國立中山大學114學年度
碩士班考試入學招生考試試題

科目名稱：資料結構【資管系碩士班乙組】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

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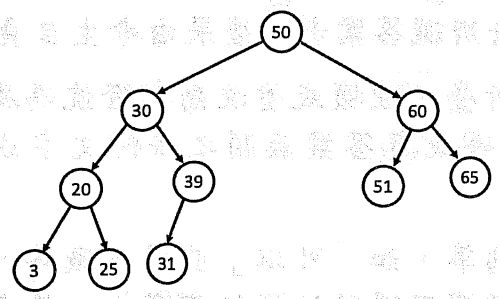
※本科目依簡章規定「不可以」使用計算機(選擇題)　　

Multiple Choice Questions

1. If a list of items B, C, A, D, E are enqueued into a queue in this order, what is the item that will be extracted when dequeuing from the queue the 2nd time? (3%)
   A. B
   B. C
   C. A
   D. E
   E. D

2. Which sorting algorithm takes the most space? (3%)
   A. Quicksort
   B. Selection Sort
   C. Insertion Sort
   D. Heapsort
   E. Mergesort

3. What is the in-order traversal of the following binary search tree? (4%)



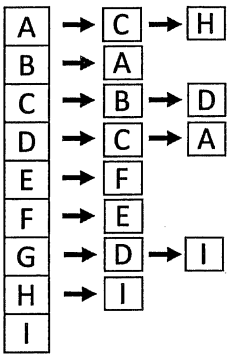
   A. 3 20 25 30 31 39 50 51 60 65
   B. 50 30 20 3 25 39 31 60 51 65
   C. 3 25 20 31 39 30 51 65 60 50
   D. 3 25 20 31 39 30 50 51 65 60
   E. 65 60 51 50 39 31 30 25 20 3

4. What is the time complexity of the following code? (4%)

```
-----------------------------------------------
int aggregate = 0;
for (int i = 1; i <= N; i = i * 2){
   for (int j = N; j > 0; j--){
      aggregate += i+j;
   }
}
-----------------------------------------------
```

   A. O(1)
   B. O(N)
   C. O(logN)
   D. $O(N^2)$
   E. O(NlogN)

5. Which node is in the largest strongly connected component of the following directed graph represented in an adjacency list? (4%)



A. B
B. H
C. I
D. F
E. G

6. Which item is the root of a red-black tree when constructed with the items 5, 7, 20, 31, 6, 2, 8, 1, 3, 26 inserted in this order? (4%)
A. 5
B. 6
C. 7
D. 8
E. 20

7. For a binary search tree whose pre-order traversal is 10 5 3 2 1 7 6 8 20 15 12 16 and in-order traversal is 1 2 3 5 6 7 8 10 12 15 16 20, what would be the 5th item in its post-order traversal? (4%)

