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UNIVERSITY OF SWAZILAND

Faculty of Science

Department of Computer Science

Main Examination, November-December 2010

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) Describe the main steps in address translation carried out by pure paging memory systems. [4]

(c) Describe the purpose of the following 3 fields in the page table: protection bits, modified bit and referenced bit. [3]

(d) A paging memory system with pages of size 2 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 3, 0, and 10, respectively. Assuming that all 3 of these pages are present in main memory, calculate the physical addresses corresponding to virtual addresses 0x0180 and 0x2402. [4]

(e) (i) A paged-segmented memory system has 4 KB page size and 64 KB virtual address space. Determine whether a program with 3 segments – 16 KB text, 8 KB stack and 40 KB data – would fit into the address space. [2]
(ii) Repeat question (i) assuming 8 KB page size. [2]

Question 2

(a) Describe the purpose of the 3 main kinds of program segments: text, stack and data. [3]

(b) 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]

(c) Define the term *working set*. [2]

(d) 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:

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

(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) Describe any 2 items found in a typical process control block (PCB). [2]

(c) Distinguish between processes and threads. [2]

(d) Briefly discuss any 3 goals of process scheduling (of interactive processes in particular). [6]

(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 4 quanta of running time. How much time is left until the low 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 48, 16, 24 and 32 (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, P2 down, P3 up, P1 down, P2 down, P3 up, P1 up, 3 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: P2 up. [1]

(c) Write down Peterson's algorithm for mutual exclusion and briefly comment on how it works. [8]

Question 5

(a) An MS-DOS disk has 2 files (A & B) and 1 subdirectory (D) in the root directory. There is a single file (C) inside D. Draw a labelled diagram showing how MS-DOS represents this information using 2 directory records. [4]

(b) Describe any 5 attributes given to files in typical file systems. [5]

(c) Describe the purpose of the following system calls related to files: Read, Write, Append, Seek and Close. [5]

(d) (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 1 KB disk blocks. [3]

Question 6

(a) Describe the sequence of steps required to handle an interrupt. [10]

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

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

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 ***