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LAB REPORT

on

Data Structures (23CS3PCDST)

Submitted by

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CERTIFICATE

This is to certify that the Lab work entitled "Data Structures (23CS3PCDST)" carried out by **Archie Jain K M (1BM23CS049),** who is a bonafide student of **B. M. S. College of Engineering.** It is in partial fulfilment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2024. The Lab report has been approved as it satisfies the academic requirements in respect of a Data Structures(23CS3PCDST) work prescribed for the said degree.

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GITHUB LINK

https://github.com/ArchieJain120/DS1bm23cs049

LAB PROGRAMS

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.

Program:

```
#include<stdio.h>
#include<conio.h>
#define SIZE 5
void push(int);
void pop();
void display();
int stack[SIZE],top=-1;
void main()
{
   int choice,value;
   int clrscr();
   while(1)
    {
      printf("\nMENU\n");
      printf("1.push\n 2.pop\n 3.display\n 4.exit\n");
      printf("Enter your choice:");
      scanf("%d",&choice);
      switch(choice)
       {
          case 1: printf("Enter the value to be inserted: ");
          scanf("%d",&value);
          push(value);
          break;
          case 2:pop();
          break;
          case 3:display();
          break;
          case 4: exit(0);
```

```
            default:printf("WRONG SELECTION");
        }
    }
}
void push(int value)
{
    if(top==SIZE-1)
    {
        printf("Stack is full");
    }
    else
    {
        top++;
        stack[top]=value;
        printf("Insertion successful");
    }
}
void pop()
{
    if(top==-1)
    {
        printf("Stack is empty");
    }
    else
    {
        printf("deleted=%d",stack[top]);
        top--;
    }
}
void display()
{
    if(top==-1)
    {
        printf("stack is empty,underflow");
    }
    else
    {
        int i;
        printf("stack elements are:");
        for(i=top;i>=0;i--)
        {
            printf("%d",stack[i]);
```

```
    }
  }
}
```

```
MENU
1.push
 2.pop
 3.display
 4.exit
Enter your choice:1
Enter the value to be inserted: 12
Insertion successful
MENU
1.push
 2.pop
 3.display
 4.exit
Enter your choice:1
Enter the value to be inserted: 23
Insertion successful
MENU
1.push
 2.pop
 3.display
 4.exit
Enter your choice:2
deleted=23
MENU
1.push
 2.pop
 3.display
 4.exit
Enter your choice:3
stack elements are:12
MENU
```

2.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)

Program:

```
#include <stdio.h>
#include <ctype.h>
#define SIZE 50
char stack[SIZE];
int top = -1;
void push(char elem)
{
   stack[++top] = elem;
}
char pop()
{
   return stack[top--];
```

```
}
int pr(char symbol)
{
   if (symbol == '^')
   {
      return 3;
   }
   else if (symbol == '*' || symbol == '/')
   {
      return 2;
   }
   else if (symbol == '+' || symbol == '-')
   {
      return 1;
   }
   else
   {
      return 0;
   }
}
void main()
{
   char postfix[50], infix[50], ch, elem;
   int i = 0, k = 0;
   printf("Enter the infix expression: ");
   scanf("%s", infix);
   push('#');
   while ((ch = infix[i++]) != '\0')
   {
      if (ch == '(')
      {
         push(ch);
      }
      else if (isalnum(ch))
      {
         postfix[k++] = ch;
      }
      else if (ch == ')')
      {
         while (stack[top] != '(')
         {
            postfix[k++] = pop();
```

```
            }
            pop();
        }
        else
        {
            while (pr(stack[top]) >= pr(ch))
            {
                postfix[k++] = pop();
            }
            push(ch);
        }
    }
    while (stack[top] != '#')
    {
        postfix[k++] = pop();
    }
    postfix[k] = '\0';
    printf("Postfix expression = %s\n", postfix);
}
```

Output

```
Enter the infix expression: P-Q*(R+S)/T
Postfix expression = PQRS+*T/-
```

3a) 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.

Program:

```
#include<stdio.h>
#define Max 5
int queue[Max];
int front=-1;
int rear=-1;
```

```
void insert(int item);
void delete();
void display();
void main()
{
   int choice, item;
   while(1)
   {
      printf("\nMENU\n");
      printf("1. Insert\n");
      printf("2. Delete\n");
      printf("3. Display\n");
      printf("4. Exit\n");
      printf("Enter your choice: ");
      scanf("%d", &choice);
      switch(choice)
      {
         case 1:
            printf("Enter the element to insert: ");
            scanf("%d", &item);
            insert(item);
            break;
         case 2:
            delete();
            break;
         case 3:
            display();
            break;
         case 4:
            exit(0);
         default:
            printf("Invalid choice\n");
      }
   }
}

void insert(int add_item)
{
   if(rear == Max-1)
   {
      printf("Queue overflow\n");
   }
```

```
    else
    {
        if(front == -1)
        {
            front = 0;
        }
        rear = rear + 1;
        queue[rear] = add_item;
        printf("Inserted %d\n", add_item);
    }
}

void delete()
{
    if(front == -1 || front > rear)
    {
        printf("Queue underflow\n");
        return;
    }
    else
    {
        printf("Deleted item is %d\n", queue[front]);
        front = front + 1;
    }
}

void display()
{
    int i;
    if(front == -1)
    {
        printf("Queue is empty\n");
    }
    else
    {
        printf("Queue is: ");
        for(i = front; i <= rear; i++)
        {
            printf("%d ", queue[i]);
        }
        printf("\n");
    }
```

}

Output

```
MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the element to insert: 1
Inserted 1

MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the element to insert: 2
Inserted 2

MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue is: 1 2
```

3b) WAP to simulate the working of a circular 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.

