| Question | 1 | 2 | 3 | 4 | Sum |
|---|---|---|---|---|---|
| Score | | | | | |

## 1. Choice（20%）fill in the blank with one most suitable answer

(1) Among the following memory management techniques, which one will result in external fragmentation ____B____ ?

A. Fixed Partitioning
B. Dynamic Partitioning
C. Paging
D. Combined Paging and Segmentation

(2) When we talk about Belady's anomaly problem, which is TRUE ____B____

A. LRU suffers from Belady's anomaly
B. Page fault rate might increase when more frames are allocated
C. Belady anomaly is a common phenomenon for all page replacement algorithms
D. It is impossible to remedy Belady's anomaly since we can not know the future page references.

(3) The working set for a process at time t, W(D, t), is the set of pages that have been referenced in the last D virtual time units. In this sense, we can NOT conclude that ____C____

A. W(D, t) is an approximation of the process locality
B. W(D, t) grows when the process enters a new locality
C. W(D, t) increases with t, given a fixed D.
D. W(D, t) usually decreases after a certain time spent in the locality.

(4) To manage memory, which dynamic partitioning replacement algorithm usually performs worst? A

A. Best-fit algorithm
B. First-fit algorithm
C. Next-fit algorithm
D. Worst-fit algorithm

(5) In paged virtual memory, consider a logical address space of 8 pages of 1024 bytes each, mapped onto a physical memory of 32 frames. How many bits are there in the logical address and in the physical address separately?____D____

A. 10 and 5
B. 10 and 15
C. 13 and 5
D. 13 and 15

(6) Which one of the following statements is NOT true? ____A____

A. The translation from logical address to physical address is normally implemented by software

B. Translation look-aside buffer (TLB) can be used to speed up the translation from logical address to physical address

C. By using inverted page table, there is only one page table system-wide

D. With multi-level page table, part of page table may reside on secondary storage

(7) Which disk scheduling algorithm can always achieve the best performance in all situations? D

A. SCAN algorithm

B. C-SCAN algorithm

C. Shortest Seek Time First algorithm

D. None of the above

(8) Which is NOT considered as advantages of contiguous allocation for file blocks? C

A. Fast sequential access

B. Only a single entry in the file allocation table (block # and number of blocks) is maintained

C. File can grow easily if it needs

D. Fast direct (random) access

(9) Suppose that the disk block size is 4K bytes, and disk address is 32-bit. The inode of a file requires 10 direct entries and one indirect block. What is the maximal number of blocks this file can take? D

A. 138

B. 520

C. 1024

D. 1034

(32bits=4 bytes, 4K/4+10)

## 2. Short Answer（31%）

(1) Explain the difference between logical and physical addresses in memory management. (6%)

**Answer:** Logical addresses are addresses within the process's view of memory, i.e. offets from the beginning of the memory accessible by that process.

Physical addresses are the addresses within the physical memory of the machine, i.e. offsets from the start of physical memory.

(2) List at least one advantage and one disadvantage of using a large block size to store file data. (4%)

**Answer:** Advantage: fewer blocks must be read for a given file, which, in cases of non-contiguous allocation of files, means a reduction of seek and rotational delays on average.
Advantage: page tables are smaller.
Disadvantage: leads to more space lost to internal fragmentation.

(3) In a virtual memory system, does a TLB miss imply a disk operation will follow? Why or why not? (5%)

**Answer:** A TLB miss implies that the full page table must be accessed (which is most likely stored in memory). We must have a miss of the page table (more specifically, a page fault) in order to require a disk operation.

(4) Some people suggest that the bitmap for file allocation be kept on disk, rather than in main memory. Please comment this idea. (5%)

**Answer:** In case of system crash (memory failure) the free-space list would not be lost as it would be if the bit map had been stored in main memory.

(5) How do caches help improving performance? Why do systems not use more or larger caches if they are so useful? (5%)

**Answer:** Caches allow components of differing speeds to communicate more efficiently by storing data from the slower device, temporarily, in a faster device (the cache). Caches are, almost by definition, more expensive than the device they are caching for, so increasing the number or size of caches would increase system cost.

