

考試科目	計算機概論	所別	資訊科學 814 研究所	考試時間	3 月 18 日 星期六	第 1 節
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說明：

- 請書寫必要之解題過程。過程正確但答案錯誤，可能有部分分數。如題目之解答非顯而易見者，僅書寫答案而缺乏必要之過程，亦無法獲得該題之滿分。
- 可使用中文或英文作答。

1. 選擇題(單選)(20 分，每小題兩分)

題號	題目
(1)	Assembler uses the symbol table for one of the following purpose, pick the correct one. A. Translating the symbolic name to memory address value. B. Translating the symbolic name to mnemonic name. C. Converting the opcode to its binary form. D. Translating the mnemonic name into the opcode.
(2)	In WAN, topological changes normally are kept in A. Routing table. B. Symbol table. C. Opcode table. D. Hash table.
(3)	If the complexity of an algorithm is $an^2 + bn + c$ (of a problem of input size n), the code optimization in the compilation process can A. Reduce the constant a , b , and/or c . B. Reduce the order of the complexity from 2 to 1 C. Remove the constant c D. Add extra complexity to the algorithm..
(4)	The major purpose of a modem used for connecting a computer to the networks is A. Increase the communication bandwidth. B. Convert the digital signal to analog signal and vise versa. C. Obtain a high speed communication channel. D. Creating a friendly user interface.
(5)	When we say the memory of a computer is 256 MB and can be expanded to 1GB, what is a reasonable guess of the size of MAR? A、32 B、30 C、 2^8 D、256

備	考試題隨卷繳交
命題委員：	： 59 (簽章) 年 月 日

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考 試 科 目	計 算 機 概 論	所 別	資 訊 科 學 研 究 所	考 試 時 間	3 月 18 日 星期六	第 1 節
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國立政治大學圖書館

題 號	題 目
(6)	The machine cycle of a CPU can be summarized as “fetch”, “decode”, and “execute”. How does the CPU know where to fetch the instruction? A 、 primary storage B 、 cache C 、 register D 、 program counter
(7)	Disk mirroring is a technology that A. Increases the storage capacity of a disk. B. Improves speed by allowing simultaneous-reads/writes. C. Prevents head crashes by placing a protective “stripe” over the platter. D. Improves reliability by building in fault tolerance.
(8)	A computer that helps to direct communications traffic to the most efficient path through a series of interconnected networks is called a(n) A 、 gateway B 、 front end processor C 、 path calculator D 、 router
(9)	A computer has 256MB memory. What is the input size of the memory address decoder if it is a two-dimensional memory? A 、 2^{28} B 、 2^{14} C 、 28 D 、 14
(10)	A computer designer designed a new computer that has 72 instructions and the maximal addressable memory space is 4GB. What is the size of it’s IR in order to hold a two-address instruction. A 、 8 bits B 、 64 bits C 、 23 bits D 、 71 bits

2. (6 分)
- (1) What shall an OS do in order to initiate the execution of a program after loading the program into the memory? (4分)

(2) Which program of the OS will do this process, in general? (2分)

3. (4 分)

What is the most important difference between the random access and direct access?

備 考 試 題 隨 卷 繳 交
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國立政治大學圖書館

4. (8 分, 每小題 4 分)

For a computer system with 5 ns cache and 50 ns memory, if the average hit ratio of the cache is 0.8, what is the average memory access time using

- (1) simultaneous fetch information from cache and RAM algorithm, or
- (2) fetch information from RAM only after cache not found algorithm.

5. (12 分)

The hard disk of a personal computer has the following characteristics::

Rotation speed = 7200 rev/min

Access arm movement time = 1 ms fixed start up time + 0.1 ms for each track crossed (the 1 ms time is a constant no matter how far the arm moves.)

Number of surfaces = 8.

Number of tracks per surface = 1000.

Number of sectors per track = 40.

Number of bytes per sector = 512

- (1). What is the capacity of this hard disk? (in G, M, or K bytes)
- (2). What is the average access time, if 2 sectors of data are transferred for each access? (Assume that on the average, the read/write head must move about 300 tracks)
- (3). What is the average access time, if 4 sectors of data are transferred for each access?

