VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

on

Data Structures (23CS3PCDST)

Submitted by

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in partial fulfillment for the award of the degree of

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in

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CERTIFICATE

This is to certify that the Lab work entitled "Data Structures (23CS3PCDST)" carried out by **Bhoomika B G (1BM23CS067),** who is 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. The Lab report has been approved as it satisfies the academic requirements in respect of Data Structures (23CS3PCDST) work prescribed for the said degree.

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Github Link:

https://github.com/bhoomikabg/data-structures

Program 1

Stacks

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.

```
#include<stdio.h>
#include<conio.h>
#define SIZE 10
void push(int);
void pop();
void display();
int stack[SIZE], top-1;
void main()
{
int value, choice;
while(1)(
printf("1. Push\n2. Pop\n3. Display\n4. Exit");
printf("\nEnter your choice: ");
scanf("%d",&choice);
switch(choice){
case 1: printf("Enter the value to be insert: ");
scanf("%d",&value);
push(value);
break;
case 2: pop();
break;
case 3: display();
break;
case 4: exit(0);
default: printf("\nwrong selection!!! Try again!!!");
  }
 }
}
void push(int value){
if (top == SIZE-1)
printf("\nStack is Full!!! Insertion is not possible!!!");
else{
top++;
stack[top] = value;
printf("\nInsertion success!!!");
 }
}
void pop(){
if (top == -1)
printf("\nStack is Empty!!! Deletion is not possible!!!");
else{
```

```
printf("\nDeleted: %d", stack[top]);
top--:
  }
}
void display(){
if (top == -1)
printf("\nStack is Empty!!!");
else{
int i;
printf("\nStack elements are:\n");
for(i=top; i=0; i--)
printf("%d\n", stack[i]);
  }
}
```

Output:

```
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter the value to be inserted: 2
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter the value to be inserted: 3
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2

Deleted: 31. Push
2. Pop
3. Display
4. Exit
```

Leetcode:

1.Moving zeroes to end of the array:

code:

```
void moveZeroes(int* nums, int numsSize){
    int j=0;
        for(int i=0;i<numsSize;i++){
            if(nums[i]!=0){
                int temp=nums[i];
                nums[i]=nums[j];
                nums[j]=temp;
                j++;
            }
    }
}
```

Program 2

Infix to Postfix

2. WAP toconvert 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)

Code:

```
#include<stdio.h>
#include<ctype.h>
#define SIZE 50
char stack[SIZE];
int top=-1;
push(char e)
{
   stack[++top]=e;
}
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 infix[50],postfix[50],ch,e;
   int i=0,k=0;
   printf("enter expression to be converted:");
   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();
            e=pop();
        }
        else{
            while(pr(stack[top])>=pr(ch))
                postfix[k++]=pop();
            push(ch);
         }
     }
  }
}
while(stack[top]!='#')
       {
         postfix[k++]=pop();
         postfix[k]='\0';
       }
printf("\nPOstfix Expression= %s\n",postfix);
}
```

Output:

```
Enter the infix expression: (5*4)+(2*8)-5/4
Postfix expression = 54*28*+54/-
```

Program 3
Queue

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:

```
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: 2

MENU
1.Insert
2. Delete
3. Display
4.Exit
Enter your choice: 1
Enter the element to insert: 5
Inserted 5

MENU
1.Insert
2. Delete
3. Display
4.Exit
```

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 if empty and queue overflow conditions.

Code:

```
#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("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");
}
```

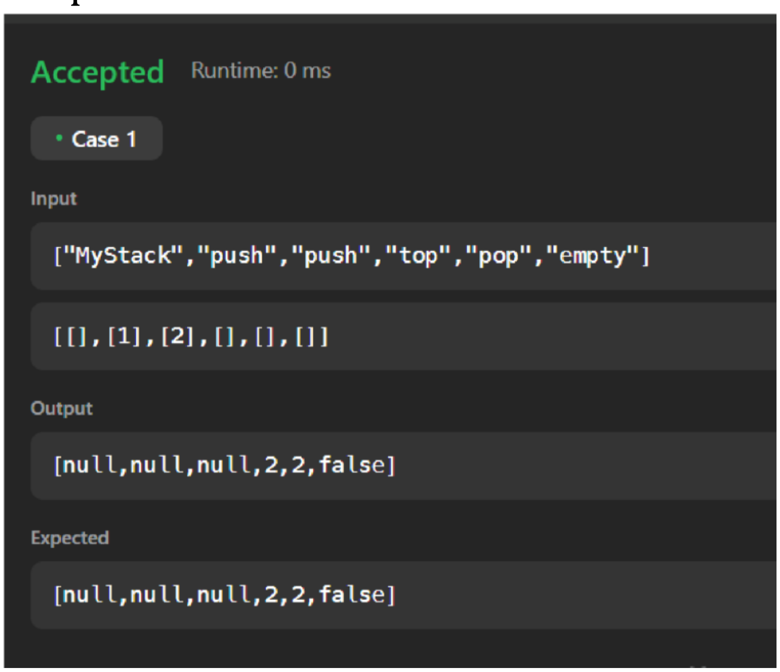
Output:

```
MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the element to insert: 19
Inserted 19

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

MENU
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue is: 19 4

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

Process returned 0 (0x0)   execution time : 14.437 s
```

