VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by
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(1BM25CS420-T)

in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **JANANI HIREMATH (1BM25CS420-T)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2025-2026. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST)** work prescribed for the said degree.

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Assistant Professor   Professor and Head
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Index Sheet

Course outcomes:

CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations of different data structures.

Lab program 1:

Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c)Display
The program should print appropriate messages for stack overflow, stack underflow

```c
#include <stdio.h>
#define SIZE 5
int stack[SIZE];

int top = -1;
// Function to push an element into the stack
void push(int value) {
   if (top == SIZE - 1) {
      printf("Stack Overflow! Cannot push %d\n", value);
   } else {
      top++;
      stack[top] = value;
      printf("%d pushed into stack\n", value);
   }
}

// Function to pop an element from the stack
void pop() {
   if (top == -1) {
      printf("Stack Underflow! No element to pop\n");
   } else {
      printf("%d popped from stack\n", stack[top]);
      top--;
   }
}

// Enhanced function to display stack elements
void display() {
   if (top == -1) {
      printf("Stack is empty!\n");
   } else {
      printf("\nCurrent Stack (Top to Bottom):\n");
      for (int i = top; i >= 0; i--) {
         if (i == top) {
            printf("| %d |  <- Top\n", stack[i]);
```

```c
        } else {
            printf("| %d |\n", stack[i]);
        }
    }
    printf(" ----- \n");
    }
}

// Main function to run the menu-driven stack program
int main() {
    int choice, value;
    while (1) {
        printf("\n---- Stack Menu ----\n");
        printf("1. Push\n");
        printf("2. Pop\n");
        printf("3. Display Stack\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to push: ");
                scanf("%d", &value);
                push(value);
                break;
            case 2:
                pop();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Exiting program.\n");
                return 0;
            default:
                printf("Invalid choice! Try again.\n");
        }
    }

    return 0;
}
```

Output:

```
---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 2
Stack Underflow! No element to pop

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 1
Enter value to push: 10
10 pushed into stack

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 1
Enter value to push: 20
20 pushed into stack

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 1
Enter value to push: 30
30 pushed into stack

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 3

Current Stack (Top to Bottom):
| 30 |  <- Top
| 20 |
| 10 |
 -----

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 2
30 popped from stack

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 2
20 popped from stack

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 3

Current Stack (Top to Bottom):
| 10 |  <- Top
 -----

---- Stack Menu ----
1. Push
2. Pop
3. Display Stack
4. Exit
Enter your choice: 4
Exiting program.
```

LEETCODE-1
TWO SUM

```c
#include <stdlib.h>

int* twoSum(int* nums, int numsSize, int target, int* returnSize) {
    int* result = malloc(2 * sizeof(int));
    *returnSize = 0;

    for (int i = 0; i < numsSize - 1; i++) {
        for (int j = i + 1; j < numsSize; j++) {
            if (nums[i] + nums[j] == target) {
                result[0] = i;
                result[1] = j;
                *returnSize = 2;
                return result;
            }
        }
    }

    return NULL;  // No solution found
}
```

LEETCODE-26

Remove Duplicates from Sorted Array

```c
int removeDuplicates(int* nums, int numsSize) {
    if (numsSize == 0) return 0; // Empty array

    int i = 0; // slow pointer

    for (int j = 1; j < numsSize; j++) {
        if (nums[j] != nums[i]) {
            i++;
            nums[i] = nums[j];
        }
    }

    return i + 1; // New length
}
```

LEETCODE-35
Search Insert Position

```c
int searchInsert(int* nums, int numsSize, int target) {
    int left = 0, right = numsSize - 1;
    while (left <= right) {
        int mid = (left + right) / 2;
        if (nums[mid] < target)
            left = mid + 1;
        else
            right = mid - 1;
    }
    return left; // insert position
}
```
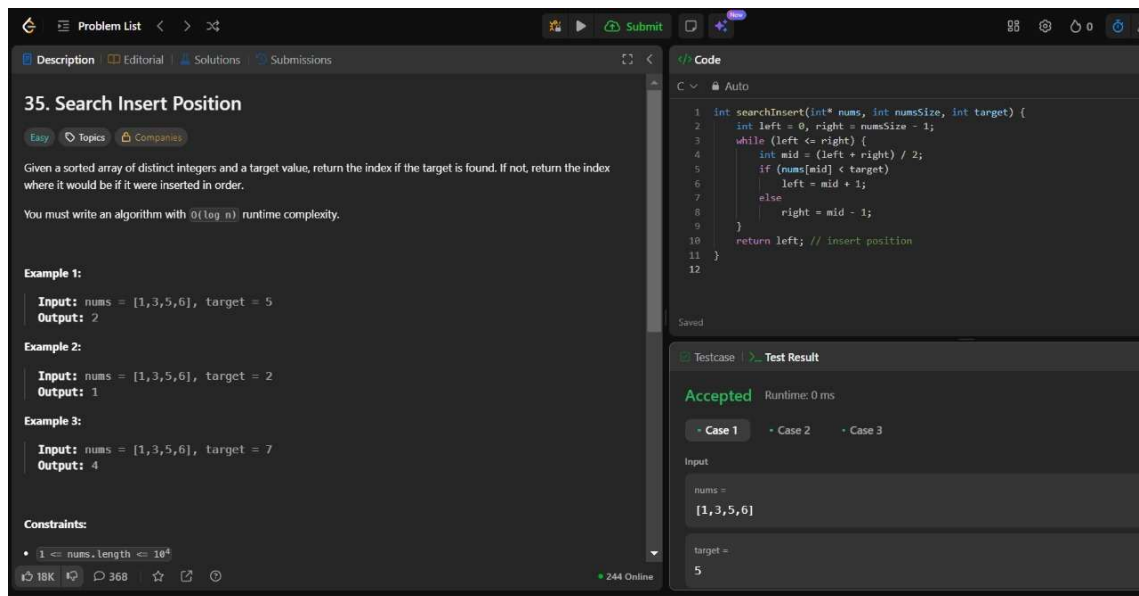
Lab Program 2

