國立臺灣師範大學九十五學年度碩士班考試入學招生試題

軟體基礎 科試題（資訊工程研究所用，本試題共 6 頁）

注意：1.依次序作答，只要標明題號，不必抄題。
2.答案必須寫在答案卷上，否則不予計分。

一、選擇題：(每題 2 分，計 30 分)

1. Which of the following statement about time-complexity (T.C.) is **incorrect**?

   (A) Algorithm with running time of $n^3 2^n + 6n^2 3^n$ has T.C. of $O(n^3 2^n)$.
   (B) Algorithm with running time of $n^{1.001} + n \lg n$ has T.C. of $\Theta(n^{1.001})$.
   (C) Algorithm with running time of $\sum_{i=0}^{n} i^2 = \Theta(n^3)$ has T.C. of $\Theta(n^3)$.
   (D) Algorithm with running time of $n!$ has T.C. of $O(n^n)$

2. If we have the declaration A[1..11][1..4][7..8] and α is the address of A[1][1][1], using row major order, what is the address for A[3][2][7]?

   (A) α+13
   (B) α+18
   (C) α+19
   (D) α+72

3. Which of the following sequences, when input into a stack and a queue, respectively, then print it back out will yield the same output?

   (A) AABBCCDD
   (B) ABCDABCD
   (C) ABCDDCBA
   (D) ABABABAB

4. The infix form of the postfix expression (AB/CD+EA–*C*–) is

   (A) A / B – C + D * E – A * C
   (B) (A / B) – C + (D * E) – A * C
   (C) (A / B) – (C + D) * (E – A) * C
   (D) A / (B – C) + D * (E – A) * C

5. At least how many pointers should be changed if we insert a new node at the front of a nonempty circular link list?

   (A) 1
   (B) 2
   (C) 3
   (D) 4

請翻頁繼續作答

6. If a tree could be written as the list (A(B(E(K,L),F),C(G),D(H(M),I,J))), how many leaves does it have?

(A) 6
(B) 7
(C) 8
(D) 9

7. The height of a complete binary tree with n nodes is

(A) $\lceil \log_2 n \rceil$
(B) $\lceil \log_2 (n+1) \rceil$
(C) $\lfloor \log_2 n \rfloor + 1$
(D) $\lfloor \log_2 n \rfloor$

8. If a binary tree has the preorder traversal sequence of ABCDEFG and the inorder traversal sequence of GFEDCBA, then its postorder traversal sequence should be

(A) ABCDEFG
(B) GFEDCBA
(C) ABDECFG
(D) DEBFGCA

9. How many distinct n-node binary trees can one create?

(A) $\frac{1}{n}\binom{2n}{n+1}$
(B) $\frac{1}{n+1}\binom{2n}{n+1}$
(C) $\frac{1}{n}\binom{2n}{n}$
(D) $\frac{1}{n+1}\binom{2n}{n}$

10. How many edges does a n-node spanning tree have?

(A) n–1
(B) n
(C) n+1
(D) less than n–1

11. Which sorting method below is more suitable for sorting data on external storage devices?

(A) counting sort
(B) heap sort
(C) quick sort
(D) merge sort

12. Which statement relative to static hashing is **incorrect**?

(A) In static hashing the identifiers are stored in a fixed-size table called the hash table.
(B) Min-Square function is one of uniform hash functions.
(C) An overflow occurs when two non-identical identifiers are hashed into the same bucket.
(D) Open addressing and chaining are two ways to handle overflow.

13. Given an extended binary tree with n **internal** nodes, let E be the external path length and I be the internal path length. Which of the following statement is **incorrect**?

(A) The smallest value for I is $\sum_{1 \le i \le n} \lfloor \log_2 i \rfloor = O(n \log_2 n)$.
(B) If the tree is skewed, then $I = \sum_{i=0}^{n-1} i = \frac{n(n-1)}{2}$.
(C) Binary trees with the maximum E also have maximum I, and E = I + 2n.
(D) The extended binary tree has 2n-1 edges.

14. Which of the following statement is **not** a property of red-black trees?

(A) Red-Black trees are binary search trees.
(B) Every internal node that is the parent of an external node has rank 1.
(C) For every node x that has a grandparent gp(x), rank(x) < rank(gp(x)).
(D) For every red-black tree RB with n (internal) nodes, $height(RB) \le 2\lfloor \log_2 (n-1) \rfloor$.

