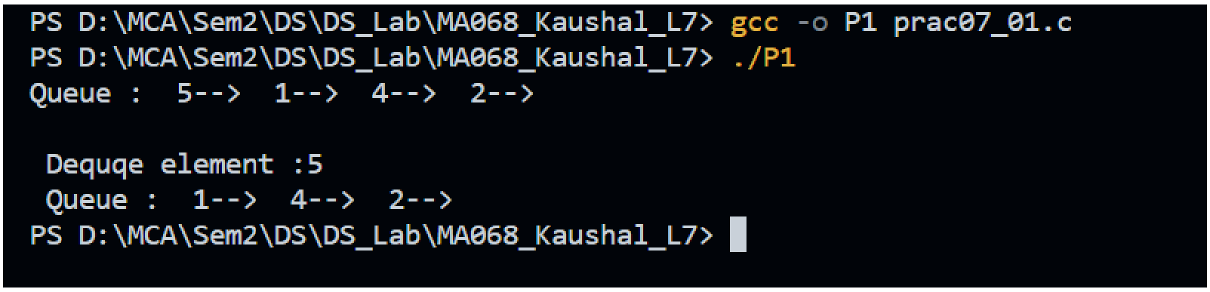
Practical – 7 Implementation of Circular and Doubly Linked List

1. **Write a program to implement Enqueue and Dequeue operations of circular queue using circular link list.**

Code :

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

typedef struct Node{

    int data;
    struct Node* next;

}node;

node *front=NULL,*rear=NULL;


void enqueue(int info){

    node *newnode=(node*)malloc(sizeof(node));
    newnode->data=info;
    newnode->next=NULL;


    if(rear==NULL){
        front=rear=newnode;
        newnode->next=front;
    }else{
        //temp->next=rear;
        rear->next=newnode;
        rear=newnode;
        rear->next=front;
    }


}
void display(){
    if(front==NULL)
        printf("\nQueue Empty");
    else{

        node *temp=front;
        printf("Queue : ");
        do
        {
            printf(" %d--> ",temp->data);
            temp=temp->next;
        }while(temp!=front);
        printf("\n");
    }
}


void dequeue(){
   if(front==NULL){
      printf("Queue is Empty\n");

   }else{
     // node *temp=rear;
      printf(" \n Dequqe element :%d\n ",front->data );
      rear->next=front->next;
      front=front->next;
   }


}
int main(){

   enqueue(5);
   enqueue(1);
   enqueue(4);
   enqueue(2);
   display();


  dequeue();
  display();
   return 0;
}
```

Output:



```
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> gcc -o P1 prac07_01.c
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> ./P1
Queue :  5-->  1-->  4-->  2-->