(a) WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide)

```c
#include <stdio.h>
#include <ctype.h>   // for isalnum() and isdigit()

#define MAX 100      // maximum size of the stack and input

// ---- Stack for operators ----
char stack[MAX];
int top = -1;        // top of stack ( -1 means empty )

// push one character onto the stack
void push(char c) {
    stack[++top] = c;
}

// pop one character from the stack
char pop() {
    return stack[top--];
}

// look at the top character without removing it
char peek() {
    return stack[top];
}

// returns precedence level of operators
int precedence(char op) {
    if(op == '^') return 3;           // highest
    if(op == '*' || op == '/') return 2;  // medium
    if(op == '+' || op == '-') return 1;  // lowest
    return 0;
}

int main() {
    char infix[MAX];

    // ask the user to enter an expression
    printf("Enter infix expression: ");
```

```c
scanf("%[^\n]", infix);  // read entire line until ENTER

// push an opening '(' so we have a marker in the stack
push('(');

// find length of infix string
int len = 0;
while(infix[len] != '\0') len++;

// add a closing ')' at the end (so we pop everything finally)
infix[len] = ')';
infix[len+1] = '\0';

printf("Postfix: ");

// go through each character in the infix expression
for(int i = 0; infix[i] != '\0'; ) {

    // ignore spaces if user typed them
    if(infix[i] == ' ') {
        i++;
        continue;
    }

    // ---- If current is a letter or digit (part of number/variable) ----
    if(isalnum(infix[i]) || infix[i]=='.') {
        // print the entire number or variable (can be many chars)
        while(isalnum(infix[i]) || infix[i]=='.') {
            printf("%c", infix[i]);
            i++;
        }
        printf(" "); // add a space after the operand
    }

    // ---- If '(' just push to stack ----
    else if(infix[i] == '(') {
        push('(');
        i++;
    }

    // ---- If ')' pop until we find '(' ----
    else if(infix[i] == ')') {
```

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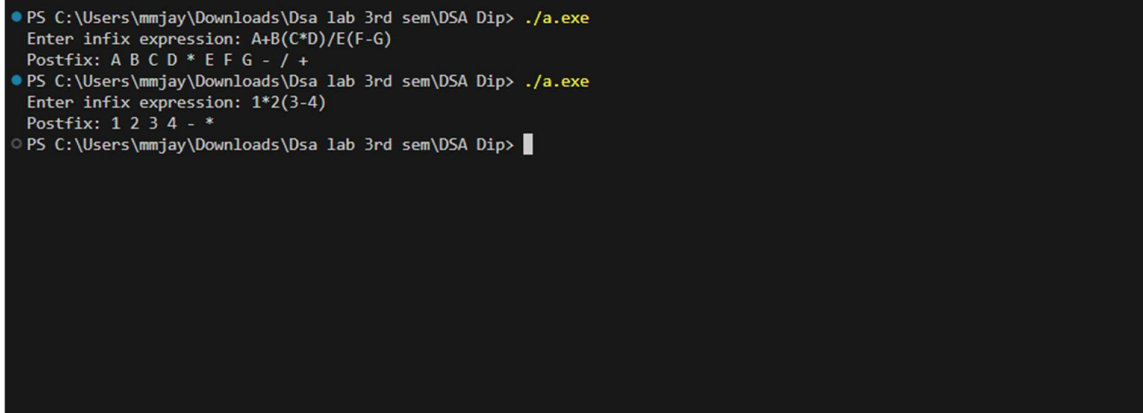
```c
        while(peek() != '(') {        // pop operators
            printf("%c ", pop());
        }
        pop(); // remove the '('
        i++;
    }

    // ---- If operator (+ - * / ^) ----
    else {
        char op = infix[i];
        // while top of stack has higher or equal precedence
        while(precedence(peek()) >= precedence(op)) {
            printf("%c ", pop());
        }
        // push the current operator
        push(op);
        i++;
    }
}

// because we put an extra ')' we don't need another loop
printf("\n");
return 0;
}
```

Output:

```
PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip> ./a.exe
Enter infix expression: A+B(C*D)/E(F-G)
Postfix: A B C D * E F G - / +
PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip> ./a.exe
Enter infix expression: 1*2(3-4)
Postfix: 1 2 3 4 - *
PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip>
```

Lab Program 3

a) **WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display The program should print appropriate messages for queue empty and queue overflow conditions**

```c
#include <stdio.h>
#define SIZE 3
int q[SIZE], front=-1, rear=-1;

void insert() {
   if (rear == SIZE-1) {
      printf("Queue Overflow!\n");
      return;
   }
   int x;
   printf("Enter value: ");
   scanf("%d",&x);
   if (front == -1) front = 0;
   q[++rear] = x;
   printf("%d inserted.\n", x);
}

void delete() {
   if (front == -1 || front>rear) {
      printf("Queue Underflow!\n");
      return;
   }
   printf("%d deleted.\n", q[front++]);
}

void display() {
   if (front==-1 || front>rear) {
      printf("Queue is empty.\n");
      return;
   }
   printf("Queue: ");
   for(int i=front;i<=rear;i++) printf("%d ", q[i]);
   printf("\n");
}

int main() {
   int ch;
```

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```
    printf("---Linear Queue---");
while(1) {
    printf("\n 1.Insert 2.Delete 3.Display 4.Exit\n Enter Choice: ");
    scanf("%d",&ch);
    switch(ch) {
        case 1: insert(); break;
        case 2: delete(); break;
        case 3: display(); break;
        case 4: return 0;
        default: printf("Invalid choice!\n");
    }
}}
```

Output:

```
C:\Users\Admin\Desktop\Linearqueue.exe
---Linear Queue---
 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 3
Queue is empty.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 1
Enter value: 10
10 inserted.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 1
Enter value: 20
20 inserted.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 1
Enter value: 30
30 inserted.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 1
Queue Overflow!

