系所組別： 電機工程學系丁組，電腦與通信工程研究所甲組

考試科目： 資料結構

考試日期：0307，節次：2

※ 考生請注意：本試題 □可 ☑不可 使用計算機

※ 本試題共計 3 頁。作答時可不必抄題，但請必須將各題之題號標註清楚。

※ Note that throughout the paper, the height of a binary tree with only one node is defined as 1 while an empty binary tree has height of zero.

1. 選擇題 (18 分，每小題 2 分)

For each question from (1-1) to (1-9) (2 points each), please choose all appropriate items from the ones given in the box below as your answer. Note that (a) there might be more than one appropriate item and you must give all such items to get the points; (b) all the items in the box can be chosen for more than one question.

(A) Table sort	(B) Bubble sort	(C) Count sort	(D) Insertion sort
(E) Quick sort	(F) Shell sort	(G) Selection sort	(H) Radix sort
(J) Topological sort	(K) Binary tree sort	(L) Biconnected graph	(M) Eulerian walk
(N) Kruskal's algorithm	(P) Prim's algorithm	(Q) Sollin's algorithm	(R) Open addressing
(S) Division	(T) Mid-square	(U) Folding	(W) Chaining
(X) Dijkstra's algorithm	(Y) Bellman and Ford Algorithm		(Z) None of the above

(1-1) Which algorithms are developed based on the divide-and-conquer approach?

(1-2) Which algorithms are developed based on the greedy method?

(1-3) Which sorting algorithms are not comparison-based sorting?

(1-4) Which stable sorting algorithms show non-constant space complexity?

(1-5) Which sorting algorithms show their worst-case performance when the input data are already sorted?

(1-6) Ignoring the issue of efficiency or performance, which sorting algorithms are suitable for LSD sorting when sorting on several keys?

(1-7) Which algorithms in the above list are developed to work on graph?

(1-8) Which hashing functions are suitable if the hash table has 2^m buckets?

(1-9) If you are staying in city X and like to visit some neighboring cities with limited budget, which algorithms will be helpful in setting up y our travel plan?

2. Please do the following: (10 points in total)

(2-1) A *perfect number* is a positive integer such that the sum of all its divisors, except itself, is equal to the number itself. For example, 28 is a perfect number since the sum of its divisors 1, 2, 4, 7 and 14 is 28. Please implement a complete program using C language which accepts an integer value, N, from the user and reports all the perfect numbers in the range from 1 to N. (6 points)

(2-2) Please give an analysis of the time complexity of your program in (2-1). (2 points)

(2-3) Please give an analysis of the space complexity of your program in (2-1). (2 points)

3. For each item below, describe its typical application (s): (2 points each)

(3-1) AOE Networks (3-2) Fibonacci heap (3-3) Bipartite graph

(背面仍有題目，請繼續作答)

※ 考生請注意：本試題 □可 ☑不可 使用計算機

4. 是非題 (16 分；每題作答正確則得 2 分，作答錯誤則得 0 分並倒扣 1 分，未作答得 0 分)

For each question from (4-1) to (4-8), mark T (or ○) if the statement given is true, mark F (or ×) otherwise. Note that you will earn 2 points for each correct answer and lose 1 point for each incorrect answer. You earn no point if you do not give any answer.

(4-1) Recursive programs are always time efficient, but space inefficient.

(4-2) Both depth first search and breadth first search can be used to create a spanning tree of a graph G.

(4-3) The edges incident on an articulation point of graph G are bridges of G.

(4-4) The output of depth first search and the output of breadth first search on an undirected graph G can uniquely define the structure of G.

(4-5) In static hashing, when the value of loading density is less than the value of the key density of the hash table, then overflow will not occur.

(4-6) In browsing web pages over Internet, if a web page is thought as a tree node which has hyperlinks connecting to other pages as its children nodes, then the web pages form a tree structure.

(4-7) The height of a height-balanced binary tree with $n!$ nodes is $O(n \cdot \log_2 n)$.

(4-8) A double-ended priority queue is a data structure such that data items can be inserted into and removed from either the front end or the rear end.

5. 複選題 (15 分，每小題 5 分): For each question below, there may be more than one correct choice. You must have all the correct choices to get the points.

(5-1)(5 points) Which of the following statement(s) is (are) true about a binary search tree T with n nodes?

(A) The time complexity of inserting a key into T is O(log n).

(B) For a binary tree, if both the left subtree and the right subtree of the root are binary search trees, then this binary tree is a binary search tree.

(C) If a binary tree and a heap both contains the same set of keys, in average, searching a key in a binary search tree is faster than a heap.

(D) Postorder traversal of T will visit all nodes in an exactly descending order.

(E) In T, the number of nodes with two children must be more than the number of leaf nodes.

(5-2)(5 points) Which of the following statement(s) is (are) true about an AVL tree T with n nodes?

(A) The time complexity of inserting a key in T is O(log n).

(B) For a binary tree, if both the left subtree and the right subtee of the root are AVL trees, then this binary tree is an AVL tree.

(C) If an AVL tree and a leftist tree both contains the same set of keys, in average, searching a key in an AVL tree is faster than a leftist tree.

(D) A full binary tree is also an AVL tree.

(E) If T is height of 4, the minimum number of nodes in T is 7.

※ 考生請注意：本試題 □可 ☑不可 使用計算機

(5-3)(5 points) Given the expression (A - B) * C + E / (C+ A * D) + F which of the following statement(s) is (are) true?

(A) The prefix of the expression is + – A * B C + / E + C * A D F

(B) The prefix of the expression is – A * B C + + / E + C * A D F

(C) The postfix of the expression is AB – C * E C A D + * F + / +

(D) The postfix of the expression is A B – C * E C A D * + / F + +

(E) None of the above.

6. (15 points) Given the sequence of numbers "12, 8, 14, 17, 9, 6, 3, 33, 25, 16". Insert these numbers sequentially into an empty tree structure specified in each of the following. Then, delete the minimum from the tree. **Draw the resulted tree** after the deletion. Also, **specify the time complexity** for the deletion operation on each of the tree structure s.

(6-1) (5 points) Binary search tree

(6-2) (5 points) Symmetric min-max heap

(6-3) (5 points) AVL tree

7. (10 points)

(7-1) (4 points) Assume the postorder traversal of a binary tree is "C, A, E, D, F, B, G, H, I " and the inorder traversal of the same tree is "C, D, A, E, I, F, H, G, B". Will yo u be able to uniquely define the tree? If yes, please draw the binary tree. If no, please indicate how many distinct binary trees can be derived.

(7-2) (6 points) Assume the preorder traversal of a binary tree is "L, J, B, A, C, G, D, E, K, I, F, H" and the postorder traversal of the same tree is "A, C, B, D, E, G, J, F, H, I, K, L". Also, assume that the subtree with J as root is a full binary tree and J is the root of L's left subtree. Hence, K is the root of L's right subtree and I the root of K's right subtree. Will you be able to uniquely define the tree? If yes, please draw the binary tree. If no, please indicate how many distinct binary trees can be derived.

8. (10 points) Assume a firewall software checks the value of a specific byte in a packet to determine whether to block, further examine, or pass the packet. Assume the table given below is the statistics collected during a period of time when 100K packets are checked. Based on the information in the table, please construct an optimal binary s earch tree which minimizes the search time. (B: Block, E: Further Examine, P: Pass) Note that 1K = 1,000.

Search value	0 – 20	21	22 – 71	72	73 – 111	112	113 – 127	128	129 – 255
Action	B	P	B	E	B	E	B	P	B
No. of packets	10K	10K	5K	25K	5K	5K	20K	15K	5K