

## Data Structure

1. (20%) Answer the following questions.
  - (a) There are many ways to represent a graph in a computer program. Give one of them and use an example to show how.
  - (b) If each edge of the graph has a weight, how would you represent this weight in your graph representation given above? Explain it.
  - (c) Write a pseudo code to show how to find minimum spanning tree based on your given graph representation. Proper illustrations of your pseudo code should be added to make your program understandable.
  
2. (30%) Answer the following questions.
  - (a) What is an AVL-tree? Describe it formally.
  - (b) Insert the following values into an AVL-tree in the given order 78, 63, 95, 51, 83, 105, 79, 85, 100, 200 and show the AVL-tree. Now, if a new value 80 is inserted, how to rebalance the tree?
  - (c) What is a B-tree? Describe it formally.
  - (d) What is a reasonable size of each node of a B-tree (i.e., the number of data elements a node should contain)? Explain why.
  - (e) Give an example to show a single linked list, a double linked list, and a circular list. Compare their advantages and disadvantages of these lists.

(背面仍有題目,請繼續作答)

Algorithm

1. (15%) If  $k$  is a nonnegative constant then the solution to the recurrence

$$T(n) = \begin{cases} k, & n=1 \\ 3T(n/2) + kn, & n > 1 \end{cases}$$

for  $n$  a power of 2 is

$$T(n) = 3kn^{\log_2 3} - 2kn$$

Prove this statement.

2. (20%) Let  $X[1..n]$  and  $Y[1..n]$  be integer arrays, each sorted in nondecreasing order. Write an  $O(\log n)$  algorithm that finds the  $k$ th smallest of the  $2n$  combined elements, where  $1 \leq k \leq n$ .

3. (15%) True or False (defined your answer): the following nondeterministic algorithm solves the No Partition Problem in nondeterministic polynomial time.

```

HalfSet := {};
p := n;
repeat
    count := choose({0,1})
    if count = 1 then
        HalfSet := HalfSet ∪ {p}
    endif
    p := p - 1;
until p = 0
if  $\sum_{i \in \text{HalfSet}} c_i \neq \sum_{i \notin \text{HalfSet}} c_i$ 
then
    success, print ("yes")
else
    failure, print ("no")
endif
    
```