(6) Under what circumstances do page faults occur? Describe the actions taken by the operating system when a page fault occurs. (6%)

**Answer:** A page fault occurs when an access to a page that has not been brought into main memory takes place [2 points]. The operating system verifies the memory access, aborting the program if it is invalid. If it is valid, a free frame or an occupied frame to be replaced is located and I/O is requested to read the needed page into the free frame. Upon completion of I/O, the process table and page table is updated and the instruction is restarted. [4points]

## 3. Calculation（29%）

(1) Suppose that a newly-created process consists of 4 pages: A, B, C, and D. This process has 3 page frames allocated to it, and then generates the following page reference sequences:

A B C B A D A B C D A B A C B D

Taking the pure demand-paging and local replacement scope, how many page faults would occur with the following page replacement policies? For each policy, please CIRCLE the references that would generate a page fault. [9 points]

**NOTE**: when there are empty frames, please COUNT each page's first unique page fault.

(a) FIFO (First In First Out) page replacement

(b) OPT (Optimal) page replacement

(c) LRU (Least Recently Used) page replacement

Answer:

(a) A B C B A D A B C D A B A C B D 12 page faults
(b) A B C B A D A B C D A B A C B D 7 page faults
(c) A B C B A D A B C D A B A C B D 10 page faults

（装订线内不要答题）

(2) Consider a file currently consisting of 100 blocks. Assume that the file control block (and the index block, in the case of indexed allocation) is already in memory. Calculate how many disk I/O operations are required for contiguous, chained, and indexed (single-level) allocation strategies, if, for one block, the following conditions hold. In the contiguous-allocation case, assume that there is no room to grow in the beginning, but there is room to grow in the end. Assume that the block information to be added is stored in memory. (12%)

a. The block is added at the beginning.
b. The block is added in the middle.
c. The block is added at the end.
d. The block is removed from the beginning.

e. The block is removed from the middle.
f. The block is removed from the end.

**Answer:**

| | Contiguous | Linked | Indexed |
|---|---|---|---|
| a. | 201 | 1 | 1 |
| b. | 101 | 52 | 1 |
| c. | 1 | 3 | 1 |
| d. | 198 | 1 | 0 |
| e. | 98 | 52 | 0 |
| f. | 0 | 100 | 0 |

(3) Suppose a disk drive has 2000 tracks numbered 0 to 1999. The disk is currently serving a request at the track 150 and the previous request was at the track 135. The queue of the pending requests (in FIFO order) are:

85, 1970, 40, 1320, 515, 1500, 1100, 1900

Write out the sequence of disk head positions in terms of track numbers in order to satisfy all the pending requests starting from the current head position, for each of the following disk scheduling algorithms? (8%)

(I) FCFS (II) SSTF (III) SCAN (IV) C-SCAN

**Answer:**

FCFS: 85→1970→40→1320→515→1500→1100→1900
SSTF: 85→40→515→1100→1320→1500→1900→1970
SCAN: 515→1100→1320→1500→1900→1970→85→40
C-SCAN: 515→1100→1320→1500→1900→1970→40→85

## 4. Analysis（20%）

(1) Consider a demand-paged computer system where the degree of multiprogramming is currently fixed at four. The system was recently measured to determine utilization of CPU and the paging disk. The results are one of the following alternatives. For each case, Can the degree of multiprogramming be increased to increase the CPU utilization? Why? (6%)
a. CPU utilization 10 percent; disk utilization 98 percent
b. CPU utilization 15 percent; disk utilization 3 percent

**Answer:**
a. Thrashing is occurring. The degree of multiprogramming can not increase the CPU utilization
b. Increase the degree of multiprogramming can increase CPU utilization.

(2) How would use of a RAM disk affect your selection of a disk-scheduling algorithm? What factors would you need to consider? Do the same considerations apply to hard-disk scheduling, given that the file system stores recently used blocks in a buffer cache in main memory? (5%)

**Answer:** Disk scheduling attempts to reduce the overhead time of disk head positioning. Since a RAM disk has uniform access times, scheduling is largely unnecessary. The comparison between RAM disk and the main memory disk-cache has no implications for hard-disk scheduling because we schedule only the buffer cache misses, not the requests that find their data in main memory.

(3) Please list one main problem in the implementations of FIFO in page replacement? What is the main motivation of using Reference-Bit in Clock algorithm? Please briefly summarize the Clock Algorithm. (9%)

**Answer:**

FIFO may throw out heavily used pages. (2 points)

Reference bit takes into account of historical usages. (2 points)

Basic Data Structure: Circular FIFO Queue with reference bit. (1 points)

Basic Mechanism: (4 points)

(1) When a page is first loaded in memory, the use bit is set to 1

(2) When the page is referenced, the use bit is set to 1

(3) When a page is selected

a) Take it as a victim if its reference bit = 0, ( it is replaced immediately)

· b) Otherwise, clear the bit and advance to the next page