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KIRIRI WOMEN'S UNIVERSITY OF SCIENCE AND TECHNOLOGY UNIVERSITY EXAMINATION FOR 2024/2025 ACADEMIC YEAR SECOND YEAR, SECOND SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN COMPUTER SCIENCE

KCS 2208 PRINCIPLES OF PROGRAMMING LANGUAGES Date: 12TH AUGUST, 2024 Time: 8:30 AM – 10:30 AM

<u>INSTRUCTIONS TO CANDIDATES</u> <u>ANSWER QUESTION ONE (COMPULSORY)</u> AND ANY OTHER TWO QUESTION

QUESTION ONE: COMPULSORY (30 MARKS)

- a) The primary difference between low and high-level languages is that any programmer can understand, compile, and interpret a high-level language feasibly as compared to the machine. The machines, on the other hand, are capable of understanding the low-level language more feasibly compared to human beings. Discuss the difference between compilers and interpreters. (4 Marks)
- b) There are several factors to take into account when choosing the right programming language for a particular project. These factors ultimately influence the performance, maintainability, and success of your project. Highlight 4 factors to consider when selecting a programming language for a project. (4 Marks)
- c) There are lots for programming language that are known but all of them need to follow some strategy when they are implemented and this methodology/strategy is paradigms. Expound on any two programming paradigms (4 Marks)
- d) Programs are designed using common building blocks. These building blocks, known as programming constructs, form the basis for all programs. Differentiate between count controlled and condition-controlled iterations. (4 Marks)
- e) All the resources necessary for running a program independently of the operating system (OS) are available on the platform. Practically speaking, a runtime environment is a piece of software that is designed to run other software. Discuss two advantages of runtime environment. (4 Marks)
- f) Each programming language has its own set of data types, with varying levels of complexity and functionalities. Knowledge of data types is essential because choosing the wrong data type can lead to incorrect results, inefficient code execution, wasted memory, or program errors. Distinguish between a variable and a data type. (4 Marks)

- g) Data types play a critical role in a wide range of real-life applications. Understanding which data types to choose for specific tasks and challenges can significantly improve your problem-solving and programming skills. Discuss two applications of float or double data type. (4 Marks)
- h) When learning about programming languages, the first concept you'll encounter is the syntax. If the syntax of a language is not followed, the code will not be understood by a compiler or interpreter. What do you understand by the term syntax?
 (2 Marks)

QUESTION TWO: (20 MARKS)

- a) While syntax is focused on the structure of a program, semantics refers to the meaning behind the code. Semantics is concerned with what happens during a program's execution and what actions your code produces. Discuss how the following languages apply the concept of semantics - Markup languages, Logical languages, Functional languages & Imperative languages. (8 Marks)
- b) Write a Java program that allows a user to input a sentence, evaluate the sentence for vowels and displays the count of the vowels in the sentence. (8 Marks)
- c) Hoare Logic is a formal system with a set of logical rules for reasoning vigorously about the correctness of computer programs. Here are a number of valid Hoare Triples, which statements are true and which is the most useful/strongest? (4 Marks)

 $\{x = 5\} x := x * 2 \{true\} \\ \{x = 5\} x := x * 2 \{x > 0\} \\ \{x = 5\} x := x * 2 \{x = 10 || x = 5\} \\ \{x = 5\} x := x * 2 \{x = 10\}$

QUESTION THREE: (20 MARKS)

a) Write a python program that can calculate the area of a circle given the radius using the formula $A = \pi r^2$.

(6 Marks)

b) A tree is a non-linear and hierarchical data structure where the elements are arranged in a tree-like structure. In a tree, the topmost node is called the root node. Each node contains some data, and data can be of any type. It consists of a central node, structural nodes, and sub-nodes which are connected via edges. Different tree data structures allow quicker and easier access to the data as it is a non-linear data structure. With the aid of a diagram illustrate the Parent Node, child node, sibling, leaf, and levels.

(8 Marks)

c) In computer science, denotational semantics (initially known as mathematical semantics or Scott–Strachey semantics) is an approach of formalizing the meanings of programming languages by constructing mathematical objects (called denotations) that describe the meanings of expressions from the languages. Given the expressions, deduce the compositionality requirement. (6 Marks)

$$\begin{bmatrix} Val \ n \end{bmatrix} = n$$
$$\begin{bmatrix} Add \ x \ y \end{bmatrix} = \begin{bmatrix} x \end{bmatrix} + \begin{bmatrix} y \end{bmatrix}$$

QUESTION FOUR: (20 MARKS)

- a) An array is a linear data structure and it is a collection of items stored at contiguous memory locations. The idea is to store multiple items of the same type together in one place. It allows the processing of a large amount of data in a relatively short period. The first element of the array is indexed by a subscript of 0. Discuss four operations that can be made possible by an array. (8 Marks)
- b) Another popular approach to semantics is the operational approach (Plotkin, 1981), in which the meaning of terms is defined using an execution relation that specifies how terms can be executed in an appropriate machine model. Using the example below describe the concept of state transition, the first rule (reduction) and the second rule (congruence) of operational semantic. (8 Marks)

$$\overline{Add (Val n) (Val m)} \longrightarrow Val (n + m)$$

$$\frac{x \longrightarrow x'}{Add x y \longrightarrow Add x' y} \qquad \qquad \frac{y \longrightarrow y'}{Add x y \longrightarrow Add x y'}$$

c) All programs use one or more of constructs. The longer and more complex the program, the more constructs will be used repeatedly. Discuss the concept of selection and sequence constructs. (4 Marks)

QUESTION FIVE: (20 MARKS)

- a) A programming language is a set of instructions written by a programmer to deliver instructions to the computer to perform and accomplish a task. Discuss, machine language, assembly language and high-level languages.
 (6 Marks)
- b) Programming languages are mainly differentiated into two categories: high and low. Languages are categorized into these two categories based on their human level of understanding. Using a table differentiate between the two.
 (8 Marks)
- c) The core concept of OOP is to separate concerns into entities which are coded as objects. OOP makes heavy usage of classes (which are a way of creating new objects starting out from a blueprint or boilerplate that the programmer sets). Objects that are created from a class are called instances. By way of an example describe the concept of object, attribute and method. (6 Marks)