

國立臺灣師範大學 98 學年度碩士班招生考試試題

科目：軟體基礎

適用系所：資訊工程學系

注意：1.本試題共 7 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

1. 選擇題 (共 30 分，單選題，請將答案寫在答案卷上)

1.1. (2 分) Here is an INCORRECT pseudocode for the algorithm which is supposed to determine

whether a sequence of
parentheses is balanced:
Which of these unbalanced
sequences does the code think
is balanced?

- (A) (((())
- (B) ()) (()
- (C) (() ()))
- (D) (())) ()

```
declare a character stack
while ( more input is available)
{
    read a character
    if ( the character is a '(' )
        push it on the stack
    else if ( the character is a ')' and
              the stack is not empty )
        pop a character off the stack
    else
        print "unbalanced" and exit
}
```

1.2. (2 分) In the array version of the Stack class, which operations require linear time for their worst-case behavior?

- (A) is_empty
- (B) pop
- (C) push when the stack is below capacity
- (D) None of these operations require linear time

1.3. (2 分) Here is an infix expression: $4+3*(6*3-12)$. Suppose it is being converted into postfix notation using the usual algorithm involving stack. What is the maximum number of symbols that will appear on the stack AT ONE TIME during the conversion of this expression?

- (A) 2
- (B) 3
- (C) 4
- (D) 5

1.4. (2 分) In the circular array version of the Queue ADT, which operations require linear time for their worst-case behavior?

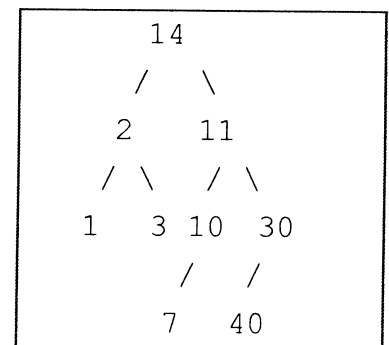
- (A) getFront
- (B) insert when the capacity has not yet been reached
- (C) isEmpty
- (D) None of these operations require linear time

1.5. (2 分) If the queue ADT is implemented with a linked list, keeping track of a front node and a rear node with two reference variables. Which reference variables will change during an insertion into an EMPTY queue?

- (A) Neither changes
- (B) Only front changes.
- (C) Only rear changes.
- (D) Both change.

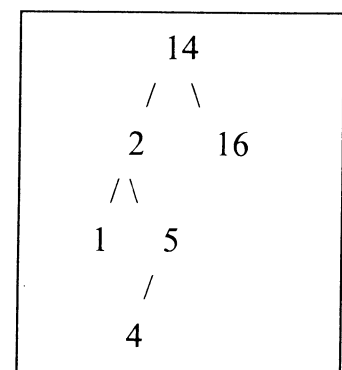
1.6. (2 分) What is the order of nodes visited using a post-order traversal on a tree to the right?

- (A) 1 2 3 7 10 11 14 30 40
- (B) 1 2 3 14 7 10 11 40 30
- (C) 1 3 2 7 10 40 30 11 14
- (D) 14 2 1 3 11 10 7 30 40



1.7. (2 分) Consider the binary search tree at right. Suppose the root node is removed and replaced with something from the left subtree. What will be the new root?

- (A) 1
- (B) 2
- (C) 4
- (D) 5



1.8. (2 分) Which formula is the best approximation for the depth of a heap with n nodes?

- (A) $\log_2 n$
- (B) The number of digits in n (base 10)
- (C) The square root of n
- (D) n

1.9. (2 分) What is the best definition of a collision in a hash table?

- (A) Two entries are identical except for their keys.
- (B) Two entries with different data have the exact same key.
- (C) Two entries with different keys have the same exact hash value.
- (D) Two entries with the exact same key have different hash values.

1.10. (2 分) What kind of initialization needs to be done for a chained hash table?

- (A) None.
- (B) The key at each array location must be initialized.
- (C) The head pointer of each chain must be set to null.
- (D) Both B and C must be carried out

1.11. (2 分) Mergesort makes two recursive calls. Which statement is true after these recursive calls finish, but before the merge step?

- (A) The array elements form a heap.
- (B) Elements in each half of the array are sorted amongst themselves.
- (C) Elements in the first half of the array are less than or equal to elements in the second half of the array.
- (D) None of the above.

1.12. (2 分) Suppose we are sorting an array of eight integers using quicksort, and we have just finished the first partitioning with the array looking like this:

2 5 1 7 9 12 11 10

Which statement is correct?

- (A) The pivot could be either the 7 or the 9.
- (B) The pivot could be the 7, but it is not the 9.
- (C) The pivot is not the 7, but it could be the 9.
- (D) Neither the 7 nor the 9 is the pivot

1.13. (2 分) How many linked lists are used to represent a graph with n nodes and m edges, when using an edge list representation?

- (A) m
- (B) n
- (C) $m + n$
- (D) $m * n$

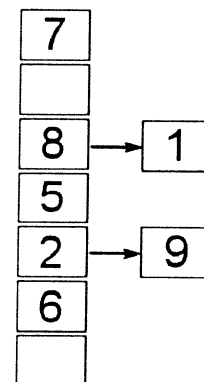
1.14. (2 分) What is the expected number of operations needed to loop through all the edges terminating at a particular vertex given an adjacency matrix representation of the graph?

(Assume n vertices are in the graph and m edges terminate at the desired node.)

- (A) $O(m)$
- (B) $O(n)$
- (C) $O(m^2)$
- (D) $O(n^2)$

1.15. (2 分) By successively inserting the numbers 2, 7, 8, 6, 5, 9, 1 into an empty hash table, the resulting table is shown on the right. Which hash function was used?

