



題目1至題目25為單選題，每題2分。

1. In the ____ topology, all nodes are connected to a single shared communication line.
 (A)star (B)ring (C)helix (D)bus
2. Which of the following layer of the TCP/IP protocol hierarchy handles framing?
 (A)data link (B)physical (C)network (D)application
3. Assigning port numbers to programs and remembering which program goes with which port is a part of the ____ layer protocols. (A)physical (B)data link (C)network (D)transport
4. The medium access control protocols and the logical link control protocols together form the ____ layer. (A) transport (B)data link (C)physical (D)network
5. In C++, an identifier cannot begin with a(n) _____. (A)upper-case letter (B)underscore (C)lower-case letter (D)digit
6. A ____ function returns a single value back to the main function. (A)void (B)nonvoid (C)sequential (D) conditional
7. The three key elements of object-oriented programming (OOP) are inheritance, polymorphism, and _____. (A) encapsulation (B)synchronization (C)compartmentalization (D)crystallization
8. In the ____ phase, the appropriate objects are identified, together with their data and the subtasks they should be able to perform. (A)feasibility study (B)maintenance (C)program specification (D)program design
9. Which of the following statement is correct? (A)a=6 (B)b=7 (C)c=8 (D)d=9
- ```
int fun(int a, int b, int *c) {
 a=a+1;
 b=b+1;
 c=c+1;
 return(a+2); }
void main() {
 int a=5, b=6, c=7, d;
 d=fun(a, b, &c); }
```
10. Because it makes use of low-level information, \_\_\_\_ is closer to assembly language than other high-level languages. (A)C (B)Java (C)C# (D)HTML
11. In \_\_\_\_ programming, multiple copies of the same subtask or multiple subtasks of the same problem are performed simultaneously by different processors. (A) functional (B) applicative (C) procedural (D) parallel
12. In the \_\_\_\_ architecture, a single control unit broadcasts a single program instruction to multiple ALUs, each of which carries out that instruction on its own local data stored in its local memory. (A)SIMD (B) MIMD (C)DVIR (D)VISM
13. During the \_\_\_\_ phase, the sequence of tokens formed by the scanner is checked to see whether it is syntactically correct according to the rules of the programming language. (A)lexical analysis (B)parsing (C) code optimization (D)semantic analysis and code generation
14. The grammatical structure of a programming language is called its \_\_\_\_\_. (A) parse tree (B)BNF (C)library (D)syntax



- 【 】 15. Each time a Turing machine operation is done, three actions take place: \_\_\_\_\_. (A) write a symbol in the cell, go into a new state, move one cell to the left or right (B) delete the symbol in the cell, go into a new state, move two cells to the left or right (C) delete the symbol in the cell, find a new address, move one cell to the left (D) write a symbol in the cell, find a new address, move one cell to the right
- 【 】 16. Based on the instructions given below, the 5-tuple representation is \_\_\_\_\_.  
 if (you are in state 1) and (you are reading symbol 0) then  
     write symbol 1 onto the tape  
     go into state 2  
     move right  
 (A) (2,1,1,2,L) (B) (1,0,1,2,R) (C) (1,0,1,3,L) (D) (1,0,1,2,L)
- 【 】 17. \_\_\_\_\_ implies that there are parts of a system that display random behavior, much like the throw of the dice or the drawing of a card. (A) continuous components (B) discrete modeling (C) stochastic components (D) computational steering
- 【 】 18. A(n) \_\_\_\_\_ attempts to mimic the human ability to engage pertinent facts and string them together in a logical fashion to reach some conclusion. (A) inference engine (B) back propagation system (C) rule-based system (D) intelligent agent
- 【 】 19. After all the fields of an assembly language instruction have been translated into binary, the newly built machine language instruction and the address of where it is to be loaded are written out to a file called the \_\_\_\_\_ file. (A) table (B) source (C) data (D) object
- 【 】 20. Given the following C program segment:  

```
int a[10], *p, i;
p=a;
for (i=0; i<10; i++)
 *(p+i)=8*i;
```

