

University of Swaziland
Final Examination
MAY 2013

Title of paper : Programming Languages

Course number : CS343

Time Allowed : Three(3) hours

Instructions :

- *Each question carries 25 marks*
- *Answer any four (4) questions from questions 1 to 6.*

This paper may not be opened until permission has been granted by the invigilator

Question 1

- (a) Explain the difference between the way a compiler and an interpreter performs translations, stating clearly the advantages and disadvantages of each form of translation. *7 marks*
- (b) *Precedence, associativity, arity* and *fixity* are properties of operators in programming languages. With the aid of examples taken actual programming languages, explain the meaning of each term. *10 marks*
- (c) In a certain language, the 3 symbols \diamond , \square and \circ denote operators., Assume that the expression

$$1 \circ (2 \diamond) \square 3 \circ 4 \square 5 \diamond$$

when fully parenthesized becomes

$$(1 \circ ((2 \diamond) \square 3)) \circ ((4 \square 5) \diamond)$$

Explain what can be deduced (if any) about the *precedence, associativity, arity* and *fixity* of these operators. *8 marks*

Question 2

- (a) Consider the statement: “The Semantic gap for imperative languages is narrower than for declarative languages. Therefore, programs in imperative languages run faster but programs in declarative languages are easier to understand.”
Explain the meaning of the underlined terms and discuss the stated conclusion. *10 marks*
- (b) Briefly describe the main properties of objects in the object-oriented paradigm. *5 marks*
- (c) With the aid of an example explain in detail how, in C++, dynamic dispatch of member functions is implemented. *10 marks*

Question 3

- (a) Using a BNF grammar, describe in detail the structure of Lambda Calculus expressions, as well as the method by which expressions are evaluated. *12 marks*
- (b) Based your answer given in (a) above, show the parse/derivation tree for the following lambda expression.

$$((\lambda x.x+1) (\lambda y.y*y)) 5 \quad 8 \text{ marks}$$

- (c) Following proper grammatical rules, show the following lambda expression reduces to its normal form:

$$(\lambda x.((\lambda y.x*y+4) ((\lambda z.z+2) 5))) 4 \quad 5 \text{ marks}$$

Question 5

- (a) With the aid code examples, explain following features of Haskell:

(i) Infinite Lists *3 marks*

(ii) Lazy Evaluation *3 marks*

- (b) Write simple Haskell expressions to perform following tasks:

(i) Return the list [10,30, 56,77,39] without the first element. *2 mark*

(ii) Return the second value in the tuple (56,77) *2 marks*

(iii) Return the largest value in the list [34, 77, 23, 5, 87, 55, 60] *2 marks*

- (c) Define the following functions in Haskell;

(i) A function that given a list of integer values, returns their average as a floating point number. *5 marks*

(ii) Ackerman's function, $a(x,y)$ that takes two integer values and evaluates recursively as shown below:

$a(x, y) =$

- $y + 1$ if $x=0; y \geq 0$
- $a(x-1, 1)$ if $x > 0, y=0$
- $a(x-1, a(x,y-1))$ otherwise

8 marks

Question 4

- (a) With the aid of examples, distinguish between statements and expressions in source code. *4 marks*
- (b) Give an overview of *by-value* and *by-reference* methods of parameter passing. *5 marks*
- (c) With the aid of examples, describe four kinds of polymorphism and show how they are manifested or implemented in C++. *16 marks*

Question 6

- (a) Write prolog knowledge base that contains following facts about a particular family. *8 marks.*
- The family has 5 males members: john, musa, lucky, siphon, keith
 - The family has 6 females members: jane, nancy, nomsa, lungile, jabulile, poppy.
 - john is the father of musa, lungile, siphon, and nancy
 - jane is the mother of musa and lungile, nomsa.
 - lungile is the mother of lucky and jabulile
 - keith is the father of lucky, jabulile and poppy
- (b) Based on the facts written in (a) above, write rules for the following:
- (i) X is a parent of Y if X is either a mother or father of Y *2 marks*
- (ii) X is a sibling of Y if they have the same parents. *2 marks*
- (iii) X is a half-sibling of Y if they share the same mother or father, but not both. *3 marks*
- (iv) X is a gran-parent of Y if the father or mother of Y is a son/daughter of X. *3 marks*
- (c) Based on the facts in (a) and the rules in (b), write a query for each of the following. In each case write the expected answer to the query.
- (i) Find all the siblings of musa. *3 marks*
- (ii) Find all individuals with unknown parents. *3 marks*