國立臺灣師範大學 109 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，否則依規定扣分。

一、選擇題(共 27 分, 每小題 3 分)　※提醒：選擇題請於「作答區」作答，勿答於「評分欄」以免扣分。

1) An array of 7 integers is being sorted by the heapsort algorithm. After the initial phase of the algorithm (constructing the heap), which of the following is a possible ordering for the array?

A) 85 78 45 51 53 47 49

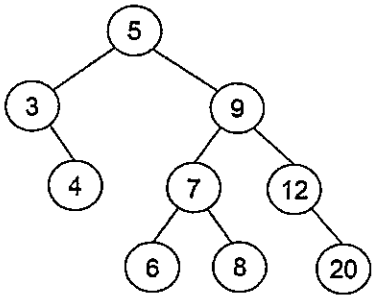
B) 85 49 78 45 47 51 53

C) 85 78 49 45 47 51 53

D) 45 85 78 53 51 49 47

E) 85 51 78 53 49 47 45

2) The binary search tree shown below was constructed by inserting a sequence of items into an empty tree. Which of the following input sequences will **not** produce this binary search tree?



A) 5 3 4 9 12 7 8 6 20

B) 5 9 3 7 6 8 4 12 20

C) 5 9 7 8 6 12 20 3 4

D) 5 9 7 3 8 12 6 4 20

E) 5 9 3 6 7 8 4 12 20

3) What is the expected number of operations needed to visit 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) $O(n^2)$

E) $O(m \times n)$

4) Here is an array of ten integers: 5, 3, 8, 9, 1, 7, 0, 2, 6, 4.

Suppose we partition this array using quicksort's partition function and using 5 for the pivot. Which shows the array after the partition finishes:

A) 5 3 4 2 1 0 7 9 6 8

B) 0 3 4 2 1 5 7 9 6 8

C) 3 1 0 2 4 5 8 9 6 7

D) 3 1 0 2 4 5 8 9 7 6

E) None of the above

5) Consider a hash table with linear probing and a size of 9. Use the hash function "k%9". Insert the keys: 5, 29, 20, 0, 27 and 18 into your table (in that order). What is the result?

A)

0	27	29	20	5	18			

B)

0	27	29	20	18	5			

C)

0	27	29	18	20	5			

D)

5	29	20	0			27		18

E) None of the above

6) The array 10, 8, 6, 2, 1, 4, 5 is organized into a heap (priority queue). Which array represents the heap after two deleteMax operations have been performed?

A) 6, 5, 4, 2, 1

B) 6, 4, 5, 2, 1

C) 6, 4, 5, 1, 2

D) 6, 5, 4, 1, 2

E) None of the above

7) If the binary tree below is printed by a preorder traversal, what will the result be?

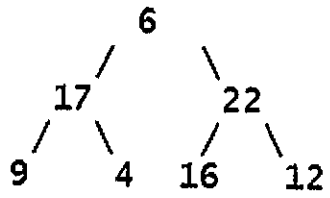
A) 9 4 17 16 12 11 6

B) 9 17 6 4 16 22 12

C) 6 9 17 4 16 22 12

D) 6 17 22 9 4 16 12

E) 6 17 9 4 22 16 12



8) Given the following functions:

f1= $8n^2+1$, f2=$n!+2^n$, f3=100, f4=2^n+n+10, f5=$2n^3+n^2+1$, f6=10n, f7=3n logn, f8=7n+log n

Please arrange their big-O time complexities in non-decreasing order.

