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

Program:

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>
#include <semaphore.h>

#define BUFFER_SIZE 5

int buffer[BUFFER_SIZE];
int in = 0, out = 0;
sem_t empty, full;
pthread_mutex_t mutex;

void* producer(void* arg) {
   int item;
   for (int i = 0; i < 10; i++) {  // Produce 10 items
      item = rand() % 100;  // Random item
      sem_wait(&empty);     // Wait if buffer is full
      pthread_mutex_lock(&mutex);

      buffer[in] = item;    // Add item to buffer
      printf("Producer produced: %d\n", item);
      in = (in + 1) % BUFFER_SIZE;

      pthread_mutex_unlock(&mutex);
      sem_post(&full);      // Signal that buffer is not empty
   }
   return NULL;
}

void* consumer(void* arg) {
   int item;
   for (int i = 0; i < 10; i++) {  // Consume 10 items
      sem_wait(&full);      // Wait if buffer is empty
      pthread_mutex_lock(&mutex);

      item = buffer[out];   // Remove item from buffer
      printf("Consumer consumed: %d\n", item);
      out = (out + 1) % BUFFER_SIZE;

      pthread_mutex_unlock(&mutex);
```

```
        sem_post(&empty);     // Signal that buffer has space
    }
    return NULL;
}

int main() {
    pthread_t prod, cons;

    sem_init(&empty, 0, BUFFER_SIZE);  // Initialize semaphore for
empty slots
    sem_init(&full, 0, 0);            // Initialize semaphore for full slots
    pthread_mutex_init(&mutex, NULL); // Initialize mutex

    pthread_create(&prod, NULL, producer, NULL); // Create
producer thread
    pthread_create(&cons, NULL, consumer, NULL); // Create
consumer thread

    pthread_join(prod, NULL); // Wait for producer to finish
    pthread_join(cons, NULL); // Wait for consumer to finish

    sem_destroy(&empty);
    sem_destroy(&full);
    pthread_mutex_destroy(&mutex);

    return 0;
}
```

Output:

```
Producer produced: 41
Producer produced: 67
Producer produced: 34
Producer produced: 0
Producer produced: 69
Consumer consumed: 41
Consumer consumed: 67
Consumer consumed: 34
Consumer consumed: 0
Consumer consumed: 69
Producer produced: 24
Producer produced: 78
Producer produced: 58
Producer produced: 62
Producer produced: 64
Consumer consumed: 24
Consumer consumed: 78
Consumer consumed: 58
Consumer consumed: 62
Consumer consumed: 64
```