# 國立成功大學

# 111學年度碩士班招生考試試題

編　號：241

系　所：資訊管理研究所

科　目：資料結構

日　期：0220

節　次：第 3 節

備　註：不可使用計算機

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A-1. [10%] Rank the following functions $f_1, f_2, \ldots, f_5$ by the order of growth and justify your answer: (note, if $f_i = O(f_j)$, then $f_i \prec f_j$):

$$f_1 = \left(\frac{n}{2}\right)\log\left(\frac{n}{2}\right)$$

$$f_2 = \log n!$$
$$f_3 = \log^2 n$$
$$f_4 = n\log n$$
$$f_5 = (4/3)^n$$

A-2. [15%] Select the best (in terms of run-time) data structure to use in the following scenarios and give a brief description of why you chose it. Choose from the following data structures (each of which may be used more than once): Move-to-front List, Stack, Queue, AVL Tree, Heap, Hash Table, B-tree.

a) [3%] Selecting the order of messages to send in a network when some messages require a faster delivery than others. New messages are always coming in.
b) [3%] Tracking the orders placed at a counter in a sandwich shop.
c) [3%] Tracking the roster of Seahawks players. Individual player records are occasionally requested by the player's name. Requesting the entire list of players sorted by player names is the most common operation. New players are added to the roster fairly often.
d) [3%] A company has a huge amount of data stored on external servers. They have even more data to add and will be performing many insert operations, which they want to be fast.
e) [3%] A company has a large amount of data that is not comparable. They want to use a data structure that gives them the fastest possible find operation. Should they use an AVL tree or a Move-to-front List?

A-3 [10%] Suppose we have an array *b* containing *n* integers. Initially the integers are in some random order. Implement a function to rearrange the array so all the negative integers precede all the zeros, and the positive integers appear at the end. *Requirement*: Your algorithm must partition the array in linear ($O(n)$) time.

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A-4 [10%] A 3-ary min heap with $n$ elements can be stored in an array $A$, where $A[0]$ contains the root of the tree.

a) [5%] Draw the 3-ary min heap that results from inserting 5, 2, 8, 3, 6, 4, 9, 7, 1 in that order into an initially empty 3-ary min heap. You do not need to show the array representation of the heap. You are only required to show the final tree, although if you draw intermediate trees, please circle your final result for ANY credit.

b) [2%] Draw the result of doing 1 *deletemin* on the heap you created in part a. You are only required to show the final tree, although if you draw intermediate trees, please circle your final result for ANY credit

c) [3%] Assuming that elements are placed in the array starting at location $A[0]$, give expressions to calculate the left, middle, and right children of the element stored in $A[i]$.

A-5. [5%] Answer the following questions regarding AVL trees.

a) [2%] What are the minimum and maximum number of nodes in an AVL tree of height 6? Give an exact number for both of your answers, not a formula.

b) [3%] Given an AVL tree of height 6, what are the minimum and maximum number of rotations we might have to do when doing an *insert*? (Give an exact number, not a formula. A single rotation = 1 rotation, a double rotation = 1 rotation)

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B1. [Sort]

i. In quick sort, pivot selection will affect the performance of the sorting process. One way called median of three rule, please use the list as an example to explain what is median of three rule {11,19,13,20,21,6,7,1,10,15,14,17,35}(3%)

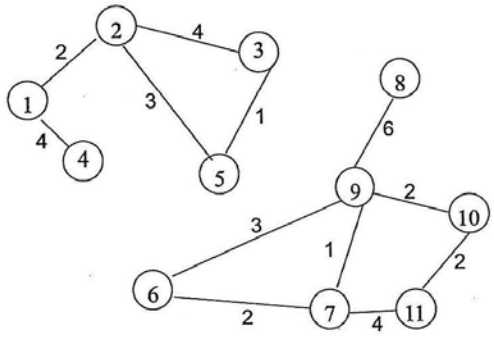
ii. Please use the median of three rule to choose the pivot and demonstrate the complete sorting process of the above numbers in an additional memory. (6%)

B2 [Graph-1]

iii. Please write a pseudo code to determine whether a graph contains a cycle. (6%)

iv. Starting from the point 1 in diagram below, if the smaller value is preferred, please explain in detail how to use stack or queue and Depth-First Search (DFS) to construct a spanning tree. Please draw the detailed construction process of the spanning tree and the used data structure (stack or queue) content (7%)

v. Using the diagram below, please use Kruskal's method to find the min spanning trees of the component with the largest vertex degree. (please explain the process in detail) (6%)




B3 [Graph-2]

i. Assum c(i,j k) is the short path from vertex i to vertex j that has no intermediate vertex larger than k where k=1,..,n. Please write a pseudo code to explain Floyd's Shortest Paths Algorithm (7%)

ii. If you have Cost Matrix (left figure) and Kay Matrix(right figure) of the algorithm from vertex i to vertex j (i=1..8, j=1..8), please find the shortest path from vertex 4 to 7 (5%)

| I \ J | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 6 | 5 | 1 | 10 | 13 | 14 | 11 |
| | 10 | 0 | 15 | 8 | 4 | 7 | 8 | 5 |
| | 12 | 7 | 0 | 13 | 9 | 9 | 10 | 10 |
| | 15 | 5 | 20 | 0 | 9 | 12 | 13 | 10 |
| | 6 | 9 | 11 | 4 | 0 | 3 | 4 | 1 |
| | 3 | 9 | 8 | 4 | 13 | 0 | 1 | 5 |
| | 2 | 8 | 7 | 3 | 12 | 6 | 0 | 4 |
| | 5 | 11 | 10 | 6 | 15 | 2 | 3 | 0 |

| I \ J | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 4 | 0 | 0 | 4 | 8 | 8 | 5 |
| | 8 | 0 | 8 | 5 | 0 | 8 | 8 | 5 |
| | 7 | 0 | 0 | 5 | 0 | 0 | 6 | 5 |
| | 8 | 0 | 8 | 0 | 2 | 8 | 8 | 5 |
| | 8 | 4 | 8 | 0 | 0 | 8 | 8 | 0 |
| | 7 | 7 | 7 | 7 | 7 | 0 | 0 | 7 |
| | 0 | 4 | 1 | 1 | 4 | 8 | 0 | 0 |
| | 7 | 7 | 7 | 7 | 7 | 0 | 6 | 0 |

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B4 [Hash]

i. Suppose you are planning to build an index file for a database by using the hash function homeBucket = (Key) % divisor. If several divisors (8, 9, 11, 27) could be selected, please explain the reasons which one you will choose and why. (5%)

ii. Bloom filter uses hash functions to generate differential file. Please explain what the differential file is and briefly explain how to use it? (5%)