St. Francis Institute of Technology, Mumbai-400 103
Department of Information Technology

A.Y. 2020-2021
Class: SE-ITA/B, Semester: III
Subject: DATA STRUCTURE LAB

Experiment – 9 Study of Josephus problem using circular linked list

1. Aim: Write a C program to implement Josephus problem using circular linked list.

2. Objectives: After study of this experiment, the student will be able to
   • To learn the principles of queue and its various operations
   • Implement an algorithm using computer to solve the given problem
   • To learn the applications of queues and linked lists

3. Outcomes: After study of this experiment, the student will be able to • Illustrate and examine the methods of queues to various real time problems • Develop an algorithm for various problem on queues and linked lists

4. Prerequisite: Queue and its operations, Linked list and its types

5. Requirements: PC and Turbo C compiler version 3.0

6. Pre-Experiment Exercise:
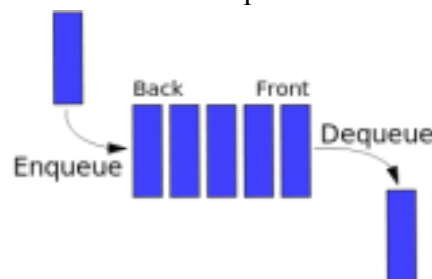   **Brief Theory:**

A. Queue
   Queue is an ADT data structure similar to stack, except that the first item to be inserted is the first one to be removed.
   This mechanism is called First-In-First-Out (FIFO)

B. Circular Queue
   When a new item is inserted at the rear, the pointer to rear moves upwards.
   Similarly, when an item is deleted from the queue the front arrow moves

   downwards.

   After a few insert and delete operations the rear might reach the end of the queue and no more items can be inserted although the items from the front of the queue have been deleted and there is space in the queue.

To solve this problem, queues implement wrapping around. Such queues are called Circular Queues. Both the front and the rear pointers wrap around to the beginning of the array. It is also called as "Ring buffer". Items can inserted and deleted from a queue in O(1) time.


C. Circular Linked List

This mechanism is called First-In-First-Out (FIFO).

Circular Linked List is a variation of Linked list in which the first element points to the last element and the last element points to the first element. Both Singly Linked List and Doubly Linked List can be made into a circular linked list.
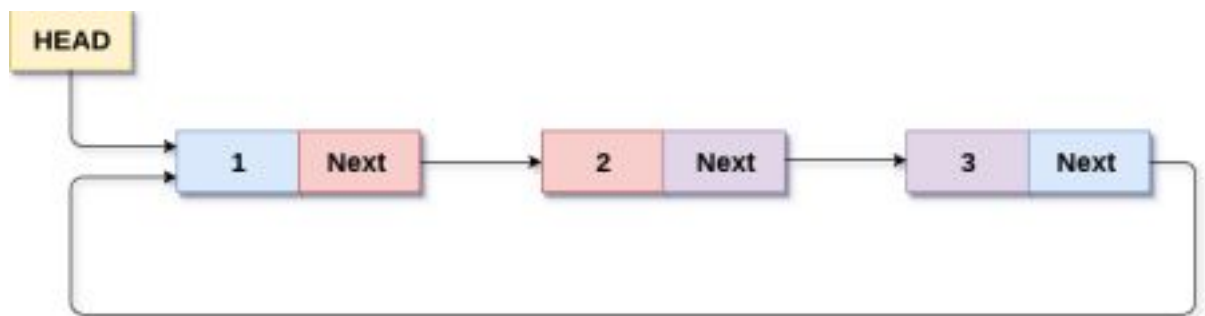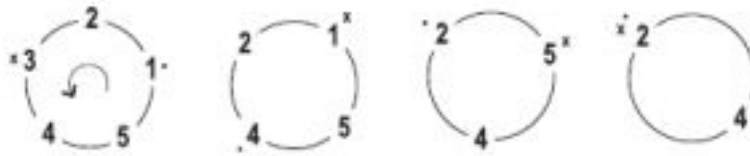

Circular Singly Linked List

D. Josephus Problem (application of queue)
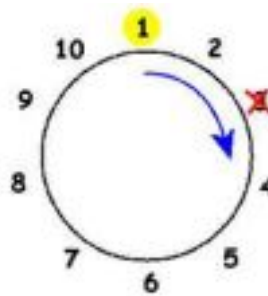
- n number of people stand in a circle to be executed

- Counting starts at some point in circle

- Proceeds in a specific direction

- In each step k-1 number of people are skipped and k'th person is executed (deleted)

- At last step only one person remains and declared as winner.