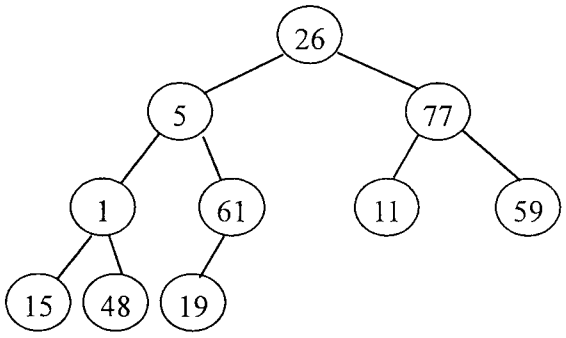
15. Which of the following statement is **incorrect**?

(A) Search trees with a worst-case height of $O(\log n)$ are called balanced search trees.
(B) A winner tree is a complete binary tree in which each node represents the smaller of its two children.
(C) A loser tree is a complete binary tree in which the key of each node is larger than that of its child.
(D) Both winner trees and loser trees are selection trees.

請翻頁繼續作答

二、 簡答題：(共 70 分)

1. Given an input list L = (26, 5, 77, 1, 61, 11, 59, 15, 48, 19), if we interpret this list as a binary tree as follows, please show its corresponding initial max heap. (4 分)



2. Given an adjacency matrix as follows.

	0	1	2	3	4	5	6	7
0	0	1	0	0	0	0	0	0
1	1	0	1	1	0	0	0	0
2	0	1	0	0	1	0	0	0
3	0	1	0	0	1	1	0	0
4	0	0	1	1	0	0	0	0
5	0	0	0	1	0	0	1	1
6	0	0	0	0	0	1	0	1
7	0	0	0	0	0	1	1	0

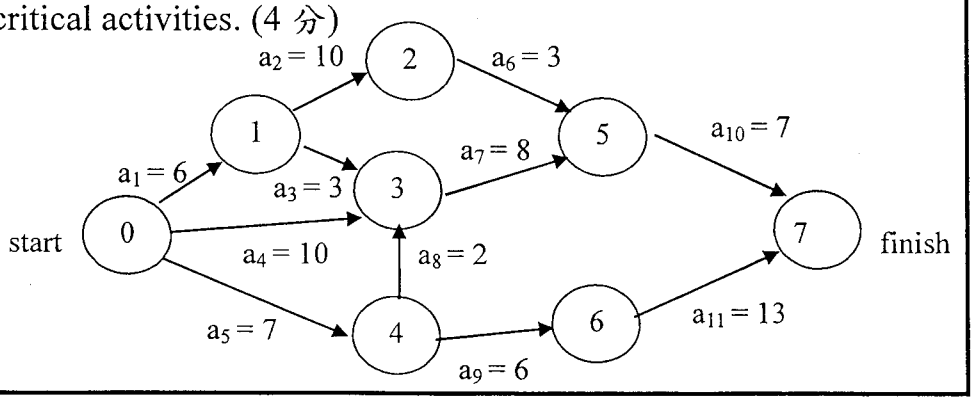
(a) Suppose this matrix represents an undirected graph, please show which vertices are the articulation points? (4 分)

(b) Suppose this matrix represents a directed graph, please show its strongly connected component. (4 分)

3. Given an AOE (activity-on-edge) graph as follows, please show

(a) the earliest time of event 5 and the latest time of activity a_7. (4 分)

(b) the noncritical activities. (4 分)



4. Suppose that we need to represent a large integer whose size exceeds the computer's hardware capability of representing integers. A straightforward way is to use an array of integers, where each array slot stores one digit. For example, the integer 314,159,265,358 can be represented in the array S = <3, 1, 4, 1, 5, 9, 2, 6, 5, 3, 5, 8>.