 If the address of a[0] is 100 and an integer is 2 bytes, which the following statement is correct?  
 (A) \*(p+2)=24 (B) p+3=108 (C) \*p=0 (D) a[4]= 24.
- 【 】 21. The set of services and resources created by the system software and seen by the user is called a(n) \_\_\_\_\_ machine. (A) naked (B) virtual (C) assembler (D) Von Neumann
- 【 】 22. When an I/O operation is done, the I/O controller transmits to the processor a special hardware signal called a(n) \_\_\_\_\_. (A) control signal (B) I/O signal (C) interrupt signal (D) switch signal
- 【 】 23. The \_\_\_\_\_ of a disk is the time needed to position the read/write head over the correct track.  
 (A) latency (B) seek time (C) transfer speed (D) frequency
- 【 】 24. \_\_\_\_\_ circuits are used to determine the order in which operations are carried out inside a computer and to select the correct data values to be processed. (A) sequential (B) combinational (C) control (D) order
- 【 】 25. In the sequential search algorithm, the minimum amount of work is done if the value being searched for is the \_\_\_\_\_ value in the list. (A) first (B) last (C) middle (D) second



26. (10 points) What would be a good hash code for a vehicle identification that is a string of numbers and letters of the form "XX9999X", where a "9" represents a digit and an "X" represents a letter?
27. (10 points) Write a complete C++ program to read in two integers and then write out the greatest common divisor of those two numbers.
28. (15 points) Insert the keys, in the order given as follows: XCYBZA; to build them into an AVL tree. Showing the detail procedure step-by-step is required.
29. (15 points) A tennis tournament has  $n$  players, where  $n > 1$ . A single match involves two players. The winner of a match will play the winner of a match in the next round, where losers are eliminated from the tournament. The two players who have won all previous rounds play the final game, and the winner wins the tournament. What is the total number of matches needed to determine the winner? Write a C++ function, `int NumberOfMatches ( int numberOfPlyers )`, to perform this task.



1. (15%) Fig. 1 shows a connection pattern of a  $5 \times 5$  bipartite graph with a complete matching, that is, only one number  $i$  ( $1 \leq i \leq 5$ ) in the left side is connected to one number  $j'$  ( $1' \leq j' \leq 5'$ ) in the right side.

(a) Please count the total number of all possible combinations for the connection patterns of this bipartite graph. (5%)

(b) Please count the total number of complete matching for this bipartite graph. (5%)

(c) Compute the probability that the connection pattern has no complete matching for the bipartite graph. (5%)

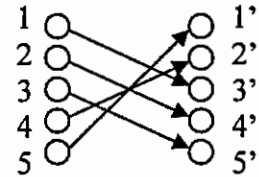


Fig. 1

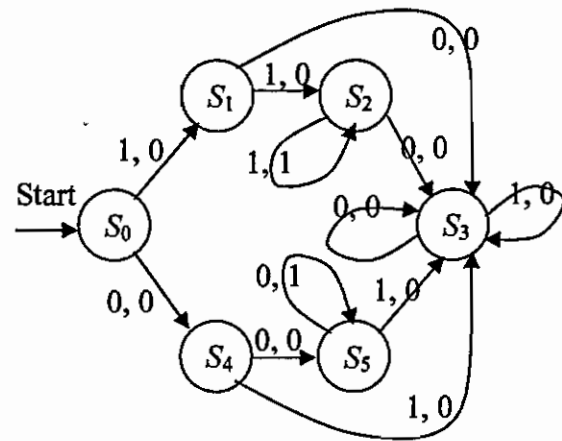
2. (10%) Prove that  $\sqrt{2}$  is irrational.

3. (15%) (a) Find the state table for the finite state machine in Fig. 2, where  $I = O = \{0, 1\}$ .