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 3
Queue: 10 20 30

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 2
10 deleted.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 3
Queue: 20 30

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 2
20 deleted.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 2
30 deleted.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 2
Queue Underflow!

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 3
Queue is empty.

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 1
Queue Overflow!

 1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 4

Process returned 0 (0x0)   execution time : 64.044 s
Press any key to continue.
```

b) WAP to simulate the working of Circular Queue using an array with the following operations: Insert, Delete and Display, also should print appropriate message for queue empty and overflow conditions.

```c
#include <stdio.h>
#define SIZE 3
int queue[SIZE];
int front = -1, rear = -1;

void insert() {
    int x;
    if ((rear + 1) % SIZE == front) {
        printf("Queue Overflow!\n");
        return;
    }
    printf("Enter value: ");
    scanf("%d", &x);
    if (front == -1) front = rear = 0;
    else rear = (rear + 1) % SIZE;
    queue[rear] = x;
    printf("%d inserted.\n", x);
}

void delete() {
    if (front == -1) {
        printf("Queue Underflow!\n");
        return;
    }
    printf("%d deleted.\n", queue[front]);
    if (front == rear) front = rear = -1;
    else front = (front + 1) % SIZE;
}

void display() {
    if (front == -1) {
        printf("Queue is empty.\n");
        return;
    }

    printf("Queue: ");
    int i = front;
    while (1) {
        printf("%d ", queue[i]);
        if (i == rear) break;
        i = (i + 1) % SIZE;
    }
    printf("\n");
}

int main() {
    int choice;
```

```
    printf("---Circular Queue---");
        while (1) {
            printf("\n1.Insert 2.Delete 3.Display 4.Exit\n Enter Choice: ");
            scanf("%d", &choice);
            switch(choice) {
                case 1: insert(); break;
                case 2: delete(); break;
                case 3: display(); break;
                case 4: return 0;
                default: printf("Invalid choice!\n");
            }
        }
    }
```

Output:

```
1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 3
Queue: 30 40

1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 2
30 deleted.

1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 2
40 deleted.

1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 2
Queue Underflow!

1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 3
Queue is empty.

1.Insert 2.Delete 3.Display 4.Exit
 Enter Choice: 4

Process returned 0 (0x0)   execution time : 80.723 s
Press any key to continue.
```

Lab Program 4
WAP to Implement Singly Linked List with following operations
a) Create a linked list.
b) Insertion of a node at first position, at any position and at end of list.
 Display the contents of the linked list.

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

struct node {
   int data;
   struct node *next;
};

struct node *head = NULL, *ptr, *temp;

// Function to create a new node
struct node* createNode(int value) {
   ptr = (struct node*)malloc(sizeof(struct node));
   ptr->data = value;
   ptr->next = NULL;
   return ptr;
}

// Insert at beginning
void insertAtBeginning(int value) {
   ptr = createNode(value);
   ptr->next = head;
   head = ptr;
}

// Insert at end
void insertAtEnd(int value) {
   ptr = createNode(value);
   if (head == NULL)
      head = ptr;
   else {
      temp = head;
      while (temp->next != NULL)
         temp = temp->next;
      temp->next = ptr;
   }
}

// Insert at any position
void insertAtPosition(int value, int pos) {
   int i;
   ptr = createNode(value);
   if (pos == 1) {
      ptr->next = head;
      head = ptr;
```

```c
        return;
    }
    temp = head;
    for (i = 1; i < pos - 1 && temp != NULL; i++)
        temp = temp->next;
    if (temp == NULL)
        printf("Position out of range!\n");
    else {
        ptr->next = temp->next;
        temp->next = ptr;
    }
}

// Display the list
void display() {
    if (head == NULL) {
        printf("List is empty!\n");
        return;
    }
    temp = head;
    printf("Linked List: ");
    while (temp != NULL) {
        printf("%d -> ", temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}

// Main function
int main() {
    int choice, value, pos;
printf("\n1. Insert at Beginning\n2. Insert at Position\n3. Insert at End\n4. Display\n5.
Exit\n");
    while (1) {
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
        case 1:
            printf("Enter value: ");
            scanf("%d", &value);
            insertAtBeginning(value);
            break;
        case 2:
            printf("Enter value and position: ");
            scanf("%d %d", &value, &pos);
            insertAtPosition(value, pos);
            break;
        case 3:
            printf("Enter value: ");
            scanf("%d", &value);
```