 Dequqe element :5
 Queue :  1-->  4-->  2-->
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> 
```

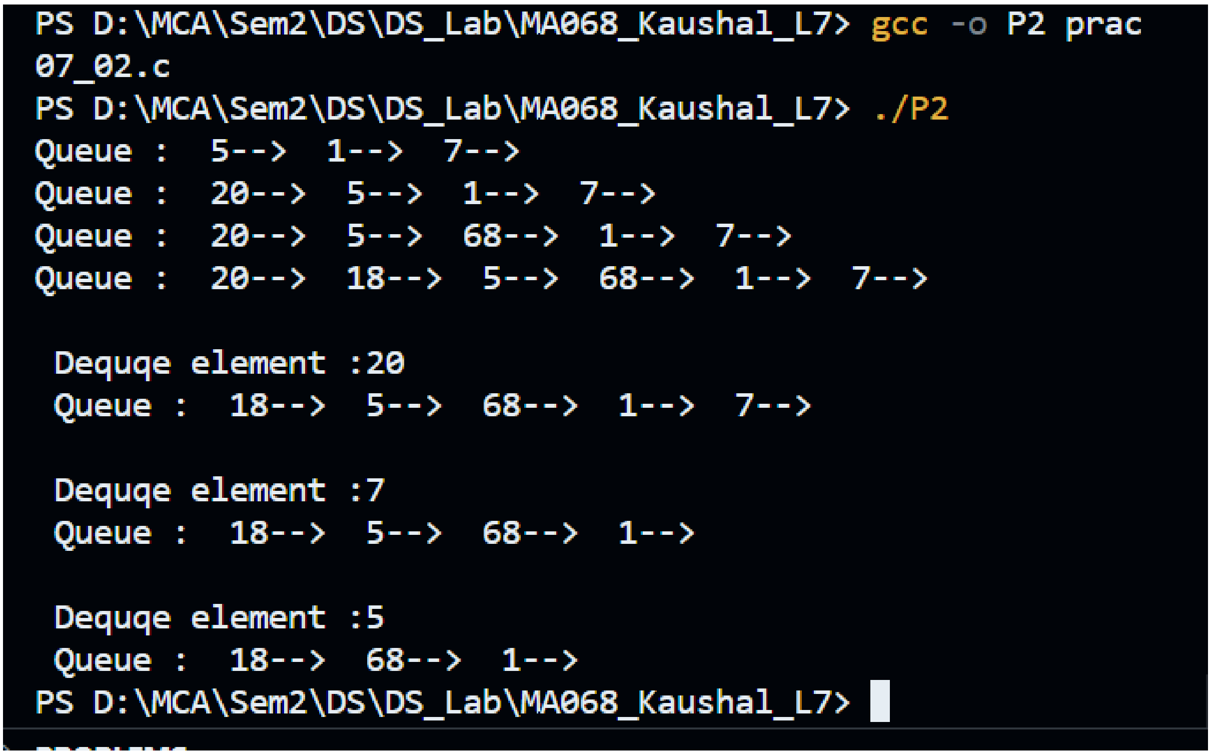
2. **Write a program for all operations of a circular singly linked list.**
    a. **Inserting Node – as First Node, at specific location, as Last Node**
    b. **Deleting Node – at First, at Last, specific node**
    c. **Display List**

Code:

```
#include <stdio.h>

#include <stdlib.h>


typedef struct Node{

   int data;
   struct Node* next;

}node;

node *head=NULL,*tail=NULL;

void insertLast(int info){

   node *newnode=(node*)malloc(sizeof(node));
   newnode->data=info;
   newnode->next=NULL;

   if(tail==NULL){
      head=tail=newnode;
      newnode->next=head;
   }else{
      tail->next=newnode;
      tail=newnode;
      tail->next=head;
   }


}
void insertFirst(int info){

   node *newnode=(node*)malloc(sizeof(node));
   newnode->data=info;
   newnode->next=NULL;

     if(tail==NULL){
      head=tail=newnode;
      // newnode->next=head;
   }else{
      newnode->next=head;
      head=newnode;
      tail->next=newnode;

   }
}

void insertLoc(int info,int loc){

   node *newnode=(node*)malloc(sizeof(node));
   newnode->data=info;
   newnode->next=NULL;

   node *temp=head;
   int count=2;

   while(count!=loc){
      temp=temp->next;
      count++;
   }
   newnode->next=temp->next;
   temp->next=newnode;

}

void deleteFirst(){
   if(head==NULL){
      printf("Queue is Empty\n");

   }else{
      printf(" \n Dequqe element :%d\n ",head->data );

      tail->next=head->next;

      head=tail->next;
   }


}

void deleteLast(){
   if(head==NULL){
      printf("Queue is Empty\n");

   }else{
      node *temp=head;
      printf(" \n Dequqe element :%d\n ",tail->data );
      while(temp->next!=tail){
           temp=temp->next;
      }
      tail=temp;
      temp->next=head;