Program:

```
#include<stdio.h>
#define Max 5
int queue[Max];
```

```
int front = -1;
int rear = -1;
void insert(int item);
void delete();
void display();
void main() {
   int choice, item;
   while(1) {
      printf("\nMENU\n");
      printf("1. Insert\n");
      printf("2. Delete\n");
      printf("3. Display\n");
      printf("4. Exit\n");
      printf("Enter your choice: ");
      scanf("%d", &choice);
      switch(choice) {
         case 1:
            printf("Enter the element to insert: ");
            scanf("%d", &item);
            insert(item);
            break;
         case 2:
            delete();
            break;
         case 3:
            display();
            break;
         case 4:
            exit(0);
         default:
            printf("Invalid choice\n");
      }
   }
}
void insert(int item)
{
   if ((front == 0 && rear == Max - 1) || (rear == (front - 1) % (Max - 1)))
   {
      printf("Queue overflow\n");
      return;
   }
   else if (front == -1)
```

```
    {
        front = rear = 0;
        queue[rear] = item;
    }
    else if (rear == Max - 1 && front != 0)
    {
        rear = 0;
        queue[rear] = item;
    }
    else
    {
        rear++;
        queue[rear] = item;
    }
    printf("Inserted %d\n", item);
}
void delete()
{
    if (front == -1) {
        printf("Queue underflow\n");
        return;
    }
    printf("Deleted item is %d\n", queue[front]);
    if (front == rear)
    {
        front = rear = -1;
    }
    else if (front == Max - 1)
    {
        front = 0;
    }
    else
    {
        front++;
    }
}
void display() {
    int i;
    if (front == -1) {
        printf("Queue is empty\n");
        return;
    }
```

```
    printf("Queue is: ");
    if (rear >= front)
    {
        for(i = front; i <= rear; i++)
        {
            printf("%d ", queue[i]);
        }
    }
    else
    {
        for(i = front; i < Max; i++)
        {
            printf("%d ", queue[i]);
        }
        for(i = 0; i <= rear; i++)
        {
            printf("%d ", queue[i]);
        }
    }
    printf("\n");
}
```

Output

```
MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the element to insert: 1
Inserted 1

MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the element to insert: 2
2
Inserted 2

MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: Deleted item is 1
```

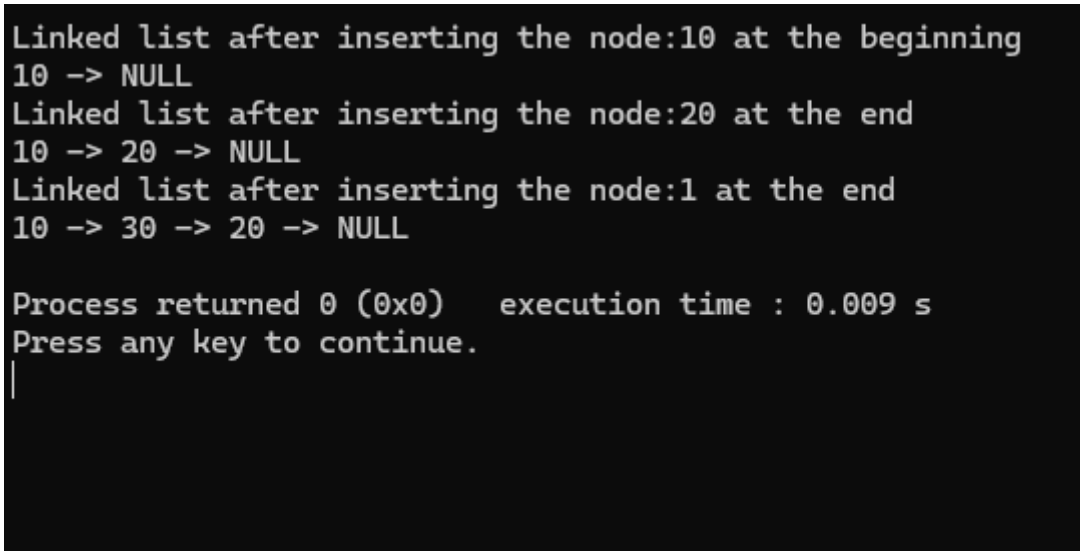
4. WAP to Implement Singly Linked List with following operations a) Createalinkedlist. b) Insertion of a node at first position, at any position and at end of list. Display the contents of the linked list.