備	考	題	隨	卷	繳	交
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6. (10%)

Given the following declarations of the stack implemented by a linked list, please complete the Push and the Pop routines listed in the following.

```

Struct Node;
typedef struct Node *PtrToNode;
typedef PtrToNode Stack;
struct Node {
    int Element;
    PtrToNode Next; }

```

(1) The routine to push a new element onto a stack.

```

void Push(int X, Stack S)
{
    PtrToNode TmpCell;

    TmpCell = malloc(sizeof(struct Node));
    if ( TmpCell == NULL)
        printf("Out of Memory");
    else
    {
        TmpCell->Element= X;
        ①...
        ②...
    }
}

```

(2) The routine to pop and return an element from a stack..

```

int Pop(Stack S)
{
    PtrToNode FirstCell;
    int First;

    ③...
    ④...
    free(FirstCell);
    return First;
}

```

備 考 試 題 隨 卷 繳 交

命 題 委 員 : 62 (簽章) 年 月 日

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國立政治大學圖書館

7. (10%)

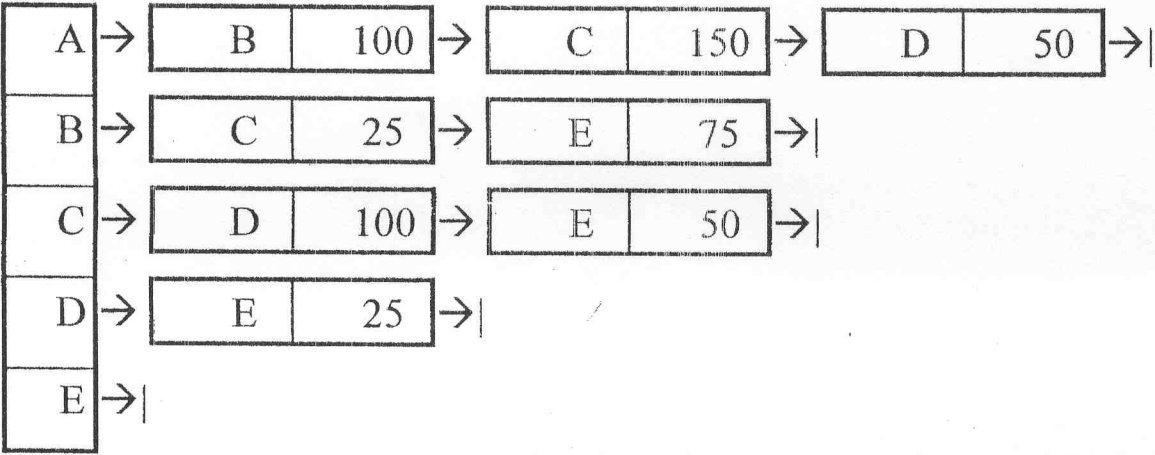
Open addressing is an alternative to resolving collisions of hashing. Given a hash function $h(X)=X \bmod 10$ and a sequence of input: 29, 38, 39, 18, 49, please show the resulting

- (1) open addressing hash table using linear probing function $F(i) = i$.
- (2) open addressing hash table using quadratic probing function $F(i) = i^2$.

8. (10%)

Given the following **acyclic directed graph** represented as an adjacency list,

- (1) to solve the shortest-path from vertex A to all the other vertices, please list the vertices in the order of selection (consideration) by **Dijkstra's algorithm**. (5%)
- (2) please list the vertices in the order of selection (consideration) to solve the longest-path from vertex A to all the other vertices by an **$O(|V|+|E|)$ algorithm**, where $|V|$ is the number of vertices, $|E|$ is the number of edges. (5%)



9. (10%)

- (1) Please list the recurrence formula for time complexity analysis of Quick sort. (2%)
- (2) Derive and prove the worst-case time complexity of Quick sort. (4%)
- (3) Derive and prove the best-case time complexity of Quick sort. (4%)

10. (10%)

An X-tree is a special binary search tree on which both the find-maximum and the find-minimum operations can be executed in $O(1)$ time.

