國　立　清　華　大　學　命　題　紙

98 學年度 服務科學研究所 系（所） 服務系統 組碩士班入學考試

科目 計算機概論 科目代碼 5401 共 3 頁第 1 頁 *請在【答案卷卡】內作答

Part I: Short Essay Questions (簡答題) 8 題，共 52 分。

1. You are asked to evaluate three different data structures for storing a set of keys. The three alternatives include: (1) a balanced binary tree, (2) an unsorted linked list, and (3) a sorted linked list. Four operations should be supported: (a) insert a key, (b) lookup a key, (c) delete a key, and (d) list all the keys in sorted order. Let n be the size of the current set of keys. For each operation and data structure, write, in the corresponding entry in the table below, the asymptotic order of the worst-case time to implement the indicated operation for the given data structure. Please note that two entries have been filled in. You only need to fill in the remaining entries in the table. **(10 points)**

	Balanced Binary Tree	Unsorted Linked List	Sorted Linked List
(a) Insert a key			
(b) Lookup a key			
(c) Delete a key	$\log n$	n	
(d) List all the keys in sorted order			

2. Assume that you develop a new computer that operates in trinary, rather than binary. That is, you have 0, 1, and 2 as digits, rather than just 0 and 1. How many binary bits will we need to represent a 4-digit trinary number? **(5 points)**

3. Two phase locking protocol is a concurrency control technique widely adopted by many database management systems. Please describe what two phase locking protocol is. **(7 points)**

4. **(6 points)**

a. What does the following function do, please describe.

b. Use one example to demonstrate how the function works. Please draw the process step by step.

```
function foo (array)
    var list A, B
    if length(array) ≤ 1
        return array
    select and remove a value TTT from array
    for each x in array
        if x ≤ TTT then append x to A
        else append x to B
    return concatenate(foo(A), TTT, foo(B))
```

5. **(6 points)** Please explain the following question.

a. Why is that a computer with a larger memory size can enhance performance,

b. Why is that a newer generation Memory module (e.g. from DDR2 to DDR3) could enhance the performance of a computer.

6. **(6 points)** A high-end computer with its CPU runs at 500 MHz, but buses run at 133 MHz. This computer has 16 CPUs, it is clear that the buses can never handle the load. The problem is dealt with by adding something to CPU.

a. Please describe one type of this design.

b. What problem may still need to be dealt with because of this design?

7. **(6 points)** Consider for a monitor to be able to display 2^{24} different colors, yet the hardware has only one byte for each pixel. Describe the design behind this.

8. **(6 points)** A computer with a five-stage pipeline deals with conditional branches by stalling for the next three cycles after hitting one. How much does stalling hurt the performance if 30% of all instructions are conditional branches? (You only need to consider stalling caused by conditional branches.)

Part II: Problem Solving Questions 4 題，共 48 分。

9. A system is composed of four processes, P_1 to P_4, and three types of consumable resources, R_1 to R_3. There is one unit each of R_1 and R_3, and R_2 currently does not have any unit. The four processes are:
   - P_1: requests a unit of R_1 and a unit of R_3.
   - P_2: produces a unit of R_1 and a unit of R_3 and requests one unit of R_2.
   - P_3: requests a unit of R_1 and a unit of R_3.
   - P_4: produces a unit of R_2 and requests a unit of R_3.

   Show the consumable resource graph to represent the system state. Is the system deadlocked? If yes, which processes are deadlocked in this state? If not, please show a possible execution sequence. **(8 points)**

10. Let two strings be $X = \langle x_1, x_2, \ldots, x_n \rangle$ and $S = \langle s_1, s_2, \ldots, s_m \rangle$, where $m \geq n$ (m is the number of elements in S and n is the number of elements in X). The string S is called a **super-sequence** of X if there exist integers $1 \leq i_1 < i_2 < \ldots < i_n \leq m$ such that $s_{i_1} = x_1$, $s_{i_2} = x_2$, …, and $s_{i_n} = x_n$ (i.e., all elements of X appear in S in the same order as they are in X). For example, the string *adecbdaed* is a super-sequence of *adcbae*, but the string *bdaedadec* is not a super-sequence of *adcbae*.

    Furthermore, let us define the concept of common super-sequence as follows: If a string C is a super-sequence of a string A and a string B, then C is a **common super-sequence** of A and B. Please note that there can be many different common super-sequences of A and B. Among all possible common super-sequences of A and B, the ones that have the minimum number of elements are called the shortest common super-sequences of A and B.

    a) Please find a shortest common super-sequence of the following two strings: *acbd* and *dccab*. **(6 points)**
    b) Please develop an algorithm (in pseudo-codes) for determining a shortest common super-sequence for any two strings A and B. **(14 points)**

11. **(10 points)** A computer has 16 pages of virtual address space but only four page frames. Initially, the memory is empty. A program references the virtual pages in the order: 7, 5, 2, 7, 5, 7, 8, 11, 9, 2, 4.
    a) Which references cause a page fault with LRU?
    b) Which references cause a page fault with FIFO?

12. (10 points) Supermarkets are constantly faced with a problem similar to page replacement in virtual memory systems. They have a fixed amount of shelf space to display an ever-increasing number of products. If an important new product comes along, some existing product must be dropped from the shelf space to make room for it. The obvious replacement algorithms are LRU and FIFO.

a) Please use one scenario to show the case when you would prefer LRU. You need to first describe the scenario and then show a sample calculation to prove your preference.

b) Please use one scenario to show the case when you would prefer FIFO. You need to first describe the scenario and then show a sample calculation to prove your preference.