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AN AUTONOMOUS INSTITUTION

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23ITB203 – PRINCIPLES OF OPERATING SYSTEMS

UNIT – 2 PROCESS MANAGEMENT

Process Synchronization - The Critical-Section problem -Synchronization hardware – Semaphores – Mutex - Classical problems of synchronization -Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.

PART A

1. **What is meant by 'starvation' in operating system?**

   Ans : A problem related to deadlock is indefinite blocking or starvation, a situation where processes wait indefinitely within a semaphore. Indefinite blocking may occur if we add and remove processes from the list associated with a semaphore in LIFO order.

2. **What is semaphore? Explain the two primitive operations of a semaphore.**

   Ans : A semaphore is a synchronization tool used in concurrent programming to manage access to shared resources. It is a lock-based mechanism designed to achieve process synchronization, built on top of basic locking techniques.

   The process of using Semaphores provides two operations:

- **wait (P):** The wait operation decrements the value of the semaphore
- **signal (V)**: The signal operation increments the value of the semaphore.

3. **Define race condition.**

   Ans : When several process access and manipulate same data concurrently, then the outcome of the execution depends on particular order in which the access takes place is called race condition. To avoid race condition, only one process at a time can manipulate the shared variable.

4. **"If there is a cycle in the resource allocation graph, it may or may not be deadlock state ". Comment on this statement.**

   Ans : The statement "If there is a cycle in the resource allocation graph, it may or may not be a deadlock state" is correct and depends on the system's resource allocation characteristics.

- If there is a single instance of each resource type, a cycle in the resource allocation graph definitely indicates a deadlock, as no process can proceed without resource release.
- If there are multiple instances of at least one resource type, a cycle does not necessarily indicate deadlock because resources may still be allocated and released dynamically, allowing some processes to proceed.

5. **Give the condition necessary for a deadlock situation to arise?**

Ans : A deadlock situation can arise if the following 4 condition hold simultaneously in a system.

- Mutual Exclusion
- Hold and Wait
- No preemption
- Circular Wait

6. **What are the requirements that a solution to the critical section problem must satisfy?**

Ans : The three requirements are

- **Mutual exclusion**
- **Progress**
- **Bounded waiting**

7. **Define: Critical section problem.**

Ans: Consider a system consists of 'n' processes. Each process has segment of code called a critical section, in which the process may be changing common variables, updating a table, writing a file.

When one process is executing in its critical section, no other process can allowed executing in its critical section.

8. **What is a semaphore?**

Ans : A semaphore 'S' is a synchronization tool which is an integer value that, apart from initialization, is accessed only through two standard atomic operations; wait and signal .Semaphores can be used to deal with the n-process critical section problem. It can be also used to solve various Synchronization problems.

9. **Define Deadlock.**

Ans : A process requests resources; if the resources are not available at that time, the process enters a wait state. Waiting processes may never again change state, because the resources they have requested are held by other waiting processes. This situation is called a deadlock.

10. **Name some classic problem of synchronization?**

Ans: The Bounded – Buffer Problem

The Reader – Writer Problem

The Dining –Philosophers Problem

11. **Define entry section and exit section.**

Ans: The critical section problem is to design a protocol that the processes can use to cooperate. Each process must request permission to enter its critical section. The section of the code implementing this request is the entry section. The critical section is followed by an exit section. The remaining code is the remainder section.

12. What is the sequence of operation by which a process utilizes a resource?

Ans: Under the normal mode of operation, a process may utilize a resource in only the following sequence:

Request: If the request cannot be granted immediately, then the requesting process must wait until it can acquire the response.

Use: The process can operate on the resource.

Release: The process releases the resource

13. What is resource-allocation graph?

Ans: Deadlocks can be described more precisely in terms of a directed graph called a system resource allocation graph. This graph consists of a set of vertices V and a set of edges E. The set of vertices V is partitioned into two different types of nodes; P the set consisting of all active processes in the system and R the set consisting of all resource types in the system.

14. Name two hardware instructions and their definitions which can be used for implementing mutual exclusion.

Ans:• TestAndSet

```
boolean TestAndSet (boolean &target)
{
 boolean rv = target;

target = true;

return rv;

}
```

• Swap

```
void Swap (boolean &a, boolean &b)

{

boolean temp = a;
a = b;
b = temp;

}
```

15. Priority inversion is a condition that occurs in real time systems – Analyzing on this statement.

Ans: Priority inversion is a problem that occurs in concurrent processes when low-priority threads hold shared resources required by some high-priority threads, causing the high priority-threads to block indefinitely. This problem is enlarged when the concurrent processes are in a real time system where high- priority threads must be served on time.

