國立中正大學
111 學年度碩士班招生考試
試 題

[第 2 節]

科目名稱	軟體設計
系所組別	資訊工程學系－甲組

1. (2%) The maximum number of comparisons needed for the binary search of a 2,000 element array is
   (a)　1,999　　(b)　9　　(c)　11　　(d)　13

2. (2%) Which of the following gives the number of elements in the array int r[ ] ?
   (a)　sizeof (r)　　(b)　sizeof (*r)　　(c)　sizeof (r) / sizeof (int)　　(d)　sizeof (*r) / sizeof (int)

3. (2%) If bPtr is assigned b (the name of an array), then array element b[3] can alternatively be referenced with the pointer expression _____.
   (a) *(bPtr + 3)　　(b) b[bPtr + 3]　　(c) *b [bPtr + 3]　　(d) *bPtr + 3

4. (2%) Let x be an int on a machine with four-byte ints.　What effect does

   ```
   x<<=1;
   x>>=1;
   ```

   have?
   (a)　There is no effect.　　　　　(b)　The leftmost bit of x is set to zero.
   (c)　The rightmost bit of x is set to zero.　　(d)　The leftmost bit of x is set to one.

5. (2%) What value does function **mystery** return when called with a value of 4 ?

   ```
   int mystery ( int number ) {
       if ( number <= 1 )
           return 1;
       else
           return number * mystery( number − 1 );
   }
   ```
   (a) 4　　(b) 6　　(c) 12　　(d) 24

6. (15%) Please write a program using C to reverse digits of an integer. Given a signed 32-bit integer x, return x with its digits reversed. If reversing x causes the value to go outside the signed 32-bit integer range [-2^{31}, $2^{31}- 1$], then return 0.

   Example1: x = 123,　　return 321
   Example2: x = -123,　　return -321
   Example3: x = 120,　　return 21

   ```
   int reverse(int x){

   }
   ```

7. (14%) Find the best match of each term with the descriptions by writing a letter from 0 to 8 in each of the blanks.

A. constructor _____   B. destructor _____   C. data member _____

D. member function _____   E. private _____   F. public _____

G. recursive _____

0. a function inside of a class definition

1. a function that calls itself

2. a special kind of member function to change a private data member

3. a special kind of member function to read a private data member

4. a variable inside of a class definition

5. called when a variable of that class ceases existence (i.e., de-allocated)

6. called when a variable of that class comes into existence (i.e., allocated)

7. the parts of a class definition that any code can access

8. the parts of a class definition that only code from that class can access

8. (10%) For each of the two data types below, and each of the five properties listed, select the correct answer (**True** or **False**).

	a dynamically allocated character array (**char***)	a **string** object
1. Able to contain **null** characters inside of it	A. True or False	F. True or False
2. Memory is automatically de-allocated	B. True or False	G. True or False
3. Characters inside of the string can be changed if desired	C. True or False	H. True or False
4. For any k, can access kth character inside of the string in constant time	D. True or False	I. True or False
5. The = operator (assignment) makes a deep copy	E. True or False	J. True or False

9. (1%) (Select **one** answer.) C++ templates allow:

A. The same generic code to operate on different variables/arguments

B. The same generic code to operate on different types of data

C. Code skeletons to be easily distributed

D. Users to re-write their code for different implementation options

E. None of the above

10. (3%) (   ) Suppose that an AVL tree is implemented/represented as an array, and we insert the following numbers one by one to construct an AVL tree:

51, 26, 11, 6, 8, 4, 7

What does the array that represents the AVL tree look like?

a. (51, 26, 11, 6, 4, 8, 7)   b. (26, 11, 51, 6, 4, 8, 7)   c. (8, 6, 26, 4, 7, 11, 51)

d. (26, 8, 51, 6, 11, 4, 7)   e. None of the above

11. (3%) (   ) There exists a binary tree, each of whose nodes contains a letter. In a post-order traversal, the sequence of the output is E D A C G F B H. Suppose that the number of children of the nodes is listed here:

A	B	C	D	E	F	G	H
1	2	0	1	0	1	0	2

Is the tree unique? What is the order of the nodes in a pre-order traversal of the binary tree?

a. No, (H A D E B C F G)   b. Yes, (H D C A G F B E)   c. No, (H B F G C A D E)

d. Yes, (H A D E B F C G)   e. None of the above

12. (3%) (   ) Given an unsorted array containing the following numbers. You should construct a binary tree from the array and convert it into a max-heap.

