[10%] 1. Determine which of the following statements are true? If the answer is false, justify it briefly.
  (a) (2%) All problems have algorithmic solutions, but some of the solutions are impractical.
  (b) (2%) The stored program concept is about representing data as binary values and storing them in memory.
  (c) (2%) In storage management, fixed-size records incur internal fragmentation while variable-size records incur external fragmentation.
  (d) (2%) Suppose that A is an assertion, and "If A then B" is a given rule, then B is an assertion.
  (e) (2%) In COM (Component Object Model), source code is reused through interface inheritance.

[6%] 2.(a) (3%) What is the principle of locality?
  (b) (3%) Please give an example where this principle is used to improve the performance of a computer system.

[5%] 3. You are given the following two tables (Student and Record) in a relational database. Please use the two tables and the common operators (SELECT, PROJECT, and JOINT) for relational database to write statements that generate a new table called *FailSP*. This table should contain only the names of the students who failed the exam (Score<60) and the names of their parents. Any intermediate tables being generated should be kept as small as possible.

Student		
StudID	StudName	Parent
002	John	Joe
004	Mary	Maria
007	Tom	Tim

Record		
CourseID	StudID	Score
001	002	46
001	002	89
002	007	55
003	004	90

[6%] 4.(a) (3%) Explain why Ethernet loses efficiency as traffic increases in LAN.
  (b) (3%) What are the corresponding positions of the following protocols in the OSI networking model: TCP, IP, Ethernet (CSMA/CD)?

[4%] 5. Use the following BNF grammar to draw the parse tree for the following assignment statement:　　　　x := x + x − y

```
<assignment>    ::= <var> := <expr>
<expr>          ::= <var> | <expr> <oper> <var>
<var>           ::= X | Y
<oper>          ::= + | -
```

[4%] 6. A rule-based system attempts to (list the letters that apply)
(a) mimic the human ability to reference pertinent facts and string them together in a logical fashion
(b) simulate the connectionist architecture of the human brain
(c) carefully distinguish between objects and their attributes
(d) contain both a set of facts about the subject matter and a mechanism for selecting the relevant facts and reasoning from them in a logical way.

[6%] 7. (a) (3%) Give the truth table that corresponds to the following circuit.
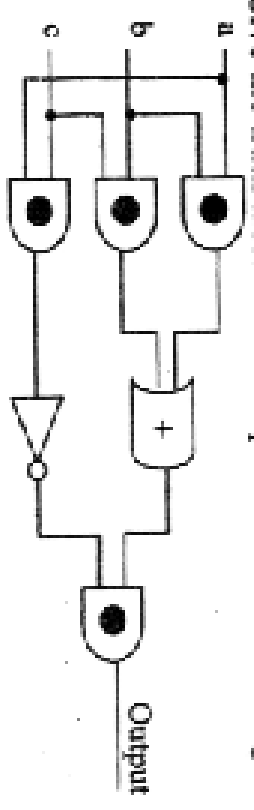
(b) (3%) For the truth table obtained in part (a), give an equivalent Boolean expression that contains the minimum number of "transistors" when implemented in circuit? What is this minimum number?

[9%] 8.(a) (6%) Write a recursive C function

```
tree_node *BtreeFindNode(tree_node *root, int taget);
```

to search a binary tree for the value target in a depth-first manner. This function should return the found node or null if no such node exists. The structure for a node in the tree is given as follows.

```
typedef struct tree_node {
    int value;
    struct tree_node *left;
    struct tree_node *right;
} tree_node;
```

(b) (3%) What are the advantages and disadvantages of using recursive routines?

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4-3

9. (6%) Please answer and explain the following questions?
(a) the worst-case time complexity of searching in a binary search tree of n elements?
(b) the worst-case time complexity of searching in an AVL tree of n elements?
(c) the average time complexity of searching in an unsorted array of n elements?
(d) the average time complexity of searching in a sorted linked list of n elements?

10. (6%) Please determine the time complexity of merge sort for
(a) sorted input
(b) reverse-ordered input
(c) random input.

11. (8%) Two binary trees are similar if they are both empty or both nonempty and have similar left and right subtrees. Given the following declaration in C, please write a function to decide whether two binary trees are similar. What is the running time of your program.

```
typedef struct TreeNode *PtrToNode;
typedef struct PtrToNode Tree;
struct TreeNode
{
    int    Element;
    Tree   Left;
    Tree   Right;
}
```

12. (10%) Suppose that there exists a city divided into 6 districts. Each district has a switching center. The distance between each pair of switching centers is shown in Table 1. Two switching centers are connected if there is a wire between them. The

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4-4

13. (10%) Please design the data structure and $O(\log n)$ algorithms to support the following two operations in **dynamic** environment: *Insert* and *Delete-Runner-Up*. The *Insert* operation inserts an element while the *Delete-Runner-Up* operation deletes the second minimum element, instead of the minimum one. You should describe the data structure and write down the two algorithms.

14. (10%) Suppose that there exists an algorithm X. With the input of a set of n integers and an integer k, algorithm X will answer "yes" or "no," indicating whether there is a subset of the n numbers whose sum is k. Please design an algorithm Y to find the subset of the n numbers whose sum is k by using the algorithm X $O(n)$ times. You should describe the idea of your algorithm.