

※請在答案卷內作答

一 (10%) Explain why a recursive program can always be implemented in a stack data structure? What is the overhead (time and space complexity) of executing a recursive program?

二 (10%) A linked list $[I_1, I_2, \dots, I_n]$ is symmetric if $I_1 = I_n, I_2 = I_{n-1}, \dots$. Write a function (by using a stack) to determine if the list is symmetric.

三 (10%) A bounded buffer is implemented as a circular queue. The algorithms for add and delete on the queue are shown as follows:

```
/* Add to a circular queue */
void add (element item)
{ if (front == (rear+1) % N)
    queueFull();
  queue[rear] = item;
  rear = (rear +1) % N;
}

/* Delete from a circular queue */
element delete()
{ element item;
  if (front == rear)
    queueEmpty();
  return queue[front];
  front = (front+1) % N;
}
```

(一) (3%) What is the capacity (maximum number of items) of the queue?

(二) (7%) Modify both the algorithms such that the capacity of the queue is N.



注意：背面有試題

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- 四 (10%) A square matrix A is called an upper triangular matrix when all the elements below the main diagonal of the matrix are zero. Obtain an addressing formula for element a_{ij} in the upper triangular if this upper triangular is stored by rows in an array $B[n(n+1)/2]$ with $A[0][0]$ being stored in $B[0]$. What is the relationship between i and j for elements in the zero part of A ?
- 五 (10%) The period of a string $x_1...x_n$ is the smallest $k > 0$ such that $x_1...x_{n-k} = x_{k+1}...x_n$. That is, removing the first k characters yields the same string as removing the last k characters. For example, the period of string $abcabcab$ is 3, since you get $abcab$ both by removing the first 3 characters and by removing the last 3 characters. Describe an algorithm to compute the period of a length n string that runs in time $O(n)$.
- 六 (10%) Assume we are executing the last procedure of Merge Sort to merge the following two sorted list: $[1, 5, 12, 18, 19, 20]$ and $[2, 3, 4, 17]$. Please show the content of the first list, the second list, and the result list at each step of the merging procedure.
- 七 (10%) Please show each step of Insertion Sort on the list $[\text{Fred}, \text{Alex}, \text{Diana}, \text{Byron}, \text{Carol}]$.

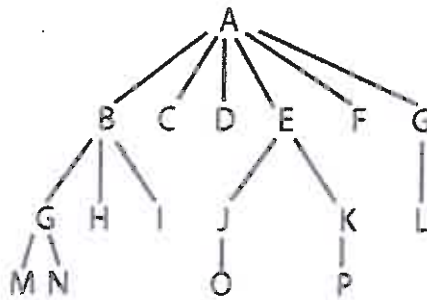


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八 (10%) We have five records 'Fred,' 'Alex,' 'Diana,' 'Byron,' and 'Carol.' The *key* of each record is defined by the sum of the ASCII code of each character (ASCII of 'A' is 65 and 'a' is 97) in the record. We would like to use the hash function $h(key) = key \% 13$ to add these records into an array of size 13 (array index starts from 0). Please determine the array index of each record.

九 (10%) Please convert the following tree to a binary tree.



十 (10%) Assume we have the following courses to take:

Course	Prerequisite	Course	Prerequisite
CS150	None	CS351	CS151
CS151	CS150	CS370	CS151
CS221	CS151	CS375	CS151, CS222
CS222	CS221	CS425	CS325, CS222
CS325	CS221		

Please draw a directed graph to show the relation between courses. A path from node X to node Y means that you have to take course X before course Y .