Priority inversion occurs when task interdependency exists among tasks with different priorities.

16. What are the methods for handling deadlocks?

Ans: The deadlock problem can be dealt with in one of the three ways:

a. Use a protocol to prevent or avoid deadlocks, ensuring that the system will never enter a deadlock state.

b. Allow the system to enter the deadlock state, detect it and then recover.

c. Ignore the problem all together, and pretend that deadlocks never occur in the system.

17. Define busy waiting and spinlock.

Ans: When a process is in its critical section, any other process that tries to enter its critical section must loop continuously in the entry code. This is called as busy waiting and this type of semaphore is also called a spinlock, because the process keeps on waiting for the lock.

PART – B

1. Outline a solution to solve Bounded buffer, Readers and Writers problem and Dining philosopher problem.
2. Consider the following system snapshot using data structures in the Banker's algorithm with resources A, B, C and D and process P0 to P4:

	Max	Allocation	Available	Need
	A B C D	A B C D	A B C D	A B C D
P0	6 0 1 2	4 0 0 1	3 2 1 1	
P1	1 7 5 0	1 1 0 0		
P2	2 3 5 6	1 2 5 4		
P3	1 6 5 3	0 6 3 3		
P4	1 6 5 6	0 2 1 2		

Using Banker's algorithm, answer the following questions:
(i) How many resources of type A, B, C and D are there?
(ii)What are the contents of the need matrix? (3) iii. Is the system in a safe state? Why?
iii. If a request from process P4 arrives for additional resources of (1,2,0,0) Can the banker's algorithm grant the request immediately? Show the new system state and other criteria.

3. Design how to implement wait () and signal () semaphore operations. Explain the same with suitable coding
4. Explain the deadlock prevention techniques by eliminating one or more Coffman conditions.
5. Describe two different recovery methods after a deadlock is detected and discuss their advantages and disadvantages.

6. Consider the following snapshot using data structures in the Banker's algorithm with resources A,B,C and processes P0 to P4. Using banker' algorithm answer the questions below.
(i) What are the contents of the need matrix?
(ii) Is the system in a safe state? Why?
(iii) If a request from process P4 arrives for additional resources of (1,0,2), Can the Bankers algorithm grant the request immediately? Show the new state and the other criteria.

	Max				Allocation				Need			Available		
	A	B	C		A	B	C		A	B	C	A	B	C
P0	6	0	1		4	0	0		?	?	?	3	2	1
P1	1	7	5		1	1	0							
P2	2	3	5		1	2	5							
P3	1	6	5		0	6	3							
P4	1	6	5		0	2	1							

7. Explain dining philosopher's problem.
8. Write about critical regions and monitors.
9. How can deadlock be detected? Explain.
10. State critical section problem? Discuss three solutions to solve the critical section problem.
11. Write about Deadlock Prevention Methods?
12. Discuss about the following A) Semaphore B) Monitor
13. Define process synchronization and explain Peterson solution algorithms?
14. Show how wait () and signal () semaphore operations could be implemented in multiprocessor environments using the test and set instruction. The solution should exhibit minimal busy waiting. Develop pseudo code for implementing the operations
15. Explain banker algorithm for deadlock avoidance with suitable example. (7) (ii) A system has four processes and five resources. The current allocation and maximum need are as follows

	Allocated	Maximum	Available
Process A	1 0 2 1 1	1 1 2 1 3	0 0 × 1 1
Process B	2 0 1 1 0	2 2 2 10	
Process C	1 1 0 1 0	2 1 3 1 0	
Process D	1 1 1 1 0	1 1 2 2 1	

Consider value of x as 1,2,3. What is the smallest value of x in which the above system become a safe state?

16. What do you mean by term synchronization? 'What is Semaphore? Explain how semaphore can used as synchronization tool. Consider a coke machine that has 10 slots. The producer is the delivery person and the consumer is the student using the machine- It uses the following three semaphores.

semaphore mutex semaphore fullBuffer /* Number of filled slots: */ semaphore emptyBuffer /* Number of empty slots */

(i) Write pseudo code for delivery_person() and student()

(ii)What will be the initial values of the semaphores?

(iii)Write a solution that guarantees the mutual exclusion and has no deadlocks