   }


}
```

```
void deleteLoc(int loc){
    int count=2;
    if(loc==1){
      deleteFirst();
    }else{
        node *temp=head;
        while(loc!=count){
            temp=temp->next;
            count++;
        }
        printf(" \n Dequqe element :%d\n ",temp->next->data );
        temp->next=temp->next->next;
    }
}
void display(){
    if(head==NULL)
        printf("\nQueue Empty");
    else{

        node *temp=head;
        printf("Queue : ");
        do
        {
               printf(" %d--> ",temp->data);
               temp=temp->next;
        }while(temp!=head);
        printf("\n");
    }
}

int main(){

    insertLast(5);
    insertLast(1);
    insertLast(7);
    display();

    insertFirst(20);
    display();

    insertLoc(68,3);
    display();
    insertLoc(18,2);
    display();

    deleteFirst();
    display();

    deleteLast();
    display();

    deleteLoc(2);
    display();

    return 0;
}
```

Output:



```
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> gcc -o P2 prac
07_02.c
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> ./P2
Queue :  5-->  1-->  7-->
Queue :  20-->  5-->  1-->  7-->
Queue :  20-->  5-->  68-->  1-->  7-->
Queue :  20-->  18-->  5-->  68-->  1-->  7-->

 Dequqe element :20
 Queue :  18-->  5-->  68-->  1-->  7-->

 Dequqe element :7
 Queue :  18-->  5-->  68-->  1-->

 Dequqe element :5
 Queue :  18-->  68-->  1-->
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7>
```

3. Write a program for all operations of doubly linked list

a. Inserting Node – as First Node, at specific location, as Last Node

b. Deleting Node – at First, at Last, specific node

c. Display List

Code:

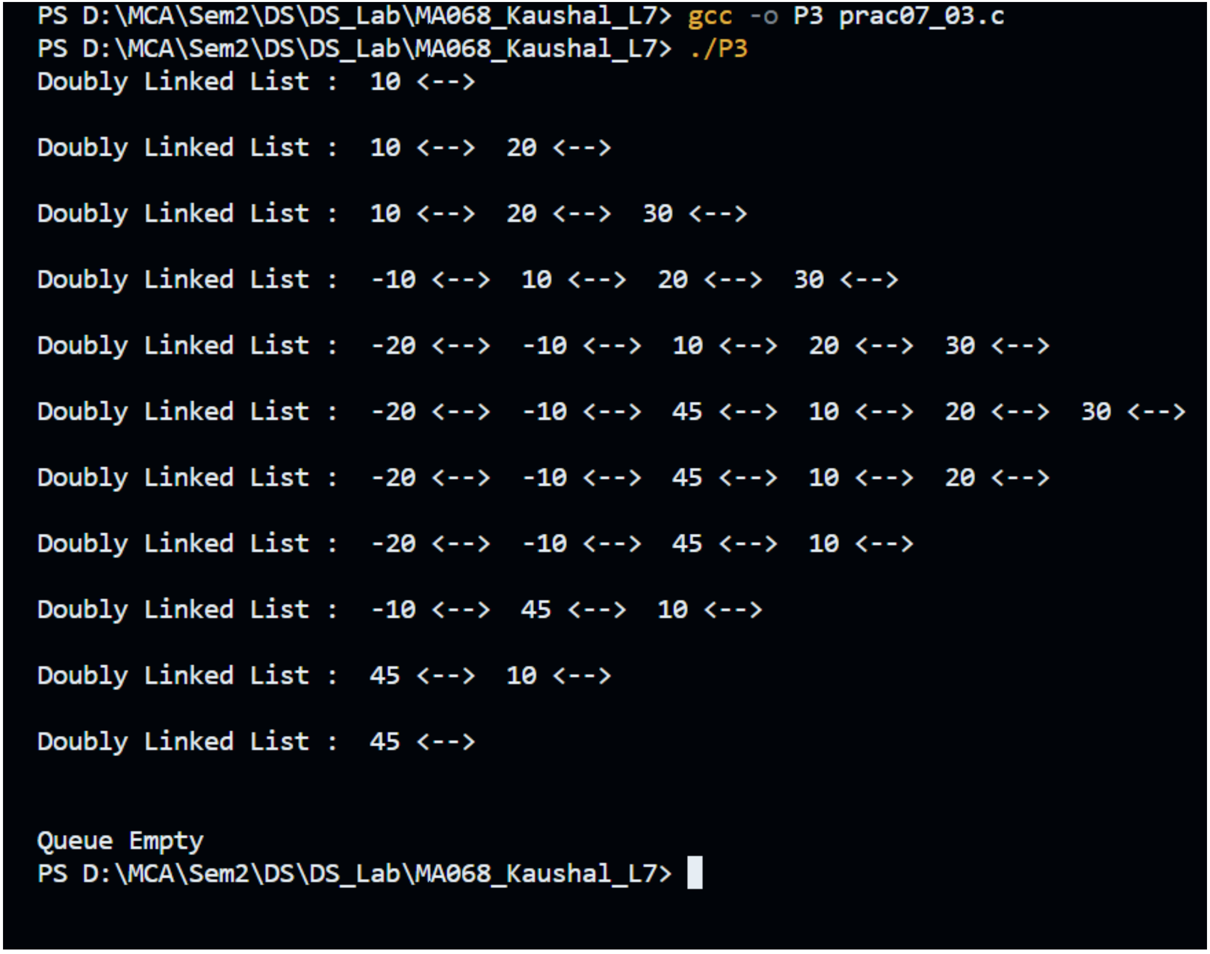
```
#include <stdio.h>
#include <stdlib.h>

