國 立 清 華 大 學 命 題 紙

97 學年度 科管、服科 系（所） 乙 組碩士班入學考試

科目 計算機概論 科目代碼 6001 5401 共 4 頁第 1 頁 *請在【答案卷卡】內作答

Part I: Multiple Choice Questions (單選題) 共 10 題，每題 2 分，共 20 分。答錯不倒扣。

1. On a direct access storage device, each storage position
   - A. can be individually accessed in approximately the same length of time.
   - B. must be accessed in a predefined sequence.
   - C. has a unique address.
   - D. shares an address with other positions on the same device.
   - E. both A and C are correct.
   - F. both B and D are correct.

2. Encryption
   - A. is a form of transmission control.
   - B. involves scrambling data into a coded form before transmission and decoding it upon arrival.
   - C. involves the use of account numbers and passwords to control access to a network.
   - D. involves the use of parity checking to control errors in transmission.
   - E. is another term for file transfer.

3. What is the equivalent octal representation for the binary number 1010111100?
   - A. 1247
   - B. 2174
   - C. 1274
   - D. 11274
   - E. 11247
   - F. None of the above

4. The central processing component that interprets instructions and transmits directions to other components of the computer system is called
   - A. the control unit.
   - B. the arithmetic-logic unit.
   - C. the intelligence unit.
   - D. the primary storage unit.
   - E. the secondary storage unit.

5. When a computer's CPU is determining if an employee should be paid overtime (if they worked more than 40 hours that week), the part of the CPU making this decision is
   - A. the control unit.
   - B. the primary storage unit.
   - C. the arithmetic-logic unit.
   - D. the secondary storage unit.
   - E. none of the above.

6. Which one of the following statements concerning the storage function of computer systems is correct?
   A. Data and instructions can only be stored in primary storage devices.
   B. Data and instructions must be placed in the secondary storage unit before they can be used in processing.
   C. Secondary storage devices decrease the storage capacity of the computer.
   D. The storage function takes place in the primary storage unit of the CPU and in secondary storage devices.
   E. Primary storage devices provide permanent storage for data and instructions.

7. Which one of the following best describes an operating system?
   A. An operating system is an integrated collection of program function which control and support the operation of a computer system.
   B. An operating system is a very large piece of hardware.
   C. An operating system makes the role of computer operators very difficult.
   D. An operating system is a tool which makes program writing harder for programmers.
   E. An operating system includes word processing and presentation graphics functions.

8. Which one of the following is true for high-level languages?
   A. Programs written in a high-level language are usually more efficient than those written in machine language.
   B. They require the use of a compiler for language translation to machine code.
   C. They are very rigid in form and syntax.
   D. They are known as machine or assembler languages.
   E. They are machine-dependent.

9. Which one of the following is not typically a feature of decision support systems?
   A. They use decision models and specialized databases.
   B. They are most useful for highly structured decisions.
   C. They provide users with interactive responses on an ad hoc basis.
   D. They provide analytical modeling, data retrieval, and information presentation capabilities.
   E. They do not require that the manager's information needs be precisely specified in advance.

10. Which one of the following is not a component of a database management system?
   A. Query optimizer.
   B. Transaction manager.
   C. Concurrency control scheduler.
   D. Intrusion detector.
   E. Recovery manager.

Part II: Short Essay Questions (簡答題) 3 大題，共 24 分。

1. Let $G = (V, E)$ be an undirected graph in which each vertex $v \in V$ is associated with a positive weight $W(v) > 0$. A subset $S \subseteq V$ is **independent** if for all $u, v \in S$, there is no edge between u and v (i.e., $(u, v) \notin E$). Given a G, we want to compute an independent subset $S \subseteq V$ where the weight $W(S) := \sum_{u \in S} W(u)$ is maximum. Assume that $V = \{v_1, \ldots, v_n\}$ and $W(v_1) \leq W(v_2) \leq \ldots \leq W(v_n)$.

   a) For the following algorithm, give a counterexample (i.e., an example graph) on which the algorithm will not return a maximum weight independent set. **(5 points)**

```
Algorithm Independent-by-Appending (V)
Begin
    S ← ∅ (i.e., empty set);
    For i = n downto 1
        If S ∪ {v_i} is independent Then append v_i to S;
    RETURN(S)
End.
```

   b) Again, for the following algorithm, give a counterexample (i.e., an example graph) on which the algorithm will not return a maximum weight independent set. **(5 points)**

```
Algorithm Independent-by-Removing (V)
Begin
    S ← V;
    For i = 1 to n
        If there is some u ∈ S such that (u, v_i) ∈ E
        Then remove v_i from S;
    RETURN(S)
End.
```

2. What are the differences between a primary index and a secondary index in a database management system? **(6 points)**

3. Peer-to-peer computing represents another form of distributed processing. Two types of architecture are generally adopted: pure peer-to-peer network architecture and central server architecture. Please identify the advantages and disadvantages of each type of architecture. **(8 points)**

Part III: Problem Solving Questions 2 大題，共 56 分。

4. You are given an unsorted array of *n* distinct items from some totally ordered universe (say, the integers). Assume that it is not possible for you to compare two items directly. Instead, you only have access to a **Median** function that takes as its inputs three items from the array and returns, in order O(1) time, which of the three input items is between the other two. For example, a call of **Median**(7, 1, 6) will return 6 because 6 is the median of the three input values (i.e., between 1 and 7).

a) Prove that it is impossible to find the minimum element of the array using only the **Median** function. **(10 points)**

b) Develop an algorithm (in pseudo-codes) for finding the minimum and maximum elements of the array using the **Median** function. Please note that your proposed algorithm does not need to differentiate which one is the minimum element and which one is the maximum. Instead you only need to return two values that are the minimum and maximum elements of the input array. **(15 points)**

c) Please show the time complexity of your algorithm proposed in b). **(4 points)**

5. Consider a finite number of towns, some of them are connected by roads. There are two types of roads: one-way roads and two-way roads. A town X is called a **Metropolitan City** if and only if it is possible to drive from every other town to X.

You are required to develop an algorithm called metropolitan city. Given one of the towns as the input, the algorithm returns true if and only if the town is a Metropolitan City, otherwise, false. For example, assume that we are given four towns called A, B, C and D. Let A and B be connected by a two-way road, A and C are also connected by a two-way road. However, there exists only a one-way road from D to B. There are no other roads available. In this example, we can derive that A is a Metropolitan City but D is not. Please answer the following questions.

a) Please develop your metropolitan city algorithm (in pseudo-codes). Please first define the abstract data type that you will use to represent the towns and their connections in your metropolitan city algorithm. **(15 points)**

b) Let us revise the definition of the metropolitan city. A town X is called a Metropolitan City if and only if it is possible to drive from every other town to X within 2 steps (i.e., via at most only one intermediary city). A town X is called a **Skirt City** if and only if it is possible to drive from every other town to X but at least one of the towns requires more than 2 steps to reach X (i.e., via two or more intermediary cities). Using the example illustrated above, C is a Skirt City rather than a Metropolitan City in this new definition, because D needs to go through B and then A in order to reach C (i.e., 3 steps). Please propose a skirt city algorithm (in pseudo-codes) by revising the metropolitan city algorithm that you develop in b). **(12 points)**