1. Briefly explain the client-server and peer-to-peer models using in networks. Name two applications for each model. (8%)

2. Answer the following questions: (12%)
   (a) Why the quicksort program is not stable?
   (b) Consider the search problem in a sorted list of size N. If the sorted list is stored in a linked list structure, how do you modify the linked list such that it supports $O(\min(d, N-d))$ time for searching a key, where d is the location of the key.

3. State briefly why the 2-3-4 Tree can always maintain perfect balancing after insertion. Convert the following 2-3-4 Tree (Fig. 1) into a Red-Black Tree. (10%)

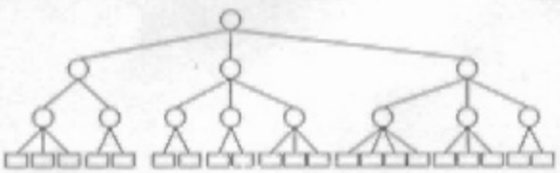

Fig. 1

4. What is a short-circuit evaluation of an expression in programming languages? What is the possible effect for the following expressions if evaluation is not short circuit? (8%)

```
index = 1;
while ((index < listlen) && (list[index] <> key))
    index = index + 1;
```

5. Given a binary tree stored by a linked representation, (12%)
   (a) write a pseudo program to compute the distance from the root node to a given leaf node (Assume the distance is 1 for each edge in the tree).
   (b) write a pseudo program to dump the nodes along the path from the root node to a given leaf node.

6. For Error-Correcting-Codes, the Hamming weight for a binary codeword X, $W_H(X)$, is defined as the number of "1" and the Hamming distance, $D_H(X,Y)$, is the number of different positions between two codewords X and Y. Table 1 shows an error-correcting code. Please answer the following questions:
   (a) When the received pattern is (010100), please list the Hamming distance between the received pattern and the symbols A~H, respectively. (4%)

(b) If there is one error occurred, what is the correct symbol for the received pattern in (a). (4%)

(c) Please prove that $D_H(X,Y) = W_H(X \oplus Y)$, where $\oplus$ is XOR. (4%)

(d) Please find the minimum Hamming distance D_{min} for Table 1, i.e. the minimum value for $D_H(X,Y)$, where X and $Y \in$ {A~H}. (4%)

(e) Try to answer a code with minimum Hamming distance D_{min} can correct $\lfloor (D_{min}-1)/2 \rfloor$ errors and detect $(D_{min}-1)$ errors. (4%)

(f) Please decode the following messages using Table 1:
001111 100100 001100 010001 000000 001011 011010. (4%)

(g) Please encode A, B, C and D using bit patterns of length five such that the Hamming distance between any two patterns is at least three. (4%)

Table 1

Symbol	Code
A	000000
B	001111
C	010011
D	011100
E	100110
F	101001
G	110101
H	111010

7. Please Uses the following 64K×8 RAM chips (Fig. 2) and a decoder to design a 256K×16 RAM. (10 %)

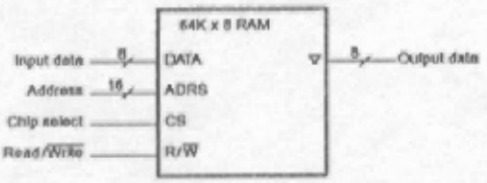

Fig. 2

8. (a) Plot the K-map and write out minimum POS (product of sum) expression for $F = AC\overline{D} + AB\overline{C} + \overline{B}D$. (6%)

(b) Plot the truth-table and write out minimum SOP (sum of product) expression for the following K-map (Fig. 3), where "x" denotes *don't care* condition (6%)

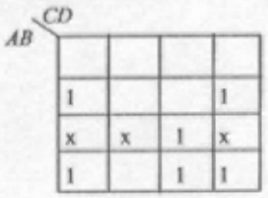

Fig. 3