Program:

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

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

```
struct Node* createNode(int data)
{
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = data;
   newNode->next = NULL;
   return newNode;
}

void insertAtFirst(struct Node** head, int data)
{
   struct Node* newNode = createNode(data);
   newNode->next = *head;
    *head = newNode;
}

void insertAtEnd(struct Node** head, int data)
{
   struct Node* newNode = createNode(data);
   if (*head == NULL)
    {
    *head = newNode;
   return;
    }
   struct Node* temp = *head;
   while (temp->next != NULL)
    {
   temp = temp->next;
    }
   temp->next = newNode;
}


void insertAtPosition(struct Node** head, int data, int position)
 {
   struct Node* newNode = createNode(data);
   if (position == 0)
    {
   insertAtFirst(head,data);
   return;
    }
   struct Node* temp = *head;
```

```
    for (int i = 0; temp != NULL && i < position - 1; i++)
    {
    temp = temp->next;
    }
    if (temp == NULL)
    {
    printf("Position out of range\n");
    free(newNode);
    return;
    }
    newNode->next = temp->next;
    temp->next = newNode;
}

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


int main()
{
    struct Node* head = NULL;
    printf("Linked list after inserting the node:10 at the beginning \n");
    insertAtFirst(&head, 10);
    display(head);
    printf("Linked list after inserting the node:20 at the end \n");
    insertAtEnd(&head, 20);
    display(head);
    printf("Linked list after inserting the node:1 at the end \n");
    insertAtPosition(&head,30,1);
    display(head);
}
```



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.

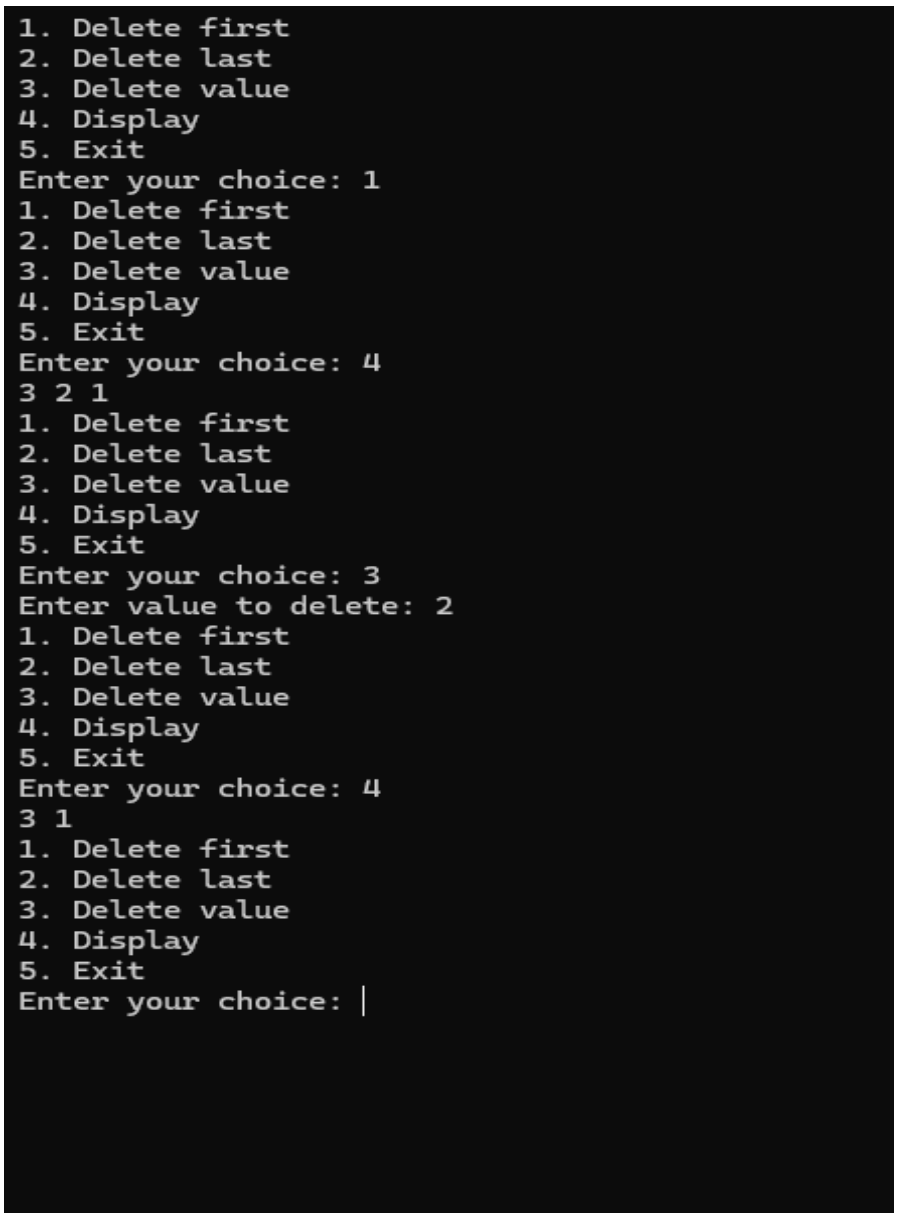
Program:

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

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

typedef struct node* NODE;

NODE get_node() {
   NODE ptr = (NODE)malloc(sizeof(struct node));
   if (ptr == NULL) {
      printf("Memory not allocated\n");
    }
   return ptr;
}

NODE delete_first(NODE first) {
   NODE temp = first;
   if (first == NULL) {
      printf("Linked list is empty\n");
      return NULL;
```

```
    }
    first = first->next;
    free(temp);
    return first;
}

NODE delete_last(NODE first) {
    NODE prev, last;
    if (first == NULL) {
        printf("Linked list is empty\n");
        return NULL;
    }
    prev = NULL;
    last = first;
    while (last->next != NULL)
        {
        prev = last;
        last = last->next;
        }
    if (prev == NULL)
        {
        free(first);
        return NULL;
    }
    prev->next = NULL;
    free(last);
    return first;
}

