

Data Structures Worksheet: Array-Based Stack & Circular Queue

Students Names: _____

Part 1: Array-Based Stack

Conceptual Questions

1. Explain the Last-In-First-Out (LIFO) property of a stack. Why is it useful in computing?
2. Describe the key operations of a stack (**push**, **pop**, **peek**). What are their time complexities?
3. What happens when you push an element onto a full stack? How would you handle this situation?
4. Given a stack with an initial state of $[-, -, -, -]$ (capacity = 5), perform the following operations and show the stack state after each step:
 - push(5)
 - push(10)

- push(15)
- pop()
- push(20)
- push(25)
- push(30) (What happens here?)

5. Stacks can be used for function call management in programming languages. Explain why this is the case and how the stack helps in function execution.

6. Consider a postfix expression evaluation. How would a stack help in computing $5\ 3\ +\ 8\ *\ 2\ -$?

Part 2: Array-Based Circular Queue

Conceptual Questions

1. Explain how a circular queue differs from a standard queue.

2. Why do we use modular arithmetic in implementing a circular queue?

3. What is the condition to check if the circular queue is full? How do we distinguish between an empty and a full queue?

4. Consider a circular queue of max size 5. Given the operations below, trace the state of the queue, including the front and rear pointers:
 - enqueue(1)
 - enqueue(2)
 - enqueue(3)
 - enqueue(4)
 - enqueue(5)
 - dequeue()
 - dequeue()
 - enqueue(6)
 - enqueue(7)
 - dequeue()
 - enqueue(8)
 - enqueue(9) (What happens here?)

5. Suppose a circular queue of size 6 is initially empty. Show the changes in the queue state and the front/rear indices after performing these operations:
- enqueue(10), enqueue(20), enqueue(30)
 - dequeue()
 - enqueue(40), enqueue(50), enqueue(60), enqueue(70)
 - dequeue(), dequeue()
 - enqueue(80), enqueue(90)
 - What happens when we attempt another enqueue(100)? Explain.
6. In real-world applications, where would a circular queue be more efficient than a standard queue? Provide an example.

Submission Instructions

- Complete all conceptual questions with a partner.
- Fill in the stack and circular questions and draw tracing tables.
- Submit a document with your answers at the end of class.
- Ensure your names are on the document.

Due Date: _____