45, 83, 7, 61, 12, 99, 44, 77, 14, 29

What does the array look like after the second phase (continuously output the first two largest numbers) of performing a heap sorting?

a. 77, 61, 45, 14, 29, 7, 44, 12   b. 45, 7, 61, 12, 44, 77, 14, 29   c. 77, 61, 44, 45, 29, 7, 12, 14

d. 77, 61, 44, 45, 12, 7, 29, 14   e. None of the above

13. (2%) (   ) The following values are to be stored in a hash table. Use the division method of hashing with a table size of 11 (index starting at 0) and use the linear probing method of resolving collisions.

25, 42, 96, 101, 102, 162, 197, 201

What does the table look like?

a.

			25	42	162	162	197	201	96	101	102
0	1	2	3	4	5	6	7	8	9	10	11

b.

		25	42	162	197	201		96	101	102	
0	1	2	3	4	5	6	7	8	9	10	11

c.

197			101	25	102	201			96	42	162	
0	1	2	3	4	5	6	7	8	9	10	11

d.

201	102	101	25				162	96	42	197	
0	1	2	3	4	5	6	7	8	9	10	11

14. (3%) (　　) The following is a list representation for a tree. The format of P(C1, C2) in the representation represents that P is a parent node with two children nodes C1 and C2.

(A (B (E (K , L), F), C (G), D (H (M), I, J)))
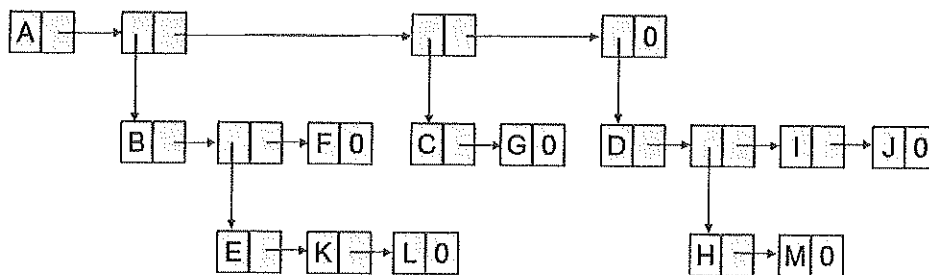
Please draw this tree and convert it into a binary tree. What is the order of the nodes in a post-order traversal of the binary tree?

a. L, K, F, E, G, M, H, J, I, D, C, B, A　　　b. L, K, F, E, G, M, J, I, H, D, C, B, A

c. K, L, F, E, G, M, H, J, I, D, C, B, A　　　d. K, L, F, E, G, M, J, I, H, D, C, B, A　　　e. None of the above

15. (3%) (　　) What is the prefix form of the following expression?

$$B - E / (F / A - A * D / F) + E * C * D - (A + B) * E$$

a.　$- + - B / E - / F A / * A D F * * E C D * + A B E$

b.　$+ / - B E / - F A / * A D F - * * E C D * + A B E$

c.　$- B / E + - / F A / * A D F * E C - * D * + A B E$

d.　$- / B E / - * / F A A D F + E - * * C D + * A B E$　　　e. None of the above

16. (4%) To find the articulation points in the graph below, start with constructing a depth-first spanning tree by doing a depth-first search of the graph. Instead of choosing an arbitrary vertex to start, your first vertex must be set to vertex B, and select the smallest vertex in alphabetical order first when performing the depth-first search. The depth-first number starts at 1.
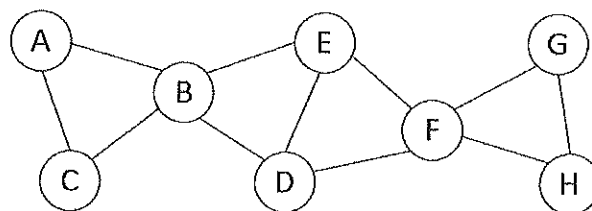
16.1 (1%) (　　) What are the edges of the depth-first spanning tree?

