※ 注意：請於試卷上「選擇題作答區」依序作答。

(一) 單選題 (每題 5 分; 答錯不倒扣)

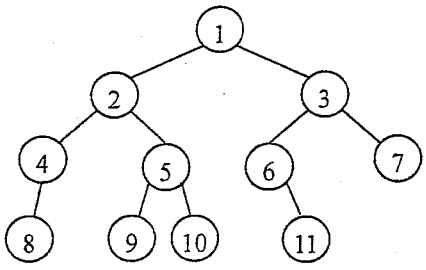
1. Which of the following best describes "Abstract Data Type (ADT)"? (A) To guide the writing of object-oriented programming such as C++, (B) To have a better memory management for complex data structures, (C) To specify a set of data and associated operations that are independent of any particular implementation, (D) To operate on discrete data types, (E) To implement tree structures with less memory usage.

2. Which of the following best describes "amortized analysis"? (A) Computing the worst-case overhead of an operation, (B) Analyzing the amount of efforts (time, money, etc) over a sequence of tasks, (C) Estimating the potential gain on an algorithm, (D) Generating test patterns or cases for an algorithm, (E) Finding the average running time per operation over a worst-case sequence of operations.

3. Which of the following best describes "dynamic array"? (A) The memory of the array is dynamically allocated, (B) The data in the array is dynamically sorted, (C) The capacity of the array is dynamically resized, (D) The name of the array can be dynamically changed, (E) An array that can be dynamically reconstructed into a tree data structure.

4. A relation "$\leq$" is a partial order on a set S if it has the following properties: (1) Reflexivity: $a \leq a$ for all $a \in S$, (2) Antisymmetry: $a \leq b$ and $b \leq a$ implies $a = b$, and (3) Transitivity: $a \leq b$ and $b \leq c$ implies $a \leq c$. The question is: given a set of data with the "partial order" property, what would be the best data structure to store these data and retrieve the partial order relations later? (A) Doubly-linked list, (B) Directed acyclic graph, (C) Binary tree, (D) Hash, (E) Trie.

5. The order of nodes by the post-order traversal on the following tree is: (A) { 8, 4, 9, 10, 5, 2, 11, 6, 7, 3, 1 }, (B) { 8, 4, 2, 9, 10, 5, 1, 11, 6, 7, 3 }, (C) { 1, 2, 4, 8, 5, 9, 10, 3, 6, 11, 7 }, (D) { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 }, (E) { 8, 4, 2, 1, 9, 5, 10, 11, 6, 3, 7 }

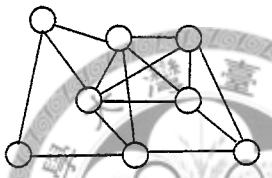


接背面

6. The complexity of inserting a node into an arbitrary binary search tree is (n is the number of nodes in the tree): (A) O(1), (B) O(n), (C) O(log n), (D) O(n log n), (E) $O(n^2)$.

7. Which one of the following is NOT true about the quicksort algorithm? (A) The performance of quicksort may depend on the selection of the "pivot", (B) The worst case for quicksort can be $O(n^2)$, (C) The amortized average case for quicksort is O(n log n), (D) The implementation of the quicksort algorithm is usually by recursion, (E) Quicksort is a stable sorting method.

8. The "clique number $\omega(G)$" of a graph G is the cardinality of its largest clique. What is $\omega(G)$ of the following graph? (A) 1, (B) 2, (C) 3, (D) 4, (E) 5.



(二) 複選題 (每題答對 6 分, 答錯 0 分; 答錯不倒扣)

9. Suppose we implement a hash with number of buckets = 100, denoted as B[0], B[1], B[2], ..., B[99]. Let the hash function be "h(i) = $(i^2 + 1)$ % 100", where 'i' is the data to be hashed, and '%' is the modulo operation. When two or more data are hashed into the same bucket (collision), we use a singly-linked list to store these numbers in the bucket (i.e. using chaining; no probing or rehashing). Let the number of data in bucket 'k' be denoted as "|B[k]|". If we insert integral data from 1 to 1000 into the hash, which of the following is (are) correct? (A) |B[2]| = 10, (B) |B[3]| = 0, (C) |B[26]| = 100, (D) |B[15]| = 15, (E) |B[37]| = 40.

10. Which of the following runtime complexity analysis on the programs is (are) correct? (A) Program 2.a: $O(n^2)$, (B) Program 2.b: $O(2^n)$, (C) Program 2.c: O(n), (D) Program 2.d: $O(n^2 \log n)$, (E) Program 2.e: O(n log n).

