display(self):
      if len(self.stack_arr) == 0:
         print('Stack is empty!')
         return None
      else:
         print(self.stack_arr)

A = Stack()
B = Stack()
C = Stack()
def towerOfHanoi(n, fromrod,to,temp):
   if n == 1:
      fromrod.pop()
      to.push('disk 1')
```

```
        if to.display() != None:
            print(to.display())

    else:

        towerOfHanoi(n-1, fromrod, temp, to)
        fromrod.pop()
        to.push(f'disk {n}')
        if to.display() !=  None:
            print(to.display())
        towerOfHanoi(n-1, temp, to, fromrod)

n = int(input('Enter the number of the disk in rod A : '))
for i in  range(n):
    A.push(f'disk {i+1} ')

towerOfHanoi(n, A, C, B)
```

Output:



Practical 3(C)

Aim: WAP to scan a polynomial using linked list and add two polynomials.

Theory:

Polynomial is a mathematical expression that consists of variables and coefficients. for example x^2 - 4x +7. In the Polynomial linked list, the coefficients and exponents of the polynomial are defined as the data node of the list.For adding two polynomials that are stored as a linked list. We need to add the coefficients of variables with the same power. In a linked list node contains 3 members, coefficient value link to the next node a linked list that is used to store Polynomial looks like −Polynomial : 4x7 + 12x2 + 45

Code and Output:

main.py Run

```python
class Node:

    def __init__(self, element, next=None):
        self.element = element
        self.next = next
        self.previous = None

    def display(self):
        print(self.element)


class LinkedList:

    def __init__(self):
        self.head = None
        self.size = 0

    def add_head(self, e):
        self.head = Node(e)
        self.size += 1

```

Shell Clear

```
Enter the order for polynomial : 10
Enter coefficient for power 10 : 100
Enter coefficient for power 9 :
```

Practical 3(d)

Aim: WAP to calculate factorial and to compute the factors of a given no.

(i) usingrecursion

(ii) usingiteration

Theory:

The factorial of a number is the product of all the integers from 1 to that number. For example, the factorial of 6 is 1*2*3*4*5*6 = 720. Factorial is not defined for negative numbers and the factorial of zero is one, 0! = 1.

- Recursion: In Python, we know that a function can call other functions. It is even possible for the function to call itself. These types of construct are termed as recursive functions.

- Iteration: Repeating identical or similar tasks without making errors is something that computers do well and people do poorly. Repeated execution of a set of statements is called iteration. Because iteration is so common, Python provides several language features to make iteasier.

Code and Output:

main.py

```
def factorial(number):
    if number < 0:
        print('Invalid entry! Cannot find factorial of a negative number')
        return -1
    if number == 1 or number == 0:
        return 1
    else:
        return number * factorial(number - 1)


def factorial_iteration(number):
    if number < 0:
        print('Invalid entry! Cannot find factorial of a negative number')
        return -1
    fact = 1
    while(number > 0):
        fact = fact * number
        number = number - 1
    return fact
```

Shell

```
Factorial using Recursion of 8 is: 40320
Factorial using Iteration of 8 is: 40320
>
```

Practical 4

Aim: Perform Queues operations using Circular Array implementation.

Theory:

Circular queue avoids the wastage of space in a regular queue implementation using arrays. Circular Queue works by the process of circular increment i.e. when we try to increment the pointer and we reach the end of the queue, we start from the beginning of the queue. Here, the circular increment is performed by modulo division with the queue size. That is, if REAR + 1 == 5 (overflow!), REAR = (REAR + 1)%5 = 0 (start of queue) The circular queue work as follows:

two pointers FRONT and REAR FRONT track the first element of the queue

REAR track the last elements of the queue initially, set value of FRONT and REARto -1

1. Enqueue Operation check if the queue is full for the first element, set value of FRONT to 0 circularly increase the REAR index by 1 (i.e. if the rear reaches the end, next it would be at the start of the queue) add the new element in the position pointed to byREAR

2. Dequeue Operation check if the queue is empty return the value pointed by FRONT circularly increase the FRONT index by 1 for the last element, reset thevalues of FRONT and REAR to -1

Code and Output:

main.py

```python
class CircularQueue:

    #Constructor
    def __init__(self):
        self.queue = list()
        self.head = 0
        self.tail = 0
        self.maxSize = 8

    #Adding elements to the queue
    def enqueue(self,data):
        if self.size() == self.maxSize-1:
            return ("Queue Full!")
        self.queue.append(data)
        self.tail = (self.tail + 1) % self.maxSize
        return True