a. (A, B), (A, C), (B, E), (B, D), (D, F), (F, G), (F, H)

b. (B, C), (A, C), (B, D), (D, F), (E, F), (F, G), (G, H)

c. (A, B), (B, C), (B, E), (B, D), (D, F), (F, G), (F, H)

d. (A, B), (A, C), (B, D), (D, E), (E, F), (F, G), (G, H)　　　e. None of the above

16.2 (2%) (　　) What are the output value of the low function (i.e., *low(v)*) for each vertex (in the order of A, B, C, D, E, F, G, H).

a. (1, 2, 1, 1, 1, 1, 7, 6)　　b. (1, 1, 1, 1, 1, 4, 6, 6)　　c. (1, 1, 1, 1, 1, 1, 6, 6)

d. (1, 1, 1, 1, 1, 6, 6, 6)　　e. (1, 1, 1, 4, 5, 6, 6, 6)　　f. None of the above

16.3 (1%) (　　) What are the articulation points in the graph?

a. (B, F)　　b. (B, F, G)　　c. (A, D, F)　　d. (B, G)　　e. None of the above

17. (4%) Given the below directed graph, please answer the following questions.
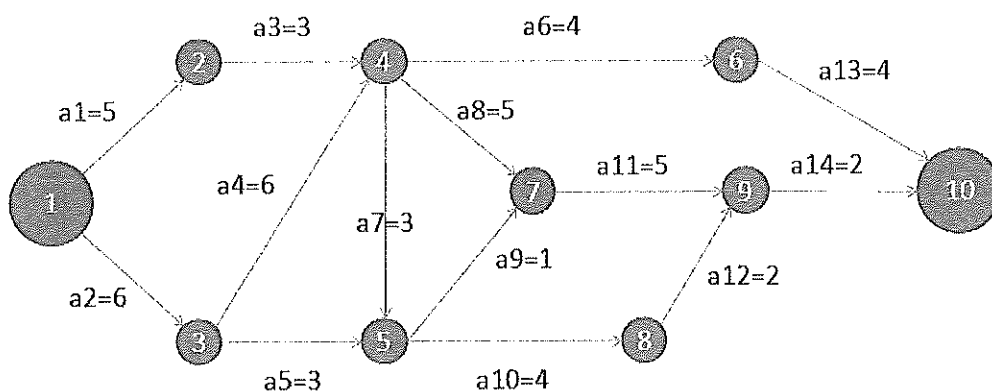
17.1 (2%) (　　) In the directed graph, each node represents an event, and each edge represents an activity with the time required to perform the activity. What is the critical path?

a. (1 →2 →4 →7 → 9 → 10)　　b. (1 →2 →4 →5 → 8 → 9→ 10)

c. (1 →3 →4 →7 → 9 → 10)　　d. (1 →3 →4 →5 → 7 → 9→ 10)　　e. None of the above

17.2 (2%) (　　) Please perform Dijkstra's algorithm running on the graph above. Use the cost on each edge as the weight and find the shortest path from vertex 1 to all vertices. What are the vertices in the order they are selected by Dijkstra's algorithm?

a. (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)　　b. (1, 2, 3, 5, 6, 4, 7, 8, 9, 10)　　c. (1, 2, 3, 4, 5, 7, 6, 8, 9, 10)

d. (1, 2, 5, 6, 3, 4, 7, 9, 8, 10)　　e. None of the above

18. (4%) Argue whether the following algorithms are asymptotically optimal or not. Write down your reasoning. (a) Quicksort; (b) Mergesort.
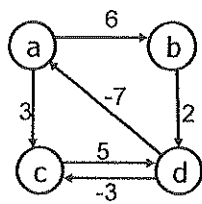
19. (17%)

a. (2%) Argue what the output will be if we specify a source node and input the graph at left into the Dijkstra algorithm. Write down your reasoning.

b. (4%) Reweight the graph at left.

c. (8%) Apply Floyd-Warshall algorithm to the left graph and derive the distance and predecessor matrices. Write down your derivation.

d. (3%) Given another graph G={V,E}, how do you tell which of Floyd-Warshall algorithm and Johnson's algorithm is theoretically faster to solve the shortest path problem?

20. (4%) Derive the optimal ternary Huffman code for the following symbols with probabilities

Symbols	α	β	γ	δ	ε	θ	η
Probabilities	0.25	0.2	0.15	0.14	0.13	0.08	0.05