- (A) $h(k) = 2k \bmod 7$
- (B) $h(k) = \lfloor (0.5k + 3) \rfloor \bmod 7$
- (C) $h(k) = k^2 \bmod 7$
- (D) None of the above



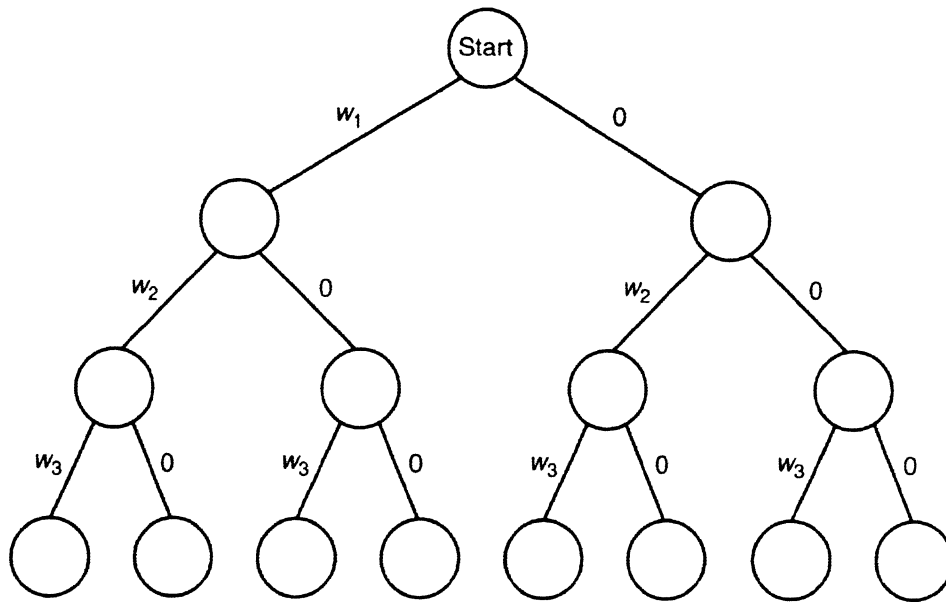
2. 簡答題 (共 20 分)

- (a) (4 分) Consider the usual algorithm for determining whether a sequence of parentheses is balanced. What is the maximum number of parentheses that will appear on the stack AT ANY ONE TIME when the algorithm analyzes: $(((()) (())))$?
- (b) (4 分) What is the value of the postfix expression $6\ 3\ 2\ 4\ +\ -\ *$
- (c) (4 分) Suppose T is a binary tree with 14 nodes. What is the minimum possible depth of T ?
- (d) (4 分) A chained hash table has an array size of 512. What is the maximum number of entries that can be placed in the table?
- (e) (4 分) Suppose that a non-leaf node in a B-tree has 41 entries. How many children will this node have?

3. (10 分) Kruskal's algorithm is a famous algorithm for the minimum spanning tree problem. You can use it to check if a given graph G is connected or not. Please briefly explain your method.

4. In the sum-of-subsets problem, there are n positive integers (weights) w_i and a positive integer W . The goal is to find all subsets of the integers that sum to W .

- (a) (5 分) Suppose that $n = 5$, $W = 21$, and $w_1 = 11$, $w_2 = 16$, $w_3 = 10$, $w_4 = 5$, $w_5 = 6$. What are the solutions?
- (b) (5 分) For smaller values of n , this problem can be solved by inspection. For larger values of n , a systematic approach is necessary. One approach is to create a state space tree. A possible way to structure the tree appears in the following figure. For the sake of simplicity, the tree in this figure is for only three weights. We go to the left from the root to include w_1 , and we go to the right to exclude w_1 . Similarly, we go to the left from a node at level 1 to include w_2 , and we go to the right to exclude w_2 , etc. Each subset is represented by a path from the root to a leaf. When we include w_i , we write w_i on the edge where we include it. When we do not include w_i , we write 0. What is the worst-case time complexity of this approach?



(c) (5 分) Please suggest a more efficient method to solve this problem. Please briefly explain your method.

5. Given a Quicksort algorithm (program) shown as below. The algorithm is implemented by defining S globally and n is the number of items in S, the top-level call to quicksort would be quicksort(1, n).

```

void quicksort (index low, index high)
{
    index pivotpoint;
    if (high > low) { partition(low, high, pivotpoint);
                      quicksort (low, pivotpoint - 1);
                      quicksort (pivotpoint + 1, high); } }
void partition (index low, index high, index& pivotpoint)
{
    index i, j;
    keytype pivotitem;
    pivotitem = S[low];           // Choose first item for pivotitem.
    j = low;
    for (i = low + 1; i <= high; i++)
        if (S[i] < pivotitem) { j++;
                               exchange S[i] and S[j]; }
    pivotpoint = j;
    exchange S[low] and _____; // Put pivotitem at pivotpoint. }

```

- (a)(5 分) What is the correct answer in the blank spaces at the bottom of the algorithm?
- (b)(5 分) What is the worst-case time complexity of the algorithm?
- (c)(5 分) Quicksort has the advantage over Mergesort that no extra array is needed. However, it is still not an in-place sort. What is the worst-case extra space usage of Quicksort?
- (d)(5 分) A stable sorting algorithm is one that preserves the original order of equal keys. Is the above Quicksort algorithm stable? Justify your answer.
- (e)(5 分) The above program can sort n keys in nondecreasing order. If we want to sort n keys in nonincreasing order, what should be changed in the above program?