( $I$ : input set,  $O$ : output set) (5%)

(b) Let  $x \in I^*$  with  $\|x\|=4$ . If 1 is a suffix of  $\omega(s_0, x)$ , what are the possibilities for the string  $x$ . ( $\omega$  is the output function of this FSM) (5%)

(c) Let  $A \subseteq \{0, 1\}^*$  be the language where  $\omega(s_0, x)$  has 1 as a suffix for all  $x$  in  $A$ . Determine  $A$ . (5%)



4. (10%) Let  $A = \{1, 2, 3, 4, 5, 6\} \times \{1, 2, 3, 4, 5, 6\}$ . Define a relation  $\mathfrak{R}$  on  $A$  by  $(x_1, y_1) \mathfrak{R} (x_2, y_2)$ , if  $x_1 y_1 = x_2 y_2$ .

(a) Verify that  $\mathfrak{R}$  is an equivalence relation on  $A$ . (5%)

(b) Determine the equivalence classes  $[(1, 1)]$ ,  $[(2, 2)]$ ,  $[(3, 2)]$ , and  $[(4, 3)]$ . (5%)

5. (20%) (a) Is the cardinality of the integers the same as that of the natural numbers? (3%)

(b) Prove your answer to (a). (7%)

(c) Is the cardinality of the real numbers the same as that of the natural numbers? (3%)

(d) Prove your answer to (c). (7%)



6. (20%) The language  $\{0,1\}^*$  can be defined inductively (or recursively) as follows:
- (i) Empty string is a member of  $\{0,1\}^*$ .
  - (ii) Consider any string  $w$  in  $\{0,1\}^*$ , then  $0w$  and  $1w$  are also in  $\{0,1\}^*$ .
- Let  $L = \{w \in \{0,1\}^* \mid \text{number of 0's in } w \text{ is odd}\}$ .
- (a) Define  $L$  inductively similar to the definition of  $\{0,1\}^*$  given above. (6%)
  - (b) Using the answer in (a), write a context-free grammar  $G$  that generates  $L$ . (7%)
  - (c) Can  $L$  be accepted by a finite automaton? If yes, construct one. Otherwise, prove your answer. (7%)
7. (10%) Let  $L$  be the language of strings that contain exactly two  $b$ 's and at least three  $a$ 's. Construct a deterministic finite automaton that accepts  $L$ .



題目1至題目10為多選題，每題5分。每題需全部答對才給分，答錯倒扣1分。

1. What components do an I/O subsystem consist of?
  - (A) a memory-management component that includes buffering, caching, and spooling
  - (B) a general device-driver interface
  - (C) a component mapping files onto secondary storage
  - (D) drivers for specific hardware devices
  
2. Which are correct for operating-system structures?
  - (A) Mach modularized the kernel using the microkernel approach.
  - (B) Solaris structures the operating system using a layered technique where one layer consists of the Mach microkernel.
  - (C) The main advantage of the layered approach is simplicity of construction and debugging.
  - (D) MS-DOS and the original UNIX are monolithic systems.
  
3. What schedulers control the degree of multiprogramming?
  - (A) CPU scheduler
  - (B) job scheduler
  - (C) medium-term scheduler
  - (D) disk scheduler
  
4. Which are correct for multithreading?
  - (A) Green threads – a thread library available for Solaris – uses the many-to-one model.
  - (B) One-to-one model provides more concurrency than the many-to-one model by allowing another thread to run when a thread makes a blocking system call.
  - (C) Typically, RPC servers are multithreaded. When a server receives a message, it services the message using a separate thread.
  - (D) Pthreads refers to the POSIX standard defining an API for thread creation and synchronization. This is also an implementation for thread behavior.
  
5. Under what circumstances does the preemptive scheduling take place?
  - (A) When a process switches from the running state to the waiting state.
  - (B) When a process terminates.
  - (C) When a process switches from the running state to the ready state.
  - (D) When a process switches from the waiting state to the ready state.



