The University of Adelaide

Examination for
Bachelor of Computer Science
Graduate Diploma in Computer Science

Primary Examination, November 2009

Operating Systems
COMPSCI 3004, 7064

Official Reading Time:	10 mins
Writing Time:	120 mins
Total Duration:	130 mins

Questions	Time	Marks
Answer all 6 questions	120 mins	120 marks 120 Total

Instructions

- Begin each answer on a new page
- Examination material must not be removed from the examination room

Materials

- 1 Blue book
- Foreign Language Dictionaries are Permitted

DO NOT COMMENCE WRITING UNTIL INSTRUCTED TO DO SO

Processes & threads

Question 1

(a) A Process Control Block is a data structure in the operating system kernel containing the information needed to manage a particular process. Name the fields of a generic PCB and briefly describe which components of the Operating System use and/or modify each field.

[8 marks]

(b) Give two reasons why it is important for system calls to check the validity of pointers that are supplied to them by processes.

[4 marks]

(c) How can a process create an unnamed pipe? What type of communication will it provide?

[4 marks]

(d) Describe two important differences between pipes and message passing.

[6 marks]

[Total for Question 1: 22 marks]

CPU scheduling

Question 2

(a) You are looking at a snapshot status of all processes being run by some operating system. Which of the following sentences is always true?

1. the number of blocked processes is not greater than the number of I/O devices available in the system.
2. the number of ready processes is not greater than the number of running processes.
3. the number of running processes is not greater than the number of CPU cores available in the system.
4. the number of blocked processes is not less than the number of CPUs available in the system.

[3 marks]

(b) The following jobs are submitted to a batch system:

- A: Duration 4, arrival time 0
- B: Duration 5, arrival time 2
- C: Duration 2, arrival time 3
- D: Duration 2, arrival time 5
- E: Duration 1, arrival time 9

For the following two scheduling algorithms, calculate the completion time of each job, showing your working.

i. First come first served

ii. Shortest job first (assuming no pre-emption)

[8 marks]

(c) For each of the following types of systems, list an important criterion that must be considered when choosing a scheduling algorithm. Explain your answers.

i. Batch systems

[2 marks]

ii. Real-time systems

[2 marks]

[Total for Question 2: 15 marks]

Process Synchronization

Question 3

(a) Below is a solution to the second Reader-Writers problem using 3 semaphores and 4 shared counters (AR = active readers, WR = waiting readers, AW = active writers, and WW = waiting writers).

Reader Process

```
wait(mutex);
if ((AW+WW) == 0) \ {
   signal(OKToRead);
   AR = AR+1;
 } else {
    WR = WR+1;}
signal(mutex);

wait(OKToRead);

 read the necessary data;

wait(mutex);
AR = AR-1;
if (AR==0 && WW>0) {
   signal(OKToWrite);
   AW = AW+1;
   WW = WW-1;
  }

signal(mutex);
```

Writer Process

```
wait(mutex);
if ((AW+AR+WW) == 0) {
   signal(OKToWrite);
   AW = AW+1;
 } else {
   WW = WW+1;}
 signal(mutex);
 wait(OKToWrite);
  write the necessary data;

 wait(mutex);
 AW = AW-1;
 if (WW>0) {
    signal(OKToWrite);
    AW = AW+1;
    WW = WW-1;
 } else while (WR>0) {
     signal(OKToRead);
     AR = AR+1;
     WR = WR-1; }
signal(mutex);
```

This solution will work, provided the semaphores and counting variables are set properly. Can you determine their initial values?

[5 marks]

(b) After reading the code of part (a), briefly answer the following questions:

i. Can *OKToRead* ever become greater than 1? What about *OKToWrite*?

[3 marks]

ii. Is the WW necessary in the writer's first *if*?

[3 marks]

iii. Is the first writer to execute wait(mutex) guaranteed to be the first writer to access the data?

[2 marks]

iv. In case of competition between readers and writers, who gets priority?

[3 marks]

[Total for Question 3: 16 marks]

Input/Output

Question 4

(a) Disk controllers have internal buffers and they are getting larger with each new model. Why?

[4 marks]

(b) While the disk is completing a block access at cylinder 14, disk requests for cylinders 8,12, 20, 4, 28, and 10 arrived in that order. A seek takes 5 msec per cylinder moved. How much seek time is needed for:

i. FCFS

ii. SSF

iii. Elevator algorithm (initially moving upwards)

[9 marks]

(c) Give one advantage and one disadvantage of the Shortest Seek First (SSF) algorithm.

[3 marks]

(d) A system that uses Banker's Algorithm deadlock avoidance has five processes (1, 2, 3, 4, and 5) and uses resources of four different types (A, B, C, and D). The resources available are (3, 4, 0, 1). The state of the system with respect to resource allocation is shown below.

Process	Allocated A B C D	Max A B C D
1	1 0 2 0	3 2 4 2
2	0 3 1 2	3 5 1 2
3	2 4 5 1	2 7 7 5
4	3 0 0 6	5 5 0 8
5	4 2 1 3	6 2 1 4

i. Is the system in a safe state?

[6 marks]

ii. Give an example of a process request that cannot be granted because it will be unsafe.

[3 marks]

[Total for Question 4: 25 marks]

Memory Management

Question 5

(a) Consider a computer with the following specification:
32 bit, byte addressible physical memory
page size = block size = 1 MB
main memory size = 64MB bytes
page map table entry length = 4 bytes
The address of the current process' page table is 0x00200000
The TLB currently contains:

page	block
0x 073	0x 1A
0x 833	0x 22
0x f33	0x 0E
0x 733	0x 31

Given the virtual address 0x 073337ff.

i. What is the page number and offset of this virtual address (VA)?
ii. What is the address of the page table entry corresponding to that page number?
iii. How many blocks are in the main memory?
iv. What is the physical address?

[9 marks]

(b) Why are segmentation and paging sometimes combined into one scheme?

[4 marks]

(c) Choosing the best page size for a virtual paged memory is a trade-off. Can you give an advantage and a disadvantage of choosing a large page size?.

[3 marks]

(d) What is thrashing?

[3 marks]

(e) Explain how thrashing can be controlled using the PFF (Page Fault Frequency) algorithm.

[5 marks]

[Total for Question 5: 24 marks]

Filesystems

Question 6

(a) Explain the difference between a sequential read and a random access read.

[3 marks]

(b) Three common block allocation schemes are *contiguous*, *linked*, and *indexed*. List each of these schemes in order of their efficiency (from best to worst) for the case of retrieving a single block using random access. Explain your answer.

[3 marks]

(c) Name and briefly describe a technique used to improve file system performance

[4 marks]

(d) Consider a file system with capacity for 16 block, which uses a bit map to keep track of free blocks. The following sequence of operations is performed on a newly initialised filesystem:

- A = new file of 1 block
- B = new file of 1 block
- C = new file of 1 block *
- Append 3 blocks to B
- Append 2 blocks to A
- Append 2 blocks to C *
- Append 1 block to B
- Append 1 block to A *
- Delete B *
- Append 2 blocks to A
- Append 1 block to C *

Each block allocation chooses the lowest-numbered free block. Show the contents of the free block bit map after each operation marked with a * is completed.

[8 marks]

[Total for Question 6: 18 marks]

End of exam