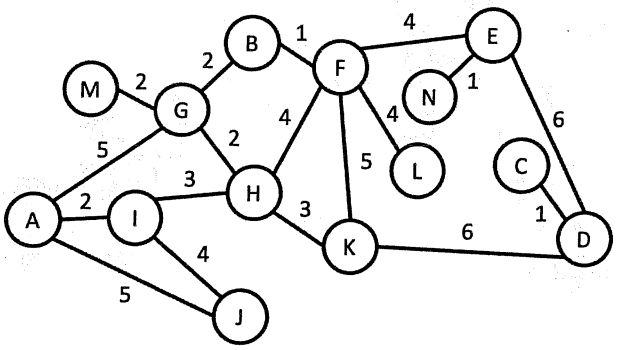
A. 8
B. 15
C. 5
D. 6
E. 7

8. What is the postfix expression of the following infix expression? (4%)

5+(7-2)*2+5/2

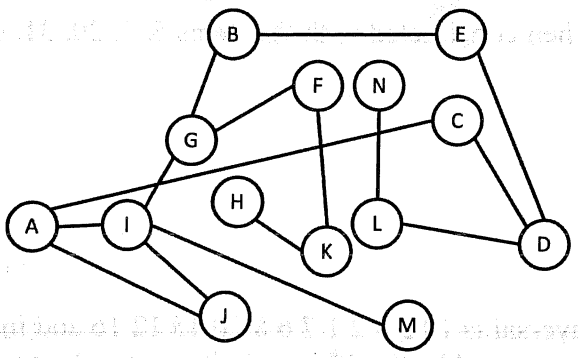
A. +*-+5722/52
B. ++5*-722/52
C. 57+2-2*52/+
D. 572-2*+52/+
E. 57+22*-52/+

9. What is the weight of the minimal spanning tree of the following graph? (4%)



A. 33
B. 34
C. 35
D. 36
E. 37

10. Which node among the nodes in the options is the last reached in a breadth-first search of the following graph when starting at the node A? (4%)



A. D
B. C
C. M
D. B
E. K

11. How many compares are needed to find 26 in a binary search tree with the following items inserted into the tree initially in this order? (4%)

10, 22, 18, 1, 5, 20, 7, 70, 12, 3, 15, 55, 43, 61, 11, 26, 22, 67

A. 2
B. 3
C. 4
D. 5
E. 6

12. The first step of heapsort is to build a max heap from an input array. What will the last item of the input array [8,11,2,6,10,7,3,1,15] become after running heapify to generate and store a max heap? (4%)

A. 1
B. 2
C. 3
D. 6
E. 7

13. What is the number of connected components in the graph represented by the adjacency matrix below? (4%)

	A	B	C	D	E	F	G	H	I	J
A	0	0	0	0	1	0	0	0	0	1
B	0	0	0	0	0	0	1	0	1	0
C	0	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0	0
E	1	0	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	1	0	0
G	0	1	0	0	0	0	0	0	1	0
H	0	0	0	0	0	1	0	0	0	0
I	0	1	0	0	0	0	1	0	0	0
J	1	0	0	0	0	0	0	0	0	0

A. 1
B. 2
C. 3
D. 4
E. 5

14. In a height-balanced binary search tree, the heights of the left and right descendants of any node differ by at most 1. Which of the following are true of such a tree? (3%)

I. Worst-case search time is logarithmic in the number of nodes.
II. Average-case search time is logarithmic in the number of nodes.
III. Best-case search time is proportional to the height of the tree.
IV. The height of the tree is logarithmic in the number of nodes.

A. I and III only
B. II and III only
C. II and IV only
D. I, II, and IV
E. I, III, and IV

15. Which of the following choices gives the best bound for the value of $f(N)$ where f is a solution to the recurrence:
$f(2N+1) = f(2N) = f(N) + \log N$ for $N \geqq 1$ with $f(1) = 0$? (3%)

A. O(logN)
B. O(NlogN)
C. O(logN) + O(1)
D. $O((\log N)^2)$
E. O(N)

16. The following pseudo code solves a set of equations $Lx = b$, where L is a unit lower-triangular matrix (ones on the diagonal and zeros above the diagonal)

```
for i := 1 to n do
  x[i] := b[i];
for i := 2 to n do
  for j := 1 to i − 1 do
    < statement >
```

The missing <statement> in the code is: (3%)

A. $x[i] := x[i] - L[i,j]*x[j]$
B. $x[j] := x[j] - L[i,j]*x[i]$
C. $x[j] := x[j] - L[i,j]*x[j]$
D. $x[i] := b[j] - L[i,j]*x[i]$
E. $x[i] := x[i] - L[i,j]*x[i]$

17. Consider the following equations concerning a stack that has the operations *Push*, *Pop*, *Top*, and *IsEmpty*. Which of the equations does not represent the conventional semantics of a stack? (3%)