- (1) Please construct an example of X-tree with at least 10 nodes. (5%)
- (2) Please list the algorithm to insert an element into an X-tree. (Note that an X-tree, after insertion of an element, must be also an X-tree) (5%)

備 考	試 題 隨 卷 繳 交
命 題 委 員 :	63 (簽章) 年 月 日

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考試科目	計算機系統	所別	資訊科學	考試時間	3月18日 星期六	第2節
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一. Computer Organization and Design

1. [I/O] (1) Both networks and buses are connected components together. Which of the following are true about them? (6%)
 - (a) Networks and I/O buses are almost always standardized.
 - (b) Shared media networks and multimaster buses need an arbitration scheme.
 - (c) Local area networks and processor-memory buses are almost always synchronous.
 - (d) High-performance networks and buses use similar techniques compared to their lower-performance alternatives: they are wider, send many words per transaction, and have separate address and data lines.(2) In ranking of the three ways of doing I/O, which statements are true? (4%)
 - (a) If we want the lowest latency for an I/O operation to a single I/O device, the order is polling, DMA and interrupt-driven.
 - (b) If we want the lowest impact on processor utilization from a single I/O device, the order is DMA, interrupt-driven and polling.
2. [RAID] What does RAID stand for? (4%) Regarding RAID levels 1,3,4,5, and 6, which one has the highest check disk overhead? (3%) Which one has worst throughput for small writes? (3%)
3. [Memory Hierarchies]
 - (1) Which of the following statements (if any) are generally true? (4%)
 - (a) There is no way to reduce compulsory misses.
 - (b) Fully associative caches have no conflict misses.
 - (c) In reducing misses, associativity is more important than capacity.
 - (2) A new processor can use either a write-through or write-back cache selectable through software. (6%)
 - (a) Assume the processor will run data intensive applications with a large number of load and store operations. Explain which cache write policy should be used.
 - (b) Consider the same question but this time for a safety critical system in which data integrity is more important.
4. [Multiprocessors, Amdahl's law] A program takes T_s seconds when executed on a single CPU. Now assume that we have p processors which can be used for parallel processing. (a) If only a fraction f of the program can be speeded up to take advantage of parallel processing, what is the speedup S ? (4%) (b) Now assume that the improvement in performance by using p processor can be formulated as $p/(1+px)$ for the parallelizable portion, find the value p that will maximize the overall speedup. (6%)
5. [Floating-point Representation] Consider a shorten version of the IEEE standard floating point format with only 12 bits: one sign bit, 5 bits for the exponent, and 6 bits for the significand.
 - (a) Represent 1.5 and -0.75 with this format. (4%)
 - (b) What is the range of numbers it could represent? (excluding denormalized numbers.) (6%)

備 考 試 題 隨 卷 繳 交

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:-: 64

(簽章)

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考試科目	計算機系統	所別	資訊科學 8141	考試時間	3月18日 星期六	第2節
國立政治大學圖書館 二. 1. [Basic Concepts] These are true or false problems. If your answer is false please give the true statement with respect to the original false one. (a) (3%) [Context Switch] Switching the CPU to another process requires saving the state of the new process and loading the saved state of the old process. This task is known as a context switch. The context of a process is represented in the Process Control Block (PCB) of a process; it includes the value of the CPU registers, the process state, and memory-management information. When a context switch occurs, the kernel saves the context of the new process in its PCB and loads the saved state context of the old process scheduled to run. Context-switch time is pure overhead, because the system does no useful work while switching. (b) (3%) [Semaphore] A semaphore <i>S</i> is an integer variable that, apart from initialization, is accessed only through two standard atomic operations: wait and signal. Although under the classical definition of semaphores with busy waiting the semaphore value is never negative, we may still have negative semaphore values in the implementation. If the semaphore value is negative, its magnitude is the number of processes waiting on that semaphore. A binary semaphore is a semaphore with an integer value that can range only between 0 and 1 while a counting semaphore its integer value can range over an unrestricted domain. In fact, a counting semaphore can be implemented using binary semaphores. (c) (3%) [Dynamic Loading] To obtain better memory-space utilization, we can use dynamic loading. With dynamic loading, a routine is not loaded until it is called. All routines are kept on disk in a relocatable load format. The main program is loaded into memory and is executed. The advantage of dynamic loading is that unused routine is never loaded. Dynamic loading does not require special support from the operating system. It is the responsibility of the users to design their programs to take advantage of such a method. Operating systems may help the programmer, however, by providing library routines to implement dynamic loading. (d) (3%) [Network File Systems (NFS)] NFS views a set of interconnected workstations as a set of independent machines with independent file systems. The goal is to allow some degree of sharing among these file systems in a transparent manner. Sharing is based on a client-server relationship. Two separate protocols are specified for these services: a mount protocol and the NFS protocol. The mount protocol provides a set of RPCs for remote file operations. The procedures support the following operations: searching for a file within a directory; reading a set of directory entries; manipulating links and directories; accessing file attributed; reading and writing files. (e) (3%) [Protection] The main differences between capability lists and access lists for the implementation of access matrix are: each row in the access matrix can be implemented as an access list for one object while the capability list associates each column with its domain so a capability list for a domain is a list of objects together with the operations allowed on those objects.						
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考試科目	計算機系統	所別	資訊科學	考試時間	3月18日 星期六	第2節
國立政治大學圖書館 2. [Process Synchronization] (a) (6%) Demonstrate what are the appropriate conditions on using semaphores, conditional critical regions, and monitors to solve the process synchronization problem? (b) (4%) Describe the Dining Philosophers Problem? (c) (5%) How do we model Dining Philosophers Problem as a process synchronization problem (Note: you can use either semaphore or monitor primitives to explain your design philosophy but you do not have to write their complete source code)? 3. [Memory Management] (a) Consider a two-level page-table scheme, in which the outer page table itself is also paged with the page table stored in memory: i. (2%)If a memory reference takes 90 nanoseconds, how long does a paged memory reference take? ii. (3%)If we add TLBs, and 95 percent of all page-table references are found in the TLBs, what is the effective memory reference time? (Assume that finding a page-table entry in the TLBs take 9 nanoseconds, if the entry is there. (b) (5%)Consider a demand-paging system with a paging disk that has an average access and transfer time of 15 milliseconds. Addresses are translated through a two-level hierarchical paging systems with a page table in main memory, with an access time of 2 microsecond per memory access. Thus, each memory reference through the page table takes two accesses. To improve this time, we have added an associative memory that reduces access time to one memory reference, if the page-table entry is in the associative memory. Assume that 85 percent of the accesses are in the associative memory, and that, of the remaining, 30 percent (or 4.5 percent of the total) cause page faults. What is the effective memory access time? 4. [Protection] (a) (5%) What is the confinement problem? Why we said this problem is in general unsolvable? (b) (5%) In a ring-protection system, level 0 has the greatest access to objects, and level n (greater than zero) has fewer access rights. The access rights of a program at a particular level in the ring structure are considered as a set of capabilities. What is the relationship between the capabilities of a domain at level j and a domain at level i to an object (for $j > i$)? 備考 試題隨卷繳交 命題委員： 66 (簽章)						