A) f3, f6, f7, f8, f1, f2, f5, f4

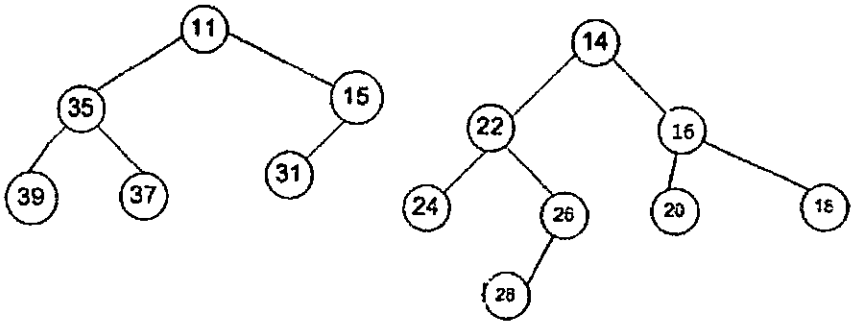
B) f3, f6, f8, f7, f1, f5, f4, f2

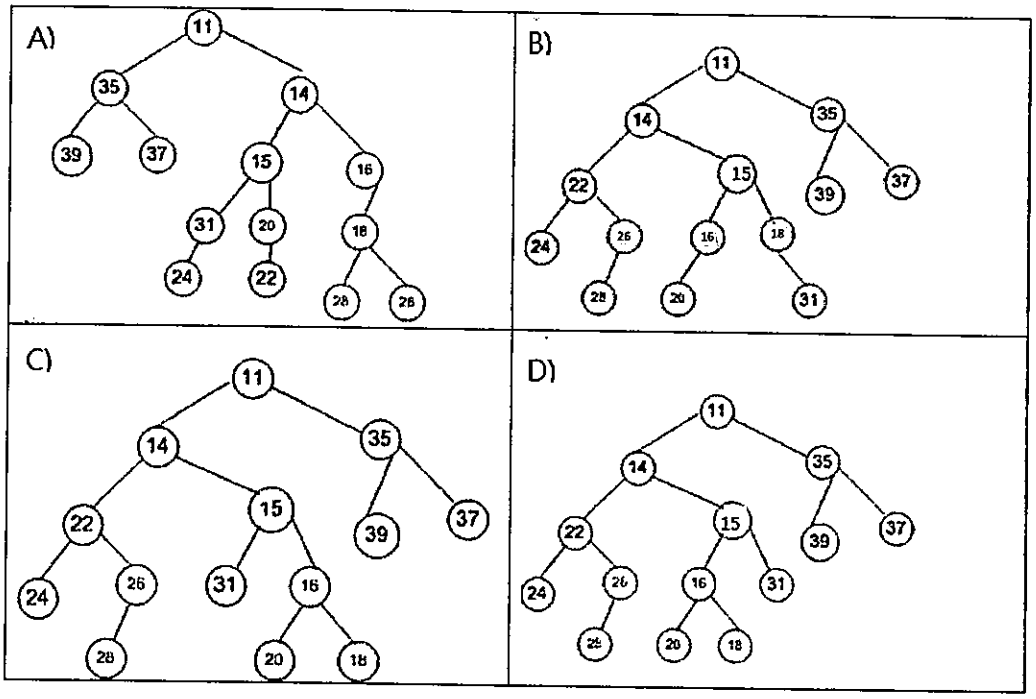
C) f3, f8, f6, f7, f1, f5, f2, f4

D) f3, f6, f8, f7, f1, f5, f2, f4

E) None of the above

9) Which is the result of merging the two leftist heaps below?





E) None of the above

二、With an empty AVL tree. (共 6 分)

(a) Obtain the resulted AVL tree after inserting the following sequence: 61, 23, 92, 33, 54, 77, 20, 11. (3 分)

(b) What is the resulted AVL tree after inserting 31, 47 to the resulted AVL tree of (a) ? (3 分)

三、Given an infix arithmetic expression: (A-2)*((B+C)-D*E)*A

Please explain the process step by step to convert the infix expression into a postfix expression by using a stack. (5 分)

四、(共 8 分)

(a) Let ***a*** denote a pointer which points to the first node of a circular linked list, where the *link* field of each node points to its next node. Please use pseudo code to describe how to delete the first node from the circular list. (3 分)

