一、選擇題 (單選) 28 題，每題 2.5 分，共 70 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)

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 is wrong about Von Neumann architecture? (A) it has four main units: CPU, memory, input, and output (B) memory is simply a linear array of storage locations (C) data and instructions are separated into different memory (D) a central processing unit has a control unit and an arithmetic/login unit (E) all the above are correct (choose this one only if none of the above can be chosen).

2. [ ] Which of the following is wrong about process architecture? (A) in general, program compiled in CISC architecture has fewer instructions than that compiled in RISC architecture (B) the CISC approach tries to make each instruction more powerful (C) in general, instructions in a CISC approach will need more clock cycles to execute than in a RISC approach (D) in general, the instruction set in a CISC approach is typically smaller than the instruction set in a RISC approach (E) all the above are correct (choose this one only if none of the above can be chosen).

3. [ ] Which of the following is wrong about computer architecture? (A) A processor with 32-bit address buses can access at most 2^{32} bytes of memory (B) in memory-mapped I/O, I/O devices use the same address space as memory devices (C) in memory-mapped I/O, the same instructions are used to access I/O devices and memory devices (D) the internal data storage of a processor is known as its registers (E) all the above are correct (choose this one only if none of the above can be chosen).

4. [ ] Which of the following is wrong about Input/Output in a computer system? (A) in interrupt-driven I/O, an external device interrupts the processor to execute an interrupt service routine (B) an external device interrupts the processor by triggering an interrupt signal to the processor (C) Direct Memory Access (DMA) allows data to be transferred from I/O devices to memory directly without the continuous involvement of the processor (D) a hardware device is needed to allow I/O devices to directly access memory with less participation of the processor (E) all the above are correct (choose this one only if none of the above can be chosen).

5. [ ] Which of the following is wrong about CPU cache? (A) register in CPU is usually faster than L1 cache (B) number of registers in CPU is smaller than the size of L1 cache (C) the size of L1 cache in current CPUs typically ranges in dozens to hundreds bytes (D) the size of L2 cache is typically much bigger than L1 cache (E) all the above are correct (choose this one only if none of the above can be chosen).

6. [ ] Which of the following is not a major functionality of operating systems? (A) Resource Management (B) Process Management (C) Memory Management (D) Security Management (E) all the above are major functionalities.

見背面

7. [ ] Operating systems divide virtual and physical memory into fixed-sized chunks called pages. Which of the following page size is currently most common than the others? (A) 128 bytes (B) 512 bytes (C) 4KB (D) 128KB (E) 512KB.

8. [ ] Which of the following is wrong for applications running in an operating system? (A) user applications usually run in user-mode (B) applications running in user-mode shares a virtual address space (C) a process running in user mode can't access virtual addresses that are reserved for the operating system (D) core operating system components run in kernel mode (E) all the above are correct (choose this one only if none of the above can be chosen).

9. [ ] Which of the following is wrong about computer clusters? (A) nodes in a cluster are typically independent and connected by a high-speed LAN (B) clustering computers can increase computing power (C) clustering computers can prevent security attacks (D) clustering computers can improve fault tolerance (E) all the above are correct (choose this one only if none of the above can be chosen).

10. [ ] With regard to process management, which of the following is generally not the responsibility of operating systems (OS)? (A) creating and deleting user processes (B) suspending and resuming processes (C) process synchronization (D) deadlock handling (E) all the above are OS's responsibility.

11. [ ] With regard to storage management, which of the following is generally not the responsibility of operating systems? (A) creating and deleting files (B) file integrity check (C) disk scheduling (D) backing up files onto stable permanent storage media (E) supporting primitives for manipulating files and directories.

12. [ ] A uniprocessor system achieves multiprogramming by _____ in CPU scheduling. (A) dynamic allocation (B) process rotating (C) pipelining (D) time slicing (E) none of the above.

13. [ ] When a process is running in Unix-like systems, which of the following is wrong about its memory layout? (A) the code section starts at location 0 (B) the data section starts immediately above code section (C) the stack section starts immediately above the data section (D) the stack section can grow and shrink dynamically during process life cycle (E) all the above are correct (choose this one only if none of the above can be chosen).

14. [ ] In Ethernet, which of the following algorithm is used to resolve collision? (A) Carrier Sense (B) Exponential Backoff (C) Collision Avoidance (D) Request to Send/Clear to Send (RTS/CTS) (E) Round Robin.

15. [ ] We can apply tags to network frames and handling these tags in a local area network to create the appearance and functionality of network traffic that is physically on a single network but acts as if it is split between separate networks. This effectively creates _____ (A) virtual LANs (B) VPN (C) domains (D) subdomains (E) private LANs.

接次頁

16. [ ] In router-table construction, which of the following algorithms let routers build up their routing tables by periodically exchanging information with their immediately neighboring? (A) adaptive (B) link-state (C) distance-vector (D) incremental update (E) none of the above.

17. [ ] Which of the following is wrong about TCP? (A) it uses 2-way handshake to establish a connection (B) TCP is stream-oriented (C) TCP uses sliding window for flow control (D) TCP uses sequence numbers to ensure the correct order of delivery (E) all the above are correct (choose this one only if none of the above can be chosen).

