Computer Operating Systems

**Problem #1**

Define page-based memory allocation. Differentiate logical and physical memory address. Explain transition look-aside buffer (TLB) and how it is used for memory access. Differentiate TLB hit from TLB miss.

**Problem #2**

Describe a process control block (PCB) and how it is used. List typical contents of a PCB. Describe what process queue is and how PCBs are related to process queues. Differentiate device (I/O) queue and ready queue. Explain how both types of queues are used by the process scheduler.

**Problem #3**

Describe the need for synchronization in OS design. Define semaphores and two operations that are available on each semaphore. Define the bounded buffer (producer-consumer) problem. Given the following code for producer:

```plaintext
while (true) {
    // produce item for the buffer
    wait(empty);
    wait(mutex)
    // add item to the buffer
    signal(mutex)
    signal(full);
}
```

Reconstruct the data structures (semaphores and their initialization) and the code for consumer. Explain the operation of your code.