※ 注意：請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

(一) 單選題 (每題 5 分; 答錯不倒扣)

1. What are the run times of evaluating polynomials using "direct evaluation" and "Horner's method," respectively?

   Direct Evaluation: $p(x)=a_0x^n+a_1x^{n-1}+a_2x^{n-2}+\cdots+a_{n-1}x+a_n$

   Horner's method: $p(x)=(\cdots(((a_0)x+a_1)x+a_2)x+\cdots+a_{n-1})x+a_n$

   (a) $\Theta(n^2)$, $\Theta(n)$
   (b) $\Theta(n^2)$, $\Theta(n^2)$
   (c) $\Theta(n)$, $\Theta(n)$
   (d) $\Theta(n)$, $\Theta(n^2)$
   (e) none of the above

2. Evaluate the following postfix expression. What is the actual numeric value of the expression?

```
5  3  +  7  4  -  1  -  /
```

   (a) 2
   (b) 3
   (c) 4
   (d) 5
   (e) none of the above

3. What is the time complexity of the operation "`insert(pos, data)`" to a doubly-linked list, where "pos" is the given position (e.g. pointer) to insert "data"?

   (a) O(1)
   (b) O(log n)
   (c) O(n)
   (d) O(n log n)
   (e) $O(n^2)$

4. What's the run time of the recursive version of exponentiation function?

```
double exp(double x,int n){
   double factor = (n%2 == 0 ? 1.0 : x);
   if (n < 2) return factor;
   return factor * exp(x*x, n/2);
}
```

   (a) $\Theta(n^2)$
   (b) $\Theta(n)$
   (c) $\Theta(\log n)$
   (d) $\Theta(n\log n)$
   (e) none of the above

5. How many recursive calls would the call "`fibonacci(10)`" generate in the following factorial program?

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```
int fibonacci(int n){
   if (n < 1) return 0;
   if (n < 3) return 1;
   return fibonacci(n-1) + fibonacci(n-2);
}
```

(a) 55
(b) 110
(c) 20
(d) 108
(e) none of the above

6. For the "`fibonacci()`" program above, if we use a "computational cache" (i.e. a hash table) to speed up the program, such as:

