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

※ 本試題共計 4 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. 名詞或術語解釋 (10 分；請解釋下列各題之名詞或術語；每題 2 分)
For each term in the following, please give its definition or explanation. (2 points each)
   (1-1) Skip list (1-2) Multi-graph (1-3) LR rotation for AVL tree
   (1-4) Radix sort (1-5) Trie

2. 是非題[A] (10 分；下列(2-1) ~ (2-5)各式若正確請以 T 表示，若錯誤請以 F 表示；每題 2 分)
For each expression in the following, please indicate T if it is correct and indicate F otherwise. (2 points each)
   (2-1) $\sqrt{n}\cdot(\log\sqrt{n}) = O(n)$
   (2-2) $\Theta(n\cdot\log n) = n\cdot\log_{10} n + \log(n^3)$
   (2-3) $\sqrt[3]{n^5}\cdot\sqrt{\log n} = O(n^2\cdot\log n)$
   (2-4) $\frac{3}{n^2} + \frac{7}{n} + 2 = \Theta(\frac{1}{n})$
   (2-5) $\Theta(1) = min\,(27149,\ \ n^2 - 3n + 1)$

3. 是非題[B] (20 分；請使用 T 與 F (或 O 與 X)表示下列各題敘述是否正確；每題 2 分，答對得 2 分，答錯得 0 分並倒扣 1 分，未作答得 0 分)
For each statement in the following, please indicate T or O if it is correct and indicate F or X otherwise. (You get 2 points for each correct answer and lose 1 point for each incorrect answer.)
   (3-A) A stack can be implemented by using either data structure of queue, array or linked list.
   (3-B) In representing a network N_G, using an adjacency list always consumes less memory space than using an adjacency matrix.
   (3-C) A connected acyclic undirected graph is actually a tree structure.
   (3-D) Given a binary tree T of n_0 leaves, the height of T is at least $\lceil \log_2 n_0 \rceil + 1$.
   (3-E) When using bubble sort algorithm to sort n ($n > 2$) data items, if the number of key comparisons is k and $k < (n\log n)$, then this is the best case and the data items are already sorted in order before the sorting starts.
   (3-F) In sorting n ($n > 2$) data items using the heap sort algorithm, if k denotes the number of key comparisons and m denotes the number of data movements incurred from maintaining the order of the data items, then $m > k$.
   (3-G) If a binary search tree T is a complete binary tree, then T is an AVL tree.
   (3-H) If the adjacency list of a digraph $G = (V, E)$ has $|V|^2$ nodes, then G is strongly connected.
   (3-J) When using hash table to search in n data records, the load factor $lf = 1$ implies that the hash function is an order-preserving hash function.
   (3-K) Given the DFS (Depth First Search) result and BFS (Breadth First Search) result of a graph G, the structure of G can be uniquely determined.

4. Suppose a doubly linked list of n nodes is implemented by a one-dimension array. Each node of this linked list is composed of two 32-bit integers as the data and two 32-bit integers as the backward link and the forward link. The backward link points to its previous node while the forward link points to its next node. If the data part and the two links of each node are separately defined (e. g. the *struct* of C/C++ can not be used.) in the implementation and the index of the array starts from 0, then
   (4-A) Design an algorithm, based on the conditions listed below, to detect if any cycle exists in the list. (5 points)
   Condition 4-A-1. Excluding the array holding the list, the memory space complexity is $O(1)$.
   Condition 4-A-2. The amount of available memory in the system is 4G Bytes.
   (4-B) Design an algorithm, based on the conditions listed below, to detect if any cycle exists in the list. (5 points)
   Condition 4-B-1. $n < 10^6$
   Condition 4-B-2. The maximum available memory is 1G Bytes of RAM.
   Condition 4-B-3. The linked list is stored in ROM (Read-Only-Memory).

5. 單選題 (10 分；每小題 2 分)
   (5-1) Which of the following statement is true?
   (A) Queue is the data structure used in performing depth first search.
   (B) Queue is the data structure used in solving a maze problem.
   (C) Stack is the data structure used in level order traversal of a tree.
   (D) Stack is the data structure used in converting infix expression to postfix expression.
   (E) None of the above.

   (5-2) Which of the following statement is true?
   (A) The time complexity of postorder traversal of a binary tree with n nodes is $O(n \log n)$.
   (B) The time complexity of copying a binary tree is $O(n)$.
   (C) Assume the total number of values in k sorted lists is n and each list has n / k values. The time complexity of merging k sorted lists into a single sorted list by winner tree is $O(n*k)$.
   (D) The space complexity of inorder traversal of a binary tree with n nodes is $O(n \log n)$.
   (E) None of the above.

   (5-3) Which of the following statement is true?
   (A) Quick sort always performs faster than insertion sort.
   (B) Heap sort is based on divide-and-conquer approach.
   (C) Merge sort is a stable sorting algorithm.
   (D) The time complexity of insertion sort is $O(n \log n)$ for sorting n items.
   (E) None of the above.

