題號： 277　　國立臺灣大學114學年度碩士班招生考試試題
科目：資訊科技概論
節次： 6

一、選擇題 (單選) 24 題，每題 2.5 分，共 60 分，請在每題的選項內選擇最適當的答案。

注意：答錯倒扣 1 分，扣至零分為止。(不答不倒扣)

※ 注意：請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

1. [ ] Which of the following best describes the purpose of recursion in programming? (A) To optimize memory usage by eliminating loops (B) To solve problems by breaking them down into smaller, similar subproblems (C) To execute multiple tasks simultaneously using threads (D) To perform operations on arrays more efficiently (E) To handle errors during runtime automatically.

2. [ ] In object-oriented programming, what is the primary purpose of polymorphism? (A) To allow objects to inherit multiple classes (B) To provide a single interface for different implementations (C) To encapsulate data within a single class (D) To reuse existing code in derived classes (E) none of the above.

3. [ ] Which of the following data structures is most suitable for implementing a priority queue? (A) Stack (B) Queue (C) Binary Heap (D) Linked List (E) Hash Table.

4. [ ] Which of the following traversal techniques produces a sorted order for a binary search tree (BST)? (A) Preorder traversal (B) Postorder traversal (C) Inorder traversal (D) Level-order traversal (E) Reverse level-order traversal.

5. [ ] Consider the following algorithm for sorting an array of N numbers. It starts from the 1^{st} element of the array and compares it with the 2^{nd} element. If the 1^{st} element is greater than the 2^{nd}, the two elements are swapped. Then, the 2^{nd} element is compared with the 3^{rd} element, and the two swapped if the 2^{nd} element is greater. The process continues until the end of the array. The entire process is repeated for the first N–1 elements, N–2, … and so on if the array is not yet sorted. What is the worst-case time complexity to sort an array of N numbers? (A) $O(N)$ (B) $O(N \log N)$ (C) $O(N^2)$ (D) $O(\log^2 N)$ (E) none of the above.

6. [ ] Continue the above question. What is the best-case time complexity (A) $O(1)$ (B) $O(N)$ (C) $O(N \log N)$ (D) $O(N^2)$ (E) $O(\log^2 N)$.

7. [ ] In file systems, what is the primary purpose of an inode? (A) To store the actual content of a file (B) To store metadata about a file, such as permissions and timestamps (C) To allocate disk blocks to a file (D) To index all files in a directory (E) none of the above.

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8. [ ] Which of the following best describes the Banker's Algorithm in an operating system? (A) It is a deadlock avoidance algorithm that checks resource allocation safety. (B) It ensures mutual exclusion in critical section problems. (C) It schedules processes in a round-robin manner. (D) It optimizes disk scheduling to reduce seek time. (E) It manages cache replacement in virtual memory systems.

9. [ ] In a multilevel feedback queue scheduling algorithm, which of the following is true? (A) Processes are assigned to a single queue for their entire lifetime. (B) The algorithm ensures that all processes are executed in a round-robin manner. (C) Processes can move between queues based on their behavior and priority. (D) Only I/O-bound processes are prioritized over CPU-bound processes. (E) The algorithm is non-preemptive by default.

10. [ ] What is the primary purpose of a semaphore in an operating system? (A) To manage CPU scheduling among processes (B) To ensure mutual exclusion in concurrent programming (C) To optimize memory allocation in virtual memory (D) To transfer data between user and kernel space (E) To prioritize processes in a scheduling queue.

11. [ ] In the context of virtual memory, what is the purpose of a page table? (A) To map virtual addresses to physical addresses (B) To store process control information (C) To manage CPU scheduling among processes (D) To optimize I/O device access (E) To allocate space in secondary storage for processes.

12. [ ] Which SQL clause is used to filter groups of data after applying an aggregate function? (A) DISTINCT (B) GROUP BY (C) HAVING (D) ORDER BY (E) none of the above.

13. [ ] In the context of database normalization, what is the purpose of 3NF (Third Normal Form)? (A) To ensure that non-primary-keys are transitively dependent (B) To ensure that all attributes are dependent only on the primary key (C) To reduce the number of tables in a schema. (D) To ensure that no non-primary-key attribute is transitively dependent on the primary key (E) To ensure that foreign keys reference valid primary keys.