Leetcode question:
Implement Stack using Queues

```
 typedef struct {
} MyStack;
MyStack* myStackCreate() {
MyStack *obj=(MyStack*)malloc(sizeof(MyStack)); int front=-1;
int rear=-1; return obj; }
void myStackPush(MyStack* obj, int x) {
if (obj->front==-1) obj->front=obj->rear=0; else if(obj->rear<obj->size){
obj->rear=obj->rear+1;
} obj->rear=obj->rear=x;
}
int myStackPop(MyStack* obj) { return obj->rear-- ;
}
int myStackTop(MyStack* obj) {
return obj->rear;
}
if(obj->rear==-1)return 1 ; else return 0 ; }
void myStackFree(MyStack* obj) { free(obj);
}
```

Output:



Program 4
Insertion of node-Singly Linked List

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.

Code:

```
#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);
```

OUTPUT:

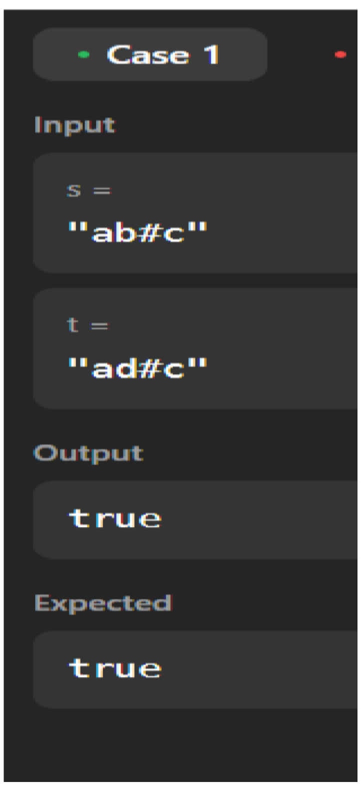
```
Linked list after inserting the node:10 at the beginning
10 -> NULL
Linked list after inserting the node:20 at the end
10 -> 20 -> NULL
Linked list after inserting the node:1 at the end
10 -> 30 -> 20 -> NULL

Process returned 0 (0x0)   execution time : 0.009 s
Press any key to continue.
```

Leetcode:

Backspace String Compare

```
typedef struct node{
    char *st; int
top; int capacity;
} stack; stack*
init(int capacity){
    struct node* node=(struct node*)malloc (sizeof(struct node)); node-
    >top=-1;
    node->capacity=capacity; node ->
st=(char*)malloc(capacity*sizeof(char));
return node; } void push(stack* node,char x ){
    if(node->top==node-
    >capacity-1){ printf("stack
    is full"); return;} node-
    >st[++node->top]=x;
} char pop(stack
* node){
    return node->st[node->top--];
}
 bool backspaceCompare(char* s,
char* t) {
    int capacity=50;
    stack *
    node=init(capacity);
    int r,i=0;
    while(*s!='\0'){
        if(*s=='#'){
    char a;
    a=pop(node); }
    else
    push(node,*s);
    s++; } char
```

```
arr1[capacity];
while(node-
>top>=0){
    arr1[i++]=pop(node);
} free(node); stack *
node1=init(capacity);
while(*t!='\0'){
    if(*t=='#'){
char a;
a=pop(node1);
} else
push(node1,*t)
; t++; } char
arr2[capacity];
int j=0;
while(node1->top>=0){
    arr2[j++]=pop(node1);
} free(node1);
for (int
k=0;k<i;k++){
    if(arr1[k]==arr2[k])
    r=1; else r=0;
}
return;
}
```



Program 5
Deletion of Node- Singly Linked List

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.