typedef struct Node{
   struct Node* pre;
   int data;
   struct Node* next;

}node;

node *head=NULL,*tail=NULL;


void insertAtLast(int info){

   node *newnode=(node*)malloc(sizeof(node));
   newnode->data=info;
   newnode->next=NULL;
   newnode->pre=NULL;

   if(head==NULL ){
      head=tail=newnode;
   }else{
      tail->next=newnode;
      newnode->pre=tail;
      tail=newnode;
   }
}

void insertAtFirst(int info){
   node *newnode=(node*)malloc(sizeof(node));
   newnode->data=info;
   newnode->next=NULL;
   newnode->pre=NULL;

   if(head==NULL){
      head=tail=newnode;
   }else{
      newnode->next=head;
      //newnode->pre=head;
      head=newnode;
   }
}
```

```
void insertLoc(int info,int loc){

      loc--;
      if(loc==1){
         insertAtFirst(info);
      }else{
         node *newnode=(node*)malloc(sizeof(node));
         newnode->data=info;
         newnode->next=NULL;
         newnode->pre=NULL;

         node *temp=head;
         while(--loc){
            temp=temp->next;
         }

         newnode->next=temp->next;
         newnode->pre=temp;
         temp->next=newnode;
         temp->next->pre=newnode;

      }
}



void deleteLast(){
   if(tail==NULL){
      printf("\nLinked List is Empty...");
   }else{

      tail=tail->pre;
      tail->next=NULL;
   }
}





void deleteFirst(){
   if(head==NULL){
        printf("\nLinked List is Empty...");
   }else if(head->next==NULL){
      head=NULL;
   }
   else{
      head=head->next;
      head->pre=head;
   }

 }
```

```
void deletePosition(int pos)
{
        int i=1;
        node *temp, *position;
        temp=head;
        if(head==NULL)
        {
                printf("List is empty\n");
        }
        else
        {
                if(pos==1)
                {
                        deleteFirst();
      return;
                }

                while(i<pos-1)
                {
                        temp=temp->next;
                        i++;
                }
                position=temp->next;
                if(position->next!=NULL)
                {
                        position->next->pre=temp;
                }
                temp->next=position->next;
                free(position);
        }
}
void display(){
  if(head==NULL)
    printf("\nQueue Empty");
  else{

    node *temp=head;
    printf("Doubly Linked List : ");
    while(temp!=NULL)
    {
        printf(" %d <--> ",temp->data);
        temp=temp->next;
    }
    printf("\n\n");
  }
}
```

