Assignment - 10
CS341: Operating System Lab

General Instructions

- Markings will be based on the correctness and soundness of the outputs. Marks will be deducted in case of plagiarism.
- Proper indentation & appropriate comments (if necessary) are mandatory in the code.

Problem Statement 1

The OS lab at IIT Patna has been facing issues with slow response times when running large applications due to frequent page faults. To help students understand the impact of page faults, you've been asked to create a program that simulates a simple page replacement system.

Question

Write a C program that simulates page replacement using the Least Recently Used (LRU) algorithm. The program should:

- Take as input the number of pages in memory, a sequence of page requests, and the total number of frames.
- Implement the LRU page replacement algorithm to handle page requests.
- Output each page request, indicating if it caused a page fault and the current state of frames.

Input Format

- First line: Number of frames in memory.
- Second line: Sequence of page requests.

Example Input

```
3
7 0 1 2 0 3 0 4 2 3 0 3 2
```

Example Output

```
Page 7 caused a page fault. Frames: [7]
Page 0 caused a page fault. Frames: [7, 0]
Page 1 caused a page fault. Frames: [7, 0, 1]
Page 2 caused a page fault. Frames: [0, 1, 2]
...
```

Problem Statement 2

During a research project at IIT Patna, a graduate student notices that they need to understand how segmentation and paging work together to manage large data sets. You are asked to create a program that simulates a virtual memory system where both paging and segmentation are used.

Question

Write a C program that simulates segmentation with paging. The program should:

- Define segments and divide each segment into pages.
- Prompt the user to input segment and page numbers, then display the physical address (using a simulated physical memory layout).
- Simulate page faults if a page is not in memory, and prompt the user to load it.

Input Format

- Number of segments.
- For each segment, input the number of pages and page sizes.
- Segment number and page number requested by the user.

Example Input

```
2 // Number of segments
3 // Segment 1 has 3 pages
4 // Segment 2 has 4 pages
Request: Segment 1, Page 2
```

Example Output

```
Physical Address for Segment 1, Page 2: (simulated address)
Page Fault: Loading Page 2 of Segment 1 into memory...
```

Problem Statement 3

As part of a project in the OS lab, students at IIT Patna are tasked with implementing a virtual memory manager for a simulation tool. The virtual memory manager should handle page requests and use a First-In-First-Out (FIFO) page replacement policy.

Question

Write a C program that simulates a virtual memory manager using FIFO page replacement. Your program should:

- Accept the number of frames available and a sequence of page requests.
- Use the FIFO policy to decide which page to replace when a page fault occurs.
- Output each page request, indicating if it caused a page fault and the updated frame content.

Input Format

- Number of frames.
- Sequence of page requests.

Example Input

```
3
1 2 3 4 1 2 5 1 2 3 4 5
```

Example Output

```
Page 1 caused a page fault. Frames: [1]
Page 2 caused a page fault. Frames: [1, 2]
Page 3 caused a page fault. Frames: [1, 2, 3]
Page 4 caused a page fault, replacing Page 1. Frames: [4, 2, 3]
...
```

Submission

Submit your C program code along with a detailed explanation of the mechanisms you used. Make sure to include comments in your code to explain the logic and try to use best coding practices.