NODE delete_value(NODE first, int value_del) {
    if (first == NULL) {
        printf("Linked list is empty\n");
        return NULL;
    }

    NODE prev = NULL;
    NODE current = first;
    while (current != NULL && current->value != value_del) {
        prev = current;
        current = current->next;
    }
```

```
    if (current == NULL) {
        printf("Value not found\n");
        return first;
    }

    if (prev == NULL) {
        first = current->next;
    } else {
        prev->next = current->next;
    }

    free(current);
    return first;
}

void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}
NODE insert_beginning(NODE first, int item) {
    NODE new_node = get_node();
    new_node->value = item;
    new_node->next = first;
    return new_node;
}

int main() {
    NODE head = NULL;
    int choice, item;
    head = insert_beginning(head, 1);
    head = insert_beginning(head, 2);
    head = insert_beginning(head, 3);
    head = insert_beginning(head, 4);
```

```
    while (1) {
        printf("1. Delete first\n");
        printf("2. Delete last\n");
        printf("3. Delete value\n");
        printf("4. Display\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                head = delete_first(head);
                break;
            case 2:
                head = delete_last(head);
                break;
            case 3:
                printf("Enter value to delete: ");
                scanf("%d", &item);
                head = delete_value(head, item);
                break;
            case 4:
                display(head);
                break;
            case 5:
                return 0;
            default:
                printf("Invalid choice\n");
        }
    }
    return 0;
}
```



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

Program:

```
#include  <stdio.h>
#include <stdlib.h>
struct Node
{
   int data;
   struct Node* next;
};
struct Node* createNode(int data)
{
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
```

```
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}
void insert(struct Node** head, int data)
{
    struct Node* newNode = createNode(data);
    if (*head == NULL)
    {
        *head = newNode;
    } else
    {
        struct Node* temp = *head;
        while (temp->next != NULL)
        {
            temp = temp->next;
        }
        temp->next = newNode;
    }
}
void printList(struct Node* head)
{
    struct Node* temp = head;
    while (temp != NULL)
    {
        printf("%d -> ", temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}

// Function to sort the linked list (Bubble Sort)
void sortList(struct Node* head) {
    if (head == NULL) return;

    struct Node *i, *j;
    int temp;
    for (i = head; i != NULL; i = i->next) {
        for (j = i->next; j != NULL; j = j->next) {
            if (i->data > j->data) {
                // Swap the data
```

```
            temp = i->data;
            i->data = j->data;
            j->data = temp;
        }
    }
  }
}

// Function to reverse the linked list
void reverseList(struct Node** head) {
  struct Node* prev = NULL;
  struct Node* current = *head;
  struct Node* next = NULL;

  while (current != NULL) {
    next = current->next;
    current->next = prev;
    prev = current;
    current = next;
  }
  *head = prev;
}

// Function to concatenate two linked lists
void concatenateLists(struct Node** head1, struct Node* head2) {
  if (*head1 == NULL) {
    *head1 = head2;
    return;
  }

  struct Node* temp = *head1;
  while (temp->next != NULL) {
    temp = temp->next;
  }
  temp->next = head2;
}

// Main function
int main() {
  struct Node* list1 = NULL;
  struct Node* list2 = NULL;
```

```
int choice, data;

while (1) {
    printf("\n1. 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 List 1 and List 2\n");
    printf("6. Print List 1\n");
    printf("7. Print List 2\n");
    printf("8. Exit\n");
    printf("Enter your choice: ");
    scanf("%d", &choice);

    switch (choice) {
        case 1:
            printf("Enter data to insert into List 1: ");
            scanf("%d", &data);
            insert(&list1, data);
            break;
        case 2:
            printf("Enter data to insert into List 2: ");
            scanf("%d", &data);
            insert(&list2, data);
            break;
        case 3:
            sortList(list1);
            printf("List 1 sorted.\n");
            break;
        case 4:
            reverseList(&list1);
            printf("List 1 reversed.\n");
            break;
        case 5:
            concatenateLists(&list1, list2);
            printf("List 2 concatenated to List 1.\n");
            break;
        case 6:
            printf("List 1: ");
            printList(list1);
            break;
```

```
            case 7:
                printf("List 2: ");
                printList(list2);
                break;
            case 8:
                exit(0);
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }

    return 0;
}
```

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate List 1 and List 2
6. Print List 1
7. Print List 2
8. Exit
Enter your choice: 1
Enter data to insert into List 1: 12

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate List 1 and List 2
6. Print List 1
7. Print List 2
8. Exit
Enter your choice: 1
Enter data to insert into List 1: 23

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate List 1 and List 2
6. Print List 1
7. Print List 2
8. Exit
Enter your choice: 1
Enter data to insert into List 1: 34

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate List 1 and List 2
6. Print List 1
7. Print List 2
8. Exit
Enter your choice: 2
Enter data to insert into List 2: 12

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate List 1 and List 2
6. Print List 1
```

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

Program:

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

struct node {
   int value;
   struct node *next;
};
typedef struct node *NODE;

NODE get_node() {
   NODE ptr = (NODE)malloc(sizeof(struct node));
   if (ptr == NULL) {
      printf("Memory not allocated\n");
   }
   return ptr;
}

NODE delete_first(NODE first){
   NODE temp=first;
   if (first == NULL) {
      printf("Empty\n");
      return NULL;
   }
   first=first->next;
   free(temp);
   return first;
}

