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PERAMBALUR-621212, TAMILNADU, INDIA.
Website: www.dsengg.ac.in

DEPARTMENT OF INFORMATION TECHNOLOGY
U23ITT32 – DATA STRUCTURES
UNIT II
2 MARKS & 16 MARKS

UNIT II LINEAR DATA STRUCTURES – STACKS, QUEUES

Stack ADT – Operations - Applications - Evaluating arithmetic expressions- Conversion of Infix to postfix expression - Queue ADT – Operations - Circular Queue – Priority Queue - deQueue – applications of queues

2MARKS

1. Define Stack

A Stack is an ordered list in which all insertions (Push operation) and deletion (Pop operation) are made at one end, called the top. The topmost element is pointed by top. The top is initialized to -1 when the stack is created that is when the stack is empty. In a stack $S = (a_1, a_n)$, a_1 is the bottom most element and element a is on top of element a_{i-1}. Stack is also referred as Last In First Out (LIFO) list.

2. What are the various Operations performed on the Stack?

The various operations that are performed on the stack are

CREATE(S) – Creates S as an empty stack.

PUSH(S,X) – Adds the element X to the top of the stack.

POP(S) – Deletes the top most elements from the stack.

TOP(S) – returns the value of top element from the stack.

ISEMTPTY(S) – returns true if Stack is empty else false.

ISFULL(S) - returns true if Stack is full else false.

3. How do you test for an empty stack?

The condition for testing an empty stack is top =-1, where top is the pointer pointing to the topmost element of the stack, in the array implementation of stack. In linked list implementation of stack the condition for an empty stack is the header node link field is NULL.

4. Name two applications of stack?

Nested and Recursive functions can be implemented using stack. Conversion of Infix to Postfix expression can be implemented using stack. Evaluation of Postfix expression can be implemented using stack.

5. Define a suffix expression.

The notation used to write the operator at the end of the operands is called suffix notation.

Suffix notation format : operand operand operator

Example: ab+, where a & b are operands and '+' is addition operator.

6. What do you meant by fully parenthesized expression? Give example.

A pair of parentheses has the same parenthetical level as that of the operator to

which it corresponds. Such an expression is called fully parenthesized expression.

Ex: (a+((b*c) + (d * e))

7. Write the postfix form for the expression -A+B-C+D?

A-B+C-D+

8. What are the postfix and prefix forms of the expression?

A+B*(C-D)/(P-R)

Postfix form: ABCD-*PR-/+

Prefix form: +A/*B-CD-PR

9. Explain the usage of stack in recursive algorithm implementation?

In recursive algorithms, stack data structures is used to store the return address when a recursive call is encountered and also to store the values of all the parameters essential to the current state of the function.

10. Define Queues.

A Queue is an ordered list in which all insertions take place at one end called the rear, while all deletions take place at the other end called the front. Rear is initialized to -1 and front is initialized to 0. Queue is also referred as First In First Out (FIFO) list.

11. What are the various operations performed on the Queue?

The various operations performed on the queue are

CREATE(Q) – Creates Q as an empty Queue.

Enqueue(Q,X) – Adds the element X to the Queue.

Dequeue(Q) – Deletes a element from the Queue.

ISEMTPTY(Q) – returns true if Queue is empty else false.

ISFULL(Q) - returns true if Queue is full else false.

12. **How do you test for an empty Queue?**

The condition for testing an empty queue is rear=front-1. In linked list implementation of queue the condition for an empty queue is the header node link field is NULL.

13. **Write down the function to insert an element into a queue, in which the queue is implemented as an array. (May 10)**

Q – Queue

X – element to added to the queue Q

IsFull(Q) – Checks and true if Queue Q is full

Q->Size - Number of elements in the queue Q

Q->Rear – Points to last element of the queue Q

Q->Array – array used to store queue elements

```
void enqueue (int X, Queue Q) {

        if(IsFull(Q))

          Error ("Full queue");

        else      {

              Q->Size++;

                  Q->Rear = Q->Rear+1;

                  Q->Array[ Q->Rear ]=X;

              }

        }
```

14. **Define Dequeue.**

Deque stands for Double ended queue. It is a linear list in which insertions and deletion are made from either end of the queue structure.

