所別：電機工程學系碩士班 甲組 科目：計算機概論與資料結構

1. Please answer the following questions:
   (1) [3pt] Explain what are "RAM" and "ROM".
   (2) [3pt] Discuss the difference between "RISC" and "CISC".
   (3) [3pt] Given a bit sequence "10010011", what is its meaning if it is a (A) unsigned binary number (B) signed 2's complement number (C) BCD number.

2.

Instruction Class	CPI on M1	CPI on M2	C1 usage	C2 usage
A	1	2	30 %	20 %
B	2	4	50 %	30 %
C	3	3	20 %	50 %

   (1) [4pt] Now, we are going to evaluate the performance of two machines M1 and M2. The operation frequency of the two machines are F1=500MHz and F2=750MHz. Assume the instruction sets can be rough divided into three primary categories A, B, C. The average clock-cycle per instruction (CPI) for the three kinds of instructions while executed on machine M1 and M2 are listed in above table. If the three kinds of instructions have the same probability to appear, which machine will be faster? Please support your answer with suitable calculations.
   (2) [4pt] If a benchmark program is compiled by two compilers C1 and C2, the distribution of the three kinds of instructions are shown in the last two columns of the above table. What is the faster machine if we adopt compiler C1? What is the faster machine if we adopt compiler C2? Please support your answer with suitable calculations.
   (3) [3pt] Assume the prices of M1 and M2 are the same. The prices of C1 and C2 are also the same. Which combination of machine and compiler will you prefer according to the evaluations in question (2)? Please briefly explain your answer.

3. [10pt] Determine a shortest path between a and z in the graph in Figure 1, where the numbers associated with the edges are the distances between vertices. Please show each step in determining the shortest path.

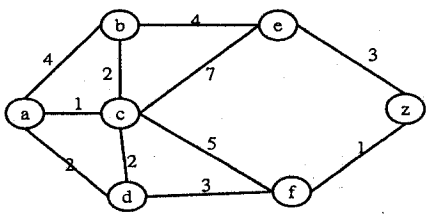

Figure 1

注意：背面有試題

所別：電機工程學系碩士班 甲組 科目：計算機概論與資料結構

4. Suppose that an arithmetic expression involving the binary operator +, -, *, and / is stored internally as a binary tree in Figure 2.
   (1) [3pt] Write down the postorder expression for the binary tree.
   (2) [7pt] Design a recursive algorithm to print out its fully parenthesized infix notation. For example,

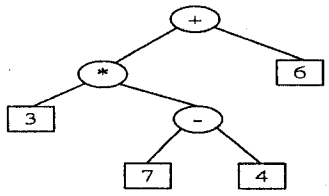

Figure 2

would be printed as : ((3*(7-4))+6).

5. [10pt] Compare the (a) insertion sort, (b) quick sort, (c) merge sort, (d) bubble sort, (e) heap sort for computing time of average and worst cases in terms of big-Oh notation.

6. [10pt] Write a recursive function subprogram using C/C++ language to calculate the Nth Fibonacci number F_N, where N is assumed to be integer and nonnegative and

$$F_N = \begin{cases} F_{N-1} + F_{N-2} & \text{if } N > 2 \\ 1 & \text{if } N = 2 \\ 0 & \text{if } N = 1 \end{cases}$$

7. [5pt] Using a while loop, write a subprogram in C/C++ language that computes and prints the average of the integers between 1 and 10, except for 3 and 6. Print the average as a fixed decimal with three digits of precision.

8. [5pt] Using C/C++ language, write a function that takes an integer parameter and returns the value of that integer modulus 7 (e.g., n % 7).

9. [5pt] Using C/C++ language, write a recursive function **`recursiveMinimum`** that takes an integer array and the array size as arguments and returns the element with the smallest value in the array. The function should stop processing and return to its caller if it receives a one-element array.

所別：電機工程學系碩士班 甲組 科目：計算機概論與資料結構

10. Using C++ language, create a class called **`ComplexVector`** for performing arithmetic with complex vectors. Complex vectors have the form

`realVector + imaginaryVector * i`

where **`i`** is $\sqrt{-1}$, and both the **`realVector`** and **`realVector`** have the form

$$\begin{bmatrix} a_0 \\ a_1 \\ \vdots \\ a_{N-2} \\ a_{N-2} \end{bmatrix}$$

Use **`double`** variables to represent the **`private`** data of the class. Provide a constructor that enables an object of this class to be initialized when it is declared. The constructor should contain default values in case no initializers are provided. Provide **`public`** member functions for each of the following:

(1) [3pt] Conjugating a ComplexVector.

(2) [3pt] Adding two ComplexVectors.

(3) [3pt] Subtracting two ComplexVectors.

(4) [6pt] Inner production of two ComplexVectors defined as follows:

$$\mathbf{A} \bullet \mathbf{B} = \begin{bmatrix} a_0 \\ a_1 \\ \vdots \\ a_{N-2} \\ a_{N-1} \end{bmatrix}^T \times \text{conjugate}\left(\begin{bmatrix} b_0 \\ b_1 \\ \vdots \\ b_{N-2} \\ b_{N-1} \end{bmatrix} \right) = \sum_{k=0}^{N-1} \left(a_k \cdot \text{conjugate}(b_k) \right)$$

where T denotes the transpose operation of vector.

(5) [10pt] Convolution of two ComplexVectors defined as follows:

$\mathbf{C} = \text{conv}(\mathbf{A}, \mathbf{B}) = \mathbf{A} \otimes \mathbf{B}$ have 2N - 1 elements c_n and

$$c_n = \sum_{k=-\infty}^{\infty} \left(a_k \cdot \text{conjugate}(b_{n-k}) \right) = \sum_{k=-N+1}^{N-1} \left(b_k \cdot \text{conjugate}(a_{N-k}) \right)$$

Note that the element is defined as zero if its subscript is less than zero or $\geq N$.