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1. Construct a C program to simulate producer-consumer problem using semaphores.

# AIM:

To construct a C program to simulate the Producer-Consumer problem using semaphores, ensuring synchronization between the producer and consumer processes while preventing race conditions and buffer overflows or underflows.

# ALGORITHM:

* 1. **Initialization:**
     + Define a shared buffer with a fixed size.
     + Initialize three semaphores:
       - empty: Counts the number of available slots in the buffer (initially equal to the buffer size).
       - full: Counts the number of filled slots in the buffer (initially zero).
       - mutex: Ensures mutual exclusion for buffer access (initialized to 1).

# Producer Process:

* + - Repeatedly execute the following steps:

1. Wait (sem\_wait) on the empty semaphore to ensure a free slot is available.
2. Wait (sem\_wait) on the mutex semaphore to gain exclusive access to the buffer.
3. Produce an item and place it in the buffer.
4. Signal (sem\_post) the mutex semaphore to release the buffer.
5. Signal (sem\_post) the full semaphore to indicate a filled slot.

# 3. Consumer Process:

o Repeatedly execute the following steps:

1. Wait (sem\_wait) on the full semaphore to ensure a filled slot is available.
2. Wait (sem\_wait) on the mutex semaphore to gain exclusive access to the buffer.
3. Remove an item from the buffer for consumption.
4. Signal (sem\_post) the mutex semaphore to release the buffer.
5. Signal (sem\_post) the empty semaphore to indicate a free slot.

# Concurrent Execution:

* + - Create separate threads for the producer and consumer processes.
    - Ensure both threads run concurrently and modify the shared buffer as per their respective logic.

# Termination:

* + - Stop the producer and consumer threads after a predefined number of operations or based on user input.
    - Destroy all semaphores to release system resources.

# PROCEDURE:

1. **Start:**

Initialize necessary variables, shared buffer, and semaphores.

# Define Semaphores:

* + Create a semaphore empty initialized to the buffer size to track available slots.
  + Create a semaphore full initialized to 0 to track filled slots.
  + Create a semaphore mutex initialized to 1 to enforce mutual exclusion.

# Define Shared Buffer:

* + Set up a circular buffer with a fixed size.
  + Use in and out pointers to manage the producer and consumer operations.

# Create Producer Thread:

* + In the producer thread:
    - Wait on empty and mutex semaphores.
    - Produce an item and insert it into the buffer at the in index.
    - Update the in index to the next position in a circular manner.
    - Signal the mutex and full semaphores to indicate a successful operation.

# Create Consumer Thread:

* + In the consumer thread:
    - Wait on full and mutex semaphores.
    - Consume an item from the buffer at the out index.
    - Update the out index to the next position in a circular manner.
    - Signal the mutex and empty semaphores to indicate a successful operation.

# Run Threads Concurrently:

* + Execute both producer and consumer threads concurrently using pthread\_create.

# Synchronization:

* + Ensure that both threads operate in sync by using semaphores to handle mutual exclusion and resource tracking.

# Stop and Cleanup:

* + Terminate the threads after a fixed number of operations.
  + Destroy the semaphores to release resources.

# End:

Stop the program after all operations are completed.

CODE:

#include <stdio.h> #include <stdlib.h> #include <pthread.h> #include <semaphore.h> #ifdef \_WIN32

#include <windows.h> // For Sleep on Windows #else

#include <unistd.h> // For sleep on Unix-like systems #endif

#define BUFFER\_SIZE 5

int buffer[BUFFER\_SIZE]; int in = 0, out = 0;

sem\_t empty, full, mutex;

void \*producer(void \*param) { int item;

while (1) {

item = rand() % 100; sem\_wait(&empty); sem\_wait(&mutex);

buffer[in] = item;

in = (in + 1) % BUFFER\_SIZE;

printf("Produced: %d\n", item);

sem\_post(&mutex); sem\_post(&full);

#ifdef \_WIN32

Sleep(1000); // Sleep for 1 second on Windows #else

sleep(1); // Sleep for 1 second on Unix-like systems #endif

}

}

void \*consumer(void \*param) { int item;

while (1) { sem\_wait(&full); sem\_wait(&mutex);

item = buffer[out];

out = (out + 1) % BUFFER\_SIZE;

printf("Consumed: %d\n", item);

sem\_post(&mutex); sem\_post(&empty);

#ifdef \_WIN32

Sleep(1000); // Sleep for 1 second on Windows #else

sleep(1); // Sleep for 1 second on Unix-like systems #endif

}

}

int main() {

pthread\_t prod, cons;

sem\_init(&empty, 0, BUFFER\_SIZE);

sem\_init(&full, 0, 0);

sem\_init(&mutex, 0, 1);

pthread\_create(&prod, NULL, producer, NULL); pthread\_create(&cons, NULL, consumer, NULL);

pthread\_join(prod, NULL); pthread\_join(cons, NULL);

sem\_destroy(&empty); sem\_destroy(&full); sem\_destroy(&mutex);

return 0;

}

OUTPUT:

