COMPUTING SCIENCE DEPARTMENT
CMPUT 379: Operating System Concepts

Wednesday, 19 April 2000

C379 Section B2 Final
Closed book examination:
Two hours (1400-1600)

Note:
There are 6 questions, worth a total of 75 marks.
Closed book examination
Use of simple calculators is permitted.

Concise, clear answers are expected.

Student ID:

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Marks:

Q1	Q2	Q3	Q4	Q5	Q6	Total
10	10	15	15	10	15	75

1 [10 Marks]
Consider the following page reference string:

6, 3, 2, 1, 2, 1, 2, 3, 6, 7, 3, 2, 1, 2, 6, 5, 1, 2, 4, 3, 2, 1

Fill the following table with the number of page faults that would occur for the given number of page frames (2, 3 and 5) and for the given page replacement algorithm--least recently used (LRU), and first-in-first-out (FIFO).

Assume that all frames are initially empty, so your first unique pages will all cost one fault each. Show how you obtain your answers.

Number of Frames	Number of Page Faults	
	LRU	FIFO
2		
3		
5		

2 [10 marks].

a. Define the terms internal fragmentation and external fragmentation (as they apply to primary memory of processes) in a clear unambiguous way.
b. In about 30 words describe a virtual memory system that strives for low internal fragmentation
c. In about 30 words describe a virtual memory system that strives for low external fragmentation.

3 [15 marks]

A barber's shop has N chairs. When there are no customers, the barber sleeps in the shop. Arriving customers sit in the next empty chair, being careful to first wake the sleeping barber (if necessary).

a. Write pseudo code for the BARBER and CUSTOMER processes that co-ordinate the activities of the customers and the barber. Use WAIT/FREE primitives for operations on counting semaphores and P/V primitives for binary semaphores, but specify them in enough detail to show you understand their important role.
b. Show clearly how you handle the case of no chair for an arriving customer.
c. Carefully define the types of all variables used, and give their initial values.
d. Show by code walk-through (hand simulation) that your program works for the case N = 1. Start and end with the barber sleeping.

4 [15 marks]. Suppose we have a file system with a block size of 256 bytes and pointers of size 4 bytes. If a linked indexed (the index blocks are linked together) file allocation scheme is used:

a. What is the maximum file size? Explain your answer.
b. In order to read block number 68 of a file, how many blocks must be accessed? Explain your answer. Make (and state) reasonable assumptions about what is in main memory.
c. If a file is of size 1 Mbyte (10^6 bytes) how much external, internal and table (i.e., index block) fragmentation is there? Explain your answer.
d. Re-answer part (a) for the case of a 2-level indexed allocation scheme.

Re-answer part (a) for the case of a combined scheme (like Unix) where the top-level index block has 4 indirect pointers, 2 double indirect pointers and the rest of the space is used for direct (to blocks) pointers.

5 [10 marks]

Consider the problem of page replacement in a virtual memory system.

a. What is thrashing?

b. A research group contributes most of money for a new computer system. They insist that the performance of their processes not be affected by the page faults of processes belonging to other users

In terms of page replacement, what can be changed in an OS to satisfy the research group's need?

c. Assume that the clock algorithm is used for selecting the page/frame to replace. Give two possible explanations for the following observation: The clock hand moves quickly, then it moves slowly, then it moves quickly again (and this alternating pattern repeats). Justify your answers.

6 [15 marks]. Consider the following small file system. It is stored on a disk consisting of 1 platter (1 side only) with 10 tracks (labelled 0 to 9) each holding 5 blocks (labelled 0 to 4). The block size is 1024 bytes and blocks are numbered from 0 to 49. Assume that all the (non-data) file system overhead, such as the device directory and allocation information, is stored in the first two blocks. There are currently 5 files (F1, F2, F3, F4, F5) in this system. A sixth file, F6, that requires 6000 bytes of storage is about to be created.

a. Define internal and external fragmentation as it pertains to file systems.

In this system file storage is based on contiguous allocation. The device directory is given below. Allocation is done based on a first fit allocation scheme and the free blocks list is given by a counting mechanism as shown below:

free list -> (2,2) -> (9,4) -> (20,4) -> (30,4) -> (38,3) -> (48,2)

Disk Directory:

File_Name	Pointer_to_Block	Length (in blocks)
F1	ptr to 41	7
F2	ptr to 13	7
F3	ptr to 4	5
F4	ptr to 34	4
F5	ptr to 24	6

b. Describe where the external and internal fragmentation exists in this scenario.

c. How many disk accesses would be needed to obtain the third block of file F2? State and justify your assumptions.

d. What will happen when File F6 requests allocation of space from the file system?

e. Suppose that the processes operating on the files in this file system request the following operations:

read byte 4000 of file F2, read byte 6000 of file F1,
write byte 3000 of file F2, and read byte 2000 of file F4.

If the read/write head of the disk is currently above track 4 and the Shortest Seek Time First (SSTF) disk scheduling algorithm is used, give the order of service for the requests and the track coverage (number of tracks passed over) for the contiguous allocation scheme described above.