TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

EXAMINATIONS — 2007
END YEAR

COMP 305

Operating Systems

CRN 965

Time allowed: 3 HOURS

Instructions: There are five questions; answer **all** questions.

Each question is worth 30 marks; there are 150 marks in total.
You should allow about 1 minute per mark, 10 minutes for reading and 20 minutes for review.

Marks for parts of questions are shown.

Non-programmable calculators are allowed in the examination.

Paper foreign to English dictionaries are allowed.

Electronic dictionaries and programmable calculators are not allowed.

Question 1 Synchronisation and Deadlock [30 marks]

a) [9 marks] Synchronization

i) [3 Marks] State the three requirements for synchronization.
ii) [2 Marks] Which of these requirements is not met by the *swap* primitive?
iii) [4 Marks] Provide pseudo code to demonstrate how *test-and-set* is used to enclose a critical section.

b) [9 marks] Deadlock Prevention

i) [4 Marks] State all four necessary conditions for deadlock to occur.
ii) [2 Marks] Select the subset of conditions from (i) for which elimination is not plausible strategy.
iii) [3 Marks] For the conditions in (ii) state why elimination is not reasonable.

c) [12 marks] Deadlock Avoidance

i) [4 Marks] Draw the resource allocation graph for the allocation given in Table 1. The maximum resources available are: $R_1 = 3$, $R_2 = 3$, $R_3 = 1$. Is this graph deadlocked? Justify your answer.

	Allocation			Requesting		
Process	R_1	R_2	R_3	R_1	R_2	R_3
P_1	1	1	0	0	0	0
P_2	0	2	0	0	0	1
P_3	2	0	1	0	1	0

Table 1: Resource Allocation Table

ii) [4 Marks] Consider a system with 4 Processes and 4 Resource types. It is currently in the state given in Table 2. Explain why this state is safe.

	Allocation				Maximum				Available			
Process	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
P_1	1	1	0	0	2	2	0	2	1	1	1	1
P_2	0	2	0	1	2	5	1	2				
P_3	2	0	1	2	5	0	2	2				
P_4	1	1	0	1	1	1	1	1				

Table 2: Resource Allocation Table

iii) [4 Marks] Assume that the following allocation ($1 \times R_4 \Rightarrow P_2$) is made based on the **initial** state given in table 2. Can this request be granted immediately? If so, why, if not, why not?

Question 2 Processes and CPU Scheduling

a) [6 Marks] Processes **[30 marks]**

i) [3 Marks] Show the lifecycle of a process in a diagram. Be sure to include labels indicating the state the process is in as it transitions through the system.

ii) [3 Marks] Indicate using arrows on your answer from (i), where the CPU scheduling opportunities are.

b) [15 Marks] Simple CPU Scheduling

i) [2 Mark] State the different role that a dispatcher and a scheduler have in a system.

ii) [3 Marks] What is the *best* metric for determining the effectiveness of a process schedule with batch, multi-programmed and interactive systems. Copy the following diagram to your answer book, and draw lines to indicate the association of metric with system type.

Batch	Waiting Time
Multi-programmed	Response Time
Interactive	Turnaround Time

iii) [5 marks] Consider the process arrivals shown in Table 3. Draw a Gant chart of the CPU schedule for a preemptive shortest remaining time first (SRTF) scheduling algorithm. Ties are broken by queued order. Compute the average waiting time.

Process	$T_{Arrival}$	T_{CPU}
P_1	0	5
P_2	1	1
P_3	3	3
P_4	4	1

Table 3: Process arrival and burst time

iv) [5 Marks] Consider the process arrivals shown in Table 3. Draw a Gant chart of the CPU schedule for a RR scheduling algorithm with quantum = 2. Compute average response time.

c) [9 Marks] Priority and Multi-level Scheduling

i) [2 Marks] What is priority scheduling, and how might it lead to starvation?

ii) [2 Marks] How can starvation be avoided in priority scheduling systems?

[2 Marks] What problem is addressed by the adoption of multi-level feedback scheduling?

iii) [3 Marks] Draw a diagram of a multi-level feedback queue and indicate on the diagram how processes might move between the queues.

Question 3 File Systems

[30 Marks]

a) [12 Marks] Disk Structures

i) [4 Marks] How do i-nodes improve the storage efficiency of a disk system?

ii) [4 Marks] If I seek to a data block linked via the double indirect block in an i-node, how many reads am I performing (assuming the i-nodes are not cached)?

iii) [4 Marks] How is a file updated safely when using i-nodes cached in kernel memory. Draw a diagram showing how the update is performed.

b) [12 Marks] Read Scheduling

i) [2 Marks] What is the primary purpose of scheduling disk reads.

ii) [5 Marks] Draw the scan patterns for FCFS when operating on a drive with 400 cylinders, with the following set of seek requests: 10, 147, 169, 194, 303, 249, 222, 78, 166, 120. What is the total head movement needed for FCFS to satisfy these requests.

iii) [5 Marks] Draw the scan patterns for SCAN when operating on a drive with 400 cylinders, with the following set of seek requests: 10, 147, 169, 194, 303, 249, 222, 78, 166, 120. What is the total head movement needed for SCAN to satisfy these requests.

c) [6 Marks] Mass Storage - RAID

i) [2 Marks] How does RAID increase performance?

ii) [2 Marks] How does RAID improve reliability?

iii) [2 Marks] How many disks can fail without data loss in a RAID array with 2 parity blocks per stripe?

Question 4 Memory Management [30 marks]

a) [10 Marks] Page Tables

i) [4 Marks] What is the purpose of a page table?

ii) [6 Marks] Draw a Hashed page table.

b) [8 Marks] Virtual Memory

i) [4 Marks] What is virtual memory?

ii) [4 Marks] Draw a diagram showing the actions of demand paging in response to a page fault.

c) [12 Marks] Page Replacement

i) [2 Marks] What is the anomaly associated with FIFO page replacement?

ii) [5 Marks] Assuming a working set is recalculated at each reference with tau = 4, what are the working sets for the reference string 431334221?

iii) [5 Marks] Describe how the second-chance algorithm approximates LRU, and what bits need to be provided by the system for this approximation to work.

Question 5 Security **[30 marks]**

(a) [6 Marks] Briefly outline the following security threats

i) [3 Marks] Virus

ii) [3 Marks] Worm

(b) [4 Marks] Explain how an access matrix separates policy from mechanism

(c) [4 Marks] Explain how an attack on a computer system could be performed by exploiting a buffer overflow.

(d) [7 Marks] Consider a system with the following attributes regarding security.

- The system has three types of users: Admin, Lecturer, Student
- The System has 2 files, A and B, and 1 executable program P
- Administrators are able to Read and Write both File A and B they are also able to execute program P
- Lectures are able to Read File A and Execute Program P
- Students are allowed to read File A
- Administrators are able to pass on (delegate) the right to read File B to lecturers or students

Give an access matrix that is consistent with these requirements. Access should not be granted unless it is explicitly specified.

(e) [5 Marks] Access rights can be explicitly passed between domains in an access matrix, these rights are denoted with an '*'. Describe the three different copy semantics (copy rights) that can be applied when a right is passed on to another domain.

(f) [4 Marks] Explain what Trapdoor encryption is and how it could be used to protect password files

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