

科目：資料結構 (5002)

校系所組：中央大學電機工程學系 (電子組)  
交通大學電子研究所 (乙組)

1. [6 points] Order the following six functions from the slowest to the fastest growth:  
 $n^n$ ,  $\log^2 n$ ,  $n!$ ,  $n \log n$ ,  $2^n$ ,  $n^{0.75}$ .
  
2. [12 points] A square band matrix  $A_{n,a}$  is an  $n \times n$  matrix in which all the nonzero terms lie in a band centered around the main diagonal. The band includes the main diagonal and  $a-1$  diagonals below and above the main diagonal.
  - (a) [3 pts] How many elements are there in the band of  $A_{n,a}$ ?
  - (b) [3 pts] What is the relationship between  $i$  and  $j$  for elements  $a_{ij}$  in the band of  $A_{n,a}$ ?
  - (c) [6 pts] Assume that the band of  $A_{n,a}$  is stored sequentially in an array  $B$  by diagonals starting with the lowermost diagonal. Obtain an addressing formula for the location of an element  $a_{ij}$  in the lower band of  $A_{n,a}$ .
  
3. [6 points]  $A, B, C, D$ , and  $E$  are five operands. Using a stack to indicate how to evaluate the postfix expression  $AB/C-DE*+$  step by step. Draw the stack status after each step.
  
4. [12 points] The abstract data type (ADT) of linked list is as follows.
 

```
ADT nodeType {
    data info;
    nodeType *link;
};
```

The following statement declares some variables based on this ADT:

```
nodeType *A, *B, *list;
```

Mark each of the following statements as valid or invalid. If a statement is invalid, explain why.

  - (a)  $A = B$ ;
  - (b)  $list \rightarrow link = A \rightarrow link$ ;
  - (c)  $*A = *B$ ;
  - (d)  $*list = B$ ;
  - (e)  $B = A \rightarrow link \rightarrow info$ ;
  - (f)  $B = B \rightarrow link \rightarrow link \rightarrow link$ ;
  
5. [14 points] Binary Trees
  - (a) [8 pts] The following code lists the nodes in a binary tree in two different traversal orders, draw the binary tree.  
 Preorder: A B C D E F G H I J K L M  
 Inorder: C E D F B A H J I K G M L
  - (b) [6 pts] Given the preorder sequence and the postorder sequence, show that it may not be possible to reconstruct the binary tree.
  
6. [8 points] Please convert the following array into a max-heap. Show the final form of the array. 47, 48, 82, 65, 80, 63, 87, 95, 34, 37.
  
7. [10 points] Suppose you have  $x$  variables each defined by a function that takes two arguments. Also you can assume there is a unique value for each variable that would satisfy the given equations simultaneously.  
 Here is an example where  $x = 6$ :  $A = C * F$ ,  $B = D + E$ ,  $C = F + 1$ ,  $D = A + F$ ,  $E = A / 2$ , and  $F = 5 * 4$ .  
 Your task is to compute the value of all  $x$  variables as efficiently as possible. You can assume that each function can be computed in one step given that its two operands have already been computed.
  - (a) [4 pts] Formulate this problem as a graph problem. Draw the graph for the example given above.
  - (b) [6 pts] Design the most efficient algorithm you can to solve the given problem.

注意：背面有試題

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8. [8 points] A *run* is a sorted sequence of elements. External sorting is to merge two runs into a single run by merging sort. Assume input or output one block take  $t_{io}$  time.  $n$  runs of different sizes of block are to be merged into a single run by repeatedly merging pairs of runs until only one run remains. Now, given 8 runs of sizes: 3, 5, 6, 7, 9, 10, 14, 18.
- (a) [6 pts] Show how to merge the runs so that the total I/O time is minimum.
- (b) [2 pts] What is the minimum I/O time required in terms of  $t_{io}$ ?
9. [12 points]
- (a) [4 pts] There exists a comparison sort of 5 numbers that uses at most 6 comparisons in the worst case.  
True or False? Justify your answer.
- (b) [4 pts] Heap sort can be used as the auxiliary sorting routine in radix sort, because it operates in place.  
True or False? Justify your answer.
- (c) [4 pts] If an in-place sorting algorithm is given a sorted array, it will always output an unchanged array.  
True or False? Justify your answer.
10. [12 points]
- (a) [4 pts] Given a hash table with more slots than keys, and collision resolution by chaining, then the worst-case running time of a lookup is constant time. True or False? Justify your answer.
- (b) [4 pts] Given a hash table with  $n$  keys and  $m$  slots, with the simple uniform hashing assumption (each key is equally likely to be hashed into each slot). Collisions are resolved by chaining. What is the probability that the first slot ends up empty?
- (c) [4 pts] Assume that  $m = 2^r$  for some integer  $r > 1$ . We map a key  $k$  into one of the  $m$  slots using the hash function  $h(k) = k \bmod m$ . Give one reason why this might be a poorly chosen hash function.