108-1 Data Structure Midterm

1. Prefix, Infix, Postfix

(1) Please transform the following expression to form prefix. (3%)

A % (B + C / D) & E >= F == G ∗ H + P % M + K

(2) Please change postfix to infix using stack. What are the results to (a)~(c)?
The postfix equation is shown as below. (3%)

8 2 / 3 - 4 2 * +

(3) Please evaluate the expression of (d) to get an integer output. (4%)

Token	Stack			Top
	[0]	[1]	[2]	
8	8			0
2				
/				
3		(a)		
-	(b)			
4				(c)
2				
*				
+	(d)			

2. Sparse matrix

$$\text{matrix A} = \left\{\begin{matrix} 1 & 0 & 0 & 0 \\ 0 & 4 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 5 & 0 & 0 & 9 \\ 0 & 8 & 0 & 3 \end{matrix}\right\} \qquad \text{matrix B} = \left\{\begin{matrix} 7 & 5 & 0 \\ 0 & 0 & 1 \\ 0 & 4 & 0 \\ 0 & 0 & 3 \end{matrix}\right\}$$

(1) Please use 3-tuple matrix to represent the matrix A. (3%)

(2) Please use the answer (1) to find a transpose matrix by 3-tuple matrix. (3%)

(3) Please use 3-tuple matrix to represent the result for A*B. (3%)

3. Please write the answers as the following questions.

(1) $3n^2 + 6 * 7^n = O(\,)$ (2%)

(2) $3\log_2 5 + 10^n + 6 = O(\,)$ (2%)

(3) $7\text{logn} + \text{nlogn} = O(\,)$ (2%)

4. (1) This code implements the Double Linked Lists function. The code aims to insert a node named newnode. Please finish (a) ~ (d) as below. (4%)

```
void dinsert(node_pointer node, node_pointer newnode)
{
        newnode->llink =   /* your answer */;                          (a)
        newnode->rlink =   /* your answer */;                          (b)
        node->rlink->llink =   /* your answer */;                      (c)
        node->rlink =   /* your answer */;                             (d)
}
```

(2) The code aims to delete a node from the Double Linked Lists function. Please finish (a) ~ (b) as below. (4%)

```
void ddelete(node_pointer node, node_pointer deleted)
{
      if (node==deleted)
            printf("Deletion of head nodenot permitted.\n");
      else
      {
            deleted->llink->rlink= /* your answer */;                  (a)
            deleted->rlink->llink= /* your answer */;                  (b)
            free(deleted);
      }
}
```

5. Please use the big O to write down the time complexity and space complexity of "2D Array", "Transpose a Matrix", and "Fast Transpose Matrix". Please finish the table as below. (6%)

	Space	Time
2D Array		
Transpose a Matrix		
Fast Transpose Matrix		

6. Please write the output in this code. (4%)

```
    #include<stdio.h>
    int main(){
      int a[] = {5,7,9,11,13};
      int *p;
      int i = 2;
      p = a;
      *(p++) = ++i;
      printf("%d %d %d %d", a[0] , a[i++] , *p , *(p+2));
      return 0;
    }
```

7. Algorithm (3%)

(1) Give a definition for algorithm.

(2) What are the criteria for algorithm?

(3) What is the ADT (Abstract Data Type)?

8. Table_1 and Program_1 are shown as below. I give the information of variable "hello" and "bye" in Table_1. Please write down the output in Program_1. (6%)

Table_1

	value	address
hello	10	0066FF18
bye	0066FF18	0061FF1C

Program_1

```
int main(void) {
        int hello = 10;
        int * bye = &hello;
        printf(“%p\n” , *&bye);                              (1)
        printf(“%p\n” , &hello);                             (2)
        printf(“%p\n” , bye);                                 (3)
        printf(“%p\n” , &bye);                               (4)
        printf(“%d\n” , *bye);                                (5)
        printf(“%p\n” , &*hello);                            (6)
}
```

9. I give an array [1…n] and want to find the MaxSum from 1 to n. The MaxSum is defined as max{ $\sum_{i}^{j} k$ | k: i∼j, 1≦i≦j≦n}. Please complete the following pseudocode. (10%)

```
MaxSum(S, n)
begin
    x←0 y←0
    for i←1 to n
        do if S[i]+y> x then y ← (1)   x ← (2)
            elseif S[i]+y> 0 then y ← (3)
            else y←0
    print x
end
```

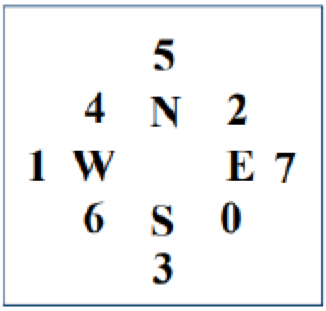
10. Please complete (1) and (2) so that it can print "123, 123, 132, 123, 123, 213, 213, 231, 213, 123, 321, 321, 312, 321,and 123". We assume X(S, 1, 3), when S[i] = i for 1≦i≦3. (10%)

```
X(S, k, n)
begin
   if k=n then print S[1..n]
   else
      for i←k to n
          do temp←S[k]
              S[k]←S[i]
              S[i]←temp
              X(S, (1) , (2) )
              temp←S[k]
              S[k]←S[i]
              S[i]←temp
              X(S, n, n)
end
```

11. I use the stack to record the way from map [4][4] (square mark) to map [1][1] (circular mark). “1” in map [6][6] means the wall (cannot go through), and “0” in map [6][6] means the way (can go through). In “Eight Directions”, there is a number from 0 to 7 that means eight directions, and we first try direction 0 and then try direction 1 and so on. Please write down the stack status in each step. I show the status of the first, second, and third steps in stack. Please write the stack status in the format until (1,1) is pushed in stack. (10%)

1	1	1	1	1	1
1	⓪	0	1	0	1
1	0	0	0	1	1
1	1	1	0	0	1
1	0	0	0	$\boxed{0}$	1
1	1	1	1	1	1

map[6][6]



Eight Directions

format

1. (4,4)
2. (4,4) (4,3)
3. (4,4) (4,3) (4,2)

…

12. I use the “Sequential Representation” method to build a binary tree.

(1) Please build a binary tree by using Table_1. (2%)

Table_1

1	A
2	B
3	C
4	
5	D
6	
7	E
8	
9	
10	F
11	G

(2) (a) How many nodes (include leaves) in level 3? (2%)

(b) What is the depth of the tree? (2%)

(3) Please write down the number of leaves in this tree. (2%)

13. There is a 10-level complete binary tree and the sequence number in root is 1.

(1) How many nodes in level 5? (2%)

(2) What is the max number of node (include leaf) in this tree? (2%)

(3) What is the sequence number of the third node in level 7? (3%)

(4) The sequence number 375 is located at which level? (3%)