


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 108 學年度碩士班考試入學試題

系所班組別：資訊工程學系

考試科目(代碼)：基礎計算機科學(2301)

— 作答注意事項 —

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。

國立清華大學 108 學年度碩士班入學考試試題

系所班組別：基礎計算機科學

考試科目（代碼）：2301

共 4 頁，第 1 頁 *請在【答案卷、卡】作答

1. (10%) Use generating functions to answer the following questions.
 - (A) (7%) Find the solution of the recurrence relation $a_n = 4a_{n-1} - 3a_{n-2} + 2^n + n + 3$ with $a_0 = 1$ and $a_1 = 4$.
 - (B) (3%) Find the coefficient of x^{10} in the power series of $x^4/(1-3x)^3$.
2. (10%) How many relations are there on a set with n elements that are
 - (A) (5%) both reflexive and symmetric?
 - (B) (5%) neither reflexive nor irreflexive?
3. (5%) How many nonisomorphic unrooted trees are there with five vertices?
4. (5%) Multiple answer question. (It is possible that more than one of the choices are correct. Find out all correct choices.)

A hash table of length 10 uses the hash function $h(k) = k \bmod 10$ and the **linear probing** for handling overflow. After inserting 6 values into an initially-empty hash table, the table is as shown below. Which one(s) of the following choices gives a possible order in which the key values could have been inserted in the table?

0	
1	
2	42
3	23
4	34
5	52
6	46
7	33
8	
9	

- (A) 46, 42, 34, 52, 23, 33
- (B) 34, 42, 23, 52, 33, 46
- (C) 46, 34, 42, 23, 52, 33
- (D) 42, 46, 33, 23, 34, 52
- (E) 42, 23, 34, 46, 52, 33

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共 4 頁，第 2 頁 *請在【答案卷、卡】作答

5. (5%) **Fill in** the six blanks (**I, II, ..., and VI**) in the following program that implements a *queue* by using 2 *stacks*.

```
class MyQueue<T>{
private:
    stack<T> stack1;
    stack<T> stack2;
public:
    MyQueue()
    {
        stack1 = new stack<T>();
        stack2 = new stack<T>();
    }
    // enqueue(): Add an element at the rear side of MyQueue
    void enqueue(T e)
    {
        stack1.push(e);
    }
    // dequeue(): Remove the front element from MyQueue
    T dequeue(T e)
    {
        if (  I  .isEmpty() )
            while( !( II ).isEmpty() )
                ( III ).push( ( IV ) .pop() );
        T temp = null;
        if( !( V ).isEmpty() )
            temp = ( VI ).pop();
        return temp;
    }
}
```

6. (5%) AVL Tree.

(A) (2%) Please draw how an initially-empty AVL tree would look like after sequentially inserting the integer keys 100, 200, 50, 300, 400. There is no need to show it in a step-by-step fashion; you only need to draw the final result.

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共 4 頁，第 3 頁 *請在【答案卷、卡】作答

- (B) (3%) Continue the previous sub-problem. Suppose that the integer keys 25, 250, 225, 500, 240, 260 are sequentially inserted into the AVL tree of the previous sub-problem. Draw the AVL tree after all of these integer keys are inserted.
7. (5%) Reconstruct and draw the maximum binary heap whose in-order traversal is 2, 16, 7, 62, 5, 9, 188, 14, 78, 10. There is no need to show it in a step-by-step fashion; you only need to draw the final result.
8. (5%) The following algorithm takes an array as input and returns the array with all the duplicate elements removed. For example, if the input array is {1, 3, 3, 2, 4, 2}, the algorithm returns {1, 3, 2, 4}.

```
S = new empty set
A = new empty dynamic array
for every element x in input array
  if not S.member(x) then
    S.insert(x)
    A.append(x)
return A
```

Suppose that the input array has n elements. What is the big-O complexity of this algorithm, if the set S is implemented as:

- (A) (1%) a hash table (with the assumption that overflow does not occur)?
- (B) (2%) a binary search tree?
- (C) (2%) an AVL tree?
9. (10%) The recurrence $T(n) = 7T\left(\frac{n}{2}\right) + n^2$ describes the running time of an algorithm A . A competing algorithm A' has a running time of $T'(n) = aT'\left(\frac{n}{4}\right) + n^2$. What is the largest integer value for a such that A' is asymptotically faster than A ?
10. (15%) Consider the following undirected graph $G=(V,E)$.

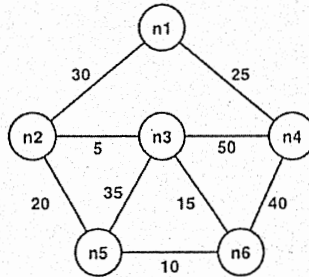
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共 4 頁，第 4 頁

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- (A) (5%) Draw the process of finding a minimum spanning tree using Kruskal's algorithm.
- (B) (5%) Draw the process of solving the single-source shortest path problem with node **n1** as the source vertex using Dijkstra's algorithm.
- (C) (5%) Starting from **n1**, find the Depth-First Search (DFS) traversal sequence of **G** (the priority of node is inversely proportional to the weight of incident edge).
11. (18%) Given an ordered file with keys 1, 2, ..., 16, determine the number of key comparisons made by a search algorithm *A* while searching for a specific key *K*.
- (A) (3%) *A* is the binary search algorithm and *K* is 2.
- (B) (3%) *A* is the binary search algorithm and *K* is 10.
- (C) (3%) *A* is the binary search algorithm and *K* is 15.
- (D) (3%) *A* is the Fibonacci search algorithm and *K* is 2.
- (E) (3%) *A* is the Fibonacci search algorithm and *K* is 10.
- (F) (3%) *A* is the Fibonacci search algorithm and *K* is 15.
12. (7%) Given a store of *n* items, what's the least upper bound (in Big-O notation) of the running time of the solutions to the following problems:
- (A) (3%) Fractional knapsack problem;
- (B) (4%) General 0/1 knapsack problem.