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考試科目	計算機數學	所別	資訊科學	考試時間	3月18日 星期六	第3節
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國立政治大學圖書館

離散 I、(10%) 1. Let the language L consist of all strings of the form $a^k b^k$, where k is a positive integer. Symbolically, L is the language over the alphabet $\Sigma = \{a, b\}$ defined by

$$L = \{s \in \Sigma^* \mid s = a^k b^k, \text{ where } k \text{ is a positive integer}\}.$$

Is there a finite-state automaton that accepts L ?

(10%) 2. Find the number of bit strings of length 10 that do not contain the pattern 11.

(10%) 3. Define a sequence $a_1, a_2, a_3, \dots$ recursively as follows:

$$a_1 = 1,$$

$$a_k = 2 \cdot a_{\lfloor k/2 \rfloor} \quad \text{for all integers } k \geq 2.$$

Use iteration to guess an explicit formula for this sequence.

(10%) 4. Design a *mod 3* counter i.e., an FSM (Finite State Machine) whose output at a given time equals the total number of 1s (*mod 3*) in the input stream, up to that time.

As an example, here is one possible input sequence and the corresponding outputs:

(Inputs) x_n	0	1	1	0	1	1	1	1	0	1	1	0	0	1	...
(Outputs) y_n	0	1	2	2	0	1	2	0	0	1	2	2	2	0	...

(10%) 5. For each of the following four regular expressions, construct an NFA (Nondeterministic Finite Automaton) that accepts the corresponding regular language.

(a) $a^*(b+\epsilon)$

(b) $a^*b^* + c^*$.

(10%) 6. Consider the set of all one-to-one and onto functions from the set $S = \{1, 2, \dots, n\}$ to itself. If f is one of these functions, a fixed point of f is an element $x \in S$ such that $f(x) = x$. If one of these functions is chosen at random, what is the probability that it has no fixed points?

