Data Structure and Algorithm Analysis

2017-18 Mid-term Examination A

Part I. Filling Question（32 marks）

1. Please write down a kind of structure that requires large storage space, and when inserting or deleting one element we do not change the memory addresses of other elements. _____

2. Please write down the corresponding postfix expression of the infix expression 2+(8-3*2)*2: _____.

3. Please calculate the result of the postfix expression (the integer in the expression range from 0 to 9) 34+932*-*5- : _____.

4. Please write down the number of non-empty substrings of "storage": _____.

5. Suppose we have a stack, and when we push an element into the stack, it prints S, when we pop an element out of the stack, it prints X. There are four integers, and the order of pushing into the stack is 1 2 3 4, if we want the pop order of these integers is 1 3 4 2, please write down the corresponding sequence of pop and push operation (the sequence consists of “X” and “S”): _____.

6. Suppose give you an empty stack, we want to push six elements into the stack with order: $e_1, e_2, e_3, e_4, e_5, e_6$. If we pop out these elements with the order: $e_2, e_4, e_3, e_6, e_5, e_1$. Please write down the minimum capacity of the stack: _____.

7. Suppose that we use an array (the capacity is 6, the index starts from 0) to simulate a ring queue. When the index of rear equals to its front, the queue is empty. Assume the index of rear and front is 5 and 3, respectively. If we enqueue two elements, please write down the index of rear: _____. Then we dequeue one element, please write down the index of its front:_____.

Part II. Short answer questions（28 marks）

In Problem 1, 2, and 3, you only need to write down your methods in pseudocode, but you cannot use the standard library functions.

1. Suppose A is a character array $[a_0, a_1, a_2, \ldots\ldots a_n]$ with continuous storage. Please write down a method then we can insert an element into it. This method **arrayInsert**(int pos, char a) has two parameters, one is the inserting position, and the other is the inserting character. （7 marks）

2. Suppose B is a linked list (head node is a reference or pointer, it does not store any value). Design a method to remove all the elements in the linked list which value is e. The method **removeList**(int e) has only one parameter, which is the value we want to remove from the list. For example, the linked list is 2 4 5 3 4 6, if e is 4, and after invoking the method, the linked list will be 2 5 3 6. （7 marks）

3. According to the queue below, please write down the method of enqueue (adding an element into the queue) and dequeue (removing an element out of the queue). （7%）

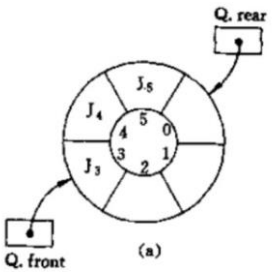

Figure. 1 Queue

4. Given a pattern string P=”ababcab” and a text string S=”ababdabaababcabac”.
   (1) Please write down the next array of the pattern string P=”ababcab”.
   (2) Suppose the character of index j in pattern string P is not match the corresponding element in text string S, which is your next start position in pattern string P according to the next array in (1): ( )
   A. j = next[j-1] B. j = next[j] C. j = next[j+1] D. j=0
   (3) Using KMP algorithm to verify whether the pattern P is in the text S by using your next array in (1). Completing the follow table, for every time when you use the way in (2) to change the index of j, write down the corresponding position of pattern P in string S.

	a	b	a	b	d	a	b	a	a	b	a	b	c	a	b	a
0	a	b	a	b	c	a										

Part III. Algorithm Design（40 marks）

For each question in this part, please briefly introduce your ideas in general words first (5%), and then write down your pseudocode according to your idea (5%). We only give full marks to those solutions with optimal time complexity.

1. Designing a method to convert a decimal number to binary number. You need to use recursion way to solve this question. (10 marks)
   Sample input:
   13
   Sample output:
   1101

2. Suppose we have a class which includes two stacks. These two stacks share only one array with array size n, please help us implement the following two operations, please note you are not allowed to use any other functions without implementation. (10 marks)
   - Push elements into the stack： push(data,x) \\push a data into No. x stack. x is 0 or 1
   - Pop elements out of the stack： pop(x) \\pop a data from No. x stack. x is 0 or 1

3. A barn has N stalls. The stalls are located along in a straight line at positions x1,...,xN. There are C horses will be put into these stalls, and each stall contains only one horse at most. To prevent these horses disturbing each other, we want to assign these horses to the stalls, such that the minimum distance between any two of them is as large as possible. Please design a function to find the largest minimum distance among these horses (10 marks)
   Input:
   Line 1: Two space-separated integers: N and C
   Line 2: The position of stalls
   Sample input:
   8 5
   1 2 5 9 10 12 15 20
   Sample output:
   4

4. A string can be treated as a kind of type: a^n, the n is an integer. For example the string “abababab” can be treated as “abababab”^1 , “abab”^2 or “ab”^4. According to the input string, please design a method to find its largest number of n. (10 marks)
   Sample input:
   3
   hello
   eeeee
   abcababcab
   Sample output:
   1
   5
   2