A. *IsEmpty*(*Push*(*Stack*, *Elem*)) = *true*
B. *Pop*(*Push*(*Stack*, *Elem*)) = *Stack*
C. *Top*(*Push*(*Stack*, *Elem*)) = *Elem*
D. *IsEmpty*(*Push*(*Push*(*Stack*, *Elem1*), *Elem2*)) = *false*
E. *Top*(*Pop*(*Push*(*Push*(*Stack*, *Elem1*), *Elem2*))) = *Elem1*

18. In the following pseudo code of binary search one can determine whether an integer x is present in the sorted (in ascending order) array $a[L..R]$.

```
Let M = (L + R) div 2.
If x = a[M], then terminate (success).
If x < a[M] and M > L, use the same algorithm on a[L..M − 1].
If x > a[M] and M < R, use the same algorithm on a[M + 1..R].
Otherwise terminate (failure).
```

Which of the following statements is (are) true about binary search in $a[1..N]$, where N is a positive integer. (3%)

I. If x is present in $a[1..N]$, then x is always found within O(logN) comparisons.
II. If x is not present in $a[1..N]$, then failure is always reached within O(logN) comparisons.
III. Searching for two different values of x, neither of which is present in $a[1..N]$, always takes the same number of steps to determine failure.

A. I only
B. II only
C. III only
D. I and II
E. II and III

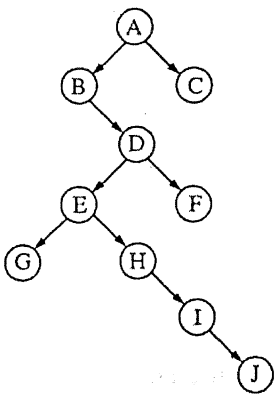
19. A data structure is comprised of nodes each of which has exactly two pointers to other nodes, with no null pointers. The following pseudo code is to be used to count the number of nodes accessible from a given node. It uses a mark field, assumed to be initially zero for all nodes. There is a statement missing from this code.

```
struct test {int info, mark; struct test *p, *q; }
int nodecount(struct test *a)
{
  if (a->mark) return 0 ;
  return nodecount(a->p) + nodecount(a->q) + 1 ;
}
```

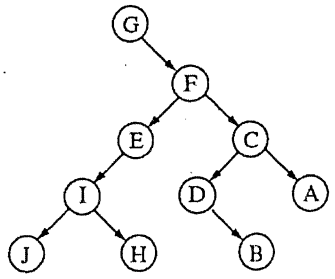
Which change should be made to make the code work properly? (3%)

A. Add "*a->mark* =1;" as the first statement.
B. Add "*a->mark* =1;" after the "if" statement.
C. Add "*a->mark* =1;" as the last statement.
D. Add "*a->mark* =0" after the "if" statement.
E. Add "*a->mark* =0" as the last statement.

20. For *Tree1* and *Tree2* indicated below, which traversals of *Tree1* and *Tree2*, respectively, will produce the same sequence of node names? (3%)



Tree1



Tree2

A. Preorder, postorder
B. Postorder, inorder
C. Postorder, postorder
D. Postorder, preorder
E. None of the above

21. Consider the following sorting algorithms, which has a running time that is least dependent on the initial ordering of the input? (3%)

A. Insertion sort
B. Selection sort
C. Quicksort
D. Merge sort
E. Shellsort

22. Consider a given undirected graph G, which of the following problems is currently known to be solvable in polynomial time? (3%)

A. Finding a shortest cycle in G
B. Finding a longest simple cycle in G
C. Finding all spanning trees of G
D. Finding a largest clique in G
E. None of the above

23. Consider the following data structures for a set of n distinct integers.

I. A min-heap
II. An array of length n sorted in increasing order
III. A balanced binary search tree.

For which of the above data structures is the number of steps needed to find and remove the 7-th largest element O(logn) in the worst case? (3%)

A. I only
B. II only
C. I and II
D. I and III
E. II and III

24. A doubly linked list is declared as

```
Element = record
            Value    :integer;
            Fwd, Bwd:↑Element
          end;
```

