THE UNIVERSITY
OF ADELAIDE
AUSTRALIA

Examination for the Ordinary degrees of Bachelor of Computer Science,
Bachelor of Engineering(Computer Systems Engineering), Bachelor of Engineering(Electrical),
Bachelor of Engineering(Information Technology and Telecommunications),
Bachelor of Economics, Bachelor of Information Science, Bachelor of Science,
Bachelor of Science(Mathematical and Computer Sciences),
Graduate Diploma of Computer Science,
Master of Engineering(Information Technology and Telecommunications)
and Master of Computer Science.

First Paper, Semester 2, November 2006

4468, 9901 COMP SCI 3004, 7064 OPERATING SYSTEMS

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

ANSWER ALL SIX QUESTIONS SHOWING ALL WORKING

Total marks: 120

The marks from this paper constitute 70% of
the total assessment for these courses

Calculators Allowed

Dictionaries Allowed

DO NOT COMMENCE WRITING UNTIL INSTRUCTED TO DO SO

Question 1

(c) **Processes, threads, and synchronisation:** Discuss the relative advantages and disadvantages of threads that are supported in kernel space versus those supported in kernel space.

[6 marks]

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

[2 marks]

(e) We have three concurrent processes as shown below. Process p1 must initialise *x* prior to process p2 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	*Process P2*	*Process P3*
x = 1	*DSE*	*DSE*
DSE	y = y*2	y = y-2
y = y+ 4	z = y/x	*DSE*
print x	print z	print y

[10 marks]

[Total Marks for Question 1: 18 Marks]

Question 2

CPU Scheduling: The table below describes the CPU-I/O Burst cycles for processes P1, P2 and P3. Assume 0 is the highest priority

Process	Priority	Arrival time	CPU Burst 1	I/O Burst 1	CPU Burst 2	I/O Burst 2	CPU Burst 3
P1	1	0	12	4	12	-	-
P2	0	4	5	9	3	12	5
P3	1	8	6	2	6	-	-

(a) Draw the Gantt chart timeline, illustrating the interleaving of processes, and calculate the average waiting time for each process under

1. a pre-emptive priority scheduling algorithm

[6 marks]

2. a round robin scheduling algorithm with quantum = 6.

[6 marks]

(b) How does the OS know when the running process has used its quantum? What action does it take?

[3 marks]

(c) Explain the differences in the degree to which the following scheduling algorithms discriminate in favor of short processes:

i. FCFS
ii. RR
iii. Credit based (Linux)

[9 marks]

[Total Marks for Question 2: 24 Marks]

Question 3

Deadlock: The banker's algorithm is used to check whether the allocation of resources requested by a process will leave the system in a safe state.

(a) Is the banker's algorithm pessimistic or optimistic? Please, explain your answer.

[4 marks]

(b) Consider the following snapshot of a system with 5 processes P_0 to P_4 and three resource types A, B and C.

	Allocation			**Max**			**Available**		
	A	B	C	A	B	C	A	B	C
P_0	0	0	2	0	3	2	2	0	1
P_1	3	1	0	3	6	5			
P_2	1	2	2	1	3	8			
P_3	0	3	1	0	3	2			
P_4	1	0	2	2	0	6			

Is the system in a safe state?

[5 marks]

If a request from process P4 arrives for (1,0,1), will this request be granted immediately?

[5 marks]

(c) A detection algorithm has determined that a system is in a deadlock state. Resource pre-emption is used to break the deadlock cycle. Explain the three issues that this pre-emption mechanism must address.

[6 marks]

[Total Marks for Question 3: 20 Marks]

Question 4

(a) **Memory**: Explain the difference between internal and external fragmentation.

[4 marks]

(b) In a paging system, give two advantages and two disadvantages of selecting a large page size.

[4 marks]

(c) In a paging system the following page accesses are recorded in a page reference string:

1, 2, 4, 6, 1, 3, 7, 2, 4, 7, 8, 7, 8, 2, 4, 5, 7, 2, 4, 7, 8, 3, 7, 2, 4, 9, 7, 8, 3, 2, 4

How many page faults would occur under LRU replacement, FIFO replacement and Optimal replacement assuming the physical memory has 5 frames?

[9 marks]

(d) Name and briefly described two strategies the OS can use to identify when a process is thrashing

[4 Marks]

(e) Once thrashing is detected, what can be done to improve system performance

[3 Marks]

[Total Marks for Question 4: 24 Marks]

Question 5

(a) **File and Disk Systems:** Explain the purpose of the close operation

[3 Marks]

(b) Consider a system that supports the strategies of contiguous, linked, and indexed allocation. Explain which strategy you will select to implement the following:

i. A small file (using 8 logical blocks) needing random access.
ii. A file that is accessed sequentially.
iii. A very large file that is accessed both sequentially and randomly.

[6 marks]

(c) Name and briefly describe 3 of the services provided by the kernel i/o subsystem

[9 marks]

[Total Marks for Question 5: 18 Marks]

Question 6

(a) **Protection**: Briefly describe the concepts of protection domains and access rights, including discussion of how they relate to one another.

[3 marks]

(b) Compare and contrast access control lists and capabilities as a means for implementing access rights and protection domains.

[4 marks]

(c) **Security**: The design of an operating system (in particular its protection mechanisms) is key to ensuring that an operating system is adequately secure.

i. Explain some of the, many, reasons why good design is insufficient to prevent malicious software attacks.

[3 marks]

ii. Authorised (ethical) hackers are often put forward as the catch-all solution to demonstrating adequate security of a given system. Discuss the merits of such claims.

[3 marks]

iii. Explain the role played by, and the limitations of, auditing and intrusion detection in limiting the damage caused by malicious intruders.

[3 marks]

[Total Marks for Question 6: 16 Marks]

END OF EXAMINATION