國立暨南國際大學 104 學年度轉學生入學考試試題　　第 2 節

科目：**資料結構與演算法**　適用：資工系三

編號：721

考生注意：
1.依次序作答，只要標明題號，不必抄題。
2.答案必須寫在答案卷上，否則不予計分。
3.限用藍、黑色筆作答；試題須隨卷繳回。

本　試　題
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The following problems can be answered either in Chinese or English.

Problem 1 (20%) Given an integer sequence $a_1, a_2, \ldots, a_n$ as the input, your job is to find the second smallest number in this sequence. Write a program in C language to solve the above problem in time $O(n)$. In order to make sure that your program is indeed an algorithm in time $O(n)$, please prove this.

Problem 2 (20%) Suppose you need a data structure that stores a set of integers as the elements and can support the following operations: (1) find the minimum between those elements; (2) remove the minimum; (3) insert a new integer into this set; and (4) decrease the value of an element and still leave this element in this data structure. What data structure would you choose for the purpose of efficiency? Show how to implement these operations in this data structure.

Problem 3 (15%) Explain the main differences between stable sorting and unstable sorting.

Problem 4 (15%) Given a graph $G = (V, E)$ where V is the set of vertices and E is the set of edges, we need to evaluate the diameter of G. Given any two vertices u and v in G, we use $d(u, v)$ to denote the length of the shortest path connecting u and v; if u and v are disconnected, $d(u, v)$ is set to be ∞. The diameter of G is defined as the largest value of $d(u, v)$ over all pairs of vertices u and v in V. Describe a polynomial-time algorithm to accomplish this task.

Problem 5 (15%) Suppose you were analyzing an algorithm and finally you got a recurrence relation for its time complexity, which is shown as follows.

$$T(n) = 2T\left(\frac{n}{2}\right) + \Theta(n)$$

Solve this equation and derive a closed form of $T(n)$.

Problem 6 (15%) Please give formal definition of minimum spanning trees in a graph.