



I. 單選題，共九分，每題三分

1. Given the following template function definition, which of the following is not a valid invocation of the function?

```
template <class T>

void swap(T& left, T& right)
{
    //implementation goes here, not relevant to the question
}
```

```
int int1, int2;
float flt1, flt2;
char ch1, ch2;
string s1, s2;
    a. swap(s1,s2);
    b. swap(int1, int2);
    c. swap(ch1, ch2);
    d. swap(int1, ch2);
```

2. What is the output of the following code fragment?

```
int v1=2, v2=-1, *p1, *p2;
p1 = & v1;
p2= & v2;
p2=p1;
cout << *p2 << endl;
    a. 2
    b. -1
    c. -2
    d. 1
```

3. Given the following function declaration

```
void insert( NodePtr afterMe, int num);
//PRE: afterMe points to some node in the non-empty list
//POST: A new node containing num is inserted after afterMe.

void insert(NodePtr afterMe, int num)
{
    // which of the following function definitions correctly
implement this //function?
}
```



- a. `afterMe->link = new Node;`
`afterMe->link->data = num;`
`afterMe -> link ->link=afterMe->link;`
- b. `NodePtr tmp=new Node;`
`tmp-> data = num;`
`afterMe -> link = tmp;`
`tmp->link = afterMe -> link;`
- c. `NodePtr tmp=new Node;`
`tmp-> data = num;`
`tmp->link = afterMe -> link;`
`afterMe -> link = tmp;`
- d. `NodePtr tmp=new Node;`
`tmp-> data = num;`
`afterMe -> link = tmp;`
`tmp->link = NULL;`

II.簡答題 (91%)

1. (3%) Given the following code fragment, what is the stopping condition(s)?

```
int f1(int x, int y)
{
    if(x<0 || y<0)
        return x-y;
    else
        return f1(x-1,y) + f1(x,y-1);
}
int main()
{
    cout << f1(1,2)<<endl;
    return 0;
}
```

2. (15%) Please describe the concept of ADT. Give the Stack ADT and Queue ADT.
3. (10%) Given the frequency of characters as shown in Table 1, please draw the Huffman coding tree and generate the final codes for each character.

Character	A	B	C	D	E
Frequency	18	11	11	26	33

Table 1. Frequency of Characters



4. (3%) What is wrong with the following definition of headInsert, which inserts a node to the head of a linked list?

```

struct Node
{
    int item;
    Node* link;
};

typedef Node* NodePtr;

void headInsert(NodePtr& head, int data)
{
    NodePtr tmp = new Node;
    tmp->item = data;
    head->next = tmp;
    tmp->next = head->next;
}

NodePtr head;
headInsert(head, 4);

```

5. (10%) Please write codes to implement QuickSort. Analyze the worst case running time and indicate when the worst case will happen.
6. (10%) Write a C/C++ recursive function that return the value of x^{-n} . (hint: $x^{-n} = \frac{1}{x^n}$)
7. (10%) Write a function definition for a function called des_order that takes three arguments of type int. The function returns true if the three arguments are in descending order; otherwise, it returns false. For example, des_order (3,2,1) and des_order (6,3,3) both return true, while des_order (1,2,3) returns false.
8. (10%) Write a void function definition for a function called add_tax. The function has two formal parameters: tax_rate, which is the amount of sales tax expressed as a percentage, and cost, which is the cost of an item before tax. The function changes the value of cost so that it includes sales tax.
9. (5%) One algorithm need 10 basic operations to process an input of size n, and another algorithm needs 25n basic operations to process the same input. Which of the two algorithms is more efficient?
10. (10%) Write a function whose prototype is
void exchange (int *p, int *q);
that takes two pointers to integer variables and exchanges the values in those variables.



