Data Structure Midterm Examination

Class:_____ ID._____Name_____上課班級:□甲□乙

Part I Choose the best answer (20%)

(Question 1~5)On a byte-addressable machine, **A** is a 2-dimensional array **A**[m][n], the location of **A**[30][20] is 3271660, and **A**[10][40] is 3273220. Assume that each element occupies 2 bytes.

1. ____ The memory alloction of array A is (a)row-major (b)column-major (c)first-in-first-out (d)last-in-first-out (e)none of above.
2. ____The row size m is ? (a)10 (b)20 (c)30 (d)40 (e)can't determine.
3. ____The column size n is ? (a)10 (b)20 (c)30 (d)40 (e) can't determine.
4. ____What is the address of array beginning? (a)3270000 (b)3270010 (c)3270020 (d)3270030 (e) can't determine.
5. ____What is the location of **A**[15][5]? (a)3270410 (b)3270420 (c)3270430 (d)3270440 (e) can't determine.

(Question 6~10) The Knuth–Morris–Pratt string-searching algorithm (or KMP algorithm) searches for occurrences of a pattern **P** =$p_0\ p_1\ p_2\ p_3\ p_4$...within a main "text string" **S**=$s_0\ s_1\ s_2\ s_3\ s_4$... by employing the observation that when a mismatch occurs (failue function as below), the pattern **P** itself embodies sufficient information to determine where the next match could begin, thus bypassing re-examination of previously matched characters. If a partial match is found such that $s_{i-j} \dots s_{i-1} = p_0 p_1 \dots p_{j-1}$ and $s_i \neq p_j$ then matching may be resumed by comparing s_i and $p_{f(j-1)+1}$ if $j \neq 0$. If $j = 0$, then we may continue to compare s_{i+1} *and* p_0. If pattern **P** is **aabbccaabbcaab** and text **S** is aabbccaabbcab...

$$f(j) = \begin{cases} \text{largest } k \quad \text{such that } k < j \text{ and } \quad p_0 p_1 \dots p_k = p_{j-k} p_{j-k+1} \dots p_j \quad \text{if such a } k \geq 0 \quad \text{exists} \\ -1 \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{otherwise.} \end{cases}$$

6. ____f(4)=? (a)-1 (b)0 (c)1 (d)2 (e)3
7. ____f(7)=? (a)-1 (b)0 (c)1 (d)2 (e)3
8. ____f(12)=? (a)-1 (b)0 (c)1 (d)2 (e)3
9. ____The first mismatch occure in s_{12} (a≠b)，and next comaparsion is s_x and p_y. What is the x=? (a)11 (b)12 (c)13 (d)14 (e)15
10. ____What is the y=? (a)0 (b)1 (c)2 (d)3 (e)4

Part II Blanks Filling(20%)

1. Suppose we have a byte-addressable machine, i.e., each byte is accessed via an address. Let the locations of an array be allocated in a row-major manner, and each element takes one byte. What is the address of the element **A**[5][15][25] in an array declared as **A**[10][20][30]_____? Assume that the address of the first byte of the array is 2222. If the allocation manner is column-major, what is the address of the element above_____?
2. Algorithmis a finite set of instructions that accomplishes a particular task and satisfy the following criteria, zero or more quantities input, _____, _____, _____, _____.
3. In a system, programs undergo a development include five process (life cycle) are requirements, _____, _____, _____, _____.

Part III Essay Questions (**two quesitions are selected**)

1. (30%)(a) One way to represent a polynomial is to use an array to hold the non-zero terms of polynomial by format (coefficient, exponent). Please use the format to represent the polynomials A(x)=$2x^5$+ 5 x^3-2 x and B(x)= $7x^8$+$5x^3$-$3x^2$+ 2 x +1. Design an algorithm for polynomial substraction, poly poly::operator-(poly B) to caculate C(x)= A(x)-B(x), when polynomials are represented as above.

   (b)Design an algorithm for polynomial addition when polynomials are implemented by linked list.

   (c)How to delete a linked list in O(1)?

   (d)Please describe the steps of deletion a node X (e.g. $5x^3$ in B(x)) from a duoble linked list and insertion a node Y after node Z (e.g. insert $4x^2$ after $5x^3$ in A(x)).
2. (20%)(a) Write the infix and prefix form of the following postfix expression, 5 35 7 / 2 * +

   (b) Please describe the data structure and algorithm to transfer infix expression into postfix form. You must demonstrate your algorithm using expression in question (a).

(c) Please describe the data structure and algorithm to evaluate postfix expression. You must demonstrate your algorithm using expression in question (a).

3. (30%) Sparse matrix by triple <row,col,value> style is adopted for computation efficiency. (a) Show the example according to right side matrix.(Generate array ***a*** []).

$$\begin{bmatrix} 15 & 0 & 0 & 22 & 0 & -15 \\ 0 & 11 & 3 & 0 & 0 & 0 \\ 0 & 0 & 0 & -6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 & 0 & 0 \end{bmatrix}$$

(b) Please describe the sparse matrix addition algorithm. Time complexity of the algorithm must be O(m+n) that m,n are non-zero item number in each sparse matrix.

(c) The time complexity of Fast_transpose algorithm for sparse matrix transposing is O(terms+columns) (hint: using row_terms and starting_pos array). Please show the Fast_transpose algorithm and analyze the time complexity. You must demonstrate your algorithm by using expression in question (a).

4. (20%) (a)Describe the principles of popular data structures 'Stack' and 'Queue'.
(b)Implement a Stack and a Queue using array. Do implementation again using linked list. Compare the advantages in two implementation methods.

5. (20%) (a)What are the definitions of asymptotic notations, O (big oh), Ω (Omega) and and Θ (Theta), which are used for time complexity comparison?
(b)Please derive the corresponding time complexity (Big-Oh) for each of the following five program segments.

(1)
```
k=0;
for(i=0;i<N;i++)
    for(j=0;j<i;j++)
        k++;
```

(2)Hanoi(from,to,temp,n){
```
        if(n<=1){ cout<<"1"<<from<<"->"<<to<<endl;
        return;}
        else{Hanoi(from,temp,to,n-1);
        cout<<n<<from<<"->"<<to<<endl;
        Hanoi(temp,to,from,n-1);
    }
```

(3)
```
k=0;
for(i=1;i<N;i*=2)
    for(j=0;j<i;j++)
        k++;
```

(4)
```
float rsum (float *a, int n) {
  if (n <= 0)return 0 ;
  else
    return (rsum(a, n-1) +
a[n-1]) ;
}
```

(5)
```
int ft(int n){
    int ac=1,c=0;
    while(ac<n){
        ac*=2; c++;
    }
    return c;
}
```