國立中正大學
109 學年度碩士班招生考試
試 題

[第 3 節]

科目名稱	計算機系統
系所組別	資訊工程學系-甲組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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1　單選題 (2% each):

(1) Consider a system crash on a log-structured file system. Which one of the following events must occur?

A. Only aborted transactions must be completed.
B. All transactions in the log must be completed.
C. All transactions in the log must be marked as invalid.
D. File consistency checking must be performed.
E. None of the above will occur.

(2) _____ allows the parent and child processes to initially share the same pages, but when either process modifies a page, a copy of the shared page is created.

A. Copy-on-write
B. Zero-fill-on-demand
C. Memory-mapped
D. Virtual memory fork
E. Copy-on-reference

(3) Which of the following statements is true?

A. A safe state is a deadlocked state.
B. A safe state may lead to a deadlocked state.
C. An unsafe state is necessarily, and by definition, always a deadlocked state.
D. A deadlocked state may lead to a safe state.
E. An unsafe state may lead to a safe state.

(4) The file-allocation table (FAT) used in some file systems is an example of _____.

A. contiguous allocation
B. indexed allocation
C. linked allocation
D. multilevel index
E. extent-based allocation

(5) A solution to the critical section problem does not have to satisfy which of the following requirements?

A. mutual exclusion
B. progress
C. atomicity
D. bounded waiting
E. All of the above

(6) Which of the following can be directly done by an application (i.e., not via a system call that asks the OS to do it) running in user mode?
A. Disarm Interrupts
B. Set the system timer
C. Modify the interrupt vector
D. Execute an I/O instruction
E. None of the above can be done in user mode.

(7) In OSs for modern machines, what is the immediate result if a process generates an address that is outside its legal address range?
A. Blue Screen of Death
B. Deadlock
C. The program will probably not work right
D. A hardware interrupt (trap) will occur
E. The system call will return an error

(8) What system call does a Linux job normally use to start another copy of itself?
A. clone
B. fork / exec
C. shell
D. dispatch
E. None of the above is used by a Linux job use to start another copy of itself.

(9) When an OS is using a Multilevel Feedback Queuing system for scheduling, how is the CPU time divided between the queues?
A. Each level gets a predefined percentage of the CPU time.
B. The top level is exhausted and then the next level gets a turn, etc.
C. Each level gets the same percentage of the CPU time.
D. The percentage of time allocated to a queue varies with the performance of the jobs in that queue. If they run too long the percentage is decreased.
E. Each OS is designed differently.

(10) With paged memory hardware there was a bit in each page table entry called the "valid" bit that originally meant the page was not a part of the logical address space for the process. When Virtual Memory was implemented on top of this hardware we changed the significance of that bit. What did it now mean?
A. The page had not been referenced lately.

B. The page was not currently in memory.

C. The page was read only.

D. The page was part of the kernel space.

E. The page was dirty.

2 (5%) Consider a file system that uses inodes to represent files. Disk blocks are 8-KB in size and a pointer to a disk block requires 4 bytes. This file system has 12 direct disk blocks, plus single, double, and triple indirect disk blocks. What is the maximum size of a file that can be stored in this file system?

3 (13%) To meet the growing needs on both of capacity and performance of storage devices, the NAND flash-memory-based devices, i.e., solid-state disks (SSDs), are regarded as the primary storage candidate on the modern computing system. To overcome the inherent constraints of NAND flash memory, a key module called "flash translation layer (FTL)" is implemented and maintained in the SSD controller for efficiently manage the whole device. The FTL consists of three components, and they are address translator, garbage collector, and wear leveler. Please answer the following questions about the SSDs.

(1) Please provide two inherent constraints of NAND flash memory. (4%)

(2) Please describe the functionalities of garbage collector and wear leveler. (6%)

(3) Over-provisioning space is usually adopted to improve the performance of garbage collection and wear leveling processes. Please explain what is "over-provisioning space" and how it helps on improving the performance of garbage collection or wear leveling processes. (3%)

4 (6%) Consider the following snapshot of a system:

	Allocation				Max			
	A	B	C	D	A	B	C	D
P0	3	0	1	4	6	2	2	8
P1	2	2	1	0	4	3	2	2
P2	3	1	2	1	4	4	3	2
P3	0	5	1	0	5	7	2	3
P4	4	2	1	2	7	4	3	6

Using the banker's algorithm, determine whether or not each of the following states is unsafe. If the state is safe, illustrate the order in which the processes may complete. Otherwise, illustrate why the state is unsafe.