```
int fibonacci(int n){
   int res;
   if (n < 1) return 0;
   if (n < 3) return 1;
   // fib_cache is the computational cache
   if (fib_cache.find(n, res)) return res;
   res = fibonacci(n-1) + fibonacci(n-2);
   fib_cache.insert(n, res);
   return res;
}
```

where "`fib_cache.insert(key, data)`" is to record the computed result so that if we encounter the same key again later, we can directly retrieve the stored result without calling the recursive function.

How many recursive calls would the call "`fibonacci(10)`" then generate?

(a) 9
(b) 10
(c) 16
(d) 18
(e) 20

7. How many different binary trees are there with size $n = 5$?

(a) 7
(b) 14
(c) 21
(d) 42
(e) none of the above

8. Which of the following is the complement graph of the Figure 8?

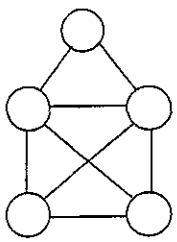

Figure 8

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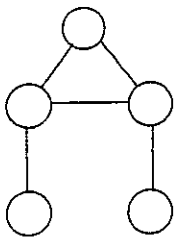
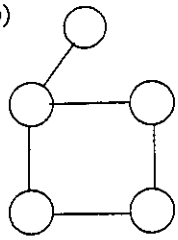
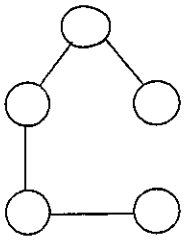
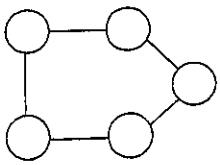
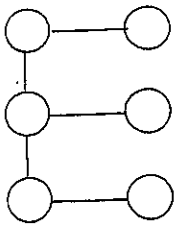
(a) 
(b) 
(c) 
(d) 
(e) 

(二) 複選題 (每題答對 6 分, 答錯 0 分; 答錯不倒扣)

9. Which of the following statement(s) is (are) true?

(a) The size of a subtree is equal to the number of descendants of the root of the subtree.
(b) If x is a descendant of y in a tree, then the depth of x is greater than the depth of y.
(c) If R is a subtree of S, and S is a subtree of T, then R is a subtree of T.
(d) A tree is full if and only if all of its leaves are at the same level.
(e) The right subtree of any node in a complete binary tree is complete.

10. Which of the following statement(s) is (are) true?

(a) Every subtree of a BST(Binary Search Tree) is another BST.
(b) If both the left and right subtrees of a binary tree T are BSTs, then T must be a BST.
(c) Even if the same keys are inserted in a different order to build a BST, the resulting BST will be the same.
(d) Every subtree of an AVL tree is also an AVL tree.
(e) If T is a BST and both the left and right subtrees of T are AVL trees, then T must be an AVL tree.

11. Which of the following statement(s) is (are) true?
(Note: the degree of a nonempty tree is the greatest degree of its nodes)

(a) The size of a full tree of degree d and height h is $n = \frac{d^{h+1}-1}{d-1}$.
(b) The minimum size n of any nonempty tree of degree d and height h is $h+d$.
(c) A complete binary tree of size n has $n/2$ internal nodes and $(n+1)/2$ leaves. (The "/" operator denotes integer division.)
(d) For all binary trees, we have $h \geq \lfloor \log n \rfloor$, where n = size and h = height.
(e) For complete binary trees, we have $h = \lfloor \log n \rfloor$, where n = size and h = height.

12. Which of the following about "Abstract Data Type (ADT)" is (are) correct?

(a) The implementation of ADTs is dependent on the algorithms and programs that use them.
(b) Dynamic array is an example of linear ADT.
(c) The "insert" and "find" operations of ADTs are required to have complexity O(log n).

