108-1Data Structure Quiz 1

1. What is algorithm?
   (1) Give a definition of algorithm. (3%)
   (2) What the criteria of algorithm. (3%)
   (3) What is the ADT (Abstract Data Type)? (3%)

2. Please compare the time complexity and space complexity of "2D Array", " Transpose a Matrix" and " Fast Transpose Matrix". (6%)

	space	time
2D Array		
Transpose a Matrix		
Fast Transpose Matrix		

3. (1) Please refer to Table_1 to complete Table_2. Please use a fast transpose matrix way and must write down the result. (2%)
   (2) Please use row_term of Table_2 to finish Table_3. (3%)

Table_1

	row	col	value
a[0]	6	6	8
a[1]	0	0	15
a[2]	0	1	22
a[3]	0	3	-15
a[4]	1	5	11
a[5]	1	0	3
a[6]	2	2	-6
a[7]	4	0	91
a[8]	5	2	28

Table_2

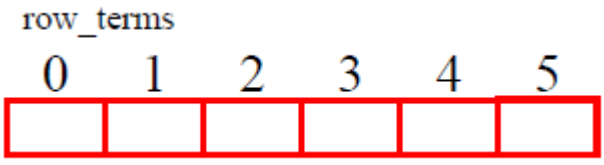
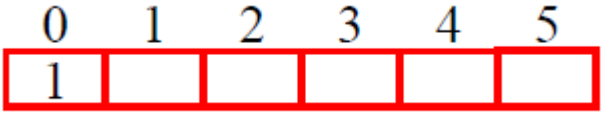


Table_3

start_pos



4. Sparse matrix and code are shown below. (n = a[0].value).

   (1) Please use this matrix fill the Table_1. Table 1 sorted by row from small to large. (3%)

   (2) Please use code to transpose matrix and fill the Table_2. (3%)

	col0	col1	col2	col3	col4	col5
row0	0	13	0	0	9	0
row1	8	0	-9	0	0	0
row2	5	0	0	0	0	-7
row3	0	7	0	0	0	0
row4	0	0	8	0	1	0
row5	2	0	0	18	0	0

```
for (i = 0; i < a[0].col; i++){
    for( j = 1; j <= n; j++){
        if (a[j].col == i) {
            b[currentb].row = a[j].col;
            b[currentb].col = a[j].row;
            b[currentb].value = a[j].value;
            currentb++;
        }
    }
}
```

Table_1

	row	col	value
a[0]	6	6	11
a[1]			
a[2]			
a[3]			
a[4]			
a[5]			
a[6]			
a[7]			
a[8]			
a[9]			
a[10]			
a[11]			

Table_2

	row	col	value
b[0]	6	6	11
b[1]			
b[2]			
b[3]			
b[4]			
b[5]			
b[6]			
b[7]			
b[8]			
b[9]			
b[10]			
b[11]			

5. Give you a string like “([[]()])”, if ‘(‘ or ‘[‘ can match the ‘)’ or ‘]’ code print “Yes”. Otherwise, code print “No”. Please follow the rules and write down your code. (8%)

```
#include<string.h>
#include<stdio.h>

char stack[10001];
char s[10001];
int main()
{
	int n;
	int top=1,len;
	scanf("%s", &s);
	len=strlen(s);
	stack[top]=s[0];
	top++;
	for(int i=1;i<len;i++)
	{
		if(s[i] == '[' || s[i] == '(')
			stack[top++]=s[i];
		else
		{
			if(stack[top-1]=='[' && s[i]==']')
				top--;
			else if(stack[top-1]=='(' && s[i]==')')
				/* your answer */		(a)
			else
				stack[/* your answer */]=s[i];		(b)
		}
	}
	if(top==1)
		printf("Yes\n");
	else
		printf("No\n");

	return 0;
}
```

6. Prefix, Infix, Postfix. (5%)

(1) Write the postfix form of the following expression.

