THE UNIVERSITY OF ADELAIDE

Term 1 , 2009

004468, 009901 Operating Systems
COMP SCI 3004NA, 7064NA

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

ANSWER ALL FIVE QUESTIONS

Total marks: 120

Instructions for Candidates

- This is a Closed-book examination.
- Begin each answer on a new page in the answer book.
- Examination materials must not be removed from the examination room.

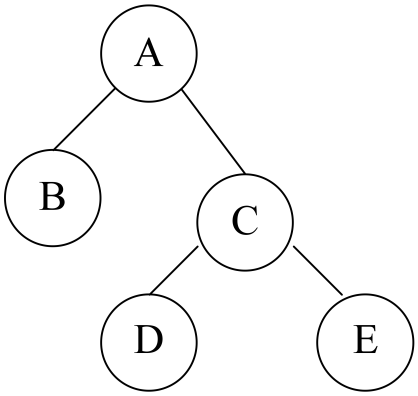
Permitted Materials

- Calculators allowed.
- Dictionary is permitted for translation only.

DO NOT COMMENCE WRITING UNTIL INSTRUCTED TO DO SO

Question 1 Processes and synchronization

(a) In MINIX, all current processes belong to a process tree. Describe the steps necessary to create the following sub-tree:



[5 marks]

(b) List the two main purposes of threads, and provide a brief explanation of each.

[6 marks]

(c) The algorithm below is intended to allow N processes to share variable *PeopleWaiting*.

Algorithm for process i:
...do work unrelated to PeopleWaiting
while turn does not equal i do nothing
work on PeopleWaiting
turn := (i + 1) mod N
...do work unrelated to PeopleWaiting

Does this algorithm satisfy the three requirements for a correct solution to the critical section problem? Assume turn is set to 0.

[6 marks]

(d) Explain how a monitor can be used to provide mutual exclusion for the variable *PeopleWaiting*.

[4 marks]

(e) Are monitors better that semaphores in dealing with mutual exclusion? Please explain your answer.

[3 marks]

[Total Marks for Question 1: 24 Marks]

Question 2 CPU Scheduling and MINIX3

The table below describes the CPU-I/O Burst cycles for processes P1, P2, P3 and P4. Assume 0 is the highest priority

Process	Priority	Arrival time	CPU Burst 1	I/O Burst 1	CPU Burst 2
P1	1	0	10	6	8
P2	0	4	3	10	3
P3	1	5	6	2	6
P4	2	12	20	-	-

(a) Draw the Gantt chart timeline, illustrating the interleaving of processes, and calculate the turnaround time for each process under a pre-emptive priority scheduling algorithm.

[8 marks]

(b) If you replace the priority scheduler with a round robin scheduler, which quantum value will you select? Explain your answer.

[4 marks]

(c) Explain the differences between pre-emptive and non-pre-emptive scheduling. Which one is better for general purpose usage? Why?

[4 marks]

(d) List three different events that will cause the operating system to do a context switch.

[3 marks]

(e) MINIX3 uses a multilevel scheduling algorithm with different priorities for classes. The lowest class (user processes) has round-robin scheduling, but the tasks and servers are allowed to run until they block. Is it possible for processes in the lowest class to starve? Why (or why not)?

[5 marks]

[Total Marks for Question 2: 24 Marks]

Question 3 Input/Output

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

[4 marks]

(b) A computer has 8 tape drives, with *n* processes competing for them. Each process may need three drives. For which values of *n* is the system always deadlock free?

[4 marks]

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

Process	Allocated A B C D	Max A B C D	Available A B C D
1	1 0 2 0	3 2 4 2	3 4 0 1
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.

[4 marks]

(d) In MINIX we can divide a disk into 4 sub-partitions, which can be divided again.

(i) Give two reasons to partition a disk device.

[4 marks]

(ii) How is each partition identified?

[2 marks]

[Total Marks for Question 3: 24 Marks]

Question 4 Memory Management

(a) Consider a computer with the following specification:

32 bit, byte addressible physical memory

page size = block size = 4096 bytes

main memory size = 64K bytes

page map table entry length = 2 bytes

The address of the current process' page table is 0x1000

The TLB currently contains:

page	block
0x733	0xd
0x7333	0xe
0xf333	0xa
0x8333	0xb

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 its physical address?

[8 marks]

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

[4 Marks]

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

10, 8, 3, 7, 8, 3, 9, 10, 3, 5, 7, 10, 3, 10, 5, 7, 12, 10, 7, 5, 12

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

[6 marks]

(d) Is Random better than LRU as a replacement algorithm? Why (or why not)?

[4 Marks]

(e) Can the optimal replacement algorithm eliminate thrashing? Explain your answer

[4 Marks]

[Total Marks for Question 4: 26 Marks]

Question 5 File Systems

(a) It has been suggested that the first part of each UNIX file be kept in the same disk block as its i-node. What good would this do?

[4 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 adding a new block to an existing file. Explain your answer.

[6 Marks]

(c) Consider a file system 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 once these operations have completed. Show your working.

[8 marks]

(d) Compare and contrast access control lists and capabilities as a means for implementing the protection matrix.

[4 marks]

[Total Marks for Question 5: 22 Marks]

END OF EXAMINATION PAPER