備 考 試 題 隨 卷 繳 交

命 題 委 員 :

67

(簽章)

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線代						
II、(10%) 1. Find the general solution of the linear system whose augmented matrix has been reduced to						
$\begin{bmatrix} 1 & 6 & 2 & -5 & -2 & -4 \\ 0 & 0 & 2 & -8 & -1 & 3 \\ 0 & 0 & 0 & 0 & 1 & 7 \end{bmatrix}$						
(10%) 2. Find an LU factorization of						
$A = \begin{bmatrix} 2 & 4 & -1 & 5 & -2 \\ -4 & -5 & 3 & -8 & 1 \\ 2 & -5 & -4 & 1 & 8 \\ -6 & 0 & 7 & -3 & 1 \end{bmatrix}$						
(10%) 3. Diagonalize the following matrix, if possible.						
$A = \begin{bmatrix} 1 & 3 & 3 \\ -3 & -5 & -3 \\ 3 & 3 & 1 \end{bmatrix}$						
That is, find an invertible matrix P and a diagonal matrix D such that $A = PDP^{-1}$.						
(10%) 4. Find the kernel of the linear transformation T from R^5 to R^4 given by the matrix						
$A = \begin{bmatrix} 1 & 5 & 4 & 3 & 2 \\ 1 & 6 & 6 & 6 & 6 \\ 1 & 7 & 8 & 10 & 12 \\ 1 & 6 & 6 & 7 & 8 \end{bmatrix}$						
備	考	試題隨卷繳交				
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國立政治大學圖書館

I. 離散 60%

(10%) 1. Let the language L consist of all strings of the form $a^k b^k$, where k is a positive integer. Symbolically, L is the language over the alphabet $\Sigma = \{a, b\}$ defined by

$$L = \{s \in \Sigma^* \mid s = a^k b^k, \text{ where } k \text{ is a positive integer}\}.$$

Is there a finite-state automaton that accepts L ?

(10%) 2. Find the number of bit strings of length 10 that do not contain the pattern 11.

(10%) 3. Define a sequence $a_1, a_2, a_3, \dots$ recursively as follows:

$$a_1 = 1,$$

$$a_k = 2 \cdot a_{\lfloor k/2 \rfloor} \quad \text{for all integers } k \geq 2.$$

Use iteration to guess an explicit formula for this sequence.

(10%) 4. Design a *mod 3* counter i.e., an FSM (Finite State Machine) whose output at a given time equals the total number of 1s (*mod 3*) in the input stream, up to that time. As an example, here is one possible input sequence and the corresponding outputs:

(Inputs) x_n	0	1	1	0	1	1	1	1	0	1	1	0	0	1	...
(Outputs) y_n	0	1	2	2	0	1	2	0	0	1	2	2	2	0	...

(10%) 5. For each of the following four regular expressions, construct an NFA (Nondeterministic Finite Automaton) that accepts the corresponding regular language.

(a) $a^*(b+\epsilon)$

(b) $a^*b^* + c^*$.

(10%) 6. Consider the set of all one-to-one and onto functions from the set $S = \{1, 2, \dots, n\}$ to itself. If f is one of these functions, a fixed point of f is an element $x \in S$ such that $f(x) = x$. If one of these functions is chosen at random, what is the probability that it has no fixed points?

備 考 試 題 隨 卷 繳 交

命 題 委 員 : 69 (簽章) 95 年 3 月 4 日

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考試科目	計算機數學與網路	所 別	資訊科學	考試時間	3月18日 星期六	第 3 節
II、「計算機數學與網路」科之「計算機網路概論」部份，共佔 40% [8%] 1. If the data link layer provides error checking, and the transport layer provides error checking, isn't this redundant? Explain. [8%] 2. What is the principle difference between connectionless communication and connection-oriented communication? [8%] 3. Give two reasons why networks might use an error-correcting code instead of error detection and retransmission. [8%] 4. A datagram subnet allows routers to drop packets whenever they need to. The probability of a router discarding a packet is p. Consider the case of a source host connected to the source router, which is connected to the destination router, and then to the destination host. If either of the routers discards a packet, the source host eventually times out and tries again. If both host-router and router-router lines are connected as hops, what is the mean number of (a) hops a packet makes per transmission? (b) transmissions a packet makes? (c) hops required per received packet? [4%] 5. Both UDP and TCP use port numbers to identify the destination entity when delivering a message. Give two reasons for why these protocols invented a new abstract ID (port numbers), instead of using process IDs, which already existed when these protocols were designed. [4%] 6. Can a firewall filter out requests to a particular IP address, a port address, or both? What is the difference?						
備 考	試 題 隨 卷 繳 交					
命 題 委 員 :				70	(簽章)	

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。
2. 書寫時請勿超出格外，以免印製不清。
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。