6. Which are correct for deadlocks?
- (A) The circular waiting condition implies deadlocks.
  - (B) The circular waiting condition implies the hold-and-wait condition.
  - (C) The side effects of preventing deadlocks by eliminating the hold-and-wait condition may incur starvation.
  - (D) For deadlock avoidance, Banker's algorithm requires the information of the maximum number of resources of each type declared by each process.
7. In a paging system using TLB, if it takes 20 ns to search TLB, and 100 ns to access memory, then under what hit ratios the effective memory-access time will be less than or equal to 130 ns?
- (A) 0.9
  - (B) 0.85
  - (C) 0.8
  - (D) 0.75
8. For the page-reference string 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6, then how many page frames given in the LRU replacement will make the page fault number less than 10?
- (A) 6
  - (B) 5
  - (C) 4
  - (D) 3
9. Which are correct for virtual-memory management?
- (A) Whereas the minimum number of frames per process is defined by the computer architecture, the maximum number is defined by the amount of available physical memory.
  - (B) Global replacement requires that each process selects from only its own set of allocated frames.
  - (C) The working-set model is based on the assumption of locality.
  - (D) If the working-set window  $\Delta$  is too large, it will not encompass the entire locality.
10. What information should be included in a typical file control block?
- (A) file permissions
  - (B) file dates
  - (C) file size
  - (D) file data blocks or pointers to file data blocks



11. What is binding? Why does delaying binding time increase both the user's and the system's flexibility? (10%)
12. Describe the differences between Unix swapping systems and Unix demand paging systems. (10%)
13. Consider a system where free space is kept in a free-space list. Suppose that the pointer to the free-space list is lost. Can the system reconstruct the free-space list? Explain your answer. (10%)
14. The Optimal Page Replacement (OPT) strategy is unrealizable because it is impossible to predict the future. There are circumstance, however, in which OPT can be implemented. What are they? (10%)
15. What is "thrashing"? The working-set model is to prevent thrashing. Explain how it works. (10%)





1. Three vectors  $\vec{b}$ ,  $\vec{v}_1$  and  $\vec{v}_2$  are in  $\mathbb{R}^3$ . (10%)
  - (a) What's the condition that  $\vec{b}$  is called linear combination of the vectors  $\vec{v}_1$  and  $\vec{v}_2$ ? (5%)
  - (b) Is the vector  $[-3 \ 0 \ 3]^T$  a linear combination of  $[1 \ 2 \ 3]^T$  and  $[4 \ 5 \ 6]^T$ ? (5%)
  
2.  $V_1$  are sets in the vectors space  $\mathbb{R}^3$ . (10%)
 
$$V_1 = \{(x_1, x_2, x_3) \mid x_2 \geq 0\},$$

$$V_2 = \{(x_1, x_2, x_3) \mid x_1 = x_2 = 2x_3\},$$
  - (a) State the requirements of a set can be a subspace. (5%)
  - (b) Whether  $V_1$  are subspaces of the vectors space  $\mathbb{R}^3$ . (5%)
  
3. Let  $T$  be a linear transformation from  $\mathbb{R}^2$  to  $\mathbb{R}^2$  that projects any vector orthogonally onto the line  $L$  spanned by the vector  $[4 \ 3]^T$ . (15%)
  - (a) Find the eigenvalues and their corresponding eigenvectors for  $T$ . (10%)
  - (b) By using the eigenvectors you found in (a) as the basis, find a transformation matrix  $A$  for  $T$ . (5%)
  
4. A linear system is as following: (15%)

$$A\vec{x} = \vec{b}, \text{ where } A = \begin{bmatrix} 1 & -1 \\ 1 & 3 \\ 1 & 3 \\ 1 & -1 \end{bmatrix} \text{ and } \vec{b} = \begin{bmatrix} -2 \\ 0 \\ 0 \\ -2 \end{bmatrix}$$

- (a) Find an orthonormal basis  $\{\vec{u}_1, \vec{u}_2\}$  of  $\text{im}(A)$ , where  $\text{im}(A)$  is the image of  $A$ . (5%)
- (b) To find the least-square solution  $\vec{x}^*$  of the system. (5%)
- (c) Graph the geometric relationship among  $A\vec{x}^*$ ,  $\text{im}(A)$ , and  $\vec{b}$ . (5%)