   (a) Please design an O(n)-time algorithm for adding two large integers S and T, where n=max{|S|, |T|} and |S|, |T| is the number of digits in S and T, respectively. (5分)

   (b) Please design an $O(n^2)$-time algorithm for multiplying two large integers S and T. (5分)

   (c) Please design an $O(n^{\log_2 3})$-time algorithm for multiplying two large integers S and T. (5分)

5. Given a sequence S of n elements, the selection problem is to find the *k*th-smallest element.

   (a) Show a simple way to find the *k*th-smallest element in O(n log n) time. (2分)

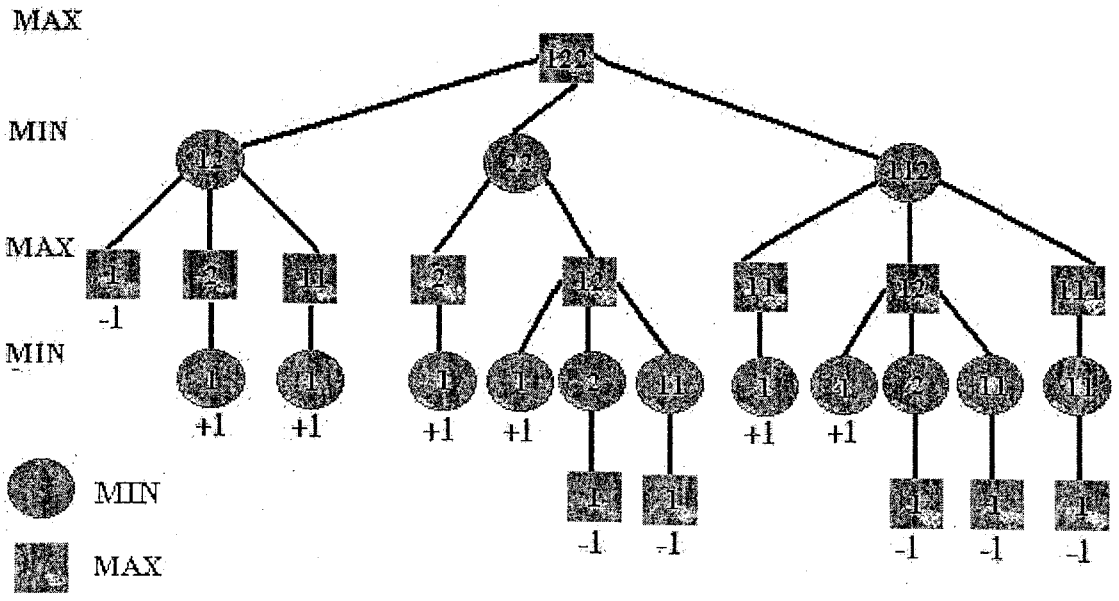
   (b) In 1973, Blum presented a famous selection algorithm. What is the time complexity of Blum's selection algorithm? (3分)

   (c) Blum's selection algorithm is very complex. We can use a simpler probabilistic algorithm for the selection problem and get the same time complexity in the expected case. Please briefly describe the probabilistic algorithm for the selection problem. (5分)

   (d) The probabilistic algorithm for the selection problem in (c) is usually classified as a Sherwood algorithm. Please briefly explain the reason. (5分)

請翻頁繼續作答

6. In the two-player NIM game, several piles of sticks are given. We represent the configuration of the piles by a monotone sequence of integers, such as (1, 2, 2) or (1, 1, 2). A player may remove, in one turn, any number of sticks from one pile of his/her choice. Thus, (1, 2, 2) would become (1, 1, 2) if the player were to remove 1 stick from the second pile. The player who takes the last stick loses. The NIM game (1, 2, 2) can be represented by the following figure, where evaluation function values are indicated at the leaf nodes. A loss is represented by "-1" and a win is represented by "+1" for the first player.



(a) Please use the minimax procedure to obtain the value of the root node. Please draw a figure to show your results. (2分)

(b) What move should the first player make in order to win the game? (2分)

(c) Please use the alpha-beta pruning procedure to obtain the value of the root node. Please draw a figure to show the evaluation function values that are actually consulted (i.e. that you made use of) during the process. (3分)

(d) What do the "alpha value" and "beta value" mean in the alpha-beta pruning procedure? (2分)

(e) If we use the minimax procedure to solve the NIM game (m, n, k), $m \leq n \leq k$, what is the memory requirement (space complexity)? (3分)

(f) In general, the execution time for alpha-beta pruning algorithm is exponential. Why? (3分)

(g) In the worst case alpha-beta pruning will have to examine all nodes just as the original minimax algorithm does. What is the best case of Alpha-Beta pruning? (5分)

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