本試題是否可以使用計算機：□可使用 ，☑不可使用　（請命題老師勾選）

注意事項：

1. 本試題除各題另有限制之外，可使用 Pseudo Code，Java、C 或 C++作答。
2. 請依題號序作答於答案紙。作答時可不必抄題，但請務必將各題之完整題號(例：*(1-A)*或*(2-B)*等等)標示清楚。
3. 本試題共計二頁。配分標示於各題或各小題。不可使用電子計算機。

試題：

(1) Briefly explain the following terms: (本題 18 分，各小題 3 分)

(1-A) AOV network　　(1-B) Priority queue
(1-C) Binary search tree　　(1-D) Biconnected component
(1-E) Min-max heap　　(1-F) Multigraph

(2) Answer **True** or **False** for each the following statements: (本題 10 分，各小題 1 分)

(2-A) Stack is an array with LIFO property.
(2-B) Circular queue can not be implemented using linked list structure.
(2-C) Every node in a tree is an articulation point.
(2-D) When applying *dfs* to a connected graph, the output forms a tree.
(2-E) The number of non-leaf nodes in a binary tree of depth k is at most 2^k-1.
(2-F) The height of an AVL tree with n nodes is $O(\log n)$.
(2-G) A full binary tree has more leaf nodes than a complete binary tree does.
(2-H) It is possible that the inorder traversal and postorder traversal of a binary tree of depth h ($h \geq 3$) give the same result.
(2-I) Every tree is a bipartite graph.
(2-J) Sollin's algorithm is an greedy method used to compute spanning forest.

(3) For each question, give your answers by choosing from the item group given below. Note that multiple choices is possible and all the items can be reused.

Item group for choices: (本題 18 分，各小題 3 分)

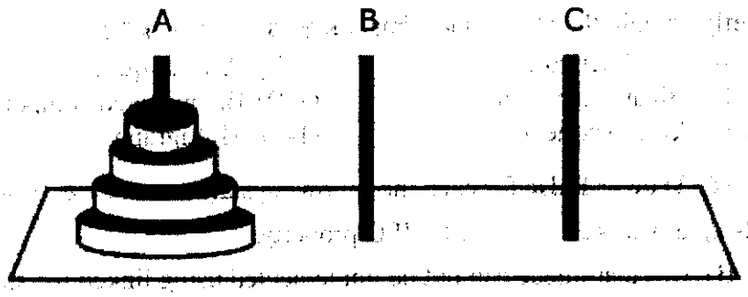
(A) Network	(B) Stack	(C) Queue	(D) Binary tree
(E) Digraph	(F) Heap	(G) Hash table	(H) File
(I) B-tree	(J) Shell sort	(K) Bubble sort	(L) Quick sort
(M) Merge sort	(N) Selection sort	(O) Radix sort	(P) Heap sort
(Q) Table sort	(R) $\Theta(k)$	(S) $O(n)$	(T) $\Omega(n)$
(U) $O(n \cdot \log n)$	(V) $\Omega(n \cdot \log n)$	(W) $O(n^2)$	(X) $O(n!)$
(Y) $O(a^n)$	(Z) None of above		

(3-A) Which sorting methods show the best worst-case space complexity?
(3-B) Which unstable sorting methods show the same best-case time complexity?
(3-C) What is the possible best average-case time complexity of sorting and which sorting methods show that performance?
(3-D) Which data structures are more space-efficient when implemented by array than linked list and the number of data items is less than 100?
(3-E) Which data structures can help speed up searching?
(3-F) What time complexity might be a feature of NP problems?

(背面仍有題目，請繼續作答)

(4) [Towers of Hanoi] (本題 18 分，各小題配分另行說明)

The Tower of Hanoi puzzle was invented by the French mathematician Edouard Lucas in 1883. Given a tower of four disks initially stacked in increasing size on peg A (please refer to the figure below). The objective is to transfer the entire tower to peg C (the rightmost one), moving only one disk at a time and never put a larger disk onto a smaller one. (Peg B can be used if necessary.)



(4-A) Design a program in C programming language that can solve the case of the Towers of Hanoi puzzle with n disks. n is an integer. (本小題 6 分)

(4-B) What is the time complexity of your program in (4-A)? (本小題 6 分)

(4-C) What is the space complexity of your program in (4-A)? (本小題 6 分)

(5) Give your answer for the following: (本題 10 分，各小題 2 分)

(5-A) How many leaf nodes does a complete binary tree of height h have in the least?

(5-B) What is the maximum number of possible binary trees with n nodes and the height is at least $(n/2)$?

(5-C) What is the time complexity of adding two sparse matrices A and B of dimension $m \times n$ and A has α non-zero elements and B has β non-zero elements? A and B are separately represented by a one-dimension array keeping the non-zero elements in the way that the kth non-zero element uses the elements of indices $3k$, $3k+1$, and $3k+2$ in the array to hold the row number, the column number, and the data value respectively.

(5-D) What is the result of post-order traversal for the left sub-tree of an AVL tree's root node with the following information given:
(a) The result of level-order traversal is **A B C D E F G H I J K L M N P**
(b) Both sub-trees of the root are complete but not full binary trees.
(c) The right sub-tree of the root has 2 more leaves than the left sub-tree.

(5-E) Given a stack and 4 elements **A B C D** to be processed in that order, how many output sequences (*e.g.* **A C D B**) can be generated by the rules:
(a) A processed element may choose to enter the stack or to be output.
(b) An element held in the stack can be popped and output at any time.
(c) Eventually all elements in the stack will be popped and output.

(6) On representing graphs, answer the following: (本題 18 分，各小題配分另行說明)

(6-A) Briefly describe the methods of representing graphs. (本小題 8 分)

(6-B) Comparing your methods in (6-A), which is better? (本小題 10 分)

(7) Show that, for a complete graph with n vertices, the number of spanning trees is at least $(2^{n-1} - 1)$. (本題 8 分)