   (5-4) Given the postfix expression "6 2 3 * / 4 * 5 +". What is the result of this evaluation?
   (A) 8　(B) 9　(C) 10　(D) 11　(E) 12

   (5-5) Given the segment of codes below. Which is its time complexity?
```
p = 0;
for (k = 1; k <= n^2; k *= 2)
    for(j = 1; j <=n; j++)
        p++;
```
   (A) $O(n)$　(B) $O(n^2)$　(C) $O(\log n)$　(D) $O(n \log n)$　(E) $O(n^2 \log n)$

6. 複選擇題 (30 分；每小題 5 分)

(6-1) Given a set of characters and their frequencies in the following, construct the optimal Huffman decoding tree.

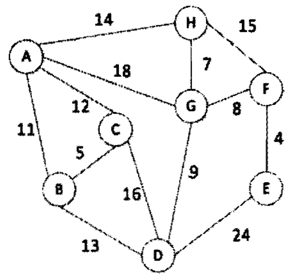
Character	A	B	C	D	E	F	G	H
Frequency	10	8	3	24	15	32	27	38

Which of the following statement(s) is (are) true about the resultant Huffman decoding tree T?

(A) The height of T is 6.
(B) T is an AVL tree.
(C) Character A is encoded as 01110
(D) If T is traversed by postorder, the first node visited is B.
(E) Character H is encoded as 10.

(6-2) Given a undirected graph G(V, E) below. Construct the minimum spanning tree (MST) starting from vertex C by using Prim's algorithm. Let vertex C be the first vertex added to the MST. Note that the root of the resultant MST is vertex C and it is on level 1.

(A) The resultant MST has height of 5.
(B) The third vertex added to the MST is H.
(C) Vertex D is vertex E's ancestor in the MST.
(D) The resultant MST is a binary tree.
(E) Vertex H is vertex A's descendant.



(6-3) Insert a sequence of numbers (48, 24, 51, 32, 26, 28, 8, 17) into an empty height-biased minimum leftist tree T, which of the following statement(s) is (are) true about the resultant T?

(A) The height of T is 5.
(B) If T is traversed by preorder traversal, the first node visited is 48.
(C) 28 is the ancestor of 32.
(D) The number of leaf nodes in T is 4.
(E) The shortest path from the root to an external node is 3.

(6-4) Insert a sequence of numbers (24, 48, 51, 32, 8, 26, 17, 28) into an empty Red-Black tree T, which of the following statement(s) is (are) true about T?

(A) The height of T is 5.
(B) T has 4 red nodes.
(C) If the tree T is traversed by postorder traversal, the first node visited is 48.
(D) Two rotation events occur in the entire insertion process.
(E) Three color-change-but-no-rotation events occur in the entire insertion process.

編號：184,195

國立成功大學一〇一學年度碩士班招生考試試題

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：0226，節次：2

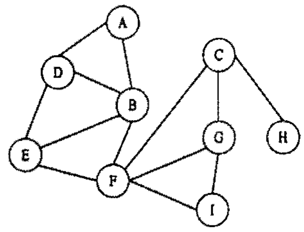
(6-5) Given a graph G(V, E) below. Perform both DFS and BFS starting from vertex E. In performing Depth First Search (DFS) and Breath First Search (BFS), resolve conflicts by following lexicon precedence. Which of the following statement(s) is (are) true?

(A) The seventh vertex visited in DFS is H.

(B) The resultant spanning tree from DFS with E as root is a binary tree.

(C) Vertex G is vertex I's parent in the resultant spanning tree from BFS with E as root.

(D) The resultant spanning tree from BFS with E as root has height of 4.



(E) The total number of biconnected components in G(V, E) is 2.

(6-6) Given a binary search tree T which has n nodes. Let its height be h. Which of the following statement(s) is (are) true about T?

(A) If n_0, n_1, and n_2 represent the number of leaf, degree-1, and degree-2 nodes in T, respectively, $n_1 = n - 2n_2 - 1$.

(B) The time complexity of searching a number in T is O(log n).

(C) The space complexity of a recursive search function for T is O(log n).

(D) T has at most $2^h - 1$ nodes at level h.

(E) Inorder traversal should be used to read all keys stored in T in ascending order.

7. (10 points) Suppose a list of **n** distinctive numbers stored in an integer array **int** a[] are sorted with the support of a table **int** t[]. After the sorting, a[t[0]], .., a[t[n-1]] are in the ascending order but the numbers in array a[] are not moved. Also, disjoint cycles are formed in t[0] …, t[n-1]. The C program tableSort() given below is to perform table sort which takes advantage of the disjoint cycles and rearranges a[0:n-1] to correspond to the sequence a[t[0]], …, a[t[n-1]]. That is, after performing tableSort(), the numbers stored in array a[] is in ascending order. Please **fill out the blanks** in the following to complete the program.

```
void tableSort(int a[], int n, int t[])
  {   int   i, current, next, temp;
  for (i = 0; i < n-1; i++){
   if ( (7-1) ) {                    /* nontrivial cycle starting at i */
       temp = a[i]; current = i;
       do {
         next = t[current];  (7-2) ;
            t[current] = current;  (7-3) ;
       } while ( (7-4) );
             a[current] = temp;
              (7-5) ;
       }
  }
```