一、單選題　請於答案卡上作答

Ten multiple choice (single answer) questions (3 points per question)

1. **Let Fibonacci(0)=0, Fibonacci(1)=1, Fibonacci(2)=1, Fibonacci(3)=2, Fibonacci(4)=3, and Fibonacci(i+2)=Fibonacci(i)+Fibonacci(i+1), what is Fibonacci(8) equal to?**
   (A) 34
   (B) 21
   (C) 8
   (D) 13

2. **If we insert a number 13 to a max-heap [16, 14, 10, 8, 7, 9, 3, 2, 4, 1] at the end of the array structure [16, 14, 10, 8, 7, 9, 3, 2, 4, 1, 13] and run the necessary procedure to maintain the max-heap property, what is the new structure after the max-heap property is restored?**
   (A) [16, 14, 10, 8, 7, 9, 3, 2, 4, 1, 13]
   (B) [16, 14, 10, 8, 7, 9, 13, 2, 4, 1, 3]
   (C) [16, 14, 10, 8, 13, 9, 3, 2, 4, 1, 7]
   (D) [16, 14, 10, 13, 7, 9, 3, 2, 4, 1, 8]

注意:背面有試題

3. Given the following pseudo code of Quicksort algorithm, which statement is true?

(A) The output of Quicksort() is a non-increasing sorted sequence.

(B) The Quicksort() is a stable sorting algorithm

(C) The worst time performance for the Quicksort() is $O(n^2)$

(D) None of the above

```
Quicksort(A,p,r)
1    if p<r
2         q=Partition(A,p,r)
3         Quicksort(A,p,q-1)
4         Quicksort(A,q+1,r)

Partition(A,p,r)
1    x = A[r]
2    i = p-1
3    for j = p to r-1
4         if A[j] <= x
5              i = i+1
6              exchange A[i] with A[j]
7      exchange A[i+1] with A[r]
8      print(A[p:r])
9      return i+1
```

注意:背面有試題

4. **According to the pseudo code given in question 3, which of the following is NOT a possible print out result by Line 8 print(A[p:r]) in Partition(A,p,r)?**

(A) 11, 12, 19, 6, 13

(B) 11, 12, 6, 13, 19

(C) 6, 11,12, 13, 19

(D) 11, 6, 12, 19, 13

5. **The following pseudo code is a simple algorithm to generate a permutation of n items. Please fill in the underscored area in Line 6 with a correct formula such that i <= j < n**

(A) n

(B) n-i

(C) i

(D) n-1

```
1 function Uniform(m)
2     return a random integer between 0 and m-1; // uniform distribution
3
4 function Permutation(A,n)
5     for i = 0 to n-2 // 0-based indexing system
6         j = i + Uniform( _____ ); // j is a random integer. i<=j<n
7         swap(A[i],A[j]);
```

注意:背面有試題

6. **Run the function Permutation(A,n) given in question 5 with A=[1,2,3,4,5,6], n=6 and the randomization results: i=0, j =4; i=1, j =3; i=2, j =2; i=3, j =5; i=4, j =5. What is the resultant permuted A?**

(A) [5,4,3,6,2,1]

(B) [4,2,6,5,3,1]

(C) [2,5,4,6,1,3]

(D) [4,6,2,5,3,1]

7. **What is the time complexity of pushing a new element onto a stack with n elements using an array-based implementation?**

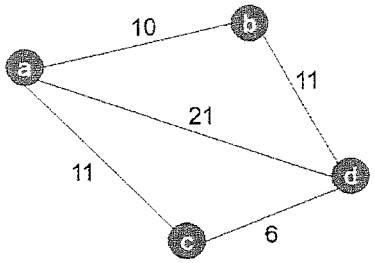
(A) O(1)

(B) O(n)

(C) O(n^2)

(D) O(log n)

8. **Consider the given graph, what is the weight of the minimum spanning tree using the Prim's algorithm, starting from vertex a?**



(A) 23

(B) 28

(C) 27

(D) 11

注意:背面有試題

9. **Let G be a complete graph with 4 vertices. How many spanning trees does graph G have?**

(A)12

(B)8

(C)16

(D)25

10. **Given the following code, what will happen during the execution?**

```
1  void do_job()
2  {
3      do_job();
4  }
5  int main()
6  {
7      do_job;
8      return 0;
9  }
```

(A) The code cannot be compiled

(B) The code will be executed successfully and "0" will be printed out

(C) The code will be executed successfully and random output will be exported

(D) The code will be executed successfully, but an overflow will occur

注意:背面有試題

二、多選題　請於答案卡上作答

Ten multiple choice questions with one or more answers (3 points per question)（每一選項單獨計分，不倒扣）

11 **Which of the following arrays are max binary heaps?**

(A) {9, 16, 3, 2, 4, 8, 5, 14, 12}

(B) {16, 9, 14, 8, 5, 12, 2, 4, 3}

(C) {16, 8, 14, 5, 2, 9, 12, 4, 3}

(D) {16, 14, 9, 4, 8, 12, 5, 3, 2}

(E) {16, 14, 9, 4, 12, 8, 5, 3, 2}

12 **Use a stack structure with only push and pop operations. An array with 4 items {A,B,C,D} is processed by push(A), push(B), push(C), push(D) sequentially with all possible legal pop() to remove the item on top of the stack at any time. For example, we can execute push(A), push(B), push(C), push(D), and then pop(), pop(), pop(), pop() to reverse the order to get D, C, B, A pop sequentially. What of the following are not possible pop sequences using a stack?**

