NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2018-2019

CE2005/CZ2005 – OPERATING SYSTEMS

Apr/May 2019 Time Allowed: 2 hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 6 pages.
2. Answer **ALL** questions.
3. This is a closed-book examination.
4. Questions **DO NOT** carry equal marks.

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1. (a) Indicate whether each of the following statements is true or false. Justify your answer.

(i) IO device utilization is higher in batch systems compared to multi-programming systems.

(2 marks)

(ii) A trap requires a switch from monitor mode to user mode.

(2 marks)

(iii) CPU scheduling is non-preemptive if it only happens when all the processes are ready.

(2 marks)

(iv) The short-term scheduler makes decision by considering all processes that are waiting for CPU and IO devices.

(2 marks)

(v) In direct message passing, a single sender can send to many receivers.

(2 marks)

Note: Question No. 1 continues on Page 2

(b) Table Q1b shows a number of processes with their respective CPU-burst time and arrival time. Calculate the average waiting time considering the following scheduling algorithms: First-Come-First-Serve, Non-preemptive Shortest Job First, Shortest Remaining Time First, and Round-Robin with quantum = 2 units of time.

(5 marks)

Table Q1b

Process	Burst Time	Arrival Time
P1	8	0
P2	6	2
P3	3	4
P4	2	3

(c) Explain briefly what is meant by the "fork-join" processing model. Devise a "fork-join" example with pseudo-code to illustrate the differences in result, if any, between two cases: 1) all required join() system calls have been put into the right place; and 2) there are some missing join() system calls.

(5 marks)

2. (a) Indicate whether each of the following statements is true or false. Justify your answer.

(i) Race conditions happen because of context switches.

(2 marks)

(ii) Mutual exclusion is to ensure that a process is not stuck in the critical section forever.

(2 marks)

(iii) Deadlock avoidance allows processes to request for resources at will.

(2 marks)

(iv) A solution for the critical section problem implemented with only the atomic TestAndSet() instruction would violate the progress requirement.

(2 marks)

(v) For semaphore, the blocking implementation is better than busy waiting if the critical section is short.

(2 marks)

Note: Question No. 2 continues on Page 3

(vi) Blocking semaphores may lead to starvation for some processes.

(2 marks)

(b) A system does not have the atomic TestAndSet() instruction. Devise a concrete example with pseudo-code to explain whether a simple Boolean variable "lock" could be used to ensure mutual exclusion for the critical section problem.

(4 marks)

(c) A system has four processes (P1, P2, P3, and P4) and three resource types (A, B, and C). The current Allocation and Need matrices are shown in Table Q2c. Justify if a request for (A=0, B=2, C=1) from P4 should be granted or not.

(3 marks)

Table Q2c

		Available
		A B C
		2 2 1
Process	**Allocation**	**Need**
	A B C	A B C
P1	1 2 1	2 1 5
P2	1 2 0	1 2 0
P3	1 0 2	3 1 1
P4	1 1 1	1 2 1

(d) Table Q2d shows the pseudo-code for two processes, P0 and P1. Justify if this code satisfies all the properties required for a solution to the critical section problem. The shared variables are "turn" (integer, initialized to 0), and "flag [2]" (Boolean, initialized to false).

(6 marks)

Table Q2d

Process P0	Process P1

while(1){
turn = 1;
flag [0] = true;
while (flag [1] and turn = 1);
critical section
flag [0] = false;
remainder section }
	while(1){
	turn = 0;
	flag [1] = true;
	while (flag [0] and turn = 0);
	critical section
	flag [1] = false;
	remainder section }

Note: Question No. 2 continues on Page 4

(e) A system has three different single-instance resource types, each of which is protected by a different binary semaphore. Assume there is no preemption in this system. Design a possible deadlock scenario in this system, then propose a deadlock prevention approach. Explain the potential downside of your approach, if any.

(5 marks)

3. (a) Indicate whether the following statements about memory management are true or false. Justify your answer.

(i) Load-time address binding generates identical logical and physical addresses.

(2 marks)

(ii) External fragmentation happens if allocated memory is larger than requested memory.

(2 marks)

(iii) Size of a page table is proportional to the size of process' logical address space.

(2 marks)

(iv) Sequential processing of a two-dimensional array always exhibits good degree of reference locality.

(2 marks)

(b) Assume a computer system uses paging for memory allocation. Logical address consists of x bits for the page number and y bits for the offset.

(i) What is the page size?

(2 marks)

(ii) What is the size of logical address space?

(2 marks)

(iii) How many entries are there in the page table?

(2 marks)

(iv) Assuming each page table entry occupies 4 bytes, how many entries are there in the outer level page table if a two-level paging scheme is used?

(2 marks)

Note: Question No. 3 continues on Page 5

(c) Table Q3c shows the content of a segment table.

Table Q3c

Segment number	Limit	Base
0	600	219
1	14	2300
2	100	90
3	580	1327
4	96	1952

In the logical address, the first number in the logical address represents segment number, and the second number represents offset. What are the physical addresses for the following logical addresses?

(i) <0, 430>

(2 marks)

(ii) <2, 500>

(2 marks)

(d) Assume a computer system uses demand paging for virtual memory management. There are three page frames available. Figure Q3d shows the behavior of the clock page replacement algorithm on a page reference string.

F1	0	0	0	0	0	0	1	1
F2		1	1	1	4	4	4	0
F3				2	2	2	2	2
	P	P		P	P		P	P

Figure Q3d

(i) Identify the reference string used.

(3 marks)

(ii) Under what situation will the clock algorithm behave like the First-In-First-Out (FIFO) algorithm?

(3 marks)

(e) Discuss how the size of physical memory, degree of multiprogramming, and access time of secondary storage may affect the performance of a virtual memory system based on demand paging.

(4 marks)

4. (a) (i) Assuming the current working directory is "/usr/peter/documents", give the absolute path name for the file "os/lecture_slides.ppt".

(2 marks)

(ii) If a user using a UNIX system allows only herself to read and write and other users in the same group to read a file, what are the corresponding protection bits of the file?

(2 marks)

(iii) Disk block size may affect both performance and space utilization of a file system. Explain the problem that may arise when the block size is very small.

(2 marks)

(iv) Consider a set of four hard-disks, each of 200 GB storage capacity. What are the corresponding storage capacities if they are configured using RAID 1+0 (i.e., strip of mirrors)?

(2 marks)

(b) Identify the most appropriate file allocation method (contiguous, linked, or indexed) to optimize efficiency in terms of speed of access, use of storage space, and ease of updating in the following two cases.

(i) Data are updated infrequently and accessed frequently in random order.

(2 marks)

(ii) Data are updated frequently and accessed frequently in random order.

(2 marks)

(c) Compare and contrast the bit-map and linked-list methods for keeping track of free disk space in terms of space utilization and efficiency.

(4 marks)

(d) The following requests, ordered according to arrival time, are in the disk queue: 20, 100, 40, 60, 75, 120, and 160. The disk head is currently at cylinder 90, servicing a request. The last request serviced was at cylinder 85. Explain whether SSTF and LOOK disk scheduling algorithms will service these requests in the same or different sequence.

(4 marks)

END OF PAPER

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Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.