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```c
            insertAtEnd(value);
            break;
        case 4:
            display();
            break;
        case 5:
            exit(0);
        default:
            printf("Invalid choice!\n");
        }
    }
    return 0;
}
```

Output:

Lab Program 5
WAP to Implement Singly Linked List with following operations
a) Create a linked list.
b) Deletion of first element, specified element and last element in the list.
c) Display the contents of the linked list.

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

struct node {
    int data;
    struct node *next;
};

struct node *head = NULL, *ptr, *temp;

// Create node function
struct node* createNode(int value) {
    ptr = (struct node*)malloc(sizeof(struct node));
    ptr->data = value;
    ptr->next = NULL;
    return ptr;
}

// Create linked list
void createList(int n) {
    int value, i;
    if (n <= 0) return;

    printf("Enter value for node 1: ");
    scanf("%d", &value);
    head = createNode(value);
    temp = head;

    for (i = 2; i <= n; i++) {
        printf("Enter value for node %d: ", i);
        scanf("%d", &value);
        ptr = createNode(value);
        temp->next = ptr;
        temp = temp->next;
    }
}

// Delete first element
void deleteFirst() {
    if (head == NULL) {
        printf("List is empty!\n");
        return;
    }
```

```c
        ptr = head;
        head = head->next;
        free(ptr);
        printf("First element deleted.\n");
    }

    // Delete last element
    void deleteLast() {
        if (head == NULL) {
            printf("List is empty!\n");
            return;
        }
        if (head->next == NULL) {
            free(head);
            head = NULL;
            printf("Last element deleted.\n");
            return;
        }
        temp = head;
        while (temp->next->next != NULL)
            temp = temp->next;
        free(temp->next);
        temp->next = NULL;
        printf("Last element deleted.\n");
    }

    // Delete specified element by value
    void deleteSpecific(int value) {
        if (head == NULL) {
            printf("List is empty!\n");
            return;
        }
        ptr = head;
        if (head->data == value) {
            head = head->next;
            free(ptr);
            printf("Element %d deleted.\n", value);
            return;
        }
        while (ptr->next != NULL && ptr->next->data != value)
            ptr = ptr->next;

        if (ptr->next == NULL)
            printf("Element not found!\n");
        else {
            temp = ptr->next;
            ptr->next = temp->next;
            free(temp);
            printf("Element %d deleted.\n", value);
        }
    }
```

```c
// Display linked list
void display() {
   if (head == NULL) {
      printf("List is empty!\n");
      return;
   }
   temp = head;
   printf("Linked List: ");
   while (temp != NULL) {
      printf("%d -> ", temp->data);
      temp = temp->next;
   }
   printf("NULL\n");
}

// Main function
int main() {
   int choice, n, value;
printf("\n1. Create List\n2. Delete First\n3. Delete Specific\n4. Delete Last\n5. Display\n6.
Exit\n");
   while (1) {
      printf("Enter your choice: ");
      scanf("%d", &choice);

      switch (choice) {
      case 1:
         printf("How many nodes? ");
         scanf("%d", &n);
         createList(n);
         break;
      case 2:
         deleteFirst();
         break;
      case 3:
         printf("Enter value to delete: ");
         scanf("%d", &value);
         deleteSpecific(value);
         break;
      case 4:
         deleteLast();
         break;
      case 5:
         display();
         break;
      case 6:
         exit(0);
      default:
         printf("Invalid choice!\n");
      }
   }
```

```
        return 0;
    }
```

Output:

```
1. Create List
2. Delete First
3. Delete Specific
4. Delete Last
5. Display
6. Exit
Enter your choice: 1
How many nodes? 4
Enter value for node 1: 10
Enter value for node 2: 20
Enter value for node 3: 30
Enter value for node 4: 40
Enter your choice: 5
Linked List: 10 -> 20 -> 30 -> 40 -> NULL
Enter your choice: 2
First element deleted.
Enter your choice: 5
Linked List: 20 -> 30 -> 40 -> NULL
Enter your choice: 3
Enter value to delete: 5
Element not found!
Enter your choice: 3
Enter value to delete: 30
Element 30 deleted.
Enter your choice: 5
Linked List: 20 -> 40 -> NULL
Enter your choice: 4
Last element deleted.
Enter your choice: 5
Linked List: 20 -> NULL
Enter your choice: 6
```

Lab Program 6

6(a) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists

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

struct Node {
   int data;
   struct Node* next;
};

struct Node* create(int x) {
   struct Node* n = (struct Node*)malloc(sizeof(struct Node));
   n->data = x;
   n->next = NULL;
   return n;
}

struct Node* insertEnd(struct Node* head, int x) {
   struct Node* n = create(x);
   if (!head) return n;

   struct Node* t = head;
   while (t->next) t = t->next;
   t->next = n;
   return head;
}

void printList(struct Node* head) {
   printf("List: ");
   while (head) {
      printf("%d -> ", head->data);
      head = head->next;
   }
   printf("NULL\n");
}

void sortList(struct Node* head) {
   struct Node *i, *j;
   int temp;

   for (i = head; i && i->next; i = i->next)
      for (j = i->next; j; j = j->next)
         if (i->data > j->data) {
            temp = i->data;
            i->data = j->data;
            j->data = temp;
         }

   printf("After Sorting: ");
```

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```c
      printList(head);
}

struct Node* reverseList(struct Node* head) {
   struct Node *prev = NULL, *cur = head, *next;

   while (cur) {
      next = cur->next;
      cur->next = prev;
      prev = cur;
      cur = next;
   }

   printf("After Reversing: ");
   printList(prev);
   return prev;
}

struct Node* concatList(struct Node* a, struct Node* b) {
   if (!a) return b;
   struct Node* t = a;

   while (t->next) t = t->next;
   t->next = b;

   printf("After Concatenation: ");
   printList(a);

   return a;
}

int main() {
   struct Node *L1 = NULL, *L2 = NULL;
   int ch, val;
    printf("\n--- MENU ---\n");
      printf("1. Insert into List 1\n");
      printf("2. Insert into List 2\n");
      printf("3. Sort List 1\n");
      printf("4. Reverse List 1\n");
      printf("5. Concatenate List1 + List2\n");
      printf("6. Print List 1\n");
      printf("7. Print List 2\n");
      printf("8. Exit\n");
   while (1) {

      printf("Choice: ");
      scanf("%d", &ch);

      switch (ch) {
         case 1:
            scanf("%d", &val);
```

```c
            L1 = insertEnd(L1, val);
            break;
        case 2:
            scanf("%d", &val);
            L2 = insertEnd(L2, val);
            break;
        case 3:
            sortList(L1);
            break;
        case 4:
            L1 = reverseList(L1);
            break;
        case 5:
            L1 = concatList(L1, L2);
            break;
        case 6:
            printList(L1);
            break;
        case 7:
            printList(L2);
            break;
        case 8:
            exit(0);
        default:
            printf("Invalid Choice!\n");
        }
    }
}
```