(A) ACBD

(B) CDBA

(C) CDAB

(D) BDCA

(E) BDAC

注意:背面有試題

13 **Suppose that we have numbers between 1 and 1000 in a binary search tree and we want to search the number 101. Which of the following sequences could NOT be the sequence of nodes examined?**

(A) 20, 252, 41, 49, 130, 120, 131, 101

(B) 252, 20, 41, 49, 131, 130, 120, 101

(C) 100, 200, 131, 130, 120, 110, 105, 101

(D) 80, 252, 90, 130, 120, 131, 110, 101

(E) 90, 252, 100, 131, 130, 120, 110, 101

14 **Which of the following data structures have constant or nearly constant data element access time O(1)?**

(A) stack

(B) linked list

(C) array

(D) hash table

(E) AVL tree

15 **Which of the following are legal postfix expressions?**

(A) ABC*+

(B) ABC*+D+

(C) AB*CD*+

(D) ABC+D+E+

(E) ++A*BCD

注意:背面有試題

16 **Given a graph G(V,E) where vertices V={A,B,C,D,E,F} and Edges E={(A,B), (A,D), (C,A), (C,E), (C,F), (D,C), (F,D)}. Edges (A,B), (A,D), … are directed from A to B, A to D, etc. Which of the following vertices form loops?**

(A) ABC
(B) ABD
(C) CAD
(D) BDF
(E) DCF

17 **Which of the following data structures are linear data structures?**

(A) Stack
(B) Queue
(C) Linked list
(D) Array
(E) Binary tree

18 **Which of the following statements are true about singly linked lists?**

(A) They use less memory than doubly linked lists
(B) They allow traversal in both directions
(C) They require less time to insert or delete elements than doubly linked lists
(D) They allow random access to elements
(E) All of the above is true

注意:背面有試題

19 **Which of the following statements about hashing tables is/are true?**

(A) Hashing tables use hash functions to map keys to indices in an array

(B) Hashing tables may have multiple keys that map to the same index

(C) Hashing tables have a fixed size and cannot grow or shrink

(D) Hashing tables can use linked lists to store elements with the same hash value

(E) All of the above is true

20 **Which of the following statements about depth first search (DFS) are true?**

(A) DFS is a searching algorithm that visits all the nodes of a graph in a depth-first manner

(B) DFS always finds the shortest path between two nodes in a graph

(C) DFS can be used to find the topological ordering of the nodes in a directed acyclic graph

(D) DFS can be used to solve the traveling salesperson problem in polynomial time

(E) All of the above is true

注意:背面有試題

三、Short description question (10 points per question) 請於答案卷上作答

21 Compare Merge_sort with Insertion_sort.

(A) Which one is in-place sorting algorithm? (2 points)

(B) What is the memory cost of Merge_sort in Big-O annotation with n? (2 points)

(C) A[p:q] and A[q+1:r] are sorted sub-arrays. A[p:q] represents the sub-array from A[p] to A[q]. A[q+1:r] represents the sub-array from A[q+1] to A[r]. Write a pseudocode to describe a function Merge(A,p,q,r) which merges A[p:q] and A[q+1:r] such that the resultant A[p:r] are sorted. Assume the array is sorted from small to large numbers. (4 points) 本題應詳列過程，無過程者不予計分

(D) What is the computation complexity of Merge(A,p,q,r) using the Big-O annotation with n. (2 points)

22 Given the following pseudo codes, Insertion-sort2 improves the performance of Insertion-sort1 by using a binary search strategy. Please write a binary search algorithm, j=Binary-search(A,p,q,key), that returns the insertion location index j. The resultant Binary-search has to be in-place, stable, and O(log n) for arrays with repeating/duplicate numbers. For example, A = {2,3,3,3,4,5,3}, Binary-search(A,1,6,3) return 5. Answer in pseudocode or C-style code with index beginning at 1. (10%)

```
Insertion-sort1(A)
1    for j=2 to A.length
2        key=A[j]
3        i=j-1
4        while i>0 and A[i]>key
5            A[i+1]=A[i]
6            i=i-1
7        A[i+1]=key
```

```
Insertion-sort2(A)
1    for j=2 to A.length
2        key=A[j]
3        i=Binary-search(A,1,j-1,key) // provide code for Binary-search
4        A[i+1:j]=A[i:j-1] // move A[i:j-1] to A[i+1:j]
5        A[i]=key
```

注意:背面有試題

23 Given the following pseudo code of Dijkstra algorithm, please point out the errors of the pseudo code. (10 points)

```
1   procedure Dijkstra(Graph, source):
2       create vertex set Q
3       for each vertex v in Graph:
4           distance[v] ← INFINITY
5           previous[v] ← UNDEFINED
6           if source!=v:
7               add v to Q
8       distance[source] ← 0
9       while Q is not empty:
10          u ← vertex in Q with max_distance[u]
11          remove u from Q
12          for each neighbor v of u:
13              alternative ← distance[u] - length(u, v)
14              if alternative < distance[v]:
15                  alternative ← distance[v]
16                  u ← previous[v]
17      return distance[], previous[]
```

24 Please construct the minimum spanning tree (MST) for the given graph using Kruskal's Algorithm. (6 points) What is the weight of the MST? (4 points)