```
int main(){

   insertAtLast(10);
   display();
   insertAtLast(20);
   display();
   insertAtLast(30);
   display();

   insertAtFirst(-10);
   display();
   insertAtFirst(-20);
   display();

   insertLoc(45,3);
   display();


   deleteLast();
   display();
   deleteLast();
   display();

   deleteFirst();
   display();
   deleteFirst();
   display();

   deletePosition(2);
   display();

   deletePosition(1);
   display();

   return 0;
}
```

Output:



```
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> gcc -o P3 prac07_03.c
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> ./P3
Doubly Linked List :  10 <-->

Doubly Linked List :  10 <-->  20 <-->

Doubly Linked List :  10 <-->  20 <-->  30 <-->

Doubly Linked List :  -10 <-->  10 <-->  20 <-->  30 <-->

Doubly Linked List :  -20 <-->  -10 <-->  10 <-->  20 <-->  30 <-->

Doubly Linked List :  -20 <-->  -10 <-->  45 <-->  10 <-->  20 <-->  30 <-->

Doubly Linked List :  -20 <-->  -10 <-->  45 <-->  10 <-->  20 <-->

Doubly Linked List :  -20 <-->  -10 <-->  45 <-->  10 <-->

Doubly Linked List :  -10 <-->  45 <-->  10 <-->

Doubly Linked List :  45 <-->  10 <-->

Doubly Linked List :  45 <-->


Queue Empty
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> 
```

4. Write a program for all operations of doubly linked list

a. **Inserting Node – as First Node, at specific location, as Last Node**

b. **Deleting Node – at First, at Last, specific node**

c. **Display List**

Code :

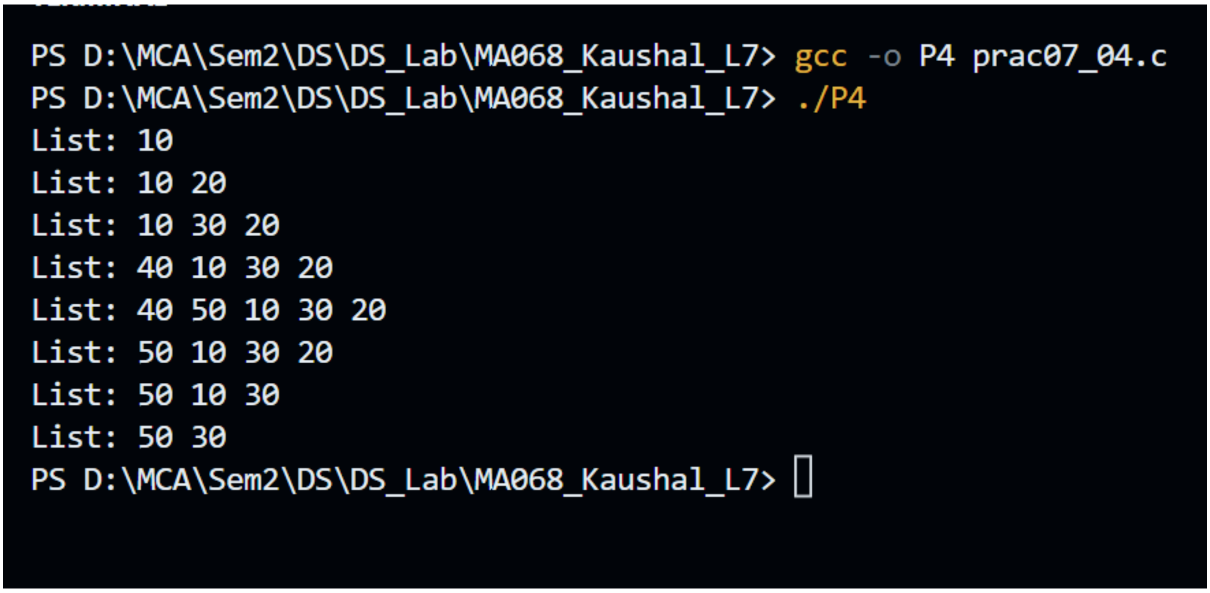
```
#include <stdio.h>
#include <stdlib.h>