Where *Fwd* and *Bwd* represent forward and backward links to adjacent elements of the list. Which of the following codes deletes the element pointed to by X from the doubly linked list, if it is assumed that X points to neither the first nor the last element of the list? (4%)

(A) X↑.Bwd↑.Fwd := X↑.Fwd ;
X↑.Fwd↑.Bwd := X↑.Bwd

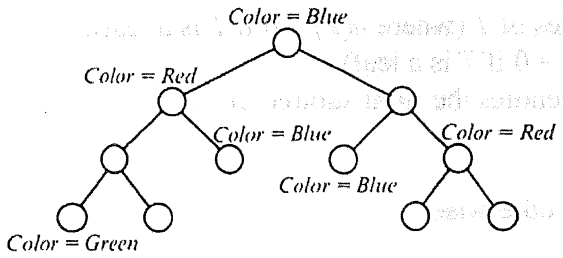
(B) X↑.Bwd↑.Fwd := X↑.Bwd ;
X↑.Fwd↑.Bwd := X↑.Fwd

(C) X↑.Bwd↑.Bwd := X↑.Fwd ;
X↑.Fwd↑.Fwd := X↑.Bwd

(D) X↑.Bwd↑.Bwd := X↑.Bwd ;
X↑.Fwd↑.Fwd := X↑.Fwd

(E) X↑.Bwd := X↑.Fwd ;
X↑.Fwd := X↑.Bwd

25. In the tree below, some nodes *n* have an attribute *Color*(*n*). To determine a color for a given node *n*, the following pseudo code is executed.

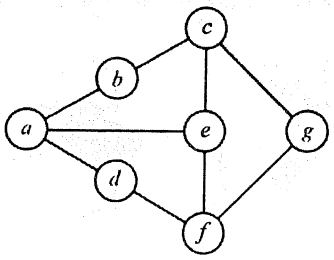



```
function FindColor(n) : Color ;
begin
  if n has attribute Color then
    FindColor := Color(n)
  else
    FindColor := FindColor(Parent(n))
end ;
```

If *FindColor*(*n*) is evaluated for each node *n*, how many evaluations of *FindColor*(*n*) will result in *Red*? (4%)

A. 2
B. 3
C. 4
D. 5
E. 6

26. An independent set *I* of nodes of a graph *G* is a collection of nodes of *G* such that no two nodes of *I* are adjacent in *G*. A maximal independent set *M* of a graph *G* is an independent set such that if *x* is any node of *G* not included in *M*, then $M \cup \{x\}$ is not an independent set. Which of the following is a maximal independent set of the graph in the figure. (4%)



A. $\{a, e\}$
B. $\{a, g\}$
C. $\{b, e, d\}$
D. $\{b, e, g\}$
E. None of the above

27. Let T denote a nonempty binary tree in which every node either is a leaf or has two children. Then (4%)
$n(T)$ denotes the number of non-leaf nodes of T (where $n(T) = 0$ if T is a leaf),
$h(T)$ denotes the height of T (where $h(T) = 0$ if T is a leaf),
T_L denotes the left subtree of T, and T_R denotes the right subtree of T.
If F is a function defined as follows:
$F(T) = 0$ if T is a leaf
$= F(T_L) + F(T_R) + min(h(T_L), h(T_R))$ otherwise
Then $F(T) =$

A. $n(T) + h(T) - 1$
B. $n(T) + h(T)$
C. $n(T) + h(T) + 1$
D. $n(T) - h(T)$
E. $n(T) - h(T) - 1$

28. Consider the collection of all undirected graphs with 10 nodes and 6 edges. Let M and m, respectively, be the maximum and minimum number of connected components in any graph in the collection. If a graph has no self-loops and there is at most one edge between any pair of nodes, which of the following is true? (4%)

A. $M = 10, m = 10$
B. $M = 10, m = 1$
C. $M = 7, m = 4$
D. $M = 6, m = 4$
E. $M = 6, m = 3$