14. [ ] What is the primary purpose of the JOIN operation in SQL? (A) To create a temporary table from existing tables (B) To combine columns from two or more tables based on a related column (C) To remove duplicate rows from a table (D) To restrict the rows returned by a query (E) To calculate aggregate values across multiple tables.

15. [ ] Which of the following is true about NoSQL databases compared to relational databases? (A) NoSQL databases do not support indexing. (B) NoSQL databases use a fixed schema for data

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storage. (C) NoSQL databases are better suited for structured data. (D) NoSQL databases are typically more scalable for distributed systems. (E) NoSQL databases do not support transactions.

16. [ ] In an ER (Entity-Relationship) diagram, what does a diamond-shaped symbol represent? (A) An attribute of an entity (B) A primary key (C) A weak entity (D) A multivalued attribute (E) none of the above.

17. [ ] What is the primary purpose of a database transaction log? (A) To store the results of executed queries for future reference. (B) To keep a record of all changes made to the database for recovery purposes. (C) To optimize the execution of complex queries. (D) To maintain a backup copy of the entire database. (E) To store metadata about tables and indexes.

18. [ ] What is a composite key in a relational database? (A) A key that consists of multiple columns to uniquely identify a row. (B) A key that acts as a foreign key in multiple tables. (C) A primary key that has been indexed for performance optimization. (D) A key that references another table's unique identifier. (E) A virtual key created by combining data from different tables.

19. [ ] What is the main purpose of a subnet mask in TCP/IP? (A) To identify the default gateway (B) To define the host and network portions of an IP address (C) To encrypt data packets (D) To limit the size of a packet (E) none of the above.

20. [ ] What is the purpose of the "window size" field in the TCP header? (A) to specify the number of bytes that can be sent before an acknowledgment is received (B) To determine the length of the TCP header (C) To indicate the size of the sliding window buffer (D) To synchronize the sequence numbers of the sender and receiver (E) none of the above.

21. [ ] Which routing algorithm is used by OSPF (Open Shortest Path First)? (A) Distance Vector (B) Link State (C) Path Vector (D) Flooding (E) none of the above.

22. [ ] Which of the following statements about NAT (Network Address Translation) is INCORRECT? (A) NAT can hide internal IP addresses from external networks. (B) NAT helps conserve IPv4 address space. (C) NAT can interfere with end-to-end connectivity for some applications. (D) NAT operates at the Network layer of the OSI model. (E) all of the above are correct (choose this one only if none of the above can be chosen).

23. [ ] What is the primary purpose of the Domain Name System (DNS)? (A) To assign IP addresses to devices on a network (B) To translate domain names into IP addresses (C) To encrypt communication between devices (D) To manage routing tables in a network (E) To speed up routing between Internet hosts.

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24. [ ] Which of the following is INCORRECT about Software-Defined Networking (SDN)? (A) Data and control planes are tightly integrated. (B) SDN separates the control plane from the data plane (C) SDN enables programmable networks using APIs (D) SDN uses abstraction to enable dynamic and programmatically efficient network configuration (E) all of the above are correct (choose this one only if none of the above can be chosen).

二、問答題，共 40 分。

※ 本大題請於試卷內之「非選擇題作答區」標明題號依序作答。

1. The following shows a **pointer-based** implementation of ADT Queue, which stores **non-negative integers** in a **circular linked list** with **one pointer – `backptr`** pointing to the last item in the list.

```
class Queue
{
public:
   // return -1 if there is no integer in the queue;
   // otherwise, return the front integer in the queue
   int  dequeue();

   // return the number of integers in the queue
   int  length();


   // reverse the order of the integers in the queue
   void reverse();

   ...
      private:

    struct QueueNode
    {   int          item;
        QueueNode    *next;
    } // end QueueNode

   QueueNode *backPtr;
};
```

(a) (5 points) Write the `Queue::length()` function that returns the number of integers in the queue.

(b) (10 points) Write the `Queue::dequeue()` function that outputs the front integer in the queue. Note: The function returns -1 if there is no integer in the queue.

(c) (25 points) Write the `Queue::reverse()` function that reverses the order of the integers in the queue. Note: No extra memory allocation for queue nodes!!! Only pointer manipulation is allowed when reversing the integers.

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