// Circular doubly linked list


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


struct Node* head = NULL;



void insertFirst(int data) {

   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = data;
   newNode->prev = NULL;
   newNode->next = NULL;


   if (head == NULL) {
      head = newNode;
      newNode->next = newNode;
      newNode->prev = newNode;
      return;
   }


   struct Node* last = head->prev;
   newNode->next = head;
   head->prev = newNode;
   newNode->prev = last;
   last->next = newNode;
   head = newNode;
}
```

```
void insertLast(int data) {

    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->prev = NULL;
    newNode->next = NULL;



    if (head == NULL) {
        head = newNode;
        newNode->next = newNode;
        newNode->prev = newNode;
        return;
    }

    struct Node* last = head->prev;
    newNode->prev = last;
    newNode->next = head;
    last->next = newNode;
    head->prev = newNode;
}


void insertAt(int data, int position) {
    if (head == NULL || position == 1) {
        insertFirst(data);
        return;
    }

    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->prev = NULL;
    newNode->next = NULL;

    struct Node* current = head;
    for (int i = 1; i < position - 1; i++) {
        if (current == NULL) {
            printf("Invalid position!\n");
            return;
        }
        current = current->next;
    }

    newNode->next = current->next;
    newNode->prev = current;
    if (current->next != NULL) {
        current->next->prev = newNode;
    }
    current->next = newNode;
}
```

```
void deleteFirst() {
    if (head == NULL) {
        printf("List is empty, deletion not possible.\n");
        return;
    }

    struct Node* temp = head;


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

    free(temp);
}



void deleteLast() {
    if (head == NULL) {
        printf("List is empty, deletion not possible.\n");
        return;
    }

    struct Node* temp = head;

    // If there is only one node
    if ((head)->next == head) {
        head = NULL;
    }
    else {
        while (temp->next != head) {
            temp = temp->next;
        }

        temp->prev->next = head;
        (head)->prev = temp->prev;
    }

    free(temp);
}
```

```
void deleteAt( int position) {
    if (head == NULL) {
        printf("List is empty, deletion not possible.\n");
        return;
    }

    if (position == 1) {
        deleteFirst(head);
        return;
    }

    struct Node* temp = head;
    int i;

    for (i = 1; i < position && temp->next != head; i++) {
        temp = temp->next;
    }

    if (i != position) {
        printf("Invalid position, deletion not possible.\n");
        return;
    }

    temp->prev->next = temp->next;
    temp->next->prev = temp->prev;

    free(temp);
}

void displayList() {

    if (head == NULL) {
        printf("List is empty!\n");
        return;
    }


    struct Node* current = head;
    do {
        printf("%d ", current->data);
        current = current->next;
    } while (current != head);
    printf("\n");
}


int main() {

    insertFirst(10);
    printf("List: ");
    displayList();

    insertLast( 20);
    printf("List: ");
    displayList();
    insertAt(30, 2);
    printf("List: ");
    displayList();

    insertAt( 40, 1);
    printf("List: ");
    displayList();

    insertAt( 50, 6);
    printf("List: ");
    displayList();


    deleteFirst();
    printf("List: ");
    displayList();

    deleteLast();
    printf("List: ");
    displayList();

    deleteAt( 2);
    printf("List: ");
    displayList();


    return 0;
}
```

Output:



```
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> gcc -o P4 prac07_04.c
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> ./P4
List: 10
List: 10 20
List: 10 30 20
List: 40 10 30 20
List: 40 50 10 30 20
List: 50 10 30 20
List: 50 10 30
List: 50 30
PS D:\MCA\Sem2\DS\DS_Lab\MA068_Kaushal_L7> 
```