NODE insert_beginning(NODE first, int item) {
   NODE new_node = get_node();
   new_node->value = item;
   new_node->next = first;
   return new_node;
}

NODE insert_end(NODE first, int item) {
   NODE new_node = get_node();
   new_node->value = item;
```

```
    new_node->next = NULL;
    if (first == NULL) {
        return new_node;
    }
    NODE temp = first;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = new_node;
    return first;
}

void display(NODE first) {
    NODE temp = first;
    if (first == NULL) {
        printf("Empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->value);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    int item, choice, deleted_item;
    NODE first = NULL;

    printf("Choose:\n");
    printf("1. Stack\n");
    printf("2. Queue\n");
    printf("Enter choice (1/2): ");
    scanf("%d", &choice);

    if (choice == 1) {
        while (1) {
            printf("\nStack Operations:\n");
            printf("1. Push\n");
            printf("2. Pop\n");
            printf("3. Display stack\n");
```

```
        printf("4. Exit\n");
        printf("Enter choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter item to push: ");
                scanf("%d", &item);
                first = insert_beginning(first, item);
                break;
            case 2:
                if (first != NULL) {
                    deleted_item = first->value;
                    first = delete_first(first);
                    printf("Deleted item from stack: %d\n", deleted_item);
                } else {
                    printf("Stack is empty\n");
                }
                break;
            case 3:
                printf("Stack: ");
                display(first);
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice.\n");
        }
    }
}
else if (choice == 2) {
    while (1) {
        printf("\nQueue Operations:\n");
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display queue\n");
        printf("4. Exit\n");
        printf("Enter choice: ");
        scanf("%d", &choice);

        switch (choice) {
```

```
            case 1:
                printf("Enter item to insert: ");
                scanf("%d", &item);
                first = insert_end(first, item);
                break;
            case 2:
                if (first != NULL) {
                    deleted_item = first->value;
                    first = delete_first(first);
                    printf("Deleted item from queue: %d\n", deleted_item);
                } else {
                    printf("Queue is empty!\n");
                }
                break;
            case 3:
                printf("Queue: ");
                display(first);
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice.\n");
        }
    }
}
else {
    printf("Invalid operation.\n");
}

return 0;
}
```

```
Choose:
1. Stack
2. Queue
Enter choice (1/2): 1

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 1
Enter item to push: 56

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 1
Enter item to push: 66

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 1
Enter item to push: 88

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 2
Deleted item from stack: 88

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 3
Stack: 66 56

Stack Operations:
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: |
```

```
Choose:
1. Stack
2. Queue
Enter choice (1/2): 2

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 1
Enter item to insert: 1

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 1
Enter item to insert: 2

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 2
Deleted item from queue: 1

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: 3
Queue: 2

Queue Operations:
1. Insert
2. Delete
3. Display queue
4. Exit
Enter choice: |
```

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

Program:

```
#include  <stdio.h>
#include <stdlib.h>
struct Node
{
   int data;
   struct Node* prev;
   struct Node* next;
};
void create(struct Node** head, int data)
{
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));
   new_node->data = data;
   new_node->prev = NULL;
   new_node->next = NULL;
   if (*head == NULL)
   {
      *head = new_node;
      return;
   }
   struct Node* temp = *head;
   while (temp->next != NULL)
   {
      temp = temp->next;
   }
   temp->next = new_node;
   new_node->prev = temp;
}
void insert_left(struct Node** head, int target_data, int new_data)
{
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));
   new_node->data = new_data;
   struct Node* temp = *head;
   while (temp != NULL)
   {
      if (temp->data == target_data)
      {
```

```
            new_node->next = temp;
            new_node->prev = temp->prev;
            if (temp->prev != NULL)
            {
                temp->prev->next = new_node;
            }
            else
            {
                *head = new_node;
            }
            temp->prev = new_node;
            return;
        }
        temp = temp->next;
    }
    printf("Node with data %d not found.\n", target_data);
}
void delete_node(struct Node** head, int value)
{
    struct Node* temp = *head;
    while (temp != NULL)
    {
        if (temp->data == value)
        {
            if (temp == *head)
            {
                *head = temp->next;
            }
            if (temp->prev != NULL)
            {
                temp->prev->next = temp->next;
            }
            if (temp->next != NULL)
            {
                temp->next->prev = temp->prev;
            }

            free(temp);
            return;
        }
        temp = temp->next;
```

```
    }
    printf("Node with data %d not found.\n", value);
}
void display(struct Node* head)
{
    if (head == NULL) {
        printf("The list is empty.\n");
        return;
    }
    struct Node* temp = head;
    while (temp != NULL)
    {
        printf("%d", temp->data);
        if (temp->next != NULL)
        {
            printf(" <-> ");
        }
        temp = temp->next;
    }
    printf("\n");
}
int main()
{
    struct Node* head = NULL;
    int choice, data, target_data, new_data;

    while (1)
    {
        printf("\nDoubly Linked List Operations:\n");
        printf("1. Create a node\n");
        printf("2. Insert node to the left of a specific node\n");
        printf("3. Delete a node\n");
        printf("4. Display the list\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice)
        {
            case 1:
                printf("Enter the data for the node to create: ");
```