15. **Define Circular Queue.**

Another representation of a queue, which prevents an excessive use of memory by arranging elements/ nodes $Q_1,Q_2,…Q_n$ in a circular fashion. That is, it is the queue, which wraps around upon reaching the end of the queue\

16. **What is the use of a stack in evaluating arithmetic expressions?**

Stacks are used to evaluate postfix expressions by storing operands. When an operator is encountered, the top two operands are popped, the operation is performed, and the result is pushed back. This continues until the expression is fully evaluated.

17. Why is stack called a Last In First Out (LIFO) structure?
In a stack, the most recently added element is the first one to be removed. This behavior is referred to as Last In First Out (LIFO), as the insertion and deletion happen only at one end—called the top.

18. What is the role of a stack in infix to postfix conversion?
During conversion, a stack is used to hold operators and parentheses. It ensures that the correct order of operations and precedence rules are followed by temporarily storing and then popping operators as needed.

19. What is a priority queue?
A priority queue is a special type of queue where each element has a priority. Elements with higher priority are served before those with lower priority, regardless of their order in the queue.

20. What is the difference between a linear queue and a circular queue?
In a linear queue, once the rear reaches the end of the array, no more elements can be added even if space is available at the front. A circular queue reuses this space by connecting the rear back to the front, forming a loop.

21. List two applications of queues.
Queues are used in CPU scheduling for managing process execution order and in printer spooling to manage multiple print jobs waiting to be printed in the order they arrived.

22. What is the primary disadvantage of a simple linear queue implemented using arrays?
The major drawback is inefficient memory usage. Once the front elements are dequeued, their space cannot be reused unless the elements are shifted manually, leading to wastage.

23. What is the main benefit of using a circular queue over a linear queue?
A circular queue allows reusing the empty spaces left by dequeued elements. This improves memory utilization and avoids the need to shift elements after deletions.

24. Mention two operations specific to a DeQueue.
In a DeQueue (Double Ended Queue), insertion and deletion can be done at both ends. Operations like `InsertFront` and `DeleteRear` are examples that differentiate it from standard queues.

25. When does overflow occur in a circular queue?
Overflow in a circular queue occurs when the next position of the rear pointer equals the front pointer, meaning there is no free space left to add new elements even though the array is circular.

16 MARKS

1. Write an algorithm for Push and Pop operations on Stack using Linked list. (8)
2. Explain the linked list implementation of stack ADT in detail?

3. Define an efficient representation of two stacks in a given area of memory with n words and explain.
4. Explain linear linked implementation of Stack and Queue?
   a. Write an ADT to implement stack of size N using an array. The elements in the stack are to be integers. The operations to be supported are PUSH, POP and DISPLAY. Take into account the exceptions of stack overflow and stack underflow. (8)

b. A circular queue has a size of 5 and has 3 elements 10,20 and 40 where F=2 and R=4. After inserting 50 and 60, what is the value of F and R. Trying to insert 30 at this stage what happens? Delete 2 elements from the queue and insert 70, 80 & 90. Show the sequence of steps with necessary diagrams with the value of F & R. (8 Marks)

5. Write the algorithm for converting infix expression to postfix (polish) expression?
6. Explain in detail about priority queue ADT in detail?
7. Write a function called 'push' that takes two parameters: an integer variable and a stack into which it would push this element and returns a 1 or a 0 to show success of addition or failure.
8. What is a DeQueue? Explain its operation with example?
9. Explain the array implementation of queue ADT in detail?
10. Explain the addition and deletion operations performed on a circular queue with necessary algorithms.(8) (Nov 09)