●不可使用電子計算機

Part A: 資料結構

一、 單選題　（每題有四個選項，正確選項只有一個）(15%，每題 3 分)

1. What is the height of a complete binary tree with n nodes?

    (a) $\lceil \log_2(n-1) \rceil$　(b) $\lceil \log_2 n \rceil$　(c) $\lceil \log_2(n+1) \rceil$　(d) $\lceil \log_2(n \div 2) \rceil$

2. Which of the following sequences of a binary tree can not uniquely define the original binary tree?

    (a) preorder and postorder sequences　(b) inorder and preorder sequences

    (c) inorder and postorder sequences　(d) level-order and inorder sequences

3. What is the minimum number of edges in a strongly connected digraph on n vertices?

    (a) $n-1$　(b) n　(c) $n+1$　(d) $n(n-1)$

4. Given the min heap: 2, 3, 6, 5, 13, 15, 18, 16, 17.　Which one is the resulting min heap after 3 is deleted?

    (a) 2, 6, 5, 13, 15, 18, 16, 17　(b) 2, 17, 6, 5, 13, 15, 18, 16

    (c) 2, 5, 6, 13, 17, 15, 18, 16　(d) 2, 5, 6, 16, 13, 15, 18, 17

5. Which one of the following problems is not a NP-complete problem?

    (a) Clique problem　(b) Euler tour problem　(c) Hamiltonian cycle problem　(d) 3-CNF-SAT problem

二、 (10%) Consider a set S of $n \geq 2$ distinct numbers (in the range 1 to n^n) given in unsorted order.　Give an O(n) expected (average) time algorithm to determine two distinct number x and y in the set S such that x + y = Z, where Z is given, or determine that no two such numbers exist.　In as few words as possible, describe your algorithm and justify its running time.

三、 (10%) 簡答下列問題
    (A) (6%) Write an approximation algorithm for the vertex-cover problem.
    (B) (4%) Give the running time and the approximation ratio for your algorithm.

Part B: 計算機組織

四、單選題　（每題有四個選項，正確選項只有一個）(15%，每題 3 分)

1. Which of the following is NOT true?
(a) Virtual memory technique treats the main memory as a fully-set associative write-back cache.
(b) Virtual address must be always larger than the physical address.
(c) TLB can be seen as the cache of a page table.
(d) If the valid bit for a virtual address is off, a page fault occurs.

2. Which of the following is true?
(a) Memory-mapped I/O is an I/O scheme in which special designed I/O instructions are used to access the memory space.
(b) The process of periodically checking status bits to see if it is time for the next I/O operation is called interrupt.
(c) Direct memory access (DMA) is a mechanism that provides a device controller the ability to transfer data directly to/from memory without involving the processor. DMA is also a bus master.
(d) In a cache-based system, because of the coherence problem, thus DMA cannot be used.

3. Given a MIPS assembly program, assume the program counter of "beq $4, $8, 8" is 64. What is the new PC if the branch is taken?
(a) 32 (b) 72 (c) 96 (d) 100.

4. Which of the following operation is equivalent to division by 2 in two's complement notation, when there is no overflow or underflow?
(a) arithmetic right shift
(b) arithmetic left shift
(c) arithmetic right rotate
(d) none of the above.

5. Which one of the following statement does NOT affect the clock per instruction (CPI)?
(a) clock cycle time
(b) memory data bus width
(c) process technology
(d) cache structure.

五、(16%) Consider a five-stage MIPS pipelined datapath with instruction fetch (IF), instruction decode (ID), execution (EX), memory access (MEM), and write back (WB). Answer the following questions: (A) (3%) Explain the structural hazard. (B) (3%) Explain the data hazard. (C) (3%) Explain the control hazard. (D) (3%) How do we avoid the structural hazard? (E) (4%) List two methods to resolve the data hazard.

六、(4%) Given a memory system with 32-bit address. Assume that there are 21 tag bits and 6 index bits in a two-way set associative cache. (A) (2%) What is the data size of a cache block? (B) (2%) What is the total data size of the cache system?

Part C: 作業系統

七、(6%) For the dining-philosopher problem, the simplest semaphore solution is shown as the right. However, this algorithm has the deadlock problem. If now we assign a unique priority to each philosopher, can this priority-based approach solve the deadlock problem? Why?

```
do  {
        wait ( chopstick[i] );
        wait ( chopStick[ (i + 1) % 5] );
        //  eat
        signal ( chopstick[i] );
        signal (chopstick[ (i + 1) % 5] );
        //  think
} while (TRUE) ;
```

八、(6%) Assuming a 1-KB page size, what are the page numbers and offsets for the following address references (provided as decimal numbers): (A) 7082 (B) 3603

九、(6%) UNIX systems use three bits "rwx" to handle file and directory protection. What does "x" mean for directory protection?

十、(6%) In Android, threads are optimized with the thread pool scheme. What are the major benefits for thread pools?

十一、(6%) On an Android 4.x smartphone, will thrashing occur? Explain your reason.