A + B * C – D / E

(2) Write the prefix form of the following expression.

A + (B – C) / D – E / (F * G)

(3) Write the infix form of the following expression.

A B C * E 2 - / F * +

(4) Write the infix form of the following expression.

/ + A B * - C D E

(5) Now I redefine the priority of the operator.
From high to low: "(" , ")" higher than "+" , "-" higher than "*" , "/".
Write the prefix form of the following expression.

A + B – C * D / F * G + H

7. Time complexity sort. (6%)
O(n!) , O(n^3) , O(3^n) , O($\sqrt{n}$) , O(nlog^2n) , O(n$log n^2$) , O(nlogn) , O(1) , O(2n) , O(n^2) , O(2^n) , O(n^n) , O(n)

8. Write down the time complexity using big O. (5%)
(1) T(n) = T(n/2) + 1
(2) $\sum_{i=0}^{n} i^2$
(3) $\sum_{i=0}^{n} i^3$
(4) $2n^2+5^n$
(5) $n^7+1.5^n$

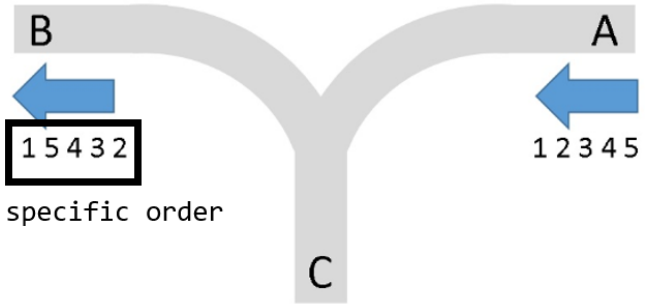
9. Please sum numbers from 1 to n, like 1+2+3+4+…+n. Please finish code by recursive function. (6%)

```
#include<stdio.h>
// recursive
int sum(int n)
{
    if (n == 0)
        return 0;
    else
        return sum(/* your answer */) + n;          (a)
```

```
}
int main()
{
	int n;
	printf("input sum number n\n");
	scanf("%d", &n);
	printf("Answer : %d" , sum(n));
	return 0;
}
```

10. Rail problem

Suppose **N** cars are entering from direction A. Its number is fixed to (1,2, 3, …N). Your task is to judge if these cars can leave to the direction B in a **specific order**. For example, according to the above rules, this picture shows **N** = 5. If **specific order** = (1,2,3,4,5) and (1,5,4,3,2) are all feasible departure orders (true). If **specific order** = (5,4,1,2,3) is not feasible (false).



(1) According to the following message to answer questions. Can the train leave to direction B in a specific order?
If the answer is true: Write “true”.
If the answer is false: Write “false”.
(a) **N** = 5, **specific order** = (1,4,2,5,3) (1%)
(b) **N** = 7, **specific order** = (1,6,2,5,4,3,7) (1%)
(c) **N** = 9, **specific order** = (1,9,2,8,3,7,4,6,5) (1%)

(2) N = 4. Write all specific orders that can leave from direction B. (3%)

11. The node_x is a user-defined structure and list_y is a pointer type that points to a linked list.

```
#include <stdio.h>
#include <stdlib.h>
typedef struct node{
        char chData;
        struct node *link;
} node_x, *list_y;

void hard (list_y *ptr, char *s){
        if(*s){
                node_x *p = malloc (sizeof (node_x));
                p->chData = *s;
                if((int)s[0]%5 == 0)
                        hard(&p->link, s+5);
                else
                        hard(&p->link, s+((int)s[0]%5));
                printf("%c", p->chData);
                *ptr = &p+1;
        }
        else
                *ptr = NULL;
}
int main( ){
        list_y p = NULL;
        hard (&p, "structure");
}
```

(1) Write down the output. (3%)

(2) Time complexity? (5%)

