VICTORIA UNIVERSITY OF WELLINGTON

Te Whare Wananga o te Upoko o te Ika a Maui

EXAMINATIONS — 2003

MID-YEAR

COMP 305

Operating Systems

Time Allowed: 3 Hours

Instructions: The exam is out of 180 marks
There are 6 questions
Each question is worth 30 marks
Answer all questions
Non electronic Foreign to English Language dictionaries are permitted
Calculators and other Electronic devices are **not** permitted

Question 1. A Mixed Bag [30 marks]

(a) [12 marks] The following table gives the arrival and burst times of processes P_1 through P_5

Process	Arrival Time	Burst Time
P_1	0	9
P_2	3	8
P_3	6	4
P_4	9	4
P_5	10	2

Create a Gantt chart for each of the scheduling algorithms below, show when each process will be scheduled, and determine the average waiting time. For simplicity ignore any context switch time.

i. FCFS

ii. Non preemptive SJF

iii. A preemptive variation of SJF, called Shortest Remaining Time First.

iv. RR with quantum of 3

1 mark gantt, 2 marks calculation

i. p1-p2-p3-p4-p5, av.wait = (0+6+11+12+15)/5 = 8.8

ii. p1-p3-p5-p4-p2, av.wait = (0+16+3+6+3)/5 = 5.6

iii. p1-p3-p5-p3-p4-p2, av.wait = (0+6+5+6+0)/5 = 5.4

iv. p1-p2-p1-p3-p2-p4-p1-p5-p3-p2-p4, av.wait = (12+15+14+14+11)/5 = 13.2

(b) [18 marks] Implement a solution to the *readers and writers problem* utilising conditional regions of the form, `region v when B do S;`. Waiting writers have priority over waiting readers. You may use pseudo code for your solution.

Question 2. File Systems [30 marks]

(a) [15 marks]

Consider a file that is 50 blocks long. Assume that the File Control Block (FCB) (and the index block, in the case of indexed allocation is already in memory). Calculate the number of disk I/O operations required to insert a new block before the last block of the file for each file allocation strategy below. Count only disk I/O operations that read or write file blocks:

i. Contiguous file allocation,

ii. Indexed file allocation,

iii. Linked file allocation.

(b) [15 marks]

i. Define the term *consistency semantics* with respect to file sharing.

> *(5) Consistency = characterization of the semantics of multiple users accessing a shared file simultaneously. Semantics should specify when modifications of data by one user are observable by other users. Looking for recognition that there is no *one* semantics that is right, depends on the filesystem and application.*

ii. Consider a file that is known by an alias. Assume that the operating system does not allow deletion of the original file until all references to it have been deleted. Describe a scheme for determining that the last reference to the file has been deleted.

> *(10) [1] keep a list (or count) of all references to the file [2] when a new link is created add it to the list or increment the count [3] when a link is deleted, remove it from the list or decrement the count. another approach would be garbage collection - mark and sweep*

Question 3. Memory Management (Not VM) [30 marks]

(a) [5 marks] Address Binding

i. What is the major advantage of using a dynamically linked library as opposed to a statically linked library.

ii. What (if any) disadvantages are there to using a dynamically linked library?

i. You do not need to relink if a dynamic or shared library is updated

ii. Versioning can sometimes be a problem.

(b) [10 marks] With the aid of separate diagrams describe the logical to physical address translation process for both:

i. segmentation, and

ii. paging.

(c) [15 marks] Explain with the aid of diagrams, how both of following schemes perform logical to physical address translation and how both address the problem of large logical address spaces.

i. inverted page tables, and

ii. hashed page tables.

Question 4. Virtual Memory [30 marks]

(a) [5 marks] List the actions that are taken by the operating system when a page fault occurs?

[8] When a process tries to access a page that was already resident in physical memory. [1] Operating system verifies the memory access, [2] aborts the program if it is invalid. [3] If it is valid, a free frame is located and I/O is requested to read the needed page into the free frame. [4] Upon completion of I/O the [5] process table and [6] pbage table are updated and [7] the instruction is restarted.

(b) [15 marks]

Consider the following page-reference string:

```
1, 2, 3, 4, 2, 1, 2, 3, 4, 1
```

Assume that there are three frames of physical memory available, and that these are initially empty. For each page replacement algorithm specified below, calculate the total number of page faults and state the set of pages that are left in physical memory after the last page-reference:

i. Optimal, and

ii. FIFO.

(c) [10 marks] To what extent can the use of a *local replacement* algorithm limit the effects of thrashing? Justify your answer.

[1] Global - any process can steal any other processes' frame. [2] With local replacement frames are allocated on a per process basis. [3] The idea is to prevent other thrashing processes from stealing frames from other processes. [4] It cannot prevent thrashing completely as the processes must share access to the paging device and [5] if another process is filling its queue with requests then the performance of the non-thrashing process will be impacted.

Question 5. I/O Subsystems [30 marks]

(a) [5 marks] Would you choose either a polling mechanism or interrupt mechanism to implement communication between a host and an I/O controller if the device connected to the controller is rarely ready for service?

[3] choose interrupt, more efficient that continually wasting CPU time polling when it is unlikely that the device is ready for service.

(b) [4 marks] State one important role that the device driver plays in an operating system architecture.

(c) [15 marks] Suppose that a disk drive has 1,000 cylinders, numbered 0 to 999. The driver is currently serving a request at cylinder 99, and the previous request was at 100. The queue of pending requests, in FIFO order, is:

```
110,5,23,6,24,111,78,900,112,113
```

For each disk scheduling algorithm specified below, calculate the seek schedule, total head movement, and last cylinder accessed. Always start from the current head position.

i. SSTF algorithm, and

ii. SCAN algorithm.

5.5 marks for the schedule, 1 mark for total head movement, 1 mark for last cylinder

(d) [6 marks] Can SSTF ever lead to a situation where a disk block request is never satisfied? Justify your answer.

[1] Starvation is possible, simply as [2] requests are inserted as they arrive then if the request is always for a cylinder that is close to the current position [3] then a cylinder that is more distant could wait forever.

Question 6. Security [30 marks]

(a) [5 marks]

i. What distinguishes mechanism from policy?

mechanism is how, policy is how

ii. Provide an example of a mechanism and an example of a policy.

(b) [5 marks] Briefly describe the term *protection domain.*

A protection domain specifies the resources that the process may access. A domain is a collection of access rights, each of which is an ordered pair <object_name, rights-set>. Ability to switch domains allows need-to-know, program does not need all rights at once.

(c) [10 marks]

i. Discuss some drawbacks of both access control lists and capabilities.

[5] Main drawback of access control lists are time to search an access control list, determining rights for a domain is difficult, - on the other hand, capabilities are difficult to revoke, hard to determine rights for a particular object

ii. How can capabilities be prevented from being copied by a user process?

[1] Tags can be used to distinguish capabilities from other data - [2] this requires hardware support. [3] Capabilities can be stored separately from data, [4] this can be implemented via memory segmentation schemes.

(d) [5 marks] Provide an example that demonstrates the need for *rights amplification.*

(e) [5 marks] A problem with password based authentication is that the list of passwords must be stored somewhere. Should a hacker steal the file then the hacker can read the list of passwords. Briefly describe how Unix authentication counters this threat.

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