    #Removing elements from the queue
    def dequeue(self):
        if self.size()==0:
            return ("Queue Empty!")
        data = self.queue[self.head]
        self.head = (self.head + 1) % self.maxSize
```

Shell

```
True
True
True
True
True
True
True
Queue Full!
Queue Full!
1
2
3
4
5
6
7
Queue Empty!
Queue Empty!
>
```

Practical 5

Aim: Write a program to search an element from a list. Give user the option to perform Linear or Binary search.

Theory:

- Linear Search: This linear search is a basic search algorithm which searches all the elements in the list and finds the required value. This is also known as sequential search.

- Binary Search: In computer science, a binary searcher half-interval search algorithm finds the position of a target value within a sorted array. The binary search algorithm can be classified as a dichotomies divide-and-conquer search algorithm and executes in logarithmictime.

Code and Output:

main.py

```python
print ("BINARY SEARCH METHOD\n")
def bsm(arr,start,end,num):
    if end>=start:
        mid=start+(end-start)//2
        if arr[mid]==x:
            return mid
        elif arr[mid]>x:
            return bsm(arr,start,mid-1,x)
        else:
            return bsm(arr,mid+1,end,x)
    else:
        return -1
arr=[10,27,36,49,58,69,70]
x=int(input("Enter the number to be searched : "))
result=bsm(arr,0,len(arr)-1,x)
if result != -1:
    print ("Number is found at ",result)
else:
    print ("Number is not present\n")

print ("Linear Search\n")
def linearsearch(arr, x):
   for i in range(len(arr)):
```

Shell

```
BINARY SEARCH METHOD

Enter the number to be searched : 27
Number is found at  1
Linear Search

enter character you want to search: 36
element found at index -1
>
```

Practical 6

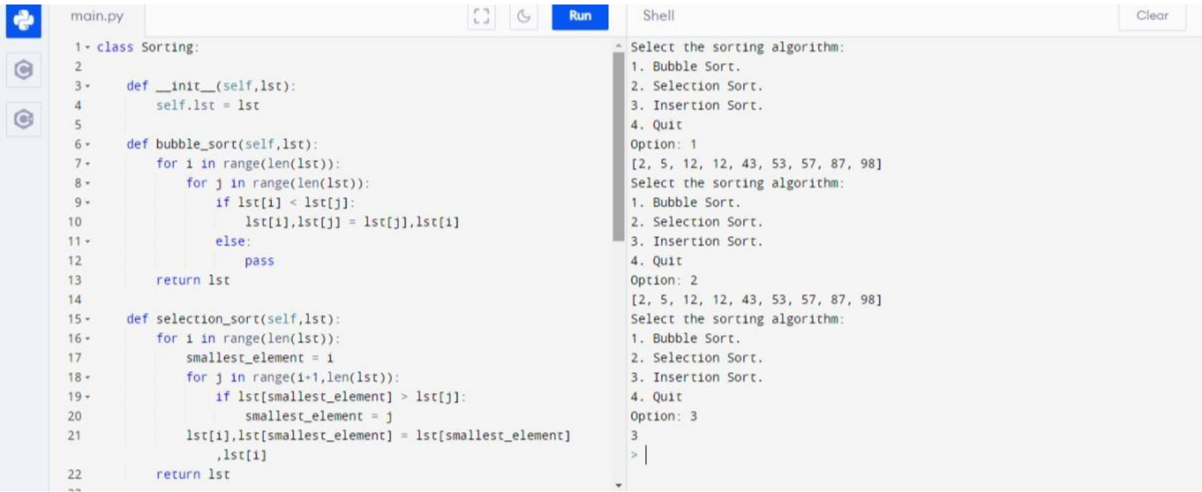
Aim: Write a program to search an element from a list. Give user the option to perform Linear or Binary search.

Theory:

- Bubble Sort: Bubble Sort is the simplest sorting algorithm that works byrepeatedly swapping the adjacent elements if they are in wrong order.
- Selection Sort: The selection sort algorithm sorts an array by repeatedly finding the minimum element (considering ascending order) from unsorted part and putting it at the beginning. The algorithm maintains two sub arrays in a givenarray
- Insertion Sort: Insertion sort iterates, consuming one input element each repetition, and growing a sorted output list. At each iteration, insertion sort removes oneelement from the input data, finds the location it belongs within the sorted list, and inserts it there. It repeats until no input elementsremain.

Code and Output:

:



main.py