5. The color of light can be represented in a vector  $\begin{bmatrix} R \\ G \\ B \end{bmatrix}$ , where  $R$  = amount of red,  $G$  = amount of green, and  $B$  = amount of blue. The human eye and the brain transform the incoming signal into the signal  $\begin{bmatrix} I \\ L \\ S \end{bmatrix}$ , where
- $$\text{intensity } I = \frac{R+G+B}{3} \quad (10\%)$$

$$\text{long-wave signal } L = R - G$$

$$\text{short-wave signal } S = B - \frac{R+G}{2}.$$

- (a) Find the matrix  $P$  representing the transformation from  $\begin{bmatrix} R \\ G \\ B \end{bmatrix}$  to  $\begin{bmatrix} I \\ L \\ S \end{bmatrix}$ . (5%)

- (b) Consider a pair of yellow sunglasses for water sports that cuts out all blue light and passes all red and green light. Find the  $3 \times 3$  matrix  $A$  that represents the transformation incoming light undergoes as it passes through the sunglasses. (5%)

6. Consider the linear transformation  $T(f) = f' + f''$  from  $P_2$  to  $P_2$ , where  $P_2$  is the set of all polynomials of degree  $\leq 2$ . Please find a  $3 \times 3$  matrix  $B$  for this linear transformation  $T$ . Note that  $f'$  and  $f''$  are the first order and second order derivatives of  $f$ , respectively. (10%)

7. Find the derivative of the function (10%)

$$f(x) = \det \begin{bmatrix} 1 & 1 & 2 & 3 & 4 \\ 9 & 0 & 2 & 3 & 4 \\ 9 & 0 & 0 & 3 & 4 \\ x & 1 & 2 & 9 & 1 \\ 7 & 0 & 0 & 0 & 4 \end{bmatrix}.$$

8. Find an orthogonal matrix  $S$  and a diagonal matrix  $D$  such that  $S^{-1}AS = D$ . (10%)

$$A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}.$$

9. Let  $L$  be a lower triangular  $3 \times 3$  matrix with positive entries on the diagonal. Please find  $L$

such that  $A = LL^T$ , where  $A = \begin{bmatrix} 4 & -4 & 8 \\ -4 & 13 & 1 \\ 8 & 1 & 26 \end{bmatrix}$ . (10%)



題目1至題目20為單選題，每題2分。

- [ ] 1. A large number of transistors, as well as the electrical conducting paths that connect them, can be printed photographically on a wafer of silicon to produce a device known as a(n) (A) integrated circuit (B) magnetic core (C) semiconductor (D) circuit board
- [ ] 2. A multiplexor chooses one specific input by using an additional set of N lines called \_\_\_\_\_ lines. (A) control (B) decision (C) selector (D) feedback
- [ ] 3. The functional unit of a computer that stores and retrieves the instructions and the data being executed is called the \_\_\_\_\_. (A) control unit (B) I/O controller (C) memory (D) cache
- [ ] 4. If there are N bits available to represent the address of a cell, then a total of \_\_\_\_\_ memory cells would be available on the computer. (A) N (B)  $2^N - 1$  (C)  $2^N$  (D)  $4^N$
- [ ] 5. The two basic memory operations are fetching and \_\_\_\_\_. (A) storing (B) computing (C) comparing (D) displaying
- [ ] 6. The \_\_\_\_\_ are the devices that allow a computer system to communicate and interact with the outside world as well as store information. (A) registers (B) arithmetic/logic units (C) control units (D) input/output units
- [ ] 7. A disk stores information in units called \_\_\_\_\_. (A) rings (B) sectors (C) cells (D) registers
- [ ] 8. A(n) \_\_\_\_\_ handles the details of input/output and compensates for any speed differences between I/O devices and other parts of the computer. (A) cache (B) I/O register (C) decoder circuit (D) I/O controller
- [ ] 9. A(n) \_\_\_\_\_ is a storage cell that holds the operands of an arithmetic operation and that, when the operation is complete, holds its result (A) decoder (B) register (C) I/O controller (D) cache
- [ ] 10. The three components of the ALU - the registers, the interconnections between components, and the ALU circuitry - are together called the \_\_\_\_\_. (A) data path (B) I/O controller (C) bus (D) decoder
- [ ] 11. The \_\_\_\_\_ machine language instructions alter the normal sequential flow of control. (A) data transfer (B) arithmetic (C) branch (D) compare
- [ ] 12. The \_\_\_\_\_ holds the address of the next instruction to be executed. (A) status register (B) program counter (C) condition register (D) instruction register
- [ ] 13. During the fetch phase, the control unit gets the next instruction from memory and moves it into the \_\_\_\_\_. (A) status register (B) program counter (C) condition register (D) instruction register
- [ ] 14. The ability to match the number of processors to the size of the problem is known as \_\_\_\_\_. (A) scalability (B) flexibility (C) malleability (D) adaptability
- [ ] 15. The term \_\_\_\_\_ to refer to any unexpected change in control flow without distinguishing whether the cause is internal or external. (A) execution (B) fetching (C) interrupt (D) exception
- [ ] 16. \_\_\_\_\_ means that the hardware cannot support the combination of instructions that we want to execute in the same clock cycle. (A) Structural hazard (B) Data hazards (C) Control hazard (D) pipeline stall
- [ ] 17. In a \_\_\_\_\_ cache, all the entries in the cache must be searched. (A) direct mapped (B) fully associative mapped (C) set-associative mapped (D) random mapped