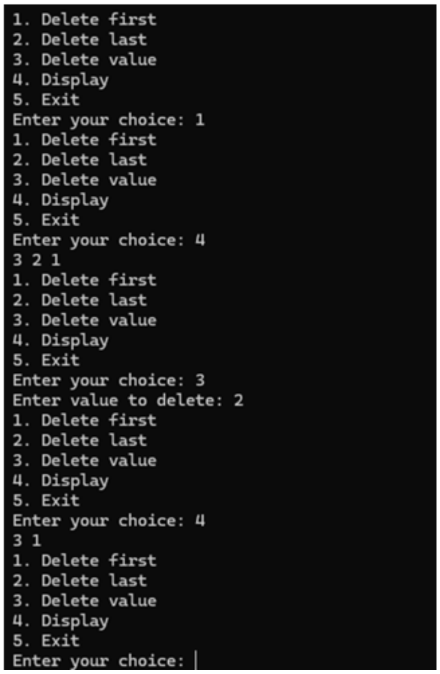
Code:

```
#include <stdio.h>
 #include <stdlib.h>
 struct node { int
 value;
 struct node* next;
 };
 typedef struct node* NODE; NODE
 get_node() {
 NODEptr = (NODE)malloc(sizeof(struct node)); if (ptr
 == NULL) {
 printf("Memory not allocated\n");
 }
 return ptr;
 }
 NODEdelete_first(NODE first) { NODE
 temp = first;
 if (first == NULL) { printf("Linked list
 is empty\n"); return NULL;
}
 first = first->next;
 free(temp);
 return first;
 }
 NODEdelete_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;
}
NODEdelete_value(NODE first, int value_del) { if (first
== NULL) {
printf("Linked list is empty\n");
return NULL;
}
NODEprev = NULL;
NODEcurrent = 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) {
NODEtemp =first;
if (first == NULL) {
printf("Empty\n");
return; }
while (temp != NULL) { printf("%d ", temp->value);
temp = temp->next; }
printf("\n");}
NODEinsert_beginning(NODE first, int item) { NODE
new_node = get_node();
new_node->value = item;
new_node->next = first;
return new_node; }
void main() {
NODEhead =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:
break;
default:
printf("Invalid choice\n");
}}}
```

Output:



```
1. Delete first
2. Delete last
3. Delete value
4. Display
5. Exit
Enter your choice: 1
1. Delete first
2. Delete last
3. Delete value
4. Display
5. Exit
Enter your choice: 4
3 2 1
1. Delete first
2. Delete last
3. Delete value
4. Display
5. Exit
Enter your choice: 3
Enter value to delete: 2
1. Delete first
2. Delete last
3. Delete value
4. Display
5. Exit
Enter your choice: 4
3 1
1. Delete first
2. Delete last
3. Delete value
4. Display
5. Exit
Enter your choice:
```

Leetcode:

Remove all adjacent duplicates in a string

```
char* removeDuplicates(char* s) {
    int n = strlen(s);
    char* stack = malloc(sizeof(char) * (n + 1));
    int i = 0 ;
    for (int j = 0; j < n; j++)
        { char c = s[j];
        if (i && stack[i - 1] == c)
        { i--;
        }
        else {
          stack[i++] = c;
         }
      }
        stack[i] ='\0';
        return stack;
    }
```

Testcase | >_ Test Result

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

s =
"abbaca"

Output

"ca"

Expected

"ca"

Contribute a

Program 6
Operations on Singly Linked List

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

Code:

```
#include
 #include
 struct Node
 {
 int data;
 <stdio.h>
 <stdlib.h>
 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");
 }
 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) {
temp = i->data;
i->data = j->data;
j->data = temp;
}}}}
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;
}
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;
}
int main() {
struct Node* list1 = NULL; struct
Node* list2 = NULL;
int choice, data;
temp = i->data;
i->data = j->data;
j->data = temp;
} }} }
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;
}
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;
}
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;
}
```

b) WAPto 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;
NODEget_node() {
NODEptr = (NODE)malloc(sizeof(struct node)); if (ptr
== NULL) {
printf("Memory not allocated\n");
}
return ptr;
}
NODE delete_first(NODE first){
NODEtemp=first;
if (first == NULL) {
printf("Empty\n");
return NULL;
}
first=first->next;
free(temp); return
first;
}
NODEinsert_beginning(NODE first, int item) { NODE
new_node = get_node();
new_node->value = item;
new_node->next = first;
return new_node;
}
NODEinsert_end(NODE first, int item) {
```