```
            scanf("%d", &data);
            create(&head, data);
            break;

        case 2:
            printf("Enter the target node data before which to insert: ");
            scanf("%d", &target_data);
            printf("Enter the data for the new node to insert: ");
            scanf("%d", &new_data);
            insert_left(&head, target_data, new_data);
            break;

        case 3:
            printf("Enter the data of the node to delete: ");
            scanf("%d", &data);
            delete_node(&head, data);
            break;

        case 4:
            printf("The current list is: ");
            display(head);
            break;

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

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

   return 0;
}
```

```
Doubly Linked List Operations:
1. Create a node
2. Insert node to the left of a specific node
3. Delete a node
4. Display the list
5. Exit
Enter your choice: 1
Enter the data for the node to create: 23

Doubly Linked List Operations:
1. Create a node
2. Insert node to the left of a specific node
3. Delete a node
4. Display the list
5. Exit
Enter your choice: 1
Enter the data for the node to create: 45

Doubly Linked List Operations:
1. Create a node
2. Insert node to the left of a specific node
3. Delete a node
4. Display the list
5. Exit
Enter your choice: 2
Enter the target node data before which to insert: 66
Enter the data for the new node to insert: 3
Node with data 66 not found.

Doubly Linked List Operations:
1. Create a node
2. Insert node to the left of a specific node
3. Delete a node
4. Display the list
5. Exit
Enter your choice: 45
Invalid choice. Please try again.

Doubly Linked List Operations:
1. Create a node
2. Insert node to the left of a specific node
3. Delete a node
4. Display the list
5. Exit
Enter your choice: 4
The current list is: 23 <-> 45

Doubly Linked List Operations:
1. Create a node
2. Insert node to the left of a specific node
```

8 Write a program a) ToconstructabinarySearchtree. b) To traverse the tree using all the methods i.e., inorder, preorder and post order c) To display the elements in the tree.

Program:

```
#include  <stdio.h>
#include <stdlib.h>
struct node
{
   int data;
   struct node *left;
   struct node *right;
};
```

```
struct node* newNode(int data)
{
   struct node* node = (struct node*)malloc(sizeof(struct node));
   node->data = data;
   node->left = node->right = NULL;
   return node;
}
struct node* insert(struct node* root, int data)
{
   if (root == NULL)
      return newNode(data);

   if (data < root->data)
      root->left = insert(root->left, data);
   else if (data > root->data)
      root->right = insert(root->right, data);

   return root;
}
void inorder(struct node* root)
{
   if (root != NULL)
   {
      inorder(root->left);
      printf("%d ", root->data);
      inorder(root->right);
   }
}
void preorder(struct node* root)
{
   if (root != NULL)
   {
      printf("%d ", root->data);
      preorder(root->left);
      preorder(root->right);
   }
}
void postorder(struct node* root)
{
   if (root != NULL)
   {
      postorder(root->left);
      postorder(root->right);
```

```
        printf("%d ", root->data);
    }
}
void display(struct node* root, int choice)
{
    switch (choice)
    {
        case 1:
            printf("\nIn-order traversal: ");
            inorder(root);
            break;
        case 2:
            printf("\nPre-order traversal: ");
            preorder(root);
            break;
        case 3:
            printf("\nPost-order traversal: ");
            postorder(root);
            break;
        default:
            printf("\nInvalid choice\n");
            break;
    }
}
int main()
{
    struct node* root = NULL;
    int n, data, choice;
    printf("Enter the number of nodes to insert in the BST: ");
    scanf("%d", &n);
    for (int i = 0; i < n; i++)
    {
        printf("Enter value for node %d: ", i + 1);
        scanf("%d", &data);
        root = insert(root, data);
    }
    while (1)
    {
        printf("\nChoose the type of traversal:\n");
        printf("1. In-order\n");
        printf("2. Pre-order\n");
        printf("3. Post-order\n");
        printf("4. Exit\n");
```

```
        printf("Enter your choice (1/2/3/4): ");
        scanf("%d", &choice);
        if (choice == 4)
        {
            printf("Exiting the program...\n");
            break;
        }
        display(root, choice);
    }

    return 0;
}
```

```
Choose the type of traversal:
1. In-order
2. Pre-order
3. Post-order
4. Exit
Enter your choice (1/2/3/4): 1

In-order traversal: 12 32 45
Choose the type of traversal:
1. In-order
2. Pre-order
3. Post-order
4. Exit
Enter your choice (1/2/3/4): 2

Pre-order traversal: 12 45 32
Choose the type of traversal:
1. In-order
2. Pre-order
3. Post-order
4. Exit
Enter your choice (1/2/3/4): 3

