Instructions

1. Read the question paper carefully and answer all the questions below. Write your answers in the provided answer booklet. Before you begin, make sure that you fill in all your personal details correctly and clearly on the front cover of the answer book.

2. This evaluation opportunity comprises of four (4) questions on three (3) pages. Please check that you have received the entire paper before you begin writing.

3. This is a closed book paper. You are not allowed to have any literature with you when writing this test.

4. Switch off your cell phone, and keep it off for the duration of the test. No electronic devices of any form are allowed to be used for the duration of the test.

5. Plagiarism or cheating of any form will not be tolerated. If you are found guilty of any such transgressions, disciplinary action will be taken. This may include suspension of your studies at the University of Pretoria.

6. Number your questions clearly and according to the numbering scheme provided in this question paper (unless otherwise instructed). Provide a clear separation between each of the 5 main questions, preferably with a heading at the start of each. Clearly number each of the sub-questions under each main question.

7. Write clearly and concisely. Use bulleted lists to clearly organise an answer, if you are asked to discuss multiple points. If you need to continue an answer on another page, please indicate this clearly.

8. For all of the test’s questions, you may provide program code to illustrate your point. It is, however, not required to provide program code, as long as your answer is clear enough.
Question 1: Preliminaries (13 marks)

1. **Explain** how studying the concepts of programming languages can lead to the overall advancement of computing.

2. Programming languages are applied within one or more programming domains. **List** two important requirements of a programming language that is to be used in the domain of scientific programming.

3. Consider the concept of programming language orthogonality, and answer the following questions:
   (a) **Define** the concept of orthogonality, in the context of programming languages.
   (b) Consider two hypothetical programming languages. Language A supports the multiplication of two integer operands using one operator, and the multiplication of two floating point operands using another operator. Language B supports multiplication of two operands using only one operator, where either operand may be an integer or a floating point value. **Compare** the orthogonality of the two languages, and **explain** your answer.

4. There are various factors that affect the cost of a programming language. **List** the three (3) most important factors. You do not need to provide an explanation of any of these factors.

Question 2: Programming Language Evolution (13 marks)

1. COBOL programs contain two divisions: the procedure division and the data division. **Identify** which one (1) of these divisions is better developed. **Explain** why this is the case, taking into consideration the programming domain that COBOL is intended for.

2. **Compare** the general approaches that Fortran and COBOL use in terms of syntax.

3. **Describe** the most important programming language feature or paradigm that each of the following languages introduced:
   (a) Prolog.
   (b) SIMULA 67.
   (c) LISP.
   (d) Smalltalk.
   (e) ALGOL 68.

4. **Compare** APL and COBOL in terms of readability and writability.

5. Consider the C programming language, and answer the following questions:
   (a) **Name** the programming domain within which C was originally intended to be used.
   (b) **Explain** why C is considered to be a relatively unreliable language, taking into consideration your answer to (a), above.

Question 3: Names, Bindings and Scopes (12 marks)

1. **Critique** the use of case sensitivity in names (i.e. identifiers) within a programming language, both in terms of readability and writability.

2. **Name** the two (2) things that are determined by a variable’s type.

3. Consider the concept of keywords and reserved words in programming languages, and answer the following questions:
   (a) **Explain** what a keyword is, as opposed to a reserved word.
   (b) **Explain** how reserved words can adversely affect the writability of a programming language.

4. **Name** one (1) advantage associated with variables that have static storage binding.
5. Consider the following statements in a hypothetical programming language:

```plaintext
var myValue;
myValue = 12;
myValue = [4, 3, 2, 1];
```

Answer the questions that follow:
(a) Identify the type binding that is taking place in the above program code. [1]
(b) Identify the storage binding that is taking place in the above program code. [1]

6. Consider the following set of subprograms in a hypothetical programming language:

```plaintext
int var1;
Main {
    int var2;
    call Sub1;
}
Sub1 {
    int var3;
    <-- (A)
}
```

Write down the referencing environment at point (A) in the program, for each of the following cases:
(a) If the hypothetical language uses static scoping rules. [1]
(b) If the hypothetical language uses dynamic scoping rules. [1]

Question 4: Data Types (12 marks)

1. Consider floating point and decimal data types, and answer the following questions:
   (a) Name one (1) disadvantage associated with floating point data types. [1]
   (b) Name one (1) disadvantage associated with decimal data types. [1]

2. The inclusion of a separate Boolean value is not a requirement within a programming language. Explain how a programming language might be able to do without a separate Boolean type. [2]

3. Consider the concept of a string type, and answer the following questions:
   (a) Contrast the methods used by C and C# to represent strings. [2]
   (b) Name one (1) disadvantage associated with dynamic length strings. [1]

4. Consider the following program code snippet in a hypothetical programming language:

```plaintext
void function() {
    int size = 10;
    int myArray[size];
}
```

Identify the type of array, in terms of its subscript and storage binding. [1]

5. Describe the basic difference between normal arrays, and associative arrays. [2]

6. Explain what an elliptical reference is, in the context of record types. [1]

7. Describe the main difference between pointers and references. [1]