```
NODEnew_node = get_node();
new_node->value = item;
new_node->next = NULL; if
(first == NULL) {
return new_node;
}
NODEtemp =first;
while (temp->next != NULL) { temp =
temp->next;
}
temp->next = new_node;
return first;
}
void display(NODE first) {
NODEtemp =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;}
```

Output:

```
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: |
```

Program 7
Doubly Linked List

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 =(structNode*)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
```

Program 8
Binary Search Tree

Write a program a) To construct a binary Search tree. 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): |
```

Program 9
Graph

Write a program to traverse a graph using BFS method. Program:

```
#include < stdio.h >
#include < stdlib.h >
#include < stdbool.h >
#define MAX 100 struct

Queue {

    int items[MAX];
    int front, rear;

} ;

void initQueue(struct Queue* q) {
    q->front = -1
; q->rear = -1 ; }

bool isEmpty(struct Queue* q) { return
    q->front == -1 ;
}

void enqueue(struct Queue* q, int value) { if
    (q->rear == MAX - 1)
        return;
    if (q->front == -1)
        q->front = 0 ;
    q->rear++; q->items[q-
    >rear] = value;
}

int dequeue(struct Queue* q) { if
    ( isEmpty(q ))
        return -1 ;
    int item = q->items[q->front]; if
    (q->front == q->rear) { q-
        >front = q->rear = -1 ;
    } else { q-
    >front++; }
    return item;
```

```
}
struct Graph { int
    vertices;
    int adjMatrix[MAX][MAX];
} ;

void initGraph(struct Graph* g, int vertices)
    { g->vertices = vertices; for (int i = 0; i <
    vertices; i++) { for ( int
        j = 0; j < vertices; j++) {
            g->adjMatrix[i][j] = 0 ;
        }

    }
}

void addEdge(struct Graph* g, int u, int v) {
    g->adjMatrix[u][v] = 1 ; g-
    >adjMatrix[v][u] = 1 ;
}

void bfs(struct Graph* g, int start) {
    bool visited[MAX] = {false}; struct
    Queue q; initQueue(&q);
    visited[start] = true; enqueue(&q,
    start);

    while (!isEmpty(&q)) {
        int node = dequeue(&q); printf("%d
        ", node);

        for (int i = 0; i < g->vertices; i++) {
            if (g->adjMatrix[node][i] == 1 && !visited[i]) { visited[i]
                = true;
                enqueue(&q, i);
            }
        }
    }
}

int main() { struct Graph g; initGraph(&g, 6) ;
    addEdge(&g, 0, 1) ; addEdge(&g, 0, 2) ;
    addEdge(&g, 1, 3) ; addEdge(&g, 1, 4) ;
    addEdge(&g, 2, 5) ; printf("BFS traversal starting
    from node 0: "); bfs(&g,
```

```
    0) ;
    return 0
    ;
}
```

Output

```
BFS traversal starting from node 0: 0 1 2 3 4 5

=== Code Execution Successful ===
```

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

Program:

```
#include < stdio.h >
#include < stdlib.h >
#include < stdbool.h >
#define MAX 100 struct
   Graph {
    int vertices;
    int adjMatrix[MAX][MAX];
} ;

void initGraph(struct Graph* g, int vertices) { g-
    >vertices = vertices;
    for (int i = 0; i < vertices; i++) { for ( int
        j = 0; j < vertices; j++) { g-
            >adjMatrix[i][j] = 0 ;
        }
    }
}

void addEdge(struct Graph* g, int u, int v) {
    g->adjMatrix[u][v] = 1 ; g-
    >adjMatrix[v][u] = 1 ;
}

void dfs(struct Graph* g, int vertex, bool visited[]) { visited[vertex] = true;
    for (int i = 0; i< g->vertices; i++) {
        if (g->adjMatrix[vertex][i] == 1 && !visited[i]) { dfs(g, i,
            visited);
        }
    }
}
```

```
bool isConnected(struct Graph* g) { bool
    visited[MAX] = {false}; dfs(g, 0 ,
    visited);
    for (int i = 0; i < g->vertices; i++) { if
        (!visited[i]) {
            return false;
        }
    } return
true; }

int main() { struct Graph g; int
    vertices = 6; initGraph(&g,
    vertices);

    addEdge(&g, 0, 1) ;
    addEdge(&g, 0, 2) ;
    addEdge(&g, 1, 3) ;
    addEdge(&g, 1, 4) ;
    addEdge(&g, 2, 5) ;

    if (isConnected(&g)) {
        printf("The graph is connected.\n");
    } else { printf("The graph is not
        connected.\n");
    }

    return 0 ;
}
```

Output

```
The graph is connected.