12. Adding polynomials.

(1) Please use linked list to implement this polynomial. (1%)

a = $11x^{13}+9x^5+6x^3-108x^2-17$

(2) Please finish the function below. (6%)

```
typedef struct polyNode *polyPointer;
typedef struct polyNode
{
```

```
    int coef;
    int expon;
    polyPointer link;
};
polyPointer a , b;
polyPointer padd(polyPointer a , polyPointer b)
{//return a polynomial = a+b
    polyPointer c , rear , temp;
    int sum;
    malloc (rear , sizeof(*rear));
    c = rear;
    while( a && b){
        switch(compare(a->expon , b->expon))
        {
            case -1:    //a -> expon < b->expon
                attach(b->coef, b->expon, &rear);
                b = b->link;
                break;
            case 0:     //a -> expon = b->expon
                /* your answers */          (a)
            case 1:     //a-> expon > b->expon
                /* your answers */          (b)
        }
    }
    /* copy rest of list */
    for( ; a ; a = a->link)
        attach(a->coef , a->expon , &rear);
    for( ; b ; b = b->link)
        attach(b->coef , b->expon , &rear);
    rear -> link = NULL;

    /*delete extra initial node*/
    temp = c;
    c = c->link;
    free(temp);
    return c;
}
```

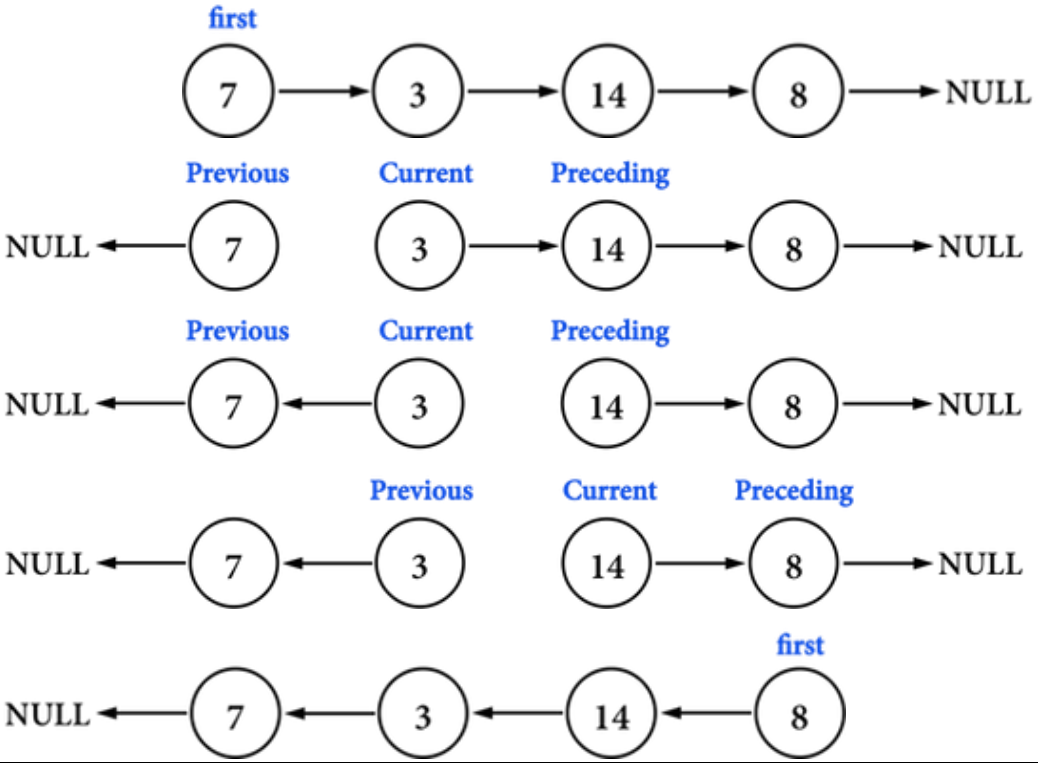
13. I want you to create stack and queue by linked lists. Stack should have push and pop functions. Queue should have enqueue and dequeue functions. Please finish the program below. (8%)

```
#include <stdio.h>
void stack_push(int i , element item)
{
      stackPointer temp;
      malloc (temp , sizeof(*temp));
      temp->data = item;
      temp->link = top[i];
      top[i] = temp;
  }
element stack_pop(int i)
{
      /* your answers */                (a)
      free(temp);
      return item;
}

void queue_enqueue(int i , element item)
{
      queuePointer temp;
      malloc (temp , sizeof(*temp));
      temp->data = item;
      temp->link = NULL;
      if (front[i])
           rear[i]->link = temp;
      else
           front[i] = temp;
      rear[i] = temp;
}
element queue_ dequeue (int i)
{
      /* your answers */                (b)
      free(temp);
      return item;
}
```

```
int main()
{
        int i ;
        element item;
        stack_push(i , item);
        stack_pop(i);
        queue_ enqueue (i , item);
        queue_ dequeue (i);
}
```