Post-order traversal: 32 45 12
Choose the type of traversal:
1. In-order
2. Pre-order
3. Post-order
4. Exit
Enter your choice (1/2/3/4): |
```

9 a) Write a program to traverse a graph using BFS method.

Program:

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

#define MAX 100


int adjMatrix[MAX][MAX];
int visited[MAX];
```

```
int queue[MAX];
int front = -1, rear = -1;
int numVertices;

// Enqueue operation
void enqueue(int vertex) {
    if (rear == MAX - 1) {
        printf("Queue overflow!\n");
        return;
    }
    if (front == -1)
        front = 0;
    queue[++rear] = vertex;
}


int dequeue() {
    if (front == -1 || front > rear) {
        printf("Queue underflow!\n");
        return -1;
    }
    return queue[front++];
}


void BFS(int startVertex) {
    for (int i = 0; i < numVertices; i++) {
        visited[i] = 0;
    }

    printf("BFS traversal starting from vertex %d: ", startVertex);
    enqueue(startVertex);
    visited[startVertex] = 1;

    while (front <= rear && front != -1) {
        int currentVertex = dequeue();
        printf("%d ", currentVertex);

        for (int i = 0; i < numVertices; i++) {
            if (adjMatrix[currentVertex][i] == 1 && !visited[i]) {
                enqueue(i);
                visited[i] = 1;
            }
        }
```

```
    }
    printf("\n");
}


void addEdge(int u, int v) {
    if (u >= 0 && u < numVertices && v >= 0 && v < numVertices) {
        adjMatrix[u][v] = 1;
        adjMatrix[v][u] = 1;
    } else {
        printf("Invalid vertices!\n");
    }
}


void displayAdjMatrix() {
    printf("Adjacency Matrix:\n");
    for (int i = 0; i < numVertices; i++) {
        for (int j = 0; j < numVertices; j++) {
            printf("%d ", adjMatrix[i][j]);
        }
        printf("\n");
    }
}

int main() {
    int choice, startVertex, u, v;

    printf("Enter the number of vertices in the graph: ");
    scanf("%d", &numVertices);

    if (numVertices <= 0 || numVertices > MAX) {
        printf("Invalid number of vertices!\n");
        return 1;
    }


    for (int i = 0; i < numVertices; i++) {
        for (int j = 0; j < numVertices; j++) {
            adjMatrix[i][j] = 0;
        }
        visited[i] = 0;
    }
```

```
    while (1) {
        printf("\nMenu:\n");
        printf("1. Add edge\n");
        printf("2. Display adjacency matrix\n");
        printf("3. Perform BFS traversal\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the edge (u v): ");
                scanf("%d %d", &u, &v);
                addEdge(u, v);
                break;
            case 2:
                displayAdjMatrix();
                break;
            case 3:
                printf("Enter the starting vertex: ");
                scanf("%d", &startVertex);
                if (startVertex < 0 || startVertex >= numVertices) {
                    printf("Invalid starting vertex!\n");
                } else {
                    BFS(startVertex);
                }
                break;
            case 4:
                printf("Exiting the program.\n");
                exit(0);
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }

    return 0;
}
```

```
Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 3
The graph is not connected.

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 1
Enter the edge (u v): 0 1

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 1
Enter the edge (u v): 0 2

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 1
Enter the edge (u v): 1 3

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 2
Adjacency Matrix:
0 1 1 0
1 0 0 1
1 0 0 1
0 1 1 0
```

```
Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 3
The graph is connected.
```

9 b) Write a program to check whether given graph is connected or not using DFS method.

Program:
```
#include <stdio.h>
#include <stdlib.h>

#define MAX 100 // Maximum number of vertices

int adjMatrix[MAX][MAX];
int visited[MAX];
int numVertices;

// Depth-First Search (DFS) function
void DFS(int vertex) {
    visited[vertex] = 1;

    for (int i = 0; i < numVertices; i++) {
        if (adjMatrix[vertex][i] == 1 && !visited[i]) {
            DFS(i);
        }
    }
}

// Function to check if the graph is connected
int isConnected() {
    for (int i = 0; i < numVertices; i++) {
        visited[i] = 0; // Initialize visited array to 0
    }

    // Start DFS from the first vertex
    DFS(0);

    // Check if all vertices are visited
    for (int i = 0; i < numVertices; i++) {
        if (!visited[i]) {
            return 0; // Graph is not connected
        }
    }
    return 1; // Graph is connected
```

```
}

// Function to add an edge to the graph
void addEdge(int u, int v) {
    if (u >= 0 && u < numVertices && v >= 0 && v < numVertices) {
        adjMatrix[u][v] = 1;
        adjMatrix[v][u] = 1; // Comment this line for directed graph
    } else {
        printf("Invalid vertices!\n");
    }
}

// Function to display the adjacency matrix
void displayAdjMatrix() {
    printf("Adjacency Matrix:\n");
    for (int i = 0; i < numVertices; i++) {
        for (int j = 0; j < numVertices; j++) {
            printf("%d ", adjMatrix[i][j]);
        }
        printf("\n");
    }
}

int main() {
    int choice, u, v;

    printf("Enter the number of vertices in the graph: ");
    scanf("%d", &numVertices);

    if (numVertices <= 0 || numVertices > MAX) {
        printf("Invalid number of vertices!\n");
        return 1;
    }

    // Initialize adjacency matrix and visited array
    for (int i = 0; i < numVertices; i++) {
        for (int j = 0; j < numVertices; j++) {
            adjMatrix[i][j] = 0;
        }
        visited[i] = 0;
```

