注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 109 學年度碩士班考試入學試題

系所班組別：資訊系統與應用研究所

科目代碼：2401
考試科目：計算機概論

一作答注意事項一

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。

2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。

3. 考生限在答案卷上標記「┌由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。

4. 答案卷用盡不得要求加頁。

5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。

6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「**國立清華大學試場規則及違規處理辦法**」，無法因本試題封面作答注意事項中未列明而稱未知悉。

1. (10%) The following code D2B is designed to print the binary representation of a nonnegative decimal number N.
    (a) (4%) Please complete the code using recursion.
    (b) (3%) Suppose the program is correctly implemented. What will be printed when D2B(N) is called with N=37?
   (c) (3%) What is the time complexity of D2B(N)? Express your answer in the big-O notation.

```
void D2B(int N) {
    if (N = = 0 or N = = 1) {
        print (N)
    } else
        (To be completed)
        ...
    }
}
```

2. (10%) Floating point representation.
    (a) (4%) What is the binary number representation of a decimal number 2.625?
    (b) (3%) Suppose there is an 8-bit floating number representation for real numbers. The floating number representation has three fields in the following order: 1 bit for sign, 4 bits for exponent (shifter), and 3 bits for mantissa (fixed-point number). The exponent is represented by the excess system with bias 7. Use this floating point representation to represent a decimal number 2.625.
    (c) (3%) What is the truncation error if the 8-bit floating number representation is used to represent a decimal number 2.625? Express your answer in the decimal format.

3. (4%) The following truth table shows a logic function that has two inputs and one output. Design a circuit using AND, OR, NOT gates to implement this function. The number of gates used should be less than four.

Input1	Input2	Output
0	0	1
0	1	0
1	0	1
1	1	1

4. (6%) Binary search and sequential search.
   (a) (3%) For an unsorted sequence, one needs to sort the sequence first to apply the binary search. Under what kind of situations the binary search is faster than the sequential search.
   (b) (3%) For a sorted sequence, under what kind of situations the sequential search is faster than the binary search.

5. (8%) Suppose that a program consists of n instructions in sequential order. A machine cycle consists of three phases, namely, phase 1, phase 2, and phase 3. All phases require the same amount of time, T, to complete.
   (a) (4%) Calculate the total amount of time to complete the execution of the program using a CPU with no pipelining.
   (b) (4%) Calculate the total amount of time to complete the execution of the program using a CPU with pipelining.

6. (4%) How many TCP connections are opened and closed to transfer 10 files using the FTP protocol?

7. (8%) Name four services that are provided by the TCP but not provided by the UDP.

8. (9%) Name three pieces of information that can be observed by a TCP sender to infer a congestion condition in the network without any explicit feedback from routers.

9. (6%) In an operating system, what are stored in a job queue? What are stored in a process queue?

10. (15%) Consider a binary tree with height equal to H. The identification numbers of the vertices in the binary tree are given in the order of level-order traversal. Then each vertex is assigned a weight equal to the inverse of its identification number. The identification numbers and weights of the vertices in an example binary tree with $H = 3$ and 6 vertices are illustrated in the figure below.

    identification number of vertices
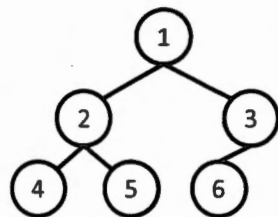
    weights of vertices
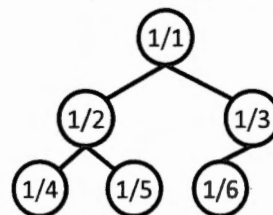
    (a) (5%) How many vertices are there in a binary tree of height H? (H can be any positive integer.)
    (b) (10%) What is the lowest height of a binary tree whose sum of weights of all vertices is greater than 14.3? [Hint: $ln2$ is roughly equal to 0.69.]

11. (10%) Some data structures.
    (a) (5%) Given a prefix expression +×a+bcd, what is the corresponding postfix expression?
    (b) (5%) Consider the list of numbers: 62, 31, 70, 91, 25, 11, 9, 61, 73, 6. Show the result of inserting the numbers in the list (in the same order specified above) into an initially-empty **binary search tree**.

12. (10%) **Fill in** the five blanks **(A, B, ..., E)** in the following C++ function, *Reverse( )*, which reverses a singly linked list (or called a *Chain* in the program code). For example, after running *X.Reverse( )* where $X=(x_1, x_2, ..., x_n)$ is a chain, X will become $(x_n, x_{n-1}, ..., x_1)$.

```
// Declaration of a node (in a chain).
template <class T>
class ChainNode   {
friend class Chain <T>;
private:
    T data;
    ChainNode<T>* link;
    // "link" points to the next node in the chain.
    // "link" of the last node is set to be NULL.
};
```

```
// Declaration of a chain.
template <class T>
class Chain   {
private:
    ChainNode<T> *first;
    // "first" points to the 1st node in the chain.
public:
    Chain(void) {first = last = NULL;}; // constructor
    void Chain<T>::Reverse(void); // The function.
};
```

```
// This is the function used for reversing the chain.
// In other words, it turns a chain (x1, x2, ..., xn) into (xn, xn-1, ..., x1).
template < class T >
void Chain<T>::Reverse(void)    {
    ChainNode<T> *next = first, *current = NULL;
    while (next) {
        ChainNode<T> *previous =    A    ;
        current =    B    ;
        next =    C    ;
        current->link =    D    ;
    }
    first =    E    ;
}
```