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## FACULTY OF ENGINEERING & TECHNOLOGY

BCA-307    Operating System

Lecturer-11

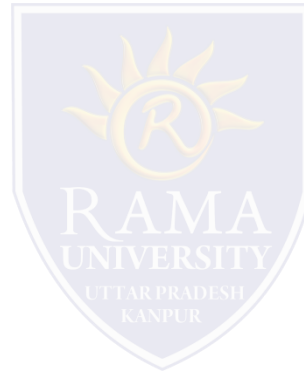
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# Synchronization

**Background**  
**Peterson's Solution**  
**Synchronization Hardware**



# Synchronization

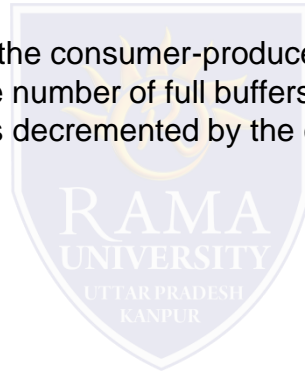
- To present the concept of process synchronization.
- To introduce the critical-section problem, whose solutions can be used to ensure the consistency of shared data
- To present both software and hardware solutions of the critical-section problem
- To examine several classical process-synchronization problems
- To explore several tools that are used to solve process synchronization problems



# Background

- Processes can execute concurrently
  - May be interrupted at any time, partially completing execution
- Concurrent access to shared data may result in data inconsistency
- Maintaining data consistency requires mechanisms to ensure the orderly execution of cooperating processes
- Illustration of the problem:

Suppose that we wanted to provide a solution to the consumer-producer problem that fills ***all*** the buffers. We can do so by having an integer **counter** that keeps track of the number of full buffers. Initially, **counter** is set to 0. It is incremented by the producer after it produces a new buffer and is decremented by the consumer after it consumes a buffer.



# Peterson's Solution

- Good algorithmic description of solving the problem

- Two process solution

Assume that the load and store machine-language instructions are atomic; that is, cannot be interrupted.

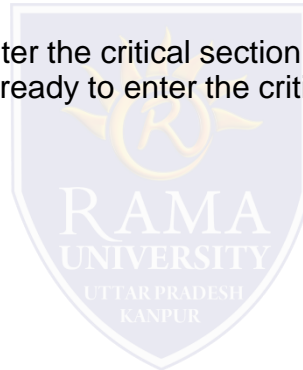
The two processes share two variables:

```
int turn;  
Boolean flag[2]
```

The variable `turn` indicates whose turn it is to enter the critical section

The flag array is used to indicate if a process is ready to enter the critical section. `flag[i] = true` implies that process  $P_i$  is ready!

```
do {  
    flag[i] = true;  
  
    turn = j;  
  
    while (flag[j] && turn == j);  
  
        critical section  
  
    flag[i] = false;  
  
        remainder section  
  
} while (true);
```



# Solution (Cont.)

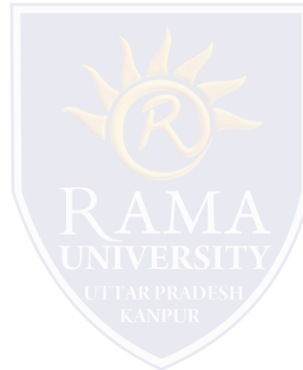
Provable that the three CS requirement are met:

1. Mutual exclusion is preserved

$P_i$  enters CS only if:

either **flag[j] = false** or **turn = i**

2. Progress requirement is satisfied
3. Bounded-waiting requirement is met



# Synchronization Hardware

Many systems provide hardware support for implementing the critical section code.

All solutions below based on idea of **locking**

Protecting critical regions via locks

Uniprocessors – could disable interrupts

Currently running code would execute without preemption

Generally too inefficient on multiprocessor systems

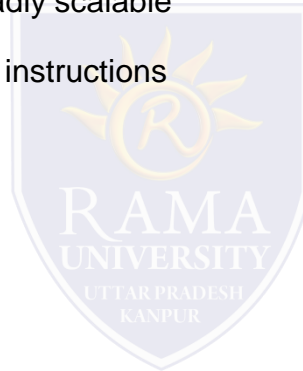
Operating systems using this not broadly scalable

Modern machines provide special atomic hardware instructions

**Atomic** = non-interruptible

Either test memory word and set value

Or swap contents of two memory words



```
do {  
    acquire lock  
    critical section  
    release lock  
    remainder section  
} while (TRUE);
```

To enforce ..... two functions are provided enter-critical and exit-critical, where each function takes as an argument the name of the resource that is the subject of competition.

- A) Mutual Exclusion
- B) Synchronization
- C) Deadlock
- D) Starvation

In ..... only one process at a time is allowed into its critical section, among all processes that have critical sections for the same resource.

- A) Mutual Exclusion
- B) Synchronization
- C) Deadlock
- D) Starvation





Which of the following is/are the disadvantages of machine instruction approach to enforce mutual exclusion.

i) Busy waiting employees ii) hard to verify iii) starvation is possible iv) Deadlock is possible

- A) i, ii and iii only
- B) ii, iii and iv only
- C) i, iii and iv only
- D) All i, ii, iii and iv

..... techniques can be use to resolve conflicts, such as competition for resources, and synchronize processes so that they can co-operate.

- A) Mutual Exclusion
- B) Synchronization
- C) Deadlock
- D) Starvation