• Example

n = 5 and k =3

7. Laboratory Exercise

A. Procedure
Write a C program to implement Josephus problem using circular linked list.

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

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

struct node *start, *ptr, *new_node;

int main()
{
    int n, k, i, count;
    printf("\n Enter the number of players : ");
    scanf("%d", &n);
    printf("\n Enter the value of k (every kth player gets eliminated): ");
    scanf("%d", &k);


    // Create circular linked list containing all the players
    start = malloc(sizeof(struct node));
    start->player_id = 1;

    ptr = start;
    for (i = 2; i <= n; i++)
    {
        new_node = malloc(sizeof(struct node));
        ptr->next = new_node;
        new_node->player_id = i;
        new_node->next=start;
```

```
        ptr=new_node;
    }


    int b = 0;
    for (count = n; count > 1; count--)
    {
        for (i = 0; i < k-1; ++i)
            ptr = ptr->next;
            b++;
            printf("The player eliminated in round %d was
%d\n",b,ptr->next->player_id);
            ptr->next = ptr->next->next;
    }


    printf("\n The Winner is Player %d", ptr->player_id);


    return 0;
}
```

B. Result/Observation/Program code:
Observe the output for the above code and print it.

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL

Microsoft Windows [Version 10.0.19042.630]
(c) 2020 Microsoft Corporation. All rights reserved.

D:\College\DSA\Experiments>cd Exp9

D:\College\DSA\Experiments\Exp9>Exp9

 Enter the number of players : 5

 Enter the value of k (every kth player gets eliminated): 2
The player eliminated in round 1 was 2
The player eliminated in round 2 was 4
The player eliminated in round 3 was 1
The player eliminated in round 4 was 5

 The Winner is Player 3
D:\College\DSA\Experiments\Exp9>
```

8. Post-Experiments Exercise

A. Questions:
1. List and explain the applications of queues.

2. Solve the given example using Josephus problem considering there are 10 number of people in a circle. Start the process from 1st person, and at every step 4th person is to be executed. Show all the steps and identify the winner.

B. Conclusion:
1. Summary of Experiment
2. Importance of Experiment

C. References:
1. S. K Srivastava, Deepali Srivastava; Data Structures through C in Depth; BPB Publications; 2011.
2. Reema Thareja; Data Structures using C; Oxford.
3. Data Structures A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, second edition, CENGAGE Learning.

Yash Mahajan SE IT B O4

8] Post Experiment Exercise :-
A) Questions :-

1) List & explain application of queues.
A queue is a linear data structure which follows a particular oder of operations of insertion and deletion. The elements in a queue are added at one end called rear and and removed from the other end called ~~rear~~ front. It is a first in first out datastructure

Queues are widely used as waiting lists for a single shared resource like printer, disk, CPU.

Queues are used to transfer data asynchronously (data not be necessarily recieved at same rat as sent) between two processes (IO buffers), eg pipes, files, IO sockets.

Queues are used as buffers on MP3 players and portable CD players, iPod playlist.