(b) Let ***a*** denote a pointer which points to the last node of a circular linked list. Please use pseudo code to describe how to delete the first node from the circular list. (3 分)

(c) Suppose the number of nodes in the circular list is *n*. What is the time complexity to perform the operations of (a) and (b), respectively? (2 分)

五、Consider an AOE network G which has 8 vertices and 10 edges. The edge set consists of

a0=(0, 1, 5), a1=(0, 2, 4), a2=(0, 3, 4), a3=(1, 4, 2), a4=(2, 4, 1), a5=(3, 5, 5), a6=(4, 5, 3), a7=(4, 6, 2), a8=(5, 7, 4), a9=(6, 7, 5), where the triple (Vi, Vj, W) represents that there is a directed edge with weight W pointed out from vertex Vi to vertex Vj. (Starting vertex: V0, Destination vertex: V7)

Please find the critical activities. (4 分)

六、Mergesort uses divide-and-conquer to solve the sorting problem. This algorithm sorts a given array $A[0..n\text{-}1]$ of n elements by dividing it into two halves, sorting each of them recursively, and then merging the two smaller sorted arrays into a

single sorted one.

(a) The recurrence for the time complexity of mergesort is:

$$C(n) = 2C(n/2) + C_{merge}(n),$$

where $C_{merge}(n)$ is the number of element comparisons performed during the merging stage. What is $C_{merge}(n)$ in the worst case? In other words, how many element comparisons are required to merge two sorted arrays of the equal size (n/2)? (5 分)

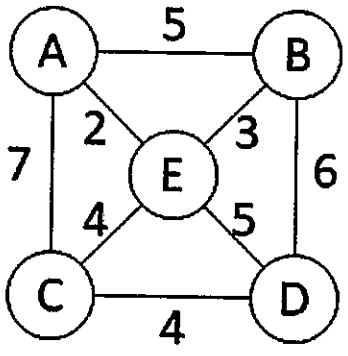
(b) What computations are eliminated in mergesort, making it performs more efficiently than a brute-force algorithm (e.g., bubble sort)? (5 分)

(c) A sorting algorithm is *stable* if elements with the same value appear in the same order in the sorted array as they do in the original array. Is mergesort stable? Please briefly explain your answer. (5 分)

七、Please answer the questions regarding Prim's algorithm.

(a) What is Prim's algorithm used for? (5 分)

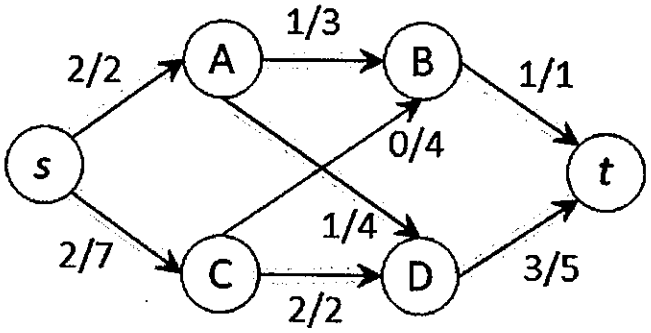
(b) Please apply Prim's algorithm to the following graph. (5 分)



(c) Please explain why the greedy choice used in Prim's algorithm would yield an optimal solution. (5 分)

(d) What happens if the input graph to Prim's algorithm has negative weights? (5 分)

八、Given the input network G and a flow f below, please answer the following questions. The numbers (i / j) on each edge denote the flow value (i) and the original capacity (j).



(a) Please write down the residual network of G induced by f. (5分)

(b) Does the flow f have maximal value? If your answer is "yes", prove it by marking a cut with a capacity equal to the flow value. If your answer is "no", show how is it possible to get a flow with a higher value. (5分)

(c) Please explain how the maximum-flow problem for a network with several sources and sinks can be transformed into the same problem for a network with a single source and a single sink. (5分)