Output:

```
--- MENU ---
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate List1 + List2
6. Print List 1
7. Print List 2
8. Exit
Choice: 1
10
Choice: 1
20
Choice: 1
30
Choice: 2
60
Choice: 2
50
Choice: 6
List: 10 -> 20 -> 30 -> NULL
Choice: 7
List: 60 -> 50 -> NULL
Choice: 3
After Sorting: List: 10 -> 20 -> 30 -> NULL
Choice: 4
After Reversing: List: 30 -> 20 -> 10 -> NULL
Choice: 5
After Concatenation: List: 30 -> 20 -> 10 -> 60 -> 50 -> NULL
Choice: 8
```

6(b) WAP to Implement Single Link List to simulate Stack & Queue Operations.

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

struct Node {
    int data;
    struct Node* next;
};

struct Node* create(int x) {
    struct Node* n = (struct Node*)malloc(sizeof(struct Node));
    n->data = x;
    n->next = NULL;
    return n;
}

void print(struct Node* head) {
    while (head) {
        printf("%d -> ", head->data);
        head = head->next;
    }
    printf("NULL\n");
}

struct Node* push(struct Node* top, int x) {
    struct Node* n = create(x);
    n->next = top;
    return n;
}

struct Node* pop(struct Node* top) {
    if (!top) { printf("Stack Underflow!\n"); return NULL; }
    struct Node* t = top;
    top = top->next;
    free(t);
    return top;
}

struct Node* enqueue(struct Node* front, int x) {
    struct Node* n = create(x);
    if (!front) return n;
    struct Node* t = front;
    while (t->next) t = t->next;
    t->next = n;
    return front;
}

struct Node* dequeue(struct Node* front) {
    if (!front) { printf("Queue Underflow!\n"); return NULL; }
```

```c
    struct Node* t = front;
    front = front->next;
    free(t);
    return front;
}

int main() {
    struct Node *stack = NULL, *queue = NULL;
    int ch, val;
    printf("\n1.Push  2.Pop  3.Display Stack\n");
    printf("4.Enqueue  5.Dequeue  6.Display Queue\n7.Exit\n");
    while (1) {

        printf("Choice: ");
        scanf("%d", &ch);

        switch (ch) {
            case 1: scanf("%d",&val); stack = push(stack,val); print(stack); break;
            case 2: stack = pop(stack); print(stack); break;
            case 3: print(stack); break;

            case 4: scanf("%d",&val); queue = enqueue(queue,val); print(queue); break;
            case 5: queue = dequeue(queue); print(queue); break;
            case 6: print(queue); break;

            case 7: exit(0);
        }
    }
}
```
Output:

```
1.Push  2.Pop  3.Display Stack
4.Enqueue  5.Dequeue  6.Display Queue
7.Exit
Choice: 1
10
10 -> NULL
Choice: 1
20
20 -> 10 -> NULL
Choice: 1
30
30 -> 20 -> 10 -> NULL
Choice: 3
30 -> 20 -> 10 -> NULL
Choice: 4
40
40 -> NULL
Choice: 4
50
40 -> 50 -> NULL
Choice: 4
60
40 -> 50 -> 60 -> NULL
Choice: 2
20 -> 10 -> NULL
Choice: 5
50 -> 60 -> NULL
Choice: 5
60 -> NULL
Choice: 7
```

LEETCODE-141
Linked List Cycle

```c
bool hasCycle(struct ListNode *head) {
    if (head == NULL) return false;

    struct ListNode *slow = head;
    struct ListNode *fast = head;

    while (fast != NULL && fast->next != NULL) {
        slow = slow->next;
        fast = fast->next->next;

        if (slow == fast)
            return true;
    }

    return false;
}
```

REMOVE NTH NODE FROM END OF THE LIST

```c
struct ListNode* removeNthFromEnd(struct ListNode* head, int n) {

    struct ListNode* dummy = (struct ListNode*)malloc(sizeof(struct ListNode));
    dummy->next = head;
    struct ListNode* fast = dummy;
    struct ListNode* slow = dummy;
    for (int i = 0; i < n; i++) {
        fast = fast->next;
    }

    while (fast->next != NULL) {
        fast = fast->next;
        slow = slow->next;
    }

    struct ListNode* temp = slow->next;
    slow->next = slow->next->next;
    free(temp);

