※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. [20%] True or False, and EXPLAIN
Circle T or F for each of the following statements to indicate whether the statement is true or false, respectively. If the statement is correct, briefly state why. If the statement is wrong, explain why or give a counter example. Answers without reasons will get at most 1 point.

(a) [4%] (**T** , **F**) Any function that is $\Omega(\log\log n)$ is also $\omega(\log\log n)$.
(b) [4%] (**T** , **F**) In a min-heap of 6 distinct integers, the second largest integer may not be a leaf.
(c) [4%] (**T** , **F**) To store a tree of n nodes, it is better to use an adjacency matrix, rather than an adjacency list, because it takes $O(1)$ time to access an arc (i, j) when scanning node i.
(d) [4%] (**T** , **F**) RADIX SORT does work correctly (i.e., produce the correct output) if we sort each individual digit using INSERTION SORT instead of COUNTING SORT.
(e) [4%] (**T** , **F**) Given a red-black tree, suppose we want to delete a black node whose children are both internal nodes (i.e. NOT a NULL object). If its successor is red, then this successor must have both NULL children.

2. [18%] Consider a connected weighted directed graph $G = (V, E, w)$, where V and E respectively represent the set of vertices and edges, $w = [w_e]$ stores the weight for each edge $e \in E$. Let $|V| = n$ $|E| = m$, and w_e be a positive real number for each edge $e \in E$ Define the fatness of a simple path P in G to be the maximum weight of any edge in P. For example, if P passes vertices 1, 3, 8, 4 in sequence, and $[w_{13}, w_{38}, w_{84}] = [5.4, 1.3, 8.2]$, then the fatness of this path equals to 8.2. Now, we want to find the minimum possible fatness of a simple path from u to v in G. Answer the following question:
(a) [4%] Suppose you are given a simple path $u - t_1 - t_2 ... - t_{k-1} - v$ that contains k edges, can you calculate the fatness of this path in $O(\log k)$ time? Explain why or why not. If your answer is NO, then give a tight complexity for this operation (e.g. in $\Theta(??)$ time)
(b) [8%] Suppose you are given a value Q, and you want to use Bread-First-Search (BFS) to answer whether it is possible to construct a path from u to v whose fatness is smaller than Q. Describe how you will do it and estimate the complexity of your method.
(c) [6%] Based on (b), give a method to find the minimum possible fatness of a simple path from u to v in G, and explain its complexity.

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3. [12%] Answer the following questions about C codes:

(a) [4%] What value will return by calling F(2,2)?

```
int F(int m, int n) {
if (m==0) return n+1 ;
if (n==0) return F(m-1,1) ;
return F(m-1, F(m,n-1)) ;}
```

(b) [4%] What is the result of the following code?

```
int main() {
int a[] = { 3, 5, 9, 4 };
int *b = a;
cout << a[ 1 ] << " ";
cout << ( a + 2 )[ 1 ] << " ";
cout << b[ 2 ] << " ";
cout << *( ++b ) << " ";
cout << ( b - 1 )[ 0 ] << " ";
return 0;}
```

(c) [4%] What is the result of the following code?

```
void swap1(int a, int b){
int tmp=a;
a=b; b=tmp; }

void swap2(int &a, int *b){
int tmp=a;
a=*b;
*b=tmp; }

void swap3(int *a, int b){
int tmp=*a;
*a=b;
b=tmp; }

int main(){
int a=5, b=3;
swap1(a, b);
cout << a << " " << b << endl;
swap2(a, &b);
cout << a << " " << b << endl;
swap3(&a, b);
cout << a << " " << b << endl;
return 0; }
```

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4. Computer Networks: (10%)

(1) Please explain as detailed as possible about how a browser/computer fetches a web page when the user enters a URL into the address box (5%)

(2) Please answer the following questions regarding web services (5%)

a) What are web services? (2%)

b) What is the foundation technology for web services? (1%)

c) What is the advantage of using web services? (2%)

5. Security: (10%)

(1) Please compare symmetric and public-key cryptosystems and explain how they are used on the web (6%)

(2) The figure below shows the authentication steps defined in the Wired Equivalent Privacy (WEP) standard. In the beginning, the client attempting to connect sends an authentication request to the access point (AP). In response, the AP generates a challenge (plaintext) and sends it back to the client. Then, the client encrypts the challenge by **XOR**ing the challenge with a key shared with the AP and sends the result back. If the AP is able to correctly decipher the encrypted challenge, the client is granted to access the network. However, this process is known to be insecure. Please identify the problem and explain your answer. (4%)

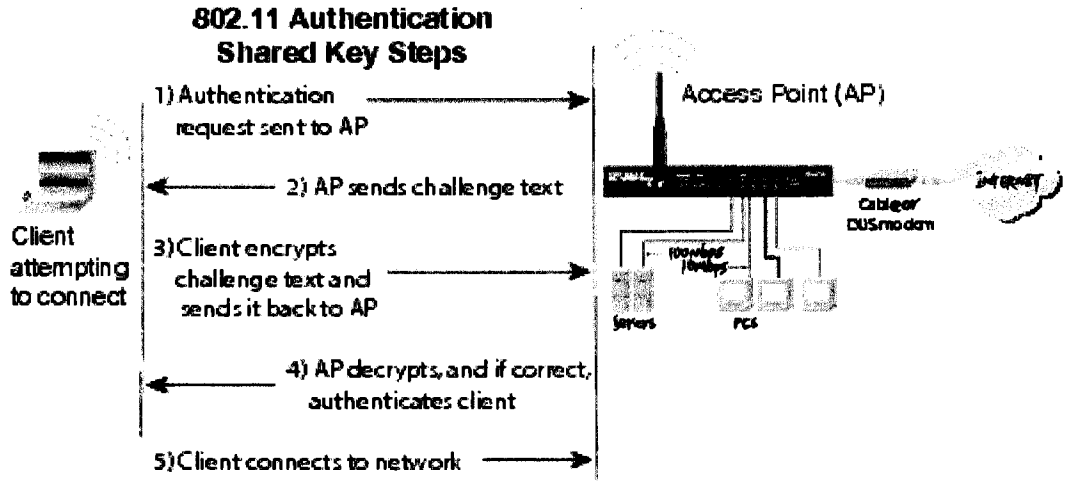

Figure 1 WEP Authentication

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6. Database: (10%)

Assuming we have the following two tables in an SQL database. Write a query to find the number of students in each class.

- *Students* containing: Student_ID, Student_Name, and Class_ID (Primary Key)
- *Classes* containing: Class_Name and Class_ID (Foreign Key)

7. Software Development (10%)

(1) What is a function object (or functor)? (5%)
(2) What are the advantages of using functors over function pointers? (5%)

8. Information Technology (10%)

Google, Apple, Microsoft, and Amazon are the four competing Internet titans. Please compare their business models and areas of strengths. Which company and/or business model do you think will eventually prevail? Explain your answer.