- [ ] 18. Consider a virtual memory system with the following properties:  
 40-bit virtual byte address  
 the page size is 16KB  
 36-bits physical byte address
- What is the total size of the page table for each process on this machine, assuming that the valid, protection, dirty, and use bits take a total of 4 bits and that all the virtual pages are in use? (Assume that disk addresses are not stored in the page table.)  
 (A)64MB (B)128MB (C)256MB (D)512MB
- [ ] 19. Suppose we enhance a machine making all floating-point instructions run five times faster. If the execution time of some benchmark before the floating-point enhancement is 10 seconds, what will the speedup be if half of the 10 seconds is spent executing floating-point instructions? (A)2 (B)1.67 (C)5 (D)1.33
- [ ] 20. \_\_\_\_\_ is an implementation technique in which multiple instructions are overlapped in execution. (A)DMA (B)virtual memory (C)caching (D)pipeline
21. (10 points) Assuming a cache of 4K blocks, a 4-word block size, and a 32-bit address, find the total number of sets and the total number of tag bits for caches that are direct mapped, two-way and four-way set associative, and fully associative.
22. (15 points) Assume an instruction cache miss rate for gcc of 3% and a data cache miss rate of 5%. If a machine has a CPI of 2 without any memory stall and the miss penalty is 40 cycles for all misses, determine how much faster a machine would run with a perfect cache that never missed. All loads and stores instruction in gcc is 36%.
23. (5 points) The performance of a 200 MHz microprocessor P is measured by execution 10,000,000 instructions of benchmark code, which is found to take 0.25 sec. What is the value of CPI?
24. (20 points) A processor runs on 200MHz. Table 1 shows the CPI values for different instruction classes. There is a compiler which compiles a program. Table 2 shows the results of the compiler. What is the CPI value? What is MIPS value of the compiler?

Table 1

| instruction class | CPI |
|-------------------|-----|
| A                 | 1   |
| B                 | 4   |
| C                 | 2   |

Table 2

| Code from | Instruction counts (in millions)<br>for each instruction class |   |   |
|-----------|----------------------------------------------------------------|---|---|
|           | A                                                              | B | C |
| Compiler  | 10                                                             | 2 | 1 |

25. (10 points) Consider a program consisting of 100 lw instructions and in which each instruction is independent upon the instruction before it. What would the actual CPI be if the program were run on the 5-stage pipelined datapath? If the working frequency is 50MHz, what is the execution time of the program?