    struct ListNode* newHead = dummy->next;
    free(dummy);
    return newHead;
}
```

Lab Program 7
WAP to Implement doubly link list with primitive operations
a) Create a doubly linked list.
b) Insert a new node to the left of the node.
c) Delete the node based on a specific value
d) Display the contents of the list

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

struct Node {
    int data;
    struct Node *prev, *next;
};

struct Node *head = NULL;

// Create a new node
struct Node* createNode(int value) {
    struct Node *newNode = malloc(sizeof(struct Node));
    newNode->data = value;
    newNode->prev = newNode->next = NULL;
    return newNode;
}

// a) Create DLL — insert at end
void createDLL() {
    int n, value;
    printf("Enter number of nodes: ");
    scanf("%d", &n);

    for (int i = 0; i < n; i++) {
        printf("Enter value for node %d: ", i + 1);
        scanf("%d", &value);

        struct Node *newNode = createNode(value);

        if (head == NULL) {
            head = newNode;
        } else {
```

```c
        struct Node *temp = head;
        while (temp->next) temp = temp->next;

        temp->next = newNode;
        newNode->prev = temp;
      }
   }
}

// b) Insert LEFT of a node
void insertLeft() {
   int key, value;
   printf("Enter key (value of node): ");
   scanf("%d", &key);
   printf("Enter new value to insert: ");
   scanf("%d", &value);

   struct Node *temp = head;

   while (temp && temp->data != key)
      temp = temp->next;

   if (!temp) {
      printf("Key not found.\n");
      return;
   }

   struct Node *newNode = createNode(value);

   if (temp == head) {
      newNode->next = head;
      head->prev = newNode;
      head = newNode;
   } else {
      newNode->next = temp;
      newNode->prev = temp->prev;
      temp->prev->next = newNode;
      temp->prev = newNode;
   }
}

// c) Delete a node by value
```

```c
void deleteValue() {
    int key;
    printf("Enter value to delete: ");
    scanf("%d", &key);

    struct Node *temp = head;

    while (temp && temp->data != key)
        temp = temp->next;
    if (!temp) {
        printf("Value not found.\n");
        return;
    }
    if (temp == head)
        head = head->next;
    if (temp->next)
        temp->next->prev = temp->prev;
    if (temp->prev)
        temp->prev->next = temp->next;
    free(temp);
    printf("Node deleted.\n");
}

// d) Display DLL
void display() {
    struct Node *temp = head;
    if (!head) {
        printf("List is empty.\n");
        return;
    }
    printf("List: ");
    while (temp) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    int choice;
printf("\n--- MENU ---\n");
        printf("1. Create Doubly Linked List\n");
```

```
        printf("2. Insert Left of Node\n");
        printf("3. Delete Node by Value\n");
        printf("4. Display List\n");
        printf("5. Exit\n");
    while (1) {
        printf("\nEnter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1: createDLL(); break;
            case 2: insertLeft(); break;
            case 3: deleteValue(); break;
            case 4: display(); break;
            case 5: exit(0);
            default: printf("Invalid choice!\n");
        }
    }
}
```

Output:

```
--- MENU ---
1. Create Doubly Linked List
2. Insert Left of Node
3. Delete Node by Value
4. Display List
5. Exit

Enter your choice: 1
Enter number of nodes: 3
Enter value for node 1: 10
Enter value for node 2: 20
Enter value for node 3: 30

Enter your choice: 2
Enter key (value of node): 30
Enter new value to insert: 25

Enter your choice: 4
List: 10 <=>20 <=>25 <=>30 <=>

Enter your choice: 3
Enter value to delete: 30
Node deleted.

Enter your choice: 4
List: 10 <=>20 <=>25 <=>

Enter your choice: 5
```
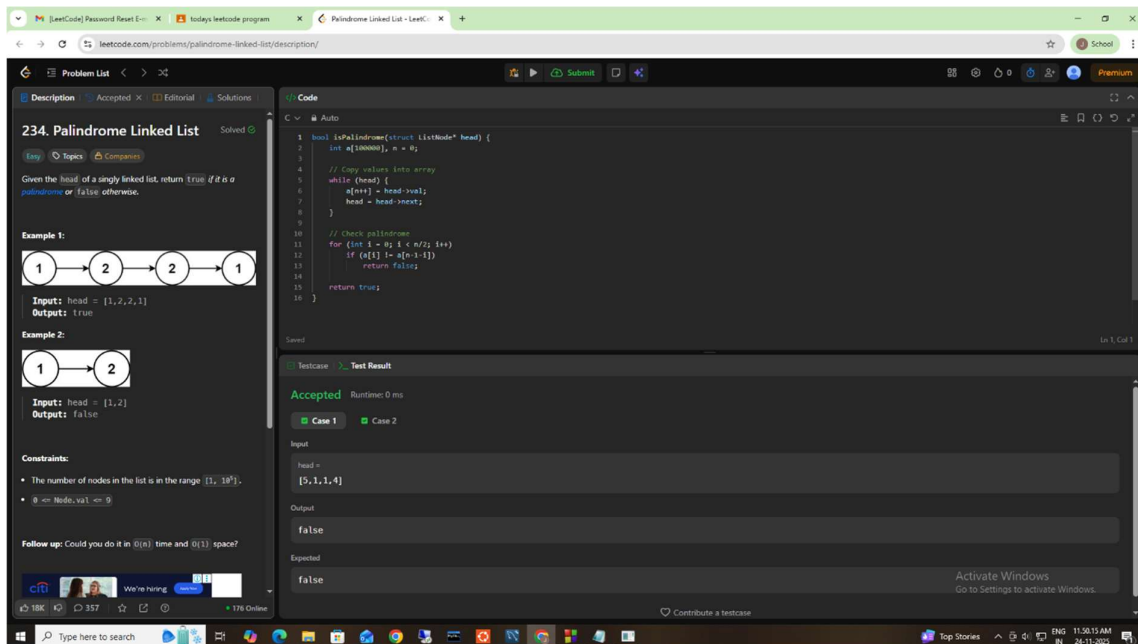
LEETCODE-234

PALINDROME LINKED LIST

```c
bool isPalindrome(struct ListNode* head) {
    int a[100000], n = 0;

    // Copy values into array
    while (head) {
        a[n++] = head->val;
        head = head->next;
    }

    // Check palindrome
    for (int i = 0; i < n/2; i++)
        if (a[i] != a[n-1-i])
            return false;

    return true;
}
```

Lab Program 8

8(a)Write a program

 a) To construct a binary Search tree.

 b) To traverse the tree using all the methods i.e., in order, preorder and post order

 c) To display the elements in the tree.