```
class Sorting:

    def __init__(self,lst):
        self.lst = lst

    def bubble_sort(self,lst):
        for i in range(len(lst)):
            for j in range(len(lst)):
                if lst[i] < lst[j]:
                    lst[i],lst[j] = lst[j],lst[i]
                else:
                    pass
        return lst

    def selection_sort(self,lst):
        for i in range(len(lst)):
            smallest_element = i
            for j in range(i+1,len(lst)):
                if lst[smallest_element] > lst[j]:
                    smallest_element = j
            lst[i],lst[smallest_element] = lst[smallest_element]
                ,lst[i]
        return lst
```

Shell

```
Select the sorting algorithm:
1. Bubble Sort.
2. Selection Sort.
3. Insertion Sort.
4. Quit
Option: 1
[2, 5, 12, 12, 43, 53, 57, 87, 98]
Select the sorting algorithm:
1. Bubble Sort.
2. Selection Sort.
3. Insertion Sort.
4. Quit
Option: 2
[2, 5, 12, 12, 43, 53, 57, 87, 98]
Select the sorting algorithm:
1. Bubble Sort.
2. Selection Sort.
3. Insertion Sort.
4. Quit
Option: 3
3
>
```

Practical 7(a)

Aim: Implement the following for Hashing:

Write a program to implement the collision technique.

Theory:

Hashing:

Hashing is an important Data Structure which is designed to use a special function called the Hash function which is used to map a given value with a particular key for faster access of elements. The efficiency of mapping depends of the efficiency of the hash functionused.

- Collisions: A Hash Collision Attack is an attempt to find two input stringsof a hash function that produce the same hash result. If two separate inputs produce the same hash output, it is called a collision.

- Collision Techniques: When one or more hash values compete with a single hashtable slot, collisions occur. To resolve this, the next available empty slot is assigned to the current hashvalue

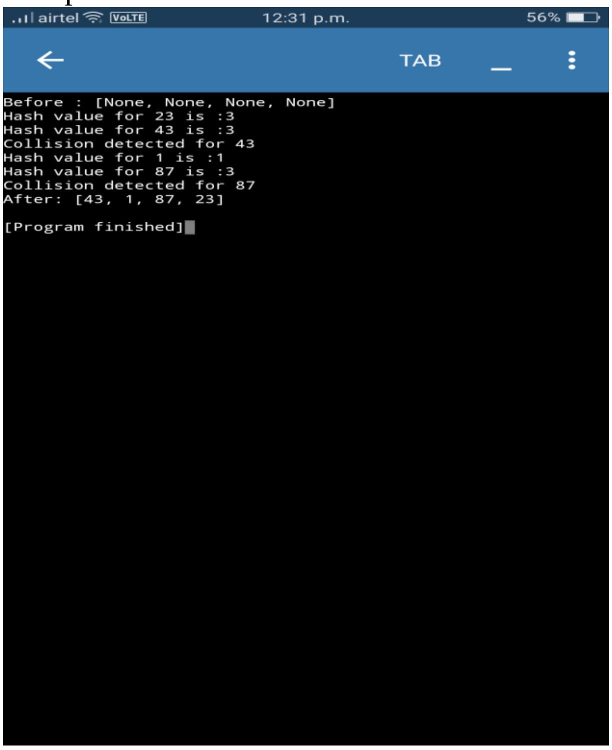
- Separate Chaining: The idea is to make each cell of hash table point to a linked listof records that have same hash functionvalue.

- Open Addressing: Like separate chaining, open addressing is a method for handling collisions. In Open Addressing, all elements are stored in the hash table itself. So at any point, the size of the table must be greater than or equal to the total number of keys (Note that we can increase table size by copying old data ifneeded)

Code:

```
class Hash:
    def __init__(self, keys: int, lower_range: int, higher_range: int) -> None:
        self.value = self.hash_function(keys, lower_range, higher_range)

    def get_key_value(self) -> int:
        return self.value

    @staticmethod
    def hash_function(keys: int, lower_range: int, higher_range: int) -> int:
        if lower_range == 0 and higher_range > 0:
            return keys % higher_range