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科目：計算機概論(2)

11. (5%) What is the output of the following program?

```
#include <iostream>
using namespace std;

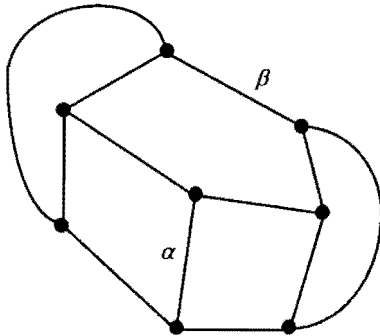
void test(int=6, int=1, int=5);

int main( )
{
    test ( );
    test (2);
    test (3,3);
    test (9, 7, 8);
    return 0;
}

void test (int first, int second, int third)
{
    first +=4;
    second+=5;
    third +=6;
    cout << first << " " << second << " " << third <<endl;
}
```



1. Show that any Hamiltonian cycle in the following graph that contains the edge α must also contain the edge β . (10%)



2. Solve the recurrence relation and find the value of a_{16} , where $a_{n+1}^2 = 5a_n^2, a_n \geq 0, a_0 = 3$. (15%)
3. Determine the generating function for the sequence: $0, 0, 1, 0, 0, 1, 0, 0, 1, \dots$ (15%)
4. (a) If the **in-order** and **post-order** results of a binary tree T are **CBFDGA** and **CFGDBA**, respectively, please determine the binary tree T, where $\{A, B, C, D, E, F, G\}$ are tree nodes. (5%)
 (b) Meanwhile, list the **pre-order** of the binary tree T. (5%)
5. The population of Olympia is approximately 18, 273. Show that at least two people in Olympia have the same initials. (Note that some people do not have middle names.) (5%)
6. Define the relation R on Z to be $a R b$ if $a - b$ is prime. Is R reflexive? Symmetric? Transitive? Explain why! (5%)
7. Let $\Sigma = \{a, b, c, d, e\}$. (a) What is $|\Sigma^2|$? $|\Sigma^3|$? (b) How many strings in Σ^* have length at most 5? (8%)
8. Verify that the expression $(p \Rightarrow q) \Leftrightarrow (\neg p \vee q)$ is a tautology. (7%)
9. Write a Turing machine that, when run on the tape (8%)
 ... b 1 1 1 0 b ...
 will produce an output tape of
 ... b 1 1 1 0 1 b ...
10. Consider the open statement (10%)
 $p(x, y): y - x = y + x^2$
 where the universe for each of the variables x, y comprises all integers. Determine the **True** or



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False value for each of the following statements:

A) $p(0,1)$

B) $\forall y p(0,y)$

C) $\exists y p(1,y)$

D) $\forall x \exists y p(x,y)$

E) $\exists y \forall x p(x,y)$

11. Please minimize the finite state machine shown below. (7%)

	Next State		Output	
	0	1	0	1
S_1	S_4	S_3	0	0
S_2	S_5	S_2	1	0
S_3	S_2	S_4	0	0
S_4	S_5	S_3	0	0
S_5	S_2	S_5	1	0
S_6	S_1	S_6	1	0



A. 題目1至題目10為單選題，每題5分。(50%)

1. Which is not the main advantage of multiprocessor systems?
 - (A) increased throughput
 - (B) economy of scale
 - (C) increased reliability
 - (D) high CPU utilization

2. Which is a closed-source operating system?
 - (A) GNU/Linux
 - (B) Microsoft Windows
 - (C) BSD UNIX
 - (D) Solaris

3. What is the structure of Solaris?
 - (A) monolithic structure
 - (B) layered approach
 - (C) microkernel
 - (D) modules

4. Which is not the benefit of multithreaded programming?
 - (A) real-time
 - (B) resource sharing
 - (C) economy
 - (D) scalability

5. Which is a nonpreemptive process scheduling algorithm?
 - (A) FCFS scheduling
 - (B) SJF scheduling
 - (C) priority scheduling
 - (D) RR scheduling

6. Which is not the condition the deadlock prevention approach tries to prevent?
 - (A) no preemption
 - (B) circular wait
 - (C) mutual exclusion
 - (D) hold and wait