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

// Structure for a tree node
struct node {
    int data;
    struct node *left, *right;
};

// Function to create a new node
struct node* createNode(int value) {
    struct node* newNode = (struct node*)malloc(sizeof(struct node));
    newNode->data = value;
    newNode->left = newNode->right = NULL;
    return newNode;
}

// Function to insert a value into the BST
struct node* insert(struct node* root, int value) {
    if (root == NULL) {
        root = createNode(value);
    }
    else if (value < root->data) {
        root->left = insert(root->left, value);
    }
    else if (value > root->data) {
        root->right = insert(root->right, value);
    }
    return root;
}

// Inorder traversal (Left → Root → Right)
void inorder(struct node* root) {
    if (root != NULL) {
        inorder(root->left);
        printf("%d ", root->data);
        inorder(root->right);
    }
}

// Preorder traversal (Root → Left → Right)
void preorder(struct node* root) {
```

```c
    if (root != NULL) {
        printf("%d ", root->data);
        preorder(root->left);
        preorder(root->right);
    }
}

// Postorder traversal (Left → Right → Root)
void postorder(struct node* root) {
    if (root != NULL) {
        postorder(root->left);
        postorder(root->right);
        printf("%d ", root->data);
    }
}

int main() {
    struct node* root = NULL;
    int choice, value;
     printf("\n Binary Search Tree Menu \n 1. Insert element\n 2. Display Inorder Traversal\n 3.
Display Preorder Traversal\n 4. Display Postorder Traversal\n 5. Exit\n");

    while (1) {

        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert: ");
                scanf("%d", &value);
                root = insert(root, value);
                break;

            case 2:
                printf("Inorder Traversal: ");
                inorder(root);
                printf("\n");
                break;

            case 3:
                printf("Preorder Traversal: ");
                preorder(root);
                printf("\n");
                break;

            case 4:
                printf("Postorder Traversal: ");
                postorder(root);
                printf("\n");
                break;
```

```
        case 5:
            printf("Exiting program.\n");
            exit(0);

        default:
            printf("Invalid choice, try again.\n");
        }
    }

    return 0;
}
```

Output:

```
 Binary Search Tree Menu
 1. Insert element
 2. Display Inorder Traversal
 3. Display Preorder Traversal
 4. Display Postorder Traversal
 5. Exit
Enter your choice: 1
Enter value to insert: 20
Enter your choice: 1
Enter value to insert: 4
Enter your choice: 1
Enter value to insert: 79
Enter your choice: 1
Enter value to insert: 38
Enter your choice: 1
Enter value to insert: 28
Enter your choice: 1
Enter value to insert: 80
Enter your choice: 1
Enter value to insert: 45
Enter your choice: 2
Inorder Traversal: 4 20 28 38 45 79 80
Enter your choice: 3
Preorder Traversal: 20 4 79 38 28 45 80
Enter your choice: 4
Postorder Traversal: 4 28 45 38 80 79 20
Enter your choice: 5
Exiting program.
```

LEETCODE-1971

Find if the path exists in graph

```c
bool validPath(int n, int** edges, int edgesSize, int* edgesColSize,
        int source, int destination) {

   if (source == destination) return true;

   int* deg = calloc(n, sizeof(int));
   for (int i = 0; i < edgesSize; i++) {
      deg[edges[i][0]]++;
      deg[edges[i][1]]++;
   }

   int** g = malloc(n * sizeof(int*));
   for (int i = 0; i < n; i++)
      g[i] = malloc(deg[i] * sizeof(int));

   int* d = calloc(n, sizeof(int));
   for (int i = 0; i < edgesSize; i++) {
      int u = edges[i][0], v = edges[i][1];
      g[u][d[u]++] = v;
      g[v][d[v]++] = u;
   }

   bool* vis = calloc(n, sizeof(bool));
   int* q = malloc(n * sizeof(int));
   int f = 0, r = 0;

   q[r++] = source;
   vis[source] = true;

   while (f < r) {
      int u = q[f++];
      if (u == destination) return true;
      for (int i = 0; i < deg[u]; i++) {
         int v = g[u][i];
         if (!vis[v]) {
            vis[v] = true;
            q[r++] = v;
         }
      }
   }
}
```

```
    return false;
}
```

Lab Program 9

(A) Write a program to traverse a graph using BFS method.

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

#define MAX 20

struct Node {
    int vertex;
    struct Node* next;
};

struct Node* adj[MAX];
int visited[MAX];
int queue[MAX], front = 0, rear = 0;
int n;

void addEdge(int src, int dest) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->vertex = dest;
    newNode->next = adj[src];
    adj[src] = newNode;
}

void bfs(int start) {
    int v;
    queue[rear++] = start;
    visited[start] = 1;

    printf("BFS Traversal: ");
    while (front < rear) {
        v = queue[front++];
        printf("%d ", v);

        struct Node* temp = adj[v];
        while (temp != NULL) {
            if (!visited[temp->vertex]) {
                queue[rear++] = temp->vertex;
                visited[temp->vertex] = 1;
            }
            temp = temp->next;
        }
    }
}

int main() {
    int edges, src, dest, start;

    printf("Enter number of vertices: ");
```

```c
    scanf("%d", &n);

    printf("Enter number of edges: ");
    scanf("%d", &edges);

    for (int i = 0; i < edges; i++) {
        printf("Enter edge (src dest): ");
        scanf("%d %d", &src, &dest);
        addEdge(src, dest);
        addEdge(dest, src);
    }

    printf("Enter starting vertex: ");
    scanf("%d", &start);

    bfs(start);

    return 0;
}
```

Output:

```
PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip> ./a.exe
Enter number of vertices: 4
Enter number of edges: 3
Enter edge (src dest): 1 2
Enter edge (src dest): 1 3
Enter edge (src dest): 2 3
Enter starting vertex: 1
BFS Traversal: 1 3 2
PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip>
```

