國立清華大學 103 學年度碩士班考試入學試題

系所班組別：資訊系統與應用研究所

考試科目（代碼）：計算機概論 (2201)

1. (5%) Solve for λ in

$$A\mathbf{x} = \lambda B\mathbf{x},$$

where

$$A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}, B = \begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix}, \mathbf{x} \neq \mathbf{0}.$$

2. (5%) Consider an $n \times n$ zero-one matrix of which every entry is either 0 or 1. For example, $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ is a 3×3 zero-one matrix containing five 0's and four 1's. What is the maximum number of 0's that an invertible $n \times n$ zero-one matrix can have? Please justify your answer.

3. (5%) If a finite set $\{x_0, x_1, \ldots, x_n\}$ of vectors is dependent, does it follow that at least one of them is a linear combination of the others? Please justify your answer.

4. (a) (5%) What is the rank of the matrix $\begin{bmatrix} 1 & 3 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 0 & 4 & 0 & 0 \end{bmatrix}$?

(b) (5%) Compute the inverse of the matrix $\begin{bmatrix} 1 & 2 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 2 \end{bmatrix}$.

5. (a) (5%) What is Software Quality Assurance (SQA)? What is the role of the SQA group within a software development organization?
(b) (5%) What is the difference between *alpha testing* and *beta testing*?

6. The Fibonacci sequence is typically defined by the following equations:
   $F_0 = 1$
   $F_1 = 1$
   $F_n = F_{n-1} + F_{n-2}$ when $n \geq 2$
   (a) (2%) Please write a recursive algorithm to generate the sequence.
   (b) (3%) Please prove your recursive algorithm is correct.
   (c) (5%) Please evaluate the efficiency of you recursive algorithm and consider proposing a method to make the recursive algorithm more efficient if necessary.

7. (5%) You have approximately 1,000 reduced-size versions of pictures that your company would like to store in an online dictionary that uses hashing in its implementation. Each picture is 20 pixels wide by 20 pixels high, and each pixel is one of 256 colors. Please list and explain the selected hash function.

8. (6%) What letters are checked by the binary search algorithm if it is applied to the list A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, when searching for the value Z?

9. You are given a linked list L to print out. Answer the following two questions:
   (a) (6%) Design a procedure for printing L in **reverse** order using a stack as a supporting storage. Show your pseudocode.
   (b) (6%) Is it possible to perform the same task without explicitly using a stack? If so, how?

10. (6%) Let R1 be the "less than" relation on the set of real numbers and let R2 be the "greater than" relation on the set of real numbers. That is, R1={(x, y) | x < y} and R2 ={(x, y) | x > y}. Answer the following three quesitons:
    (a) What is R1∩R2?
    (b) What is R1∪R2?
    (c) What is R1 – R2?

11. (a) (4%) A process is said to be CPU/memory/IO-bound if its performance bottleneck is at CPU/memory/IO. When you use a browser to search something from Google, is the corresponding process CPU-, memory-, or IO-bound? Explain you answer. (b) (2%) In a multiprogramming computer, a process may be context-switched for causes such as expiration of time slices, IO requests, hardware errors, etc. Explain what cause of context switches that an OS may use to determine whether a process is CPU-bound.

12. Suppose a computer has *n* non-premptive processes to schedule for execution. By "non-premptive", we mean that each of these *n* processes must run to completion before the next process can be scheduled for execution. (a) (4%) Write a recurrence relation to show how many different schedules for these *n* processes that the OS scheduler has to evaluate before it can determine the optimal (best) schedule, assuming there is only one optimal schedule. (b) (4%) A smarter OS scheduler examines randomly *x* schedules and uses the best among these *x* schedules to schedule the *n* processes. For $n = 5$, how many random schedules, *x*, this smarter OS has to examine so that the probability that the optimal schedule is found is higher than 0.8?

13. Consider a computer with a CPU that has 16 general-purpose registers numbered 0 through F (in hexadecimal). Each register is one byte long. There are 256 cells in the main memory of the computer. Each cell can hold one byte of data and be addressed by a unique 8-bit address. Each machine instruction of the CPU is 2 bytes long. The first 4 bits provide the op-code, and the last 12 bits make up the operand field. Suppose the program to be executed is stored in the memory starting from the cell at address 00. (a) (6%) Write the machine code (in hexadecimal) of a program to swap the data in memory cells 02 and 03 using the machine instructions given below. (b) (6%) Show contents of relevant registers and memory cells after execution of EACH machine instruction.

Op-code	Operand	Description
1	RXY	LOAD the register R with the data found in memory cell whose address is XY, e.g., 14A3 would load the contents of the memory cell located at address A3 to the register 4.
3	RXY	STORE the data in register R to the memory cell whose address is XY, e.g., 35B1 would cause the contents of register 5 to be placed in the memory cell located at address B1.
C	000	HALT execution