Q. 1 A state in which a process has finished its computation and will not restart any action unless it receives a message is called as

A. Partially terminated state  
B. Locally terminated state  
C. Globally terminated state  
D. Terminating state  

**Ans:** Locally terminated state

**Explanation:** A distributed computation is globally terminated if every process is locally terminated and there is no message in transit between any processes.

“Locally terminated” state is a state in which a process has finished its computation and will not restart any action unless it receives a message.

Q. 2 In spanning-tree-based termination detection algorithm of Topor, the best case message complexity is ____________ and worst case complexity of the algorithm is ______, where N is the number of processes and M is the number of computation messages exchanged

A. O(N), O(M)  
B. O(N), O(N*M)  
C. O(N^2), O(N^2)  
D. O(M), O(N)

**Ans:** O(N), O(N*M)

**Explanation:** The best case message complexity of the algorithm is O(N), where N is the number of processes in the computation, which occurs when all nodes send all computation messages in the first round.

The worst case complexity of the algorithm is O(N*M), where M is the number of computation messages exchanged, which occurs when only computation message is exchanged every time the algorithm is executed.
Q. 3 Consider the following statements about termination detection (TD) algorithm

Statement 1: Execution of a termination detection algorithm cannot indefinitely delay the underlying computation.

Statement 2: The termination detection algorithm required addition of new communication channels between processes.

A. Statement 1 is true and statement 2 is false
B. Statement 1 is false and statement 2 is true
C. Both statements are false
D. Both statements are true

Ans: Statement 1 is true and statement 2 is false

Explanation: A termination detection (TD) algorithm must ensure the following:

1. Execution of a TD algorithm cannot indefinitely delay the underlying computation.

2. The termination detection algorithm must not require addition of new communication channels between processes.

Q. 4 Find out the correct relation between the different message ordering paradigms, where SYNC, FIFO, A and CO denote the set of all possible executions ordered by synchronous order, FIFO order, non-FIFO order and causal order respectively.

A. SYNC ⊂ FIFO ⊂ A ⊂ CO
B. SYNC ⊂ FIFO ⊂ CO ⊂ A
C. SYNC ⊂ CO ⊂ FIFO ⊂ A
D. A ⊂ FIFO ⊂ CO ⊂ SYNCH

Ans: SYNC ⊂ CO ⊂ FIFO ⊂ A

Q. 5 Consider the dijkstra's self-stabilizing token ring system.

A legitimate state must satisfy the following constraints:

1) There must be at least one privilege in the system (liveness or no deadlock).

2) Every move from a legal state must again put the system into a legal state (closure).

3) During an infinite execution, each machine should enjoy a privilege an infinite number of times (no starvation).

4) Given any two legal states, there is a series of moves that change one legal state to the other (reachability).
A. All constraints are false
B. All constraints are true
C. Constraint 1&2 are true and Constraint 3&4 are false
D. Constraint 1&2 are false and Constraint 3&4 are true

**Ans:** All constraints are true

**Explanation:** A legitimate state must satisfy the following constraints:

1. There must be at least one privilege in the system (liveness or no deadlock).
2. Every move from a legal state must again put the system into a legal state (closure).
3. During an infinite execution, each machine should enjoy a privilege an infinite number of times (no starvation).
4. Given any two legal states, there is a series of moves that change one legal state to the other (reachability).

**Q. 6** As proven by Ghosh, the minimum number of states required in a self-stabilizing ring is:

A. One state
B. Two states
C. Three states
D. Four states

**Ans:** Three states

**Explanation:** Dijkstra offered three solutions for a directed ring with n machines, 0, 1, ………, n−1, each having K states, (i) K ≥ n, (ii) K = 4, (iii) K = 3.

It was later proven by Ghosh that a minimum of three states is required in a self-stabilizing ring.

**Q. 7** Consider the following statements about three-phase distributed algorithm

Statement 1: The three-phase distributed algorithm is closely structured along the lines of Lamport’s algorithm for mutual exclusion.

Statement 2: This algorithm uses 3(n − 1) messages for n − 1 destinations.

A. Statement 1 is true and statement 2 is false
B. Statement 1 is false and statement 2 is true
C. Both statements are false
D. Both statements are true

**Ans:** Both statements are true
Explanation: The 3 phase algorithm is closely structured along the lines of Lamport’s algorithm for mutual exclusion. This algorithm uses three phases and $3(n − 1)$ messages for $n − 1$ destinations.

Q. 8 Consider the following table of Application-Level Multicast Algorithms:

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P) Communication</td>
<td>(i) Pinwheel</td>
</tr>
<tr>
<td>history-based</td>
<td></td>
</tr>
<tr>
<td>(Q) Privilege-based</td>
<td>(ii) Propagation</td>
</tr>
<tr>
<td>(R) Moving sequencer</td>
<td>(iii) RST algorithm</td>
</tr>
<tr>
<td>(S) Fixed sequencer</td>
<td>(iv) Totem</td>
</tr>
</tbody>
</table>

Match the algorithm to the correct example

A. (P): (iii), (Q): (iv), (R): (i), (S): (ii)
B. (P): (iv), (Q): (iii), (R): (ii), (S): (i)
C. (P): (i), (Q): (ii), (R): (iv), (S): (iii)
D. (P): (i), (Q): (iv), (R): (iii), (S): (ii)

Ans: (P): (iii), (Q): (iv), (R): (i), (S): (ii)

Q. 9 Consider the following properties of different multicast algorithms:

Statement 1: Privilege-based multicast algorithms provide (i) causal ordering if closed groups are assumed, and (ii) total ordering.

Statement 2: Moving sequencer algorithms, which work with open groups, provide total ordering.

Statement 3: Fixed sequencer algorithms provide total ordering.

A. Only statement 1&2 are true
B. Only statement 1&3 are true
C. All statements are false
D. All statements are true

Ans: All statements are true