



The University of Adelaide

Examination for  
Bachelor of Computer Science  
Graduate Diploma in Computer Science

**Primary Examination, November 2010**

**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) Explain the terms *process* and *program*. [4 marks]
- (b) List two pieces of state unique to each thread, which are *not* shared with other threads in the same process. Explain why they are not shared. [6 marks]
- (c) List the three main steps involved in performing a context switch. [3 marks]
- (d) Explain the difference between a *monolithic kernel* and a *microkernel*. Give an advantage of each. [7 marks]

**[Total for Question 1: 20 marks]****CPU Scheduling****Question 2**

- (a) Explain why pre-emptive multitasking is generally superior to cooperative multitasking. [3 marks]
- (b) List two circumstances under which a context switch can occur. [3 marks]
- (c) Consider a set of processes with the following arrival times, CPU bursts, and I/O bursts:

Process	Arrival	CPU	I/O	CPU	I/O	CPU
A	0	6	2	6	3	4
B	3	4	9	3	2	3
C	6	2	2	8	5	2

Draw a Gantt chart showing the CPU and I/O state of each process with respect to time, for a round-robin scheduling algorithm with a quantum of 4.

[9 marks]

**[Total for Question 2: 15 marks]**

**Process Synchronisation****Question 3**

- (a) Name and briefly describe the requirements that a solution to the critical-section problem must satisfy.

[3 marks]

- (b) We have three concurrent processes as shown below. Process p1 must initialise  $x$  prior to other processes accessing that variable. All processes must update the shared variable  $y$  (in any order) before p3 prints its final value. Insert semaphore functions in each process code in order to provide the desired synchronization and mutual exclusion amongst processes (DSE stands for do something else, a sequence of instructions that do not use variables  $y$  or  $x$ ).

**Process P1**

$x = 1$   
DSE  
 $y = y + 4$   
print  $x$

**Process P2**

DSE  
 $y = y * 2$   
 $z = y/x$   
print  $z$

**Process P3**

DSE  
 $y = y - 2$   
DSE  
print  $y$

[9 marks]

- (c) Assume  $y$  was initially 2. List the possible values that process P3 may print.

[3 marks]

**[Total for Question 3: 15 marks]**

**Input/Output****Question 4**

- (a) Explain the term *track-at-a-time* caching.

[3 marks]

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

[3 marks]

- (c) A system that uses Banker's Algorithm for deadlock avoidance has four processes (1, 2, 3, and 4) and uses resources of three different types (A, B, and C). The state of the system with respect to resource allocation is shown below.

Process	Allocated	Max
	A B C	A B C
1	2 0 1	2 3 1
2	1 2 0	2 2 1
3	0 2 0	2 3 0
4	0 2 1	4 2 3

What is the minimum number of *available* resources of each type required for the system to be in a safe state? Show your working.

[7 marks]

- (d) In a system based on the bankers algorithm, is it possible to add additional resources while the processes are running? Explain your answer.

[3 marks]

**[Total for Question 4: 16 marks]**

**Memory Management****Question 5**

- (a) Here are six terms relating to virtual memory:

resident      write-through      LRU replacement  
write-back    TLB                  Random replacement

Name the three status bits used in a page table entry, and for each of them indicate which term of the ones listed above is most relevant.

[4 marks]

- (b) Explain what is LRU. List the advantages and disadvantages of LRU.

[6 marks]

- (c) A machine has 32 bit virtual and physical addresses. The page size is 16K bytes. Here is the TLB:

Page number	Frame number
0x0789	0x0030
0x0084	0x050a
0x0021	0x1000
0x0800	0x5683

What physical address corresponds to the virtual address 0x002124f2?

[6 marks]

- (d) Briefly explain the way a TLB miss impacts on memory access time.

[4 marks]

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

[4 marks]

**[Total for Question 5: 24 marks]**

**Filesystems****Question 6**

- (a) Give two reasons why filesystems are implemented separately from disk device drivers. [4 marks]
- (b) Which of i-nodes, linked list allocation, and contiguous allocation gives the best performance for random access reads? Explain. [4 marks]
- (c) What is the complexity of performing a directory lookup operation in revision 0 of ext2? [2 marks]
- (d) Explain, with the aid of an example, how journaling works. [8 marks]
- (e) Consider the following sequence of allocation requests to an initially empty FAT filesystem:
1. Create file A, initially containing 3 blocks
  2. Create file B, initially containing 1 block
  3. Create file C, initially containing 2 blocks
  4. Append 1 block to A
  5. Append 2 blocks to B
  6. Append 3 blocks to C
  7. Append 2 blocks to B
  8. Append 2 blocks to A.
- Each block allocation chooses the lowest-numbered free block. Show the state of the file allocation table after all of the above operations have been completed. Annotate each FAT entry with the name of the file it belongs to. [8 marks]
- (f) Give two reasons why it was important to make correct use of `bufcache_release` in the practicals. Explain your reasons. [4 marks]

**[Total for Question 6: 30 marks]**