(1) Available = (1, 4, 1, 2)

(2) Available = (2, 1, 1, 3)

5 (6%) Consider a demand-paging system with the following time-measured utilizations:

CPU utilization 20%

Paging disk 97.7%

Other I/O devices 5%

Please provide three ways to improve the CPU utilization. The brief explanation is needed.

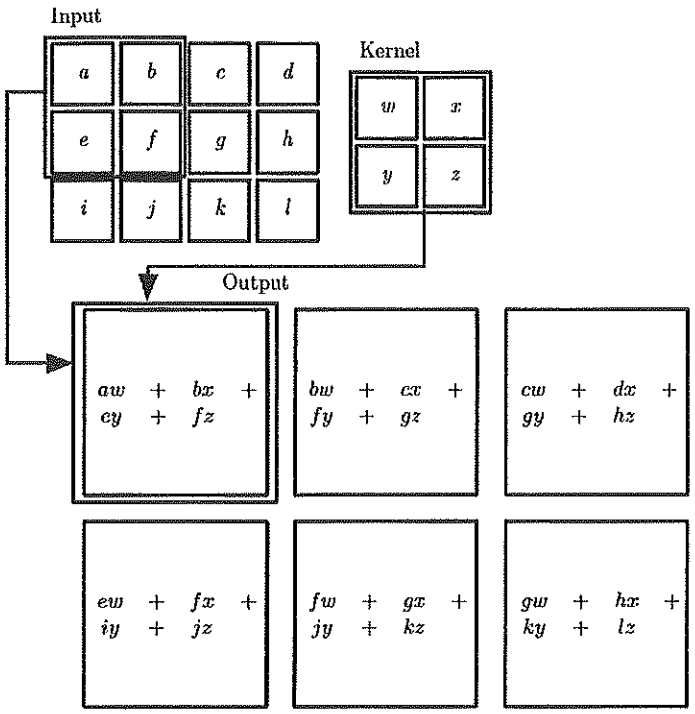
6 (5%) If we have two machines P and Q with the same instruction set architecture (ISA), the cycles per instruction (CPI) are 2.0 in P and 1.0 in Q, and the machine P has a clock cycle time of 250ps, and machine Q has a clock rate of 2.0 GHz. Then, for any program, please compare the performance between these two machines.

7 (5%) If a pipelined processor has five stages with the critical path delay of 5ns, 4ns, 6ns, 10ns, and 5ns, respectively. What is the minimum execution time for N instructions? (Assume that no pipeline stalls occur)

8 (5%) Assume a processor operates at clock frequency 2.5GHz, and the instruction cache and data cache are split. If all memory access is hit in the cache, the cycles per instruction (CPI) is 2. The miss penalty of the cache is 20ns. If a program runs on this processor, in the instructions been executed, 20% of them are memory access instructions. The miss rate for the instruction cache is 2%, and is 5% for the data cache. What is the actual CPI?

9 (10%) Convolutional neural networks (CNN) have demonstrated impressive performance in various computer vision tasks, and CNN spends the majority of computations in doing convolution. The following figure shows an example of convolution. If there is one **3×4** input map (*a* to *l*), the kernel size is **2×2** with four parameters (*w*, *x*, *y*, and *z*), and then the **2×3** output feature map can be computed as illustrated in the figure. Based on IEEE 754 standard, the single-precision numbers are stored in 32 bits with one sign bit, 8 exponent bits, and 23 mantissa bits. The inputs and kernel parameters are expressed

in the single-precision format. If we assume the values for a to l are 0xc0800000, the values for w, x, y, and z are 0x40000000. Please compute the output feature map and express the answer in the single-precision format.



10 (15%)

(1) Illustrate (a) the setup time (T_{setup}), (b) clock-to-q delay (T_{C2Q}), and (c) hold time (T_{hold}) of a flip-flop with a timing diagram.

(2) Express the minimum clock period of a synchronous circuit in terms of T_{setup}, T_{C2Q}, and T_{hold} of a flip-flop (i.e. pipeline register), and the critical path delay (T_{cp}) of the datapath.

(3) Use Amdahl's law to explain why pipelining a datapath into N stages cannot achieve the ideal speedup of N.

11 (10%) Design a 4-bit shift register with a minimum number of

(1) flip-flops, of which T_{setup}=10ps, T_{C2Q}=10ps, and T_{hold}=30ps, and

(2) inverters, of which the gate delay T_{inv}=50ps.

Draw the logic diagram and identify the critical path. What is the maximum operating frequency of your shift register?