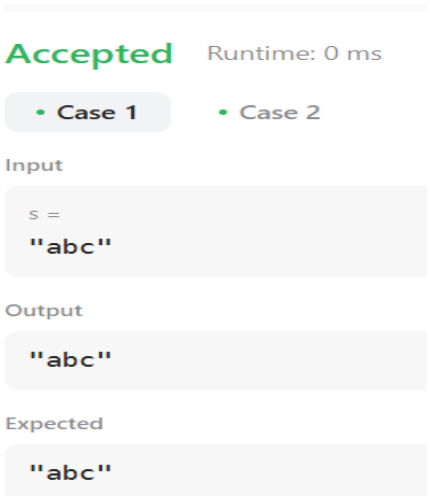
```
    }

    while (1) {
        printf("\nMenu:\n");
        printf("1. Add edge\n");
        printf("2. Display adjacency matrix\n");
        printf("3. Check if the graph is connected\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the edge (u v): ");
                scanf("%d %d", &u, &v);
                addEdge(u, v);
                break;
            case 2:
                displayAdjMatrix();
                break;
            case 3:
                if (isConnected()) {
                    printf("The graph is connected.\n");
                } else {
                    printf("The graph is not connected.\n");
                }
                break;
            case 4:
                printf("Exiting the program.\n");
                exit(0);
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }

    return 0;
}
```

```
Enter the number of vertices in the graph: 4

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 1
Enter the edge (u v): 0 1

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 1
Enter the edge (u v): 1 2

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 2
Adjacency Matrix:
0 1 0 0
1 0 1 0
0 1 0 0
0 0 0 0

Menu:
1. Add edge
2. Display adjacency matrix
3. Check if the graph is connected
4. Exit
Enter your choice: 3
The graph is not connected.
```

LEETCODE QUESTIONS:

1.You are given a string s.
Your task is to remove **all** digits by doing this operation repeatedly:
Delete the *first* digit and the **closest** **non-digit** character to its *left*.
Return the resulting string after removing all digits.

```c
char* clearDigits(char* s) {
    char *ans = (char*)malloc((strlen(s) + 1) * sizeof(char));
    if (ans == NULL) {
        return NULL;
    }

    int n = strlen(s);
    int resultIndex = 0;

    for(int i = 0; i < n; i++) {
        if(isdigit(s[i])) {
            if (resultIndex > 0) {
                resultIndex--;
            }
        } else if(islower(s[i])) {
            ans[resultIndex] = s[i];
            resultIndex++;
        }
    }
    ans[resultIndex] = '\0';

    return ans;
}
```



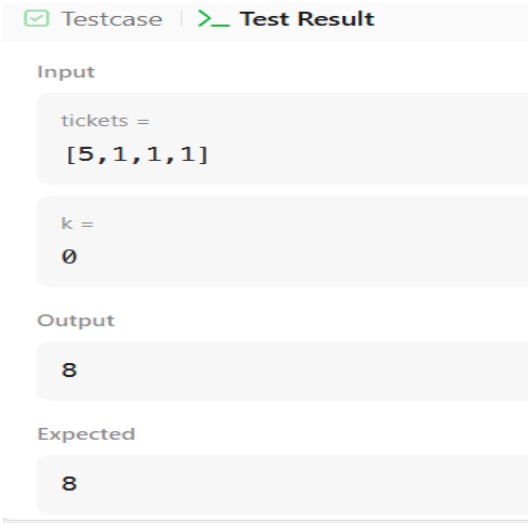
There are n people in a line queuing to buy tickets, where the 0th person is at the **front** of the line and the (n - 1)th person is at the **back** of the line.

You are given a **0-indexed** integer array tickets of length n where the number of tickets that the ith person would like to buy is tickets[i].

Each person takes **exactly 1 second** to buy a ticket. A person can only buy **1 ticket at a time** and has to go back to **the end** of the line (which happens **instantaneously**) in order to buy more tickets. If a person does not have any tickets left to buy, the person will **leave** the line.

Return the **time taken** for the person **initially** at position **k** (0-indexed) to finish buying tickets.

```c
#include <stdio.h>
int timeRequiredToBuy(int* tickets, int ticketsSize, int k) {
    int time = 0 ;
    while(tickets[k] != 0){
        for(int i = 0 ; i<ticketsSize ; i++){
            if(tickets[i] == 0 )
                continue ;
            if(tickets[k] == 0)
                break ;
            tickets[i]-- ;
            time++ ;
        }
    }
    return time ;
}
```



There are n friends that are playing a game. The friends are sitting in a circle and are numbered from 1 to n in **clockwise order**. More formally, moving clockwise from the i^{th} friend brings you to the $(i+1)^{th}$ friend for 1 <= i < n, and moving clockwise from the n^{th} friend brings you to the 1^{st} friend.

The rules of the game are as follows:

1. **Start** at the 1^{st} friend.
2. Count the next k friends in the clockwise direction **including** the friend you started at. The counting wraps around the circle and may count some friends more than once.
3. The last friend you counted leaves the circle and loses the game.
4. If there is still more than one friend in the circle, go back to step 2 **starting** from the friend **immediately clockwise** of the friend who just lost and repeat.
5. Else, the last friend in the circle wins the game.

Given the number of friends, n, and an integer k, return *the winner of the game*.

```
#include<stdio.h>
int findTheWinner(int n, int k) {
    int* circle = (int*)malloc(n * sizeof(int));
    for (int i = 0; i < n; ++i) {
        circle[i] = i + 1;
    }
    int ind = 0;
    int size = n;

    while (size > 1) {
        int next_to_remove = (ind + k - 1) % size;
        for (int i = next_to_remove; i < size - 1; ++i) {
            circle[i] = circle[i + 1];
        }
        size--;
        ind = next_to_remove;
    }

    int winner = circle[0];
    free(circle);
    return winner;
}
```

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

n =
5

k =
2

Output

3

Expected

3

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

n =
6

k =
5

Output

1

Expected

1