

國立臺灣科技大學  
九十三學年度碩士班考試試題

系所組別：電子工程系甲組  
科 目：資料結構

總分 100 分

1. (12%) Order the following functions by growth rate (in non-decreasing order). Indicate which functions grow at the same rate.

$N, N^{1.3}, N^2, N \log N, N \log \log N, N(\log N)^2, N \log(N^2), 2/N, 2^N, 2^{N/2}, 7, N^3, (1.6)^N$

2. (8%) For the following program fragment, give an analysis of the running time (in Big-Oh notation).

```
sum = 0;
for(i=1; i < n; i++)
    for(j = 1; j < i*i; j++) {
        sum++;
        for(k = 0; k < j; k++)
            sum++;
    }
```

3.

- (a) (4%) Give the recurrence equation for the worst case running time of the function recur; and  
(b) (4%) Solve the recurrence equation.

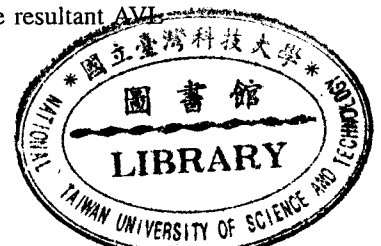
```
int recur(int n)
{
    int i, sum=0;
    if(n < 1) return 1;
    else {
        for(i=1; i<n; i++) sum += i;
        return recur(n-1)+sum;
    }
}
```

4.

- (a) (4%) Describe the properties of a red-black tree.  
(b) (8%) Draw the top-down red-black trees built when the keys 2, 1, 3, 7, 5, 8, 9, 11, and 10 are inserted into an initially empty tree. (Please show the top-down red-black trees after each insertion. Black nodes are shown with single circles and red nodes are shown with double circles.)  
(c) (4%) Draw the top-down red-black trees built when the keys 7 and 5 are deleted from the resultant red-black tree of part (b). (Please show the top-down red-black trees after each deletion.)

5.

- (a) (4%) Describe the properties of an AVL tree.  
(b) (8%) Draw the AVL trees built when the keys 2, 1, 3, 7, 5, 8, 9, 11, and 10 are inserted into an initially empty tree. (Please show the AVL trees after each insertion.)  
(c) (4%) Draw the AVL trees built when the keys 7 and 5 are deleted from the resultant AVL tree of part (b). (Please show the AVL trees after each deletion.)



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6. (10%) Show the result of running Shellsort on the input 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2 using the increments {1, 3, 7}. (Please show the number of inversions in the sequences and the sequences after each pass.)

pass	sequences	no. of inversions
initial	12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2	
increment(7)		
increment(3)		
increment(1)		

7. Find the optimal binary search tree for the following keys by employing dynamic programming: (The frequencies appear in the parentheses after each key.)

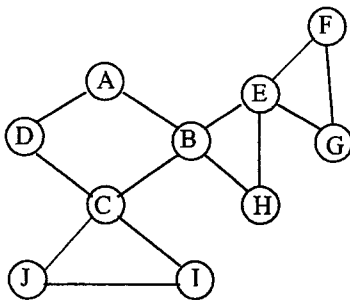
A(10), B(12), C(6), D(16)

- (a) (8%) Show the values in the following table.

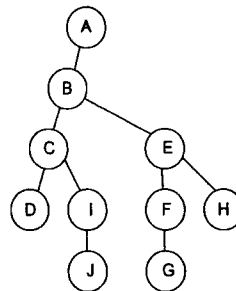
<i>optimal_cost</i>	A	B	C	D
<i>root</i>				
A	$\frac{10}{A}$	—	—	—
B		$\frac{12}{B}$	—	—
C			$\frac{6}{C}$	—
D				$\frac{16}{D}$

- (b) (2%) Draw the optimal binary search tree.

8. Find all the articulation points and the biconnected components in the following graph. The corresponding depth-first spanning tree is also shown in the following. The *dfn* numbers are defined as the preorder numbers in the depth-first spanning tree (starting with 1).



A connected graph.



The corresponding depth-first spanning tree.

- (a) (4%) Describe the definition of *low* numbers.  
 (b) (2%) Describe the definition of the articulation points? (describing with *dfn* and *low* numbers)  
 (c) (8%) Show the values in the following table.

vertex	A	B	C	D	E	F	G	H	I	J
<i>dfn</i>	1									
<i>low</i>										

- (d) (4%) Give all the articulation points in above connected graph.  
 (e) (2%) Give all the biconnected components in above connected graph.