B) Program to Check Whether Graph is Connected Using DFS (Adjacency List)
Program Code:

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

#define MAX 20

struct Node {
    int vertex;
    struct Node* next;
};

struct Node* adj[MAX];
int visited[MAX];
int n;

void addEdge(int src, int dest) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->vertex = dest;
    newNode->next = adj[src];
    adj[src] = newNode;
}

void dfs(int v) {
    visited[v] = 1;

    struct Node* temp = adj[v];
    while (temp != NULL) {
        if (!visited[temp->vertex])
            dfs(temp->vertex);
        temp = temp->next;
    }
}

int main() {
    int edges, src, dest;

    printf("Enter number of vertices: ");
    scanf("%d", &n);

    printf("Enter number of edges: ");
    scanf("%d", &edges);

    for (int i = 0; i < edges; i++) {
        printf("Enter edge (src dest): ");
        scanf("%d %d", &src, &dest);
        addEdge(src, dest);
        addEdge(dest, src);
    }
```
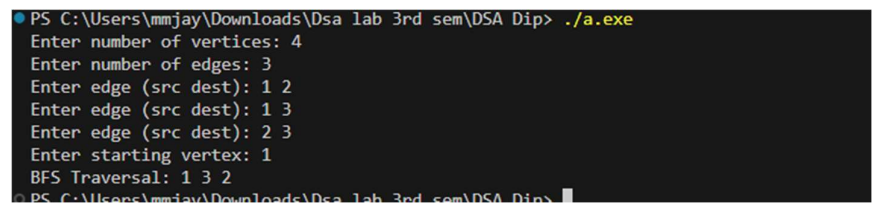
```
    dfs(1);

    for (int i = 1; i <= n; i++) {
        if (!visited[i]) {
            printf("Graph is NOT Connected\n");
            return 0;
        }
    }

    printf("Graph is Connected\n");
    return 0;
}
```
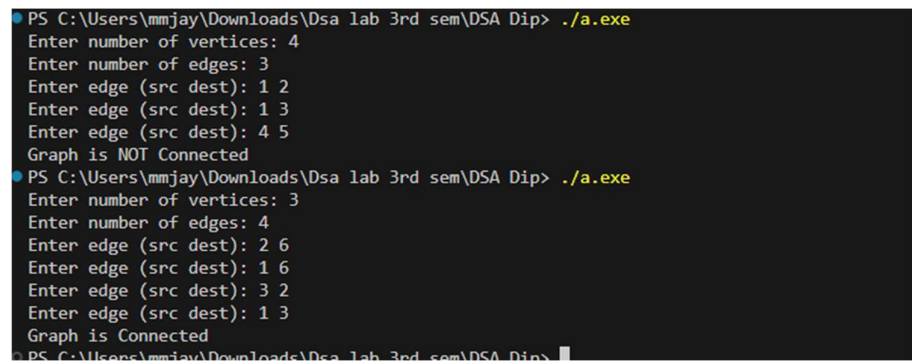
Output:

```
● PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip> ./a.exe
 Enter number of vertices: 4
 Enter number of edges: 3
 Enter edge (src dest): 1 2
 Enter edge (src dest): 1 3
 Enter edge (src dest): 4 5
 Graph is NOT Connected
● PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip> ./a.exe
 Enter number of vertices: 3
 Enter number of edges: 4
 Enter edge (src dest): 2 6
 Enter edge (src dest): 1 6
 Enter edge (src dest): 3 2
 Enter edge (src dest): 1 3
 Graph is Connected
 PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip>
```

Lab Program 10

Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F.

Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT. Let the keys in K and addresses in L are integers. Design and develop a Program in C that uses Hash

function H: K -> L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing.

```c
#include <stdio.h>
#define MAX 100

int hashTable[MAX];
int m;   // size of hash table

// Function to initialize hash table
void initialize()
{
   for (int i = 0; i < m; i++)
      hashTable[i] = -1;   // -1 indicates empty location
}

// Hash function H(K) = K mod m
int hashFunction(int key)
{
   return key % m;
}

// Function to insert a key using Linear Probing
void insert(int key)
{
   int index = hashFunction(key);

   // Linear probing in case of collision
   while (hashTable[index] != -1)
   {
      index = (index + 1) % m;
   }

   hashTable[index] = key;
   printf("Key %d inserted at address %d\n", key, index);
}
```

```c
// Function to display hash table
void display()
{
    printf("\nHash Table:\n");
    printf("Address\tKey\n");
    for (int i = 0; i < m; i++)
    {
        printf("%d\t", i);
        if (hashTable[i] == -1)
            printf("EMPTY\n");
        else
            printf("%d\n", hashTable[i]);
    }
}

int main()
{
    int n, key;

    printf("Enter size of hash table (m): ");
    scanf("%d", &m);

    initialize();

    printf("Enter number of employee records (N): ");
    scanf("%d", &n);

    printf("Enter %d employee keys (4-digit):\n", n);
    for (int i = 0; i < n; i++)
    {
        scanf("%d", &key);
        insert(key);
    }

    display();

    return 0;
}
```

Output:

```
PS C:\Users\mmjay\Downloads\Dsa lab 3rd sem\DSA Dip> ./a.exe
Enter size of hash table (m): 10
Enter number of employee records (N): 5
Enter 5 employee keys (4-digit):
1127
Key 1127 inserted at address 7
1128
Key 1128 inserted at address 8
1135
Key 1135 inserted at address 5
1179
Key 1179 inserted at address 9
1569
Key 1569 inserted at address 0

Hash Table:
Address Key
0       1569
1       EMPTY
2       EMPTY
3       EMPTY
4       EMPTY
5       1135
6       EMPTY
7       1127
8       1128
9       1179
```