

考試科目	計算機概論	系所別	資訊管理學系/資管組	考試時間	2月6日(五) 第2節
------	-------	-----	------------	------	-------------

Short-Answer Questions (100 points)

- (20 pts) You are setting up a private testing lab within your office. You have connected your own router (acting as an Access Point/NAT/DHCP server) to the existing router in the office's infrastructure.
 - Office AP IP: 34.56.34.11 (Public/WAN facing)
 - Your AP's WAN IP: 192.168.50.11 (Assigned by the Office AP via DHCP)
 This setup creates a "Double NAT" environment where packets from your private network must traverse two different translation layers before reaching the Internet.
 - (10 pts) A laptop connected to your private AP and was assigned an IP: 10.20.30.50. Suppose it sends a request to a public web server at 1.1.1.1. How are the packet headers translated as they pass through your AP and the Office AP? Please illustrate with a NAT Translation Table.
 - (5 pts) Several laptops in your private network send requests to the same public web server. How does your private AP ensure that the server's responses are correctly routed back to the senders?
 - (5 pts) Suppose that your private subnet is configured as 10.20.30.0/22. Calculate the total number of usable IP addresses available for client devices in this subnet.
- (15 pts) What are the ACID properties in database transactions? Please illustrate with examples.
- (15 pts) You want to upgrade a server for your company. There are two options: (1) upgrade the server so that its processing speed becomes k times faster; (2) replicate the server into k nodes; each node has the same processing speed as the original server. Compare the pros and cons of these two upgrade plans.
- (10 pts) You are monitoring a sluggish server and find a sudden spike in page faults with heavy disk I/O.
 - (4 pts) Describe what a page fault is and how an operating system typically handles it.
 - (3 pts) Explain the concept of "thrashing" and how it affects system performance.
 - (3 pts) What are page replacement algorithms, and how do they impact the frequency of page faults?
- (10 pts) Suppose that a score-based binary classifier accepts an input x if $f(x) > c$, and rejects x otherwise. How does increasing the value of c affect the false positive rate and the false negative rate? Why?
- (10 pts) Please explain the difference between the following three types of AI: chatbot, agent, and Copilot. Demonstrate how a user typically triggers each type of AI to complete a task.
- (20 pts) An undirected graph is represented by an $n \times n$ Boolean matrix G , where $G[x][y] = \text{true}$ if and only if the graph has an edge between vertices x and y , where $1 \leq x, y \leq n$. Design an efficient algorithm to find the *longest acyclic path* from vertex 1 to vertex n (15 pts), and explain why your algorithm is correct (5 pts).

備註

- 作答於試題上者，不予計分。
- 試題請隨卷繳交。

考 試 科 目	管理資訊系統	系 所 別	資訊管理系/資管組	考 試 時 間	2 月 6 日(五) 第 4 節
---------	--------	-------	-----------	---------	------------------

Questions:

1. As mobility systems gradually become connected, autonomous, shared, and electric, how can we align these possibilities with ethical considerations (25%)?
2. Can you explain the long-tail theory and its relevance to recommender systems? What models or solutions will you suggest for recommender systems to handle situations involving new items and new users (25%)?
3. To stay competitive in digital business, many organizations integrate various technological components into unique systems. If a synthesis function defines how the performance of each component contributes to overall system performance, what major forms may this function take (25%)?
4. A university restaurant, frequently used by students and faculty, plans to develop a mobile application to handle order processing, receipt generation, kitchen communication, and management reporting. Based on this scenario, can you draw a use case diagram and data flow diagrams, and clarify any necessary assumptions to support your design logic (25%)?

備

註

- 一、作答於試題上者，不予計分。
- 二、試題請隨卷繳交。

考試科目	計算機概論	系所別	資訊管理學系/科技組	考試時間	2月6日(五) 第2節
------	-------	-----	------------	------	-------------

Short-Answer Questions (100 points)

1. (15 pts) You are setting up a private testing lab within your office. You have connected your own router (acting as an Access Point/NAT/DHCP server) to the existing office infrastructure.

- Office AP IP: 34.56.34.11 (Public/WAN facing)
- Your AP's WAN IP: 192.168.50.11 (Assigned by the Office AP via DHCP)

This setup creates a "Double NAT" environment where packets must traverse two different translation layers before reaching the Internet.