Program 2.a

```
// Vector (inner) multiplication  z =A*B
// A and B are vectors with size 'n'; z is in integer
int z = 0;
for (int i=0; i<n; i++)
  z = z + A[i]*B[i];
```

接次頁

Program 2.b

```
// compute factorial(n)
int factorial (int n) {
   if (n <= 1)    return 1;
   else   return n * factorial(n-1);
}
```

Program 2.c

```
int factorial (int n) {
   if (n<=1)    return 1;
   else {
      fact = 1;
      for (k=2; k<=n; k++)
         fact *= k;
      return fact;
   }
}
```

Program 2.d

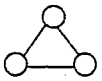
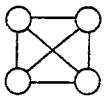
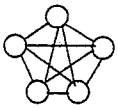
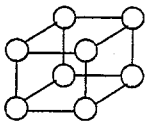
```
for (i=1; i<n-1; i++) {
   for (j=n; j>= i+1;  j--) {
      if (A(j-1) > A(j)) {
         temp = A(j-1);
         A(j-1) = A(j);
         A(j) = tmp;
      }
   }
}
```

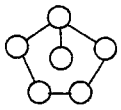
Program 2.e

```
// a[] is an sorted integer array
int binarySearch(int a[], const int x, const int n) {
   int left = 0, right = n - 1;
   while (left <= right) {
      int middle = (left + right) / 2;
      if (x > a[middle]) left = middle + 1;
      else if (x < a[middle]) right = middle - 1;
      else return middle;
   }
   return -1;
}
```

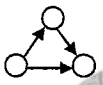
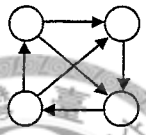
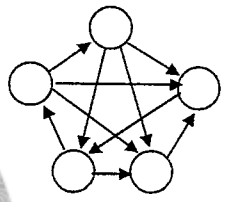
接背面

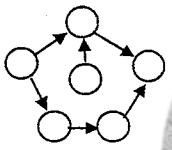
11. Which of the following is (are) planar graph(s)?

(A)  (B)  (C)  (D) 

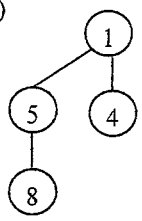
(E) 

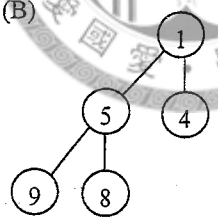
12. Which of the following digraph is (are) strongly connected?

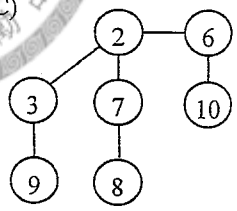
(A)  (B)  (C)  (D) 

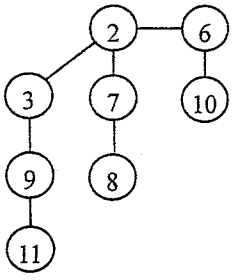
(E) 

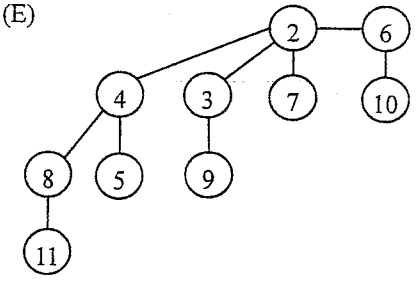
13. Which of the following is (are) valid binominal heap(s)?

(A) 

(B) 

(C) 

(D) 

(E) 

14. Which of the following about "Asymptotic Notation (O, Ω, Θ)" is (are) correct? (Note: "iff" means "if and only if") (A) f(n) = O(g(n)) iff g(n) = Ω(f(n)), (B) f(n) = Θ(g(n)) iff f(n) = O(g(n)) and f(n) = Ω(g(n)), (C) Let p(n) be a

接次頁

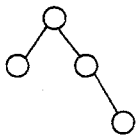
polynomial function with degree d, then $p(n) = \Theta(n^d) = O(n^d) = \Omega(n^d)$, (D) Let c be any non-negative constant integer, then $p(n) = O(c^n)$, (E) $\log^k n = O(n)$ for any power k.

15. Which of the following is (are) true about the "tree" data structure? (A) Number of internal nodes = number of external (leaf) nodes – 1, (B) Number of edges = number of nodes – 1, (C) For each external (leaf) node, there exists only one trace from the root node to this external node, (D) Each node in the tree can be a root node of a subtree, (E) Each node in the tree has only one parent node.

16. Which of the following is (are) complete binary tree(s)?

(A) (B) (C) (D) (E)

17. Below is an AVL tree of height 2. It is also the AVL tree with height 2 that contains the minimum number of nodes (i.e. number of nodes = 4). In general, what is the minimum number of nodes 'n' for an AVL tree with height 'h'? (A) h = 0 → n = 1, (B) h = 1 → n = 3, (C) h = 3 → n = 6, (D) h = 4 → n = 12, (E) h = 5 → n = 15.



18. Which of the following is (are) true about the heap data structure? (n is the number of nodes) (A) Deleting the minimum element in a min-heap takes O(log n) time, (B) Finding the minimum element in a min-heap takes O(log n) time, (C) Inserting a node into a Fibonacci heap takes O(log n) time, (D) Decrease-key operation on a node of a Fibonacci heap takes O(1) time, (E) Finding both the minimum and the maximum elements in a min-max heap takes O(1) time.

試題隨卷繳回