Ref. No.: Ex/CSE/PC/B/T/315 /2024

B.E. COMPUTER SCIENCE & ENGINEERING 3rd YEAR 1st SEMESTER EXAM- 2024

Principles of Programming Languages

Time: 3 hours | Full Marks: 100

Group A (Total Marks: 30) [CO1]
Answer any TWO questions using Java Streams

1.	(a) Differentiate between streams and collections. (b) Given a list of sentences stored in a text file, group it's words into three categories depending on word length-2-letter words, 3-letter words and more than 3 letter words. Then print the total no of words present in each subgroup. (c) Given two lists of words-(i) course names offered by the department, (ii) classroom nos.- Identify the duplicate pairs where the pairs are formed as (course name, classroom no.).	4+6+ 5=15
2.	***Artist** class denotes* an individual or group who creates music having the following fields. • *name*: The name of the artist (individual or group name) • *members*: A set of other artists who comprise this group - this field might be empty • *origin*: The primary location of origin of the group (e.g., "Kolkata"). (a)Find the bands with most members using lambda expressions and/or streams API. (b) Find the artist with the longest name. You should implement this using a Collector and the reduce higher-order function. Compare the two approaches. (c) Print the artists' names city-wise. This should be done parallelly. (d) Is this lambda expression side-effect free? Give reasons. `y→y*5` (e)Write an implementation of max() using reduce and lambda expressions.	4+5+ 2+2+ 2=15
3.	(a) Given a Stream where each element is a word, count the number of times each word appears. For example, it would return [Das → 3, Sarkar→ 2] (b) Create a collection of *n* Tribonacci numbers using java streams API. The number series looks like `0, 0, 1, 1, 2, 4, 7, 13, 24, 44, 81,...` Print the sum of first 20 such numbers. (c) Does *reduce()* implement mutable accumulator pattern? Give reasons. (d) Count the no. of lowercase letters in a string.	5+5+ 3+2= 15

Group B (Total Marks: 20) [CO2]
Answer any ONE question from this group.

4.	(a) Write code in Prolog to implement (i) maximum of 3 numbers, (ii) print first 10 natural numbers, (iii) inserting an element at the last position of a list, (iv) generating a list by replicating a number n, x times. (b) Build the search tree for (i) and (ii) stated above. (c) Write Horn clauses to compute G.C.D of numbers.	(3x4) +5+3 = 20
5.	(a) Given the following Prolog clauses: `ancestor(X, X).`	6+5+ 7+2=

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	ancestor(X,Y) :- parent(X, Z),!,ancestor(Z, Y).
	parent(amy, bob).
	Show the search tree to be generated for the query `ancestor(amy,X)`. Discuss the role of cut here.
	(b) Write Prolog code to divide a list into two parts and print the components. Print all possible combinations. Show the working for an example input.
	(c) Write the Prolog program for insertion sort. Show the steps using unification and/or resolution for the list [3,2,1].
	(d) Identify the axioms from the following clauses.
	`natural(0).`
	`natural(2).`
	`natural(-1).`
	`natural(X) :- natural(successor(X)).`
		20

Group C (Total Marks: 30) [CO3]
Answer any TWO questions.

6.	(a)
	`i=1;sum=0;`
	`while(i<n) {`
	`sum+=i; i++;`
	`}`
	`Average=sum/n;`
	Represent above construct in lambda calculus. You can assume that *Church numerals, Booleans, if-then-else* predicates are in place. *Justify your answer.*
	(b) Show the deduction steps for any number, n>3
	(c) Compare between Omega combinator and Y combinator.
		10+3 +2 =15

7.	(a) Derive the Boolean operator NOR in lambda calculus and validate its truth table. No need to define '*true*', '*false*'. (b) `In case there is one or more class tests, you sleep for five hours. Otherwise, you take a nine-hour long nap.` Take classtest count as a natural number. Represent above construct in lambda calculus without defining division. Derive any predicates, constructs and data types that you need. No need to define *Church numerals*. (c) Explain by showing the deductions of any one use-case. (d) Apply Normal order reduction to the following lambda expression. `((((λf.(λg.(λx.((fx)(gx)))))(λm.(λn.(nm))))(λn.z))p)`	4+6+ 3+2= 15
8.	(a) Reduce the following lambda expression using both normal order and applicative order reduction. (x . y)((x . x x x) (x . x x x)) (b) Derive Lambda calculus expression for factorial of a Church numeral applying the concept of tail recursion. You can assume that *Church numerals, Booleans, if-then-else* predicates are in place. (c) