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S U EXAM

COMPUTING SCIENCE DEPARTMENT
CMPUT 379: Operating System Concepts

Friday, 20 April 2001

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

Note:

There are 7 questions, worth a total of 90 marks.

Closed book examination

Use of a basic calculator is permitted.

Concise, clear answers are expected.

Student ID:

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Marks:

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total
15	10	15	10	15	15	10	90



1 [2 + 8 + 5 = 15 marks].

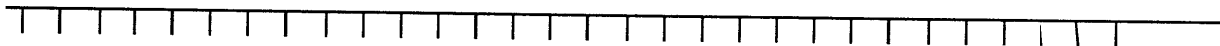
A feature of many real-time systems is that they run a set of cyclic tasks. In the table below there are three tasks. Task T_i is released R_i seconds after task T_1 , and restarts every F_i seconds thereafter. During its execution-window, task T_i must receive A_i seconds of CPU activity before its deadline (i.e., the starting time of the next occurrence of the same task).

(a). In the respective columns of the table below, fill in the priorities of these 3 tasks according to the two strategies: RMS (most frequent first) and U (largest utilization, A_i/F_i , first).

Task i	Release R_i	Frequency F_i	Activity A_i	RMS Priority	U Priority
T1	0	10	4		
T2	4	7	1		
T3	6	12	3		

(b). Complete the table below showing the release time, deadline time, start time and completion time for the first three initiations of each task, according to a priority pre-emptive scheduler employing your U priority strategy of part (a). Are all the deadlines met?

Task i	R_{i1}	D_{i1}	S_{i1}	C_{i1}	R_{i2}	D_{i2}	S_{i2}	C_{i2}	R_{i3}	D_{i3}	S_{i3}	C_{i3}
T1												
T2												
T3												



(c) Is the system RMS schedulable on theoretical grounds (hint use the RMS schedulability condition, below, and the data $2^{(1/2)} = 1.4142$, $2^{(1/3)} = 1.2599$, $2^{(1/4)} = 1.1892$ etc.)? Is there a valid RMS schedule?

$$\sum_{i=1}^k (A_i/F_i) < U(k) = k \times (2^{1/k} - 1)$$

3 [15 marks].

Suppose we have a file system with a block size of 128 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 (one root block).
- e. 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.

4 [10 marks].

- a. What are the advantages and disadvantages of a memory management system using multi-level page tables?

Suppose we have the following form for a virtual address in a two-level page table:

P1	P2	offset
3 bits	5 bits	10 bits

- b. What is the page size?
- c. What is the maximum size of the logical address space for a program in this system?
- d. How much table space will be required for this scheme, given that a page table entry requires 3 bytes of storage?
- e. State briefly the advantages and disadvantages of having a large page size versus having a small page size in a demand paging system.

5 [7 + 7+ 1 = 15 marks].

A binary semaphore has only two integer values, 0 and 1.

(a) Show how a general (counting) semaphore can be implemented using binary semaphores.

That is, present pseudo code for your binary P and V operators and for the general-purpose Wait and Free functions.

(b) Clearly identify the variables (including semaphores) you use by

- * providing an appropriate declaration for each
- * specifying their initial value
- * stating what they are used for

(c) What is the legal range of values for your counting semaphore?

6 [10 marks].

Consider the following page reference string:

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

Fill in the following table with the number of page faults that would occur for a given number of page frames (1, 2, 3, and 5) and for a given page replacement algorithm. Briefly define the LRU and FIFO replacement methods in the context of this question. Also state the optimal replacement strategy.

Assume that all frames are initially empty, so your first unique pages will all cost one fault each. By some clear means show details of your work for at least the 3 and 5-frame LRU systems.

Number of Frames	Number of page faults		
	LRU	FIFO	OPT
2	xxxxxxxx		xxxxxxxx
3			
5			

7 [10 marks].

What is the impact of the size of the I/O buffers on the frequency with which the CPU scheduler is invoked? Choose (and circle) the best answer from the following 4 possible answers. Explain your choice.

1. large I/O buffers tend to reduce the frequency with which the CPU scheduler is invoked
2. large I/O buffers tend to increase the frequency with which the CPU scheduler is invoked
3. I/O buffers have nothing to do with the CPU scheduler
4. the relationship between I/O buffer size and the CPU scheduler is complicated and difficult to predict