7. Which strategy does not need to search the entire list of free holes?
- (A) random fit
 - (B) first fit
 - (C) best fit
 - (D) worst fit
8. If it takes 20ns to search the TLB and 120ns to access memory, how long is the effective memory-access time for an 90% hit ratio?
- (A) 126ns.
 - (B) 142ns
 - (C) 152ns.
 - (D) 162ns
9. Which page-replacement algorithm may exhibit Belady's anomaly?
- (A) FIFO
 - (B) optimal page replacement
 - (C) LRU
 - (D) LFU
10. Which allocation method cannot support both sequential and direct access?
- (A) contiguous allocation
 - (B) linked allocation
 - (C) indexed allocation
 - (D) multilevel index
- B. 題目11至題目13為詳答題。(50%)
11. (a) Why we need the synchronization mechanism in an operating system? (5%)
(b) Define the Dining Philosopher (DP) problem in the operating system. (5%)
(c) Solve the DP problem by using the “Monitor” method and give some detail descriptions of the codes. (15%)
12. Determine the AWT (Average waiting time) and ATT (Average turnaround time) by using the Preemptive Shortest Job First (P-SJF) scheduling. (15%)



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科目：作業系統

Process	Arrival time	Burst Time
P1	0	8
P2	1	4
P3	2	9
P4	3	5

13. Describe how to implement an OS with supporting of multitasking? And what is the main overhead and impact of that? (10%)



本試題共九題，共計 100 分，請依題號作答並將答案寫在答案卷上，違者不予計分。

1. (20%) Let P_n denote the set of real polynomial functions of degree $\leq n$.
 - (a) (10%) Show that the set $\{x^2 + 1, 3x - 1, -4x + 1\}$ is linearly independent in P_2 .
 - (b) (10%) Show that the set $\{x + 1, x - 1, -x + 5\}$ is linearly dependent in P_1 .
2. (10%) Find the reduced echelon form for each of the following matrices. Use the echelon form to determine a basis for the row space, and the rank of each matrix.

(a) (5%)
$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & -1 & -1 \\ 3 & 4 & 7 \end{bmatrix}$$

(b) (5%)
$$\begin{bmatrix} 1 & 1 & 0 & -1 \\ 2 & 1 & 0 & 0 \\ 3 & 2 & 0 & -1 \\ -1 & 0 & 1 & 1 \end{bmatrix}$$

3. (20%) Let $T: U \rightarrow V$ be a linear transformation. Let T be defined relative to bases $\{\mathbf{u}_1, \mathbf{u}_2\}$ and $\{\mathbf{v}_1, \mathbf{v}_2\}$ of U and V as follows:

$$T(\mathbf{u}_1) = 2\mathbf{v}_1 + 3\mathbf{v}_2, \quad T(\mathbf{u}_2) = 4\mathbf{v}_1 - \mathbf{v}_2.$$

- (a) (10%) Find the matrix of T with respect to these bases.
 - (b) (10%) Use this matrix to find the image of the vector $\mathbf{u} = 2\mathbf{u}_1 + 5\mathbf{u}_2$.
4. (8%) Please answer:
 - (a) (4%) Determine the matrix of coefficients and augmented matrix of each following system of equation.

$$\begin{cases} x_1 + 2x_2 + 3x_3 = 14 \\ 2x_1 + 5x_2 + 8x_3 = 36 \\ x_1 - x_2 = -4 \end{cases}$$

- (b) (4%) Solve the system using the method of Gauss-Jordan elimination with matrices.
5. (6%) Find the image of the triangle having the following vertices $A(1, 2)$, $B(2, 8)$, $C(3, 2)$ under the rotation of $\pi/2$ with respect to point $P(5, 4)$.
 6. (12%) Evaluate the determinants of the following matrices.

(a)
$$\begin{bmatrix} 0 & 3 & 2 \\ 1 & 5 & 7 \\ -2 & -6 & -1 \end{bmatrix}$$



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科目：線性代數(2)

$$(b) \begin{bmatrix} 1 & -2 & 3 & 0 \\ 4 & 0 & 5 & 0 \\ 7 & -3 & 8 & 4 \\ -3 & 0 & 4 & 0 \end{bmatrix}$$

$$(c) \begin{bmatrix} 2 & 5 & 1 & 0 \\ 0 & 3 & 2 & -7 \\ 0 & 0 & 5 & 1 \\ 0 & 0 & 0 & -2 \end{bmatrix}$$

$$(d) \begin{bmatrix} 1 & -2 & 3 \\ 7 & 5 & 4 \\ 0 & 0 & 0 \end{bmatrix}$$

7. (10%) Consider the matrix $A = \begin{bmatrix} 0 & 0 & 3 \\ 1 & 0 & 1 \\ 0 & 1 & 3 \end{bmatrix}$.