if __name__ == '__main__':
    linear_probing = True
    list_of_keys = [23, 43, 1, 87]
    list_of_list_index = [None]*4
    print("Before : " + str(list_of_list_index))
    for value in list_of_keys:
        list_index = Hash(value, 0, len(list_of_keys)).get_key_value()
        print("Hash value for " + str(value) + " is :" + str(list_index))
        if list_of_list_index[list_index]:
            print("Collision detected for " + str(value))
            if linear_probing:
                old_list_index = list_index
                if list_index == len(list_of_list_index) - 1:
                    list_index = 0
                else:
                    list_index += 1
                list_full = False
                while list_of_list_index[list_index]:
                    if list_index == old_list_index:
                        list_full = True
                        break
                    if list_index + 1 == len(list_of_list_index):
                        list_index = 0
                    else:
                        list_index += 1
                if list_full:
                    print("List was full . Could not save")
                else:
                    list_of_list_index[list_index] = value
        else:
            list_of_list_index[list_index] = value
    print("After: " + str(list_of_list_index))
```

Output:



Practical 7(b)

Aim: Implement the following for Hashing:

Write a program to implement the concept of linear probing.

Theory:

Linear probing is a scheme in computer programming for resolving collisions in hash tables, data structures for maintaining a collection of key–value pairs and looking up the value associated with a given key. Along with quadratic probing and double hashing,linear probing is a form of open addressing.

Code:

```
size_list = 6

def hash_function(val):
  global size_list
  return val%size_list

def map_hash_function(hash_return_values):
  return hash_return_values

def create_hash_table(list_values,main_list):
  for  values in list_values:
    hash_return_values = hash_function(values)
    list_index = map_hash_function(hash_return_values)
    if main_list[list_index]:
      print("collision detected")
      linear_probing(list_index,values,main_list)
    else:
      main_list[list_index]=values

def linear_probing(list_index,value,main_list):
  global size_list
  list_full = False
  old_list_index=list_index
  if list_index == size_list - 1:
    list_index = 0
  else:
    list_index += 1

  while main_list[list_index]:
    if list_index+1 == size_list:
      list_index = 0
    else:
      list_index += 1
    if list_index == old_list_index:
      list_full = True
      break
  if list_full == True:
     print("list was full. could not saved")




def search_list(key,main_list):
  #for i in range(size_list):
  val = hash_function(key)
  if main_list[val] == key:
    print("list found",val)
  else:
    print("not found")


list_values = [1,3,8,6,5,14]

main_list = [None for x in range(size_list)]
print(main_list)
create_hash_table(list_values,main_list)
print(main_list)
search_list(5,main_list)
```

Output:


airtel VoLTE
12:29 p.m.
57%
TAB
[None, None, None, None, None, None]
collision detected
[6, 1, 8, 3, None, 5]
list found 5
[Program finished]

Practical 8

Aim: Write a program for inorder, postorder and preorder traversal of tree.

Theory:

- Inorder: In case of binary search trees (BST), Inorder traversal gives nodes in non-decreasing order. To get nodes of BST in non-increasing order, a variation of Inorder traversal where Inorder traversal s reversed can beused.
- Preorder: Preorder traversal is used to create a copy of the tree. Preorder traversal is also used to get prefix expression on of an expressiontree.
- Postorder: Postorder traversal is also useful to get the postfix expression of an expressiontree.

Code:

```
class Node:
  def __init__(self, key):
    self.left = None
    self.right = None
    self.value = key

  def PrintTree(self):
    if self.left:
      self.left.PrintTree()
    print(self.value)
    if self.right:
      self.right.PrintTree()

  def Printpreorder(self):
    if self.value:
      print(self.value)
      if self.left:
        self.left.Printpreorder()
      if self.right:
        self.right.Printpreorder()

  def Printinorder(self):
    if self.value:
      if self.left:
        self.left.Printinorder()
      print(self.value)
      if self.right:
        self.right.Printinorder()

  def Printpostorder(self):
```

```
        if self.value:
            if self.left:
                self.left.Printpostorder()
            if self.right:
                self.right.Printpostorder()
            print(self.value)

    def insert(self, data):
        if self.value:
            if data < self.value:
                if self.left is None:
                    self.left = Node(data)
                else:
                    self.left.insert(data)
            elif data > self.value:
                if self.right is None:
                    self.right = Node(data)
                else:
                    self.right.insert(data)
        else:
            self.value = data


if __name__ == '__main__':
    root = Node(10)
    root.left = Node(12)
    root.right = Node(5)
    print("Without any order")
    root.PrintTree()
    root_1 = Node(None)
    root_1.insert(28)
    root_1.insert(4)
    root_1.insert(13)
    root_1.insert(130)
    root_1.insert(123)
    print("Now ordering with insert")
    root_1.PrintTree()
    print("Pre order")
    root_1.Printpreorder()
    print("In Order")
    root_1.Printinorder()
    print("Post Order")
    root_1.Printpostorder()
```

Output:


```
Without any order
12
10
5
Now ordering with insert
4
13
28
123
130
Pre order
28
4
13
130
123
In Order
4
13
28
123
130
Post Order
13
4
123
130
28

[Program finished]
```