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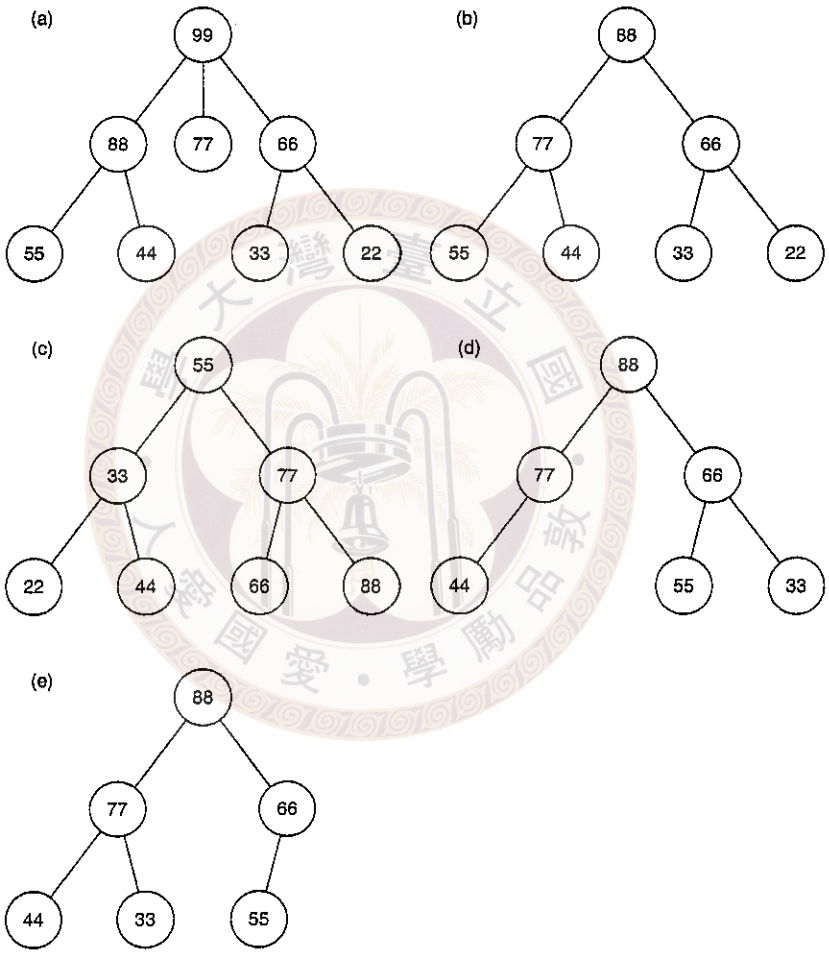
(d) Usually the "data members" of an ADT are abstracted away (i.e. hid from the users).

(e) Usually "how the member functions of an ADT are implemented" are abstracted away (i.e. hid from the users)?

13. Which of the following binary trees is a (are) max heap(s)?



14. Which of the following statement(s) is (are) true?

(a) All B-trees of order 2 are full binary trees.

(b) The time complexity for the "insert" operation of a binary search tree is O(h), where h is the height of the tree.

(c) A "trie" is a balanced binary search tree.

(d) A "2-3 tree" is a balanced binary search tree.

(e) A "red-black tree" is a balanced binary search tree.

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15. Which of the following statement(s) is (are) true for the graph in Figure 15-1? [Note: the numbers on the edges are the costs.]

(a) The vertex with the maximum degree is 'd'.
(b) The shortest path (considering costs) from vertex 'a' to 'vertex 'g' is "a → c → f → g"
(c) The minimum-cost spanning tree is as shown in Figure 15-2.
(d) The number of vertices of the maximum clique is 4.
(e) The path "b → a → d → e → g → d → c → f" is a simple path.

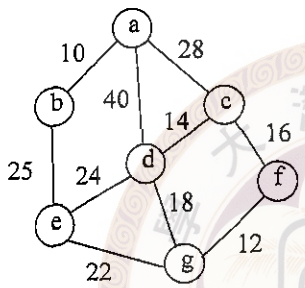

Figure 15-1

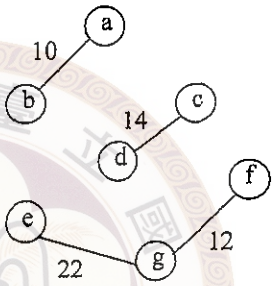

Figure 15-2

16. Which of the following statement(s) is (are) true?

(a) Figure 16-1 is a simple graph.
(b) Figure 16-1 is a directed acyclic graph.
(c) Figure 16-2 is a complete graph.
(d) Figure 16-2 is a plannar graph
(e) Figure 16-3 is a bipartite graph.

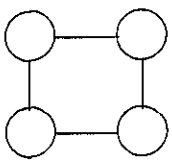
Figure 16-1

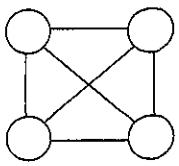
Figure 16-2

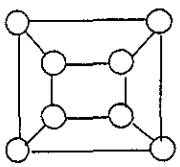
Figure 16-3

17. Suppose we would like to use "hash" to store the following strings: "paul", "emily", "christine", "alan", and "bryant". The number of buckets, B, is 6. Which of the following hash function "h(key)" will NOT produce collision among these data?

(Note: the ASCII codes for characters 'a' to 'z' are as follows)

a(97)	b(98)	c(99)	d(100)	e(101)	f(102)	g(103)
h(104)	i(105)	j(106)	k(107)	l(108)	m(109)	n(110)
o(111)	p(112)	q(113)	r(114)	s(115)	t(116)	u(117)
v(118)	w(119)	x(120)	y(121)	z(122)		

(a) h(key) = "the length of the string" modulo B.
(b) h(key) = "the ASCII code of the first character" modulo B.
(c) h(key) = "the ASCII code of the last character" modulo B.
(d) h(key) = "the summation of the ASCII codes of the first two characters" modulo B.
(e) h(key) = "the summation of the ASCII codes of the first three characters" modulo B.

18. Which of the following statement(s) is (are) true? (n is the number of elements to sort)

(a) The worst case behavior of quick sort is $O(n^2)$.
(b) The worst case behavior of iterative merge sort is $O(n^2)$.
(c) Quick sort is a stable sorting algorithm.
(d) Merge sort is a stable sorting algorithm.
(e) To achieve the O(n log n) time complexity, the sorting algorithm must be implemented on a balanced binary tree.

試題隨卷繳回