(a) (5%) Find its eigenvalues.

(b) (5%) Find the corresponding normalized eigenvectors.

8. (8%) If $A^{-1} = \begin{bmatrix} 3 & 4 \\ -1 & -1 \end{bmatrix}$; find A .

9. (6%) Determine whether the following matrices are singular. Give the reason.

(a) $\begin{bmatrix} 1 & 5 & 5 \\ 0 & -2 & -2 \\ 3 & 1 & 1 \end{bmatrix}$

(b) $\begin{bmatrix} 7 & 9 & 0 \\ -2 & 3 & 0 \\ 4 & 5 & 0 \end{bmatrix}$



- You are going to enhance a machine, and there are two possible improvements: either makes multiply instructions run five times faster than before, or make memory access instructions run two times faster than before. You repeatedly run a program that takes 10 seconds to execute. Of this time, 25% is used for multiplication, 50% for memory access instructions, and 25% for other tasks.

 - What will the speedup be if you improve only multiplication? (6%)
 - What will the speedup be if you improve only memory access? (6%)
 - What will the speedup be if both improvements are made? (6%)
- A CPU designs with pipeline technique. For pipelined execution, assume that half of the load instructions incur the data hazards (required one clock stall), that the one-quarter of the branches have control hazards (required one clock for branch delay). If one program has 40% loads, 15% stores, 20% branches, 5% jumps, and 20% ALU. What is the average CPI? (14%)

- Table 1 shows the CPI values for different instruction classes. There are two compilers which compile the same program. Table 2 shows the results for each compiler.

Table 1

instruction class	CPI
A	1
B	4
C	2

Table 2

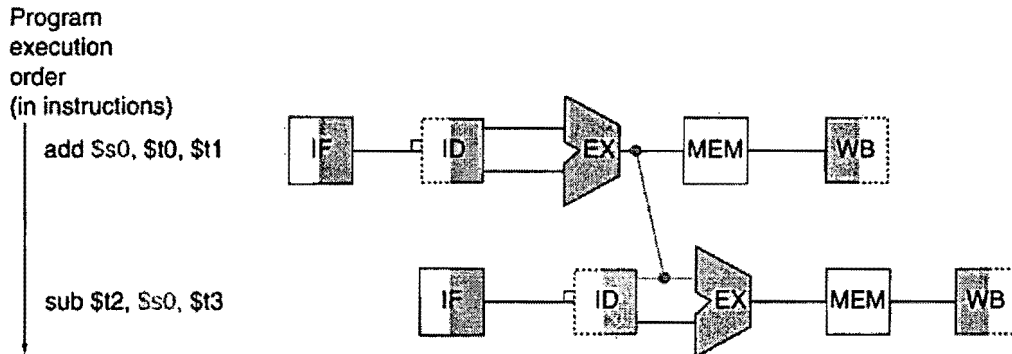
Code from	Instruction counts (in millions) for each instruction class		
	A	B	C
Compiler 1	6	1	1
Compiler 2	10	1	1

If the machine's working frequency is 100MHz, please answer the following question.

- What is the MIPS value for compiler 1 and compiler 2? (6%)
 - What is the CPI value for compiler 1 and compiler 2? (6%)
 - What is the CPU time for compiler 1 and compiler 2? (6%)
- Show the IEEE 754 binary representation of the number of -0.75_{ten} in single precision. (10%)
 - How many total bits are required for a directed-mapped cache with 16KB of data and 4-word blocks, assuming a 32-bit address? (10%)
 - Consider a cache with 64 blocks and a block size of 16 bytes. To what block number does byte address 1200 map? (10%)



7. For the instruction `sub $t2, $s0, $t3`, how many clock cycles should it have to waste after a forwarding path (shown in the figure) is added? (10%)



8

I-MEM	Add	Mux	ALU	Regs	D-Mem	Sign-extend	Shift-left-2
400ps	100ps	30ps	120ps	200ps	350ps	20ps	0ps

- (a) What is the clock cycle if the only type of instructions we need to support are ALU instructions (add, and, etc.)? (5%)
- (b) What is the clock cycle time if we only had to support lw instructions? (5%)