

THE AUSTRALIAN NATIONAL UNIVERSITY
First Semester Examination – July 1999

COMP1100

Introduction to Programming and Algorithms

SAMPLE QUESTIONS ONLY

Study Period: 15 minutes

Time Allowed: 3 hours

Permitted Materials: None

Answer ALL questions.

Name (family name first):

Student Number:

The following are for use by the examiners.

Q1 Mark	Q2 Mark	Q3 Mark	Q4 Mark	Q5 Mark	Total Mark

Question 1 [20 marks]

(a) What do you understand by the following cryptic statements.

- A computer is a programmable machine.
- A program is executed by a corresponding computer.
- An Eiffel program is executed by an idealised computer called an abstract Eiffel machine.

[5 marks]

(b) What do you understand by the following cryptic statements.

- An Eiffel program is composed of a number of classes.
- A class is text, written to precise grammatical rules.
- A class is written using a text editor.

[10 marks]

(c) What do you understand by the following cryptic statements.

- An Eiffel program is not executed directly. Rather, it is compiled and then executed.
- Execution of an Eiffel program involves a root class and a root routine.

[5 marks]

(d) Some of the following concepts are associated with an Eiffel program as a text entity, and others are associated with program execution (run-time). Briefly explain which are which.

- class
- attribute declaration
- routine declaration
- expression evaluation
- routine call
- data cell
- object
- expression declaration

[5 marks]

Question 2 [20 marks]

- (a) For the following multiple-choice questions, state the options which satisfy the question (there may be more than one option).

Which of the following describes a class?

1. A set of attributes and routines
2. A group of objects having similar structure and behaviour
3. An abstract data type encompassing data and routines
4. A particular instance of an abstract data type
5. A blueprint for a set of objects

Which of the following describe an object?

1. An abstract data type encompassing data and routines
2. A particular instance of an abstract data type
3. Something that appears in the real world
4. A description of a collection of items which share similar properties

Which of the following describe the relationship between a class and an object:

1. An object is the same as a class
2. A class describes the state and behaviour of an object
3. An object is an instance of a class
4. A class is an instance of an object

[6 marks]

- (b) Consider the execution of the following program, where `WORLD` is the root class and `make` is the root routine.

1. Consider the situation when execution of `pooh_bear.blinch` is at position (1).
 - how many objects exist of type `WORLD`?
 - how many objects exist of type `INHABITANT`?
 - what routines are being executed, in which object?
 - Draw a representation of the object referenced by `pooh_bear`.
2. How many times is the loop body in `pooh_bear.blinch` executed?

```

class WORLD
creation
  make
feature
  pooh_bear: INHABITANT
  tigger: INHABITANT
  eeeyore: INHABITANT
  make is
    do
      !!pooh_bear.make(4,"of little brain")
      !!tigger.make(1,"bouncy")
      !!eeeyore.make(12,"gloomy")
      pooh_bear.blinch
    end
end -- class WORLD

class INHABITANT
creation
  make
feature
  age: INTEGER
  nature:STRING
  make(k:INTEGER;s:STRING) is
    do
      age := k
      nature := s
    end
  blinch is
    local
      i : INTEGER
    do
      from
        i := 1
        -- (1)
      until
        (i>age)
      loop
        io.put_string("worry ")
        i := i+1
      end
      io.put_new_line
    end
end -- class INHABITANT

```

[14 marks]

Question 3 [20 marks]

- (a) For the following multiple-choice questions, simply state which of the statements are correct (there may be more than one).

What are the two kinds of features in a class?

1. Attributes and routines
2. data and variables
3. methods and procedures
4. procedures and functions
5. objects and code

What are the two kinds of routines in Eiffel?

1. procedure and function
2. data and function
3. data and attribute
4. routine and procedure
5. method and variable

Which of the following describe the difference between a function and a procedure?

1. A function appears in a class where a procedure appears in an object
2. A procedure returns a value where a function does not
3. A function returns a value where a procedure does not
4. A function appears in an object where a procedure appears in a class
5. A function does not change any attributes of a class where a procedure may

[6 marks]

- (b) Consider the execution of the following routine (it is executed in some enclosing object).

```
silly is
  local
    str : STRING
  do
    -- (1)
    str := "hello"
    -- (2)
    str.append(" sailor")
    -- (3)
  end
```

Give a schematic representation of `str` at point 1, at point 2 and at point 3 during execution. Here `append` is a routine in the library class `STRING`, with the following description.

```
append (other: STRING)
  -- Append 'other' to Current.
  require
    other /= Void
```

[7 marks]

- (c) Complete the following routine. If the array parameter `data` contains the list of integers `[3, 0, -2, -4, 6, 1]` then the routine should return the value 10.

```
sum_of_positive(data : ARRAY[INTEGER]): INTEGER is
  -- post-condition:
  -- Return = sum of positive items in data
  local
  do
  end
```

[7 marks]

Question 4 [18 marks]

- (a) Write down the following “complexity orders” in increasing order (smallest to largest):

$$O(n), O(\log n), O(n!), O(2^n)$$

[2 marks]

- (b) Write down the result of the following calculation:

```
Result := -7\2
```

[2 marks]

- (c) Apart from “sequential” commands, there are two other types of programming constructs which together make up a “structured programming” algorithm. List the other two.

[2 marks]

- (d) What **type** is `Result` in the following statement?

```
Result := a > 5
```

[2 marks]

- (e) What is the value of the binary number 111 in decimal?

[2 marks]

- (f) A floating point number can be either single or double precision. What is the practical effect on subsequent floating point computations of increasing the length of the mantissa field in a single precision number when it is promoted to be double precision?

[2 marks]

- (g) Explain what is meant by a “machine number”.

[2 marks]

- (h) If the absolute error in a floating point number, a , is equal to δa , what is the relative error?

[2 marks]

- (i) How are relative errors combined in the multiplication of two floating point numbers?

[2 marks]

Question 5 [12 marks]

The following is a segment of Eiffel code for a bubble sort of an integer array `data`. The swap part of the algorithm has been left out.

```
from
  top:=data.upper-1
  interchanged:=true
until
  interchanged:=false
loop
  interchanged:=false
  from
    i:=data.lower-1
  until
    i=top-1
  loop
    i:=i+1
    j:=i+1
    if data.item(i)>data.item(j) then
      -- code for swap goes here
      interchanged:=true
    end
  end -- inner loop
  top:=top-1
end
```

- (a) There are two mistakes in this code (one syntactical and one logical). What are they and what are the correct Eiffel statements? [5 marks]
- (b) Write down correct Eiffel code for the swap part of the algorithm. [5 marks]
- (c) What is the status of the following array after two outer loops of the correct bubble sort algorithm? [5 marks]

1	-2	0	-5	10	2	-10
---	----	---	----	----	---	-----

- (d) What assumption does this algorithm make (if any) about the number of items in the array.