Queues are used in operating system for handling interrupts. When programming a real-time system that can be interrupted, for example, by a mouse click, it is necessary to process the interrupts immediately, before proceding cirth the current job. If interrupts have to be handled in the order of arrival, then a FIFO queue es appropriate.
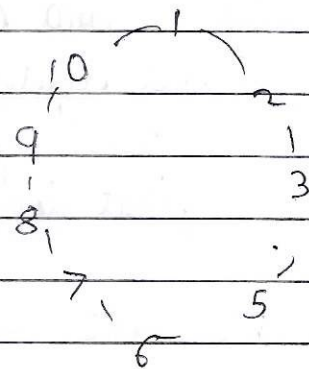
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2. Solve the given example using Josephus problem considering there are 10 numbers of people in a circle. starting process from 1st person and at every step 4th person is executed. Show all the steps and identify the winner.
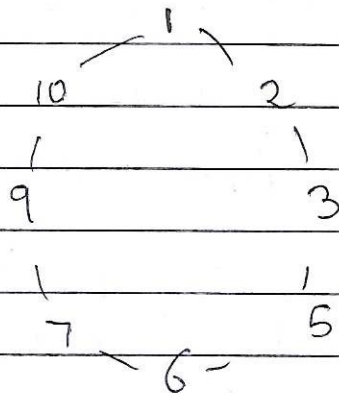
Step 1:-
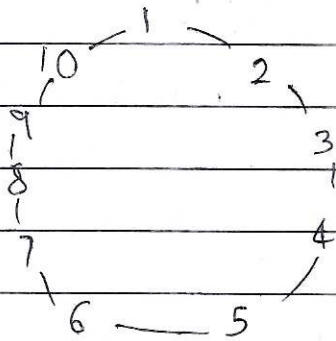
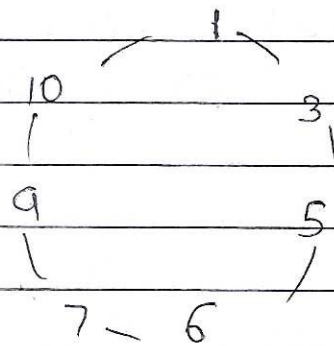4 is eliminated in round 1.
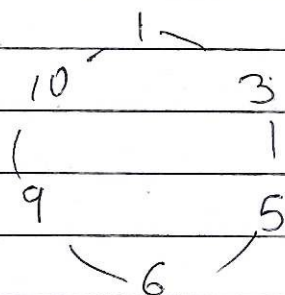
Step 2:-

8 is eliminated in round 2

Step 3:-

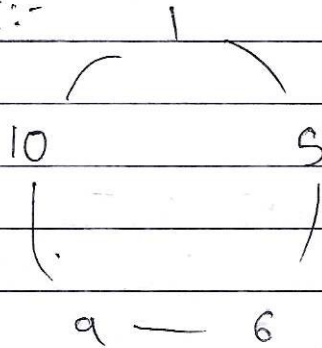2 is eliminated in round 3

Step 4

7 was eliminated in round 4.

Step 5:-

3 was eliminated in round 5.

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Step 6 :-   Step 7 :-

10   5   9   5
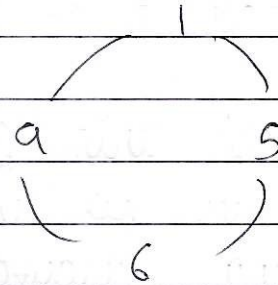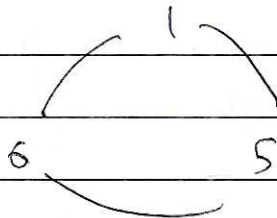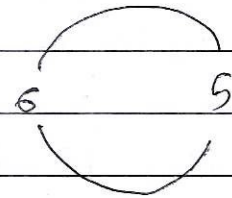   9 — 6   6

10 was eliminated in round 6   9 was eliminated
                                  in round 7

Step 8 :-

                                  Step 9 :-

        1
    6   5   6   5

1 was eliminated in round 8.   6 was eliminated
                                  in round 9

∴ 5 is the winner.

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B) Conclusion :-

In this experiment we have written C programs to implement Josephus problem using circular linked list queue. In Josephus problem, if there are n number of people in circle and every kth person is to be eliminated, after every elimination the circle becomes smaller and the last person remaining is the winner.

Circular queues are used in operating system process to complete that requires some event to occur for some other processes to complete for execution is often maintained in a circular queues so that they execute one after other when all conditions are met or when all events occur. They are also used for memory management.

Thus we have studied Josephus problem using circular queue.