Homework 4

Question 28: [illegible] the lyrics for me.

Before Starting Homework

- Do not upload to generative AI.
- Complete the Programming Assignment before beginning the written portion of the homework.
- Answer all questions below.
- **Type** answers and upload to Canvas in PDF format.

Question 1 : Producer-Consumer Example

Assume that I run your conditional wait producer/consumer methods. I create two producer threads and two consumer threads, as shown in the following Listing. Assume that a buffer `buf` was created before the Listing code snippet. The buffer can hold only a single value at a time.

Listing 1: Producer Consumer Example

```
pthread_t producer1, producer2;
pthread_t consumer1, consumer2;
data_t data1, data2;
data1.buf = buf; data1.val = 1;
data2.buf = buf; data2.val = 2;

// Create two producers and two consumers
pthread_create(&producer1, NULL, producer_thread, &data1);
pthread_create(&producer2, NULL, producer_thread, &data2);
pthread_create(&consumer1, NULL, consumer_thread, buf);
pthread_create(&consumer2, NULL, consumer_thread, buf);

// Wait for consumers and producers
int *val1, *val2;
pthread_join(producer1, NULL);
pthread_join(producer2, NULL);
pthread_join(consumer1, &val1);
pthread_join(consumer2, &val2);
```

The producer and consumer threads can be scheduled on your CPU cores in any order. Answer the following questions.

1. What are the possible values returned into `*val1` and `*val2`?
2. Describe an ordering in which the given threads are scheduled that results in both consumers sleeping at the same time.
3. Describe an ordering in which the given threads are scheduled that could result in one producer calling `put` while the other producer is sleeping.
4. In the previous example, after adding to the buffer your producer will signal for a sleeping thread to wake up. How do you guarantee that this signal will only wake up a sleeping consumer rather than the sleeping producer?
5. Your code should have `while` loops around the conditional waits. If they were instead `if` statements, the code could break. Describe a scenario where, assuming you instead used `if` statements, one of your consumers would return an incorrect value.