14. Please use C program to finish the code. (8%)




```
void LinkedListReverse()
{
        if (first == 0 || first->next == 0) {
                // list is empty or list has only one node
                return;
        }
        ListNode *previous = 0, *current = first, *preceding = first->next;
        while (preceding != 0) {
        /* your answer */                    // turn around current->next      (a)
        /* your answer */                    // put back previous              (b)
```

```
        /* your answer */                    // put back current          (c)
        /* your answer */                    // put back preceding        (d)
        }
        current->next = previous;
        first = current;
}
```

15. Please refer to Figure 1 and Figure 2 to complete the program below. (7%)

Figure 1

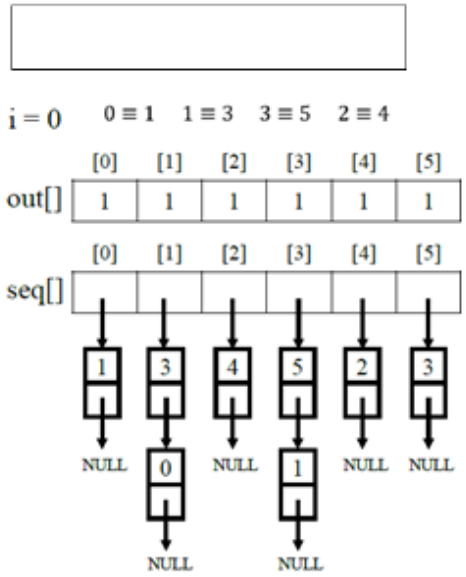
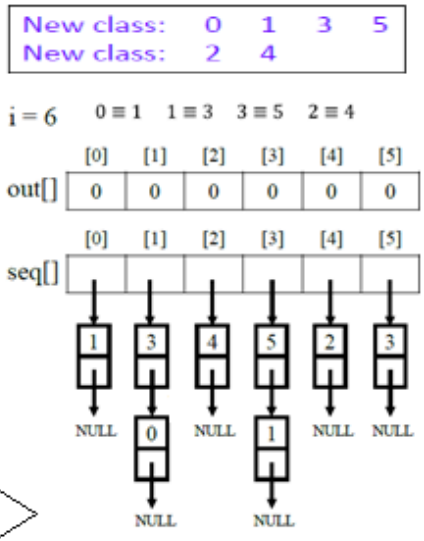


Figure 2




```
for (i = 0 ; i < n ; i++)
{
        if (out[i])
        {
                printf("\n new class : %5d" , i);
                out[i] = FALSE;
                x = seq[i];
                top = NULL;
                for(;;)
                {
                        while(x)
                        {
                        j = x->data;
```

```
                    if (out[j])
                    {
                            printf("%d" , j);
                            /* your answers */                    (a)
                    }
                    else
                    {
                            x = x->link;
                    }
            }
            if (!top)
                     break;
            x = seq[top->data];
            top = top->link;
        }
    }
}
```