國立成功大學

114學年度碩士班招生考試試題

編　號：97

系　所：工程科學系

科　目：計算機概論

日　期：0211

節　次：第 2 節

注　意：1.不可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

1. This question tests your ability to implement efficient algorithms, analyze their performance, and optimize their computational complexity. (20%)

   (1) Implement an efficient algorithm to compute Fibonacci numbers using matrix exponentiation. Analyze the time complexity and explain why this approach is more efficient than traditional recursive solutions. (5%)

   (2) Please finish the code to solve func(n) for following sequence:1, 1, 2, 6, 24, 120, 720, …, where func(0) = 1, func(1) = 1, func(2) = 6, func(3) = 24, ….(5%)

   (Use recursion to complete the func())

   ```
   def func(n):

       (Please finish the code here.)

   print(func(n))
   ```

   (3) Solve the following problem: Given a sequence of numbers, find the longest increasing subsequence. Provide the implementation and analyze its time complexity. (5%)

   (4) Write Python implementations for both Selection Sort and Insertion Sort. Conduct a performance comparison between the two algorithms for arrays of varying lengths, and present the results in a graphical format. (5%)

2. This question examines your ability to design efficient data structures and algorithms to solve complex problems. (20%)

   (1) Design a data structure that supports the following operations efficiently: (5%)

   1. Insert an element.
   2. Count the number of elements within a specified range.
   3. Delete a specific element. Describe its structure and analyze the time complexity of each operation.

   (2) Given the sequence N = [9,8,7,6,5,4,3,2,1,0], design an algorithm to compute the next lexicographic permutation. Extend your solution to handle sequences of length 10510^5105, and analyze the time complexity. (5%)

   (3) For an AVL tree, insert the following numbers: 50, 20, 60, 10, 30, 70. Draw the resulting balanced tree and explain the rebalancing process step-by-step. (5%)

   (4) Implement a hybrid sorting algorithm combining Quick Sort and Insertion Sort. Demonstrate how this hybrid algorithm outperforms pure Quick Sort for partially sorted arrays, and provide a time complexity analysis. (5%)

3. This question assesses your ability to work with different numerical representation systems, their limitations, and their practical applications. (20%)

   (1) Assume a 16-bit floating-point format with the following structure: (5%)

   1. 1-bit sign.
   2. 5-bit exponent using Excess-15 encoding.
   3. 10-bit mantissa (including an implicit leading 1). Represent the number **-45.75** in this format, and discuss how the system handles overflow when adding a large number to this value.

   (2) Perform the addition of **45.75** and **–45.75** using a fixed-point representation in the format **ssss.ffff**. Provide the result in binary and decimal forms. (5%)

   (3) Design an algorithm to convert a 16-bit floating-point number into a fixed-point representation. Clearly describe the steps, and analyze the time and space complexity of your algorithm. (5%)

   (4) Compare the floating-point and fixed-point representations regarding precision and range. Discuss their trade-offs and provide an example of an application where one is preferred over the other. (5%)

4. This question evaluates your understanding of Boolean algebra, logic gate design, and optimization. It focuses on deriving and implementing efficient circuits while analyzing their performance. (20%)

   (1) Simplify the given Boolean expression using a Karnaugh map. Ensure you minimize the number of terms in the expression and clearly show each step of simplification. (5%)
   $F(A, B, C, D) = \sum m(0,1,2,5,8,9,10,15) + \sum d(3,7,11)$

   (2) Design a logic circuit with three inputs (A, B, C) and two outputs (Y1, Y2) based on the following criteria: (5%)

   1. Y1=1 if and only if the number of 1s in the input is even.
   2. Y2=1 if and only if the input contains at least two 1s. Use Boolean expressions to describe the outputs and ensure logical correctness.

   (3) Analyze the delay time of the designed circuit. Assume that each logic gate introduces a delay of 10ns, and calculate the maximum delay path in the circuit. (5%)

   (4) Draw the logic circuit diagram corresponding to your design. Optimize the circuit to use the minimum number of gates, ensuring it meets the functional requirements. (5%)

5. This question evaluates your understanding of cryptographic principles, algorithm design, and the implications of modern threats to encryption. (20%)

   (1) Design a key distribution protocol that ensures secure communication between two parties. Your protocol must prevent man-in-the-middle attacks and minimize the number of communication rounds required. (5%)

(2) Using the RSA algorithm, encrypt the message M=12345 with the following parameters: (5%)

Public key e=17.

Private key d=2753.

Modulus n=3233.

Verify the decryption process and confirm the result matches the original message.

(3) Analyze the computational complexity of RSA encryption and discuss its performance in large-scale data transmission compared to symmetric encryption algorithms such as AES. (5%)

(4) Explain the potential threat posed by quantum computing to RSA encryption. Provide an overview of an encryption algorithm that is resistant to quantum attacks, such as lattice-based cryptography. (5%)