18. [ ] Which of the following is wrong about security attacks? (A) In *Man-in-the-Middle* attack, an attacker intercepts messages between two parties, and then steals and manipulates data between them (B) In *buffer overflow* attack, the attacker crafts an oversized input string which, when read by the server and stored in memory, overflows the buffer and overwrites subsequent portions of memory, typically containing the stack-frame pointers. (C) In *SQL Injections*, an attacker inserts malicious code into a server using server query language, forcing the server to deliver protected information (D) In *First-day* attack, an attacker exploits a network vulnerability before a patch is released and/or implemented. (E) all the above are correct (choose this one only if none of the above can be chosen).

19. [ ] Which of the following is wrong about program compilation? (A) assembler takes as input the assembly code and translates it into relocatable machine code (B) it is the linker's job to make sure all cross-file dependencies are resolved properly (C) programs can be linked either statically or dynamically (D) lexical and syntax analysis is done at compiling stage (E) all the above are correct (choose this one only if none of the above can be chosen).

20. [ ] Which of the following is wrong about NoSQL databases? (A) in *column-oriented* structure, data is stored in cells grouped in a pre-defined number of columns (B) *key-value stores* use an associative array as their data mode (C) *document stores* use documents (e.g., XML, YAML, JSON) to hold and encode data in standard formats (D) *graph databases* represent data on a graph that shows how different sets of data relate to each other (E) all the above are correct (choose this one only if none of the above can be chosen).

21. [ ] Which of the following is wrong about relational databases? (A) data are organized into tables of columns and rows (B) a unique key is used to identify each row (C) each row represents a data record (D) columns correspond to attributes of records (E) all the above are correct (choose this one only if none of the above can be chosen).

22. [ ] Which of the following is wrong about relational databases? (A) a primary key is used to ensure data in the specific column is unique (B) a foreign key refers to the field in a table which is the primary key of another table (C) foreign key does not allow NULL value (D) more than one foreign key are allowed in a table (E) all the above are correct (choose this one only if none of the above can be chosen).

見背面

23. [ ] The term _____ has been coined to represent a digital counterpart of a real-world object for use such as simulation, integration, testing, monitoring, and maintenance. (A) avatar (B) digital twin (C) virtual reality (D) cloud object (E) none of the above.

24. [ ] In blockchain technology like that used in Bitcoin, the process "mining" is designed mainly to (A) enforce concurrency control of transactions (B) ensure atomicity (C) distribute transaction (D) validate transaction (E) none of the above.

25. [ ] Which of the following is wrong about B-tree? (A) B-tree is self-balancing (B) A non-leaf node with k children contains k keys (C) a B-tree of order m has at most m children (D) every internal node has at least $\lceil m/2 \rceil$ children (E) all leaves appear on the same level.

26. [ ] Which of the following is wrong about spanning trees? (A) if all of the edges of a graph G are also edges of a spanning tree T of G, then G is a tree (B) if all of the edges of a graph G are also edges of a spanning tree T of G, then G is identical to T (C) if T is a spanning tree of G, and e is an edge of G that is not in T, then adding e to T will create a cycle (D) a graph may have more than one spanning trees (E) all the above are correct (choose this one only if none of the above can be chosen).

27. [ ] Recall that a *min heap* is a complete binary tree such that the key stored in each node is greater than or equal to the keys in the node's children. Then, the time complexity for inserting a key into a min heap of n nodes can be done in (A) O(1) (B) O(log n) (C) O(n) (D) O(n log n) (E) none of the above.

28. [ ] The time complexity for finding an arbitrary element in a min heap of n nodes can be done in (A) O(1) (B) O(log n) (C) O(n) (D) O(n log n) (E) none of the above.

接次頁

二、問答題，共 30 分。

※ 本大題((a)、(b)、(c) 3 小題)請於試卷內之「非選擇題作答區」標明題號依序作答。

Consider the following C++ code.

```
#include <bits/stdc++.h>
using namespace std;
# define NO_OF_CHARS 256

void PREPROCESS(string str, int size, int badchar[NO_OF_CHARS])
{
  int i;
     for (i = 0; i < NO_OF_CHARS; i++)
     badchar[i] = -1;
  for (i = 0; i < size; i++)
     badchar[(int) str[i]] = i;
}

void search(string txt, string pat)
{
  int m = pat.size();
  int n = txt.size();
  int badchar[NO_OF_CHARS];

  PREPROCESS(pat, m, badchar);
  int s = 0;
  while(s <= (n - m))
  {
     int j = m - 1;
     while(j >= 0 && pat[j] == txt[s + j])
        j--;
     if (j < 0)
     {
        cout << "pattern occurs at " << s << endl;
        s += (s + m < n)? m-badchar[txt[s + m]] : 1;
     }
     else
        s += max(1, j - badchar[txt[s + j]]);
  }
}
```

(a)(15 points) When given the two strings `txt = "ABAAABCDABC"` and `pat = "ABC"`, what is the output of `search(txt, pat)`?

(b) (8 points) If the lengths of `txt` and `pat` are *n* and *m* respectively, what is the worst case time complexity of `search(txt, pat)`? Briefly explain your answer.

(c) (7 points) Continue from above. What is the best case time complexity of `search(txt, pat)`? Briefly explain your answer.

試題隨卷繳回