Ref No: Ex/PG/MTCT/T/111A/2024

Master in Computer Technology
1^{st} Year, 1^{st} Semester, 2023-2024
Semester Examination
Principles of Programming Language

Full Marks : 100 Time : 3 Hrs

Write answers to the point. Make and state all the assumptions(wherever made).
ALL PARTS OF A QUESTION SHOULD BE ANSWERED TOGETHER

(Q1) Answer all questions : $(4 \times 5 = 20)$

(a) Which produces faster program execution, a compiler or a pure interpreter? Give reasons.

(b) What are the three fundamental features of an object- oriented programming language?

(c) Using Prolog, write a goal to find the existence of an element is a list $L1$, which is defined over a finite number of integers.

(d) What are α, β and η reduction ? Explain with example

(Q2) Answer QUESTION **(2a) and (2b)** and any other 2 questions: $(5+5+2\times5 = 20)$

(a) Consider the following C program segment. Rewrite it using no gotos or breaks.

```
j = -3;
for (i = 0; i < 3; i++) {
    switch (j + 2) {
        case 3:
        case 2:
        j--; break;
        case 0: j += 2; break;
        default: j = 0;
    }
    if (j > 0) break;
    j = 3 - i
}
```

(b) Consider the following programming problem: The values of three integer variables - - `first, second, third` must be placed in the three variables `max, mid, min` with the obvious meanings, without using arrays or user-defined or predefined subprograms. Write two solutions to this problem, one that uses nested selections and one that does not. Compare the complexity and expected reliability of the two.

(c) Some programming languages have static variables. What are the obvious advantages and disadvantages of having static variables? Give an example

(d) What does one have to observe for implementing a data type while designing a programming language.

(e) When might you want the compiler to ignore type differences in an expression?

(f) Should automatic type conversion be included in a programming language? Why or why not?

(Q3) Answer QUESTION **(3a)** and any other 2 questions: $(10 + 2 \times 5 = 20)$

(a) InternetFlix wants to build a web-based DVD rental business whereby customers interact with the company via the Internet. Customers use a web interface to browse the DVD inventory, ask about the availability of movies, and request to borrow movies (up to 2 movies at a time). The company mails requested DVDs out to the customer, and the customer mails the DVDs back when he is done with them. The rental period is two weeks. There is a fee for renting a movie (movies have different rental fees based on whether they are new releases, whether the movie has won any special awards, etc.). There is a late fee (assessed daily) for not returning a movie before the end of the rental period. When an account's balance falls below the value MinBal, the account is suspended and the customer cannot initiate new loans until payment is made and the balance becomes nonnegative. Information about both current and past loans is maintained.

Design an UML Use Case, Class and Sequence diagram for the system.

(b) What is the difference between a class variable and an instance variable? Give an example

(c) What is multiple inheritance? Give an example

(d) What is an overriding method? Give an example

(e) Explain why operator overloading increases the semantic capability of a language.

(Q4) Answer any **two** questions. Give the trace of the attempted goals. $(10 \times 2 = 30)$

(a) Define a goal which reverses a list.

(b) Write a rule using recursion for generating the N^{th} fibonacci number.

(c) Define the predicate **palindrome(List)**. A list is a palindrome if it reads the same in the forward and in the backward direction.

(d) Write a Prolog predicate $split(TheList, Evens, Odds)$ that asserts the following: (i) $Odds$ contains all the items in the odd positions of $TheList$ that are not the empty list (ii) $Evens$ contains all the items in the even positions of $TheList$, including the empty list. [Use $=$ and $\backslash =$ to distinguish cases].

(Q5) Answer any 2 questions: $(2 \times 10 = 20)$

(a) Evaluate : $(((\lambda f.\lambda g.\lambda x.(f\ (g\ x))\lambda s.(s\ s))\lambda a.\lambda b.b)\lambda x.\lambda y.x)$

(b) Define $\mathbf{B} \equiv \mathbf{S(KS)K}$. Then, show that $\mathbf{B}XYZ \rhd X(YZ)$ where $\mathbf{B}, \mathbf{S}, \mathbf{K}$ are combinators.

(c) Show that $\lambda x.(succ\ (pred\ x))$ and $\lambda x.(pred\ (succ\ x))$ are equivalent for arbitrary non-zero integer arguments. Explain why they are not equivalent for a zero argument.

(d) Analyse each of the following λ expressions to clarify its structure. If the expression is a function, identify the bound variable and the body expression, and then analyse the body expression. If the expression is an application, identify the function and argument expressions, and then analyse the function and argument expressions:

(i) $\lambda x.\lambda y.\lambda z((z\ x)\ (z\ y))$

(ii) $(\lambda f.\lambda g.(\lambda h.(g\ h)\ f)\ \lambda p.\lambda q.p)$