=== Code Execution Successful ===
```

Program 10
Hashing

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.

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

#define MAX 100
#define M 10

 typedef struct { int
key, char name[50];
char department[30]; }
Employee;

typedef struct {
   int key;
   Employee emp;
int isOccupied; }
HashTableEntry;

int hashFunction(int key) {
   return key % M;
}

void insert(HashTableEntry hashTable[], Employee emp) {
   int index = hashFunction(emp.key);
   int originalIndex = index;

   while (hashTable[index].isOccupied) {
      if (hashTable[index].key == emp.key) {
         printf("Error: Duplicate key
      detected!\n"); return; } index = (index + 1)
      % M;
```

```
        if (index == originalIndex) {
            printf("Error: Hash table is full!\n");
            return;
        }
    }

    hashTable[index].key = emp.key; hashTable[index].emp
    = emp; hashTable[index].isOccupied = 1 ;
    printf("Inserted key %d at index %d\n", emp.key,
    index);
}

Employee *search(HashTableEntry hashTable[], int key)
    { int index = hashFunction(key); int originalIndex =
    index;

    while (hashTable[index].isOccupied) {
        if (hashTable[index].key == key) {
            return &hashTable[index].emp;
        } index = (index + 1) %
        M;
        if (index == originalIndex) {
            break;
        }
    }

    return NULL;
}

void displayHashTable(HashTableEntry hashTable[]) {
    printf("\nHash Table:\n");
    for (int i = 0; i < M; i++) {
        if (hashTable[i].isOccupied) {
            printf("Index %d: Key = %d, Name = %s, Department = %s\n",
                   i, hashTable[i].key, hashTable[i].emp.name, hashTable[i].emp.department);
        } else { printf("Index %d:
            Empty\n", i);
        }
    }
}

int main() {
    HashTableEntry hashTable[M];
    for (int i = 0; i < M; i++) {
        hashTable[i].isOccupied = 0 ;
```

```
} int

choice;

Employee

emp;


do {
   printf("\nMenu:\n"); printf("1. Insert
   Employee Record\n"); printf("2.
   Search Employee Record\n");
   printf("3. Display Hash Table\n");
   printf("4. Exit\n"); printf("Enter your
   choice: "); scanf("%d", &choice);

   switch (choice) {
      case 1:
         printf("Enter 4-digit key: ");
         scanf("%d", &emp.key);
         printf("Enter name: ");
         scanf("%s", emp.name);
         printf("Enter department: ");
         scanf("%s", emp.department);
         insert(hashTable, emp);
         break;
      case 2: printf("Enter key to
         search: "); int key;
         scanf("%d", &key);
         Employee *result = search(hashTable, key);
         if (result) {
            printf("Employee Found: Key = %d, Name = %s, Department = %s\n", result-
                  >key, result->name, result->department);
         } else { printf("Employee with key %d not found.\n",
            key);
         }
         break;
      case 3:
         displayHashTable(hashTable);
         break;
      case 4:
         printf("Exiting...\n");
         break;
      default:
         printf("Invalid choice!\n");
   }
```

```
    } while (choice != 4) ;

    return 0 ;
}
```

```
Menu:
1. Insert Employee Record
2. Search Employee Record
3. Display Hash Table
4. Exit
Enter your choice: 1
Enter 4-digit key: 1234
Enter name: bhoomika
Enter department: cse
Inserted key 1234 at index 4

Menu:
1. Insert Employee Record
2. Search Employee Record
3. Display Hash Table
4. Exit
Enter your choice: 1
Enter 4-digit key: 3232
Enter name: thanush
Enter department: ise
Inserted key 3232 at index 2
```

```
Menu:
1. Insert Employee Record
2. Search Employee Record
3. Display Hash Table
4. Exit
Enter your choice: 3

Hash Table:
Index 0: Empty
Index 1: Empty
Index 2: Key = 3232, Name = thanush, Department = ise
Index 3: Empty
Index 4: Key = 1234, Name = bhoomika, Department = cse
Index 5: Empty
Index 6: Empty
Index 7: Empty
Index 8: Empty
Index 9: Empty
```

```
Menu:
1. Insert Employee Record
2. Search Employee Record
3. Display Hash Table
4. Exit
Enter your choice: 2
Enter key to search: 1234
Employee Found: Key = 1234, Name = bhoomika, Department = cse

Menu:
1. Insert Employee Record
2. Search Employee Record
3. Display Hash Table
4. Exit
Enter your choice: 4
Exiting...
```