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UNIVERSITY OF SWAZILAND

Faculty of Science

Department of Computer Science

Supplementary Examination, July 2011

Title of paper: **OPERATING SYSTEMS**

Course numbers: **CS442**

Time allowed: 3 hours

Instructions: Answer any 5 out of the 6 questions. Each question carries 20 marks.

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Question 1

(a) Explain why it is essential for operating systems to provide memory abstraction. [4]

(b) Draw a diagram of the components of the memory management unit (MMU) in a pure paging memory system, using labelled arrows to indicate the flow of data. In addition, describe the sequence of steps carried out by the MMU in address translation. [7]

(d) A paging memory system with pages of size 4 KB uses 16-bit virtual addresses.
(i) How many entries should be in the page table? [1]
(ii) Suppose that pages 0, 1 and 2 have page table entries of 2, 10, and 0, respectively. Assuming that all 3 of these pages are present in main memory, calculate the physical addresses corresponding to virtual addresses 0x09F0 and 0x170A. [4]

(e) (i) A paged-segmented memory system has 2 KB page size and 32 KB virtual address space. Determine whether a program with 3 segments – 9 KB text, 3 KB stack and 20 KB data – would fit into the address space. [2]
(ii) Repeat question (i) assuming 1 KB page size. [2]

Question 2

(a) Explain the problem of fragmentation that affects segmented memory systems. How does it arise, and what difficulty does it cause? In addition, explain how it may be overcome. [7]

(b) Describe the sequence of steps required for address translation in paged-segmented memory systems. [5]

(c) A small computer has 4 page frames and 8 pages of virtual address space. There are no pages in memory initially, and subsequently the following sequence of page accesses occurs:

2, 1, 2, 3, 7, 0, 2, 1, 5, 2, 4, 6

(i) What are the contents of main memory at the end of each access, assuming LRU page replacement policy? [4]
(ii) Repeat question (i) assuming FIFO page replacement. [4]

Question 3

(a) Draw a state transition diagram of the process model. In addition, describe each state and transition shown. [7]

(b) Distinguish between I/O bound and CPU bound processes. Which kind is more common in interactive systems? [2]

(c) Describe the following scheduling algorithms: *multiple queues* and *lottery scheduling*. [8]

(e) A priority-scheduling kernel uses 2 levels of priority. Assume that the ready queue consists of 1 high priority process and 1 low priority process, and that each process needs 3 quanta of running time. How much time is left until the high priority process terminates? [1]

(f) A shortest-process-next scheduler uses an ageing coefficient (a) of 1/2. The first 4 run times of a program are 32, 24, 16 and 48 milliseconds, respectively. Calculate the predicted duration of the 5th run. [2]

Question 4

(a) Define *critical region* and *mutual exclusion*. [2]

(b) (i) Define the operations on semaphores. [5]

(ii) A semaphore is shared by processes P1, P2 and P3. The semaphore is initialized to 1 and undergoes the following sequence of 8 operations:

P1 down, P1 down, P2 up, P3 down, P1 down, P2 up, P2 down, P3 up

Give the semaphore's value and draw the queue of blocked processes at the end of each operation. [4]

(iii) Explain why it is impossible for the 3rd operation in question (ii) to be: P1 up. [1]

(c) Describe the purpose of the following calls in the Posix threads package: *create, exit, join* and *yield*. [8]

Question 5

(a) Describe the following 2 alternatives for keeping track of free disk blocks: *linked list* and *bitmap*. In addition, explain the main advantage of each structure. [9]

(b) Describe the purpose of the following system calls related to directories: Create, Readdir, Link, Unlink and Closedir. [5]

(c) (i) Draw a labelled diagram of the structure of large files in Unix, including single-, double- and triple-indirect blocks. [3]

(ii) Work out the maximum size of a file in Unix, assuming 4 KB disk blocks. [3]

Question 6

(a) Define the following terms:

(i) Character device.

(ii) Block device.

(iii) A disk partition.

(iii) Master boot record. [4]

(b) I/O software can be organized into 4 layers that are situated above the hardware layer. Draw a diagram of this layered structure and describe the purpose of each layer of I/O software. [6]

(c) A disk receives the following sequence of requests:

16, 14, 8, 30, 6, 25, 7

Assuming that the head is initially over cylinder 15, and that seek time is 4 msec per cylinder moved, calculate the total seek time under each of the following disk scheduling policies:

(i) First come, first served.

(ii) Shortest seek time first.

(iii) Elevator, with head moving outward initially.

In addition, for each case, list the order in which requests are answered. [10]

***** END OF QUESTION PAPER *****