- 1.1. (5 pts) A laptop connected to your private AP and was assigned an IP: 10.20.30.50. Suppose it sends a request to a public web server at 1.1.1.1. Describe how the packet headers are translated as they pass through your AP and the Office AP. Please illustrate with a NAT Translation Table.
- 1.2. (5 pts) Several laptops in your private network send requests to the same public web server. How does your private AP ensure that the server's responses are correctly routed back to the senders?
- 1.3. (5 pts) Suppose that your private subnet is configured as 10.20.30.0/22. Calculate the total number of usable IP addresses available for client devices in this subnet.

2. (10 pts) You are a system admin of a Linux server. You found that the server is sluggish, and processes have been randomly terminated by the out-of-memory (OOM) killer.

- 2.1. (4 pts) A process in Linux has two types of memory usage: VIRT (Virtual) and RES (Resident). Which usage is a more accurate indicator of a memory leak? Why?
- 2.2. (3 pts) If you find a process leaking memory, how do you gracefully stop it or force it to quit?
- 2.3. (3 pts) Where can you confirm that the OOM killer was triggered and see which process it killed?

3. (10 pts) You are investigating a bug in an e-commerce application. The buggy logic is buried inside a complex code that processes thousands of items in a loop.

- 3.1 (5 pts) What is a conditional breakpoint, and when would you use it instead of a regular breakpoint?
- 3.2 (5 pts) What is the difference between Step Over, Step Into, and Step Out functions?

考試科目	計算機概論	系所別	資訊管理學系/科技組	考試時間	2月6日(五) 第2節
------	-------	-----	------------	------	-------------

4. (15 pts) Please outline the ACID properties in database transactions and illustrate with an example.
5. (10 pts) Consider a binary classifier that accepts an input x if $f(x) > c$, and rejects x otherwise. How does increasing the threshold c affect the false positive rate and the false negative rate of this classifier? Why?
6. (10 pts) You are monitoring a database server that has suddenly become sluggish. You notice a significant spike in the "page fault" metric, coinciding with heavy disk I/O.
- 6.1. (4 pts) What is a page fault, and how does the OS handle it?
- 6.2. (3 pts) Explain the concept of "thrashing" and how it affects system performance.
- 6.3. (3 pts) How does the page replacement algorithm (e.g., LRU) impact the frequency of page faults?
7. (10 pts) The Fibonacci sequence 0, 1, 1, 2, 3, 5, ... is defined by $a_0 = 0$, $a_1 = 1$, and $a_n = a_{n-1} + a_{n-2}$ for $n \geq 2$. Use any common programming language to write an algorithm that takes an integer input n and computes the value of a_n . Your algorithm must use only constant memory and linear time.
8. (20 pts) Suppose you have a built-in function `print(node)` that pretty-prints a given binary tree, where each tree node is an instantiation of the class on the right.
- ```
class Node {
 Node left; // can be null
 Node right; // can be null
}
```
- 8.1. (15 pts) Write an algorithm that takes an integer input  $n$  and prints all binary trees of height  $\leq n$  without repetition. Please also estimate the time complexity of your algorithm.
- (Note: the height of a tree is the length of the longest path from the root to a leaf. A tree with a single node has height = 1.)
- 8.2. (5 pts) Please explain why your algorithm is correct.

|    |                               |
|----|-------------------------------|
| 備註 | 一、作答於試題上者，不予計分。<br>二、試題請隨卷繳交。 |
|----|-------------------------------|

|      |      |     |                |      |             |
|------|------|-----|----------------|------|-------------|
| 考試科目 | 資料結構 | 系所別 | 資訊管理學系 / 本科技術組 | 考試時間 | 2月6日(五) 第四節 |
|------|------|-----|----------------|------|-------------|

Figure 1 shows a binary tree in which each node stores a string.

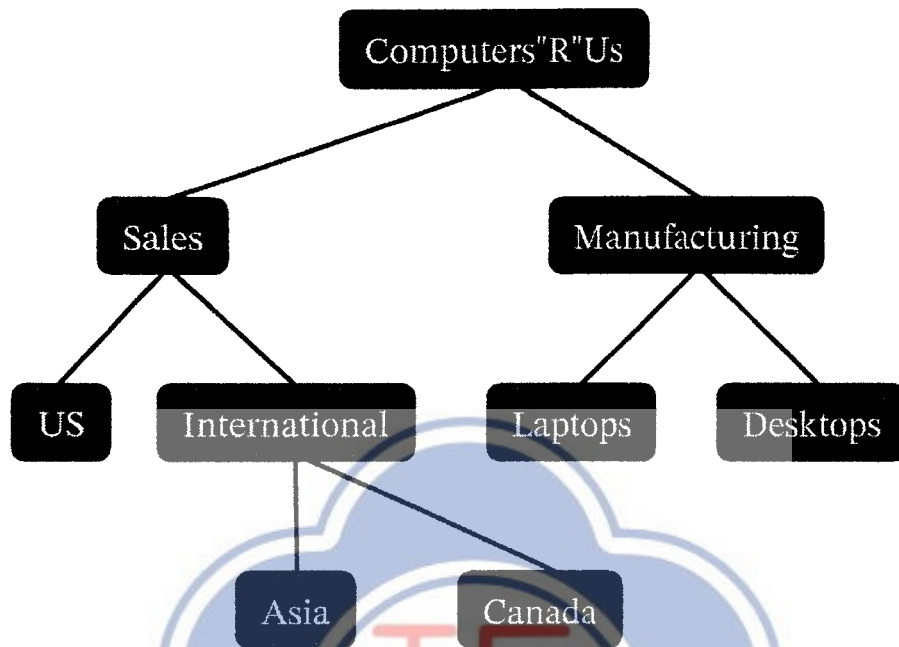


Figure 1. A Binary Tree of Computers"R"Us

**Tree Traversal and Heap Construction**

1. (10%) Define a recursive **pre-order** traversal algorithm that prints the strings stored in the nodes of a binary tree. You may write the algorithm in pseudocode or Java. Then, apply your algorithm to the binary tree shown in Figure 1 and write down the resulting output sequence.
2. (20%) Construct a min heap by inserting the strings one by one in the order obtained from Q1. The heap ordering rule is defined as follows:
  - (1) Strings with shorter length have higher priority.
  - (2) If two strings have the same length, they are compared lexicographically from left to right using the Ord encoding defined below.

The character encoding Ord is defined as:  
 Ord('A') = 1, Ord('B') = 2, ..., Ord('Z') = 26  
 Ord('a') = 27, Ord('b') = 28, ..., Ord('z') = 52  
 Ord("") = 0

Draw the heap as a binary tree after all insertions.

|      |      |     |            |      |             |
|------|------|-----|------------|------|-------------|
| 考試科目 | 資料結構 | 系所別 | 資訊管理學系/科技組 | 考試時間 | 2月6日(五) 第四節 |
|------|------|-----|------------|------|-------------|

### AVL Tree Construction

- (10%) Define an **in-order** traversal algorithm that prints the strings stored in the nodes of a binary tree. Apply it to the tree in Figure 1 and write down the resulting output sequence.
- (20%) Construct an AVL tree by inserting the strings one by one according to the output sequence of Q3. Use the same string comparison rule as in Q2 when ordering keys in the AVL tree. Clearly indicate where rotations occur and show the resulting tree.

### Hash Table Construction

- (10%) Define a **post-order** traversal algorithm that prints the strings stored in the nodes of a binary tree. Apply it to the tree in Figure 1 and write down the resulting output sequence.
- (30%) Construct a hash table of size 13 by inserting the strings in the order obtained from Q5. Use double hashing to resolve collisions.

For a string  $s$ :

$\text{HashCode}(s) =$  the sum of  $\text{Ord}(c)$  for each character  $c$  in  $s$ . (Use the  $\text{Ord}$  encoding defined above.)

$H(s) = \text{HashCode}(s) \bmod 13$

$D(s) = 11 - (\text{HashCode}(s) \bmod 11)$

The  $i^{\text{th}}$  probe position is given by  $(H(s) + i \cdot D(s)) \bmod 13$ , for  $i = 0, 1, 2, \dots$

You may assume that the probing sequence will not cycle and that an empty slot will always be found.

Show the probing sequence ( $i = 0, 1, 2, \dots$ ) for each insertion.

|    |                               |
|----|-------------------------------|
| 備註 | 一、作答於試題上者，不予計分。<br>二、試題請隨卷繳交。 |
|----|-------------------------------|