

Part 1: True False (Answer + Explain)

1. If there is very high CPU utilization, then it is likely that *thrashing* is occurring.

False, thrashing is when the CPU is underutilized, but pages are being swapped out of memory aggressively.

2. If a particular IO device implements a *blocking interface*, then you will need multiple threads to have concurrent operations which use that device.

True, only with non-blocking IO can you have concurrency without multiple threads.

3. Reading 100Mb in random 1kb chunks will take slightly longer than reading 100Mb in a single sequential scan.

False (ish) - it will take WAY longer, random access on disks is much, much slower than sequential access due to seek time.

4. For IO devices which receive new data very frequently, it is more efficient to interrupt the CPU than to have the CPU poll the device.

False, it is more efficient to poll, since the CPU will get overwhelmed with interrupts.

5. Nachos is an easy-to-understand, fun way to learn about Operating Systems - or - I am really going to miss Nachos when we finish the second assignment.

False - several answers were accepted.

Short answer:

6. Disk requests come into the disk driver for cylinders: 10, 22, 20, 2, 40, 6, and 38, in that order. The disk head is currently positioned over cylinder 20. A seek takes 6 milliseconds per cylinder moved. What is the sequence of reads and total seek time using each of the following algorithms?

i) First-come, first-served:

10, 22, 20, 2, 40, 6, 38

$10 + 12 + 2 + 18 + 38 + 34 + 32 = 146 \text{ cylinders} = 876 \text{ milliseconds.}$

ii) Shortest Seek Time First:

20, 22, 10, 6, 2, 38, 40

$0 + 2 + 12 + 4 + 4 + 36 + 2 = 60 \text{ cylinders} = 360 \text{ milliseconds.}$

iii) SCAN (initially moving upwards):

20, 22, 38, 40, 10, 6, 2

$0 + 2 + 16 + 2 + 30 + 4 + 4 = 58$ cylinders = 348 milliseconds.

7. Two-level Page Tables:

i) Give a two to three sentence description of a two-level page table.

Split the virtual address into an offset and two page table indices instead of just one. The first page table's result points to a second page table. The second page table's result points to the actual location of the data in physical memory.

ii) Briefly (2 sentences) state one advantage AND one disadvantage of two-level page tables.

+ *Better for sparse address spaces, easier memory sharing between processes, easier memory allocation*

- *2 lookups per reference, use 1 extra page table of memory in worst case*

8. What is Belady's anomaly and which page replacement algorithm(s) could display it?

Belady's anomaly refers to having more page faults when increasing the amount of memory a system has. FIFO is subject to this, as contents of memory with X pages is not a subset of contents with X+1 pages.

9. What is priority donation? What sort of information must the OS track to allow it to perform priority donation?

Priority donation is the process of avoiding priority inversion by giving ("donating") priority from a high-priority blocked thread to a lower-priority thread holding a lock needed by the high-priority thread. The OS must keep track of lock acquisition and release operations and associate them with threads in order to perform this optimization.

10. We looked at disabling CPU interrupts as a simple way to create a critical section in the kernel. Name two drawbacks of this approach. One of them should be a problem that is exacerbated by trends in modern computer hardware.

One issue is that you can't receive interrupts from devices or timers within a critical section, which may be desired. For instance, what if you accidentally have an infinite loop in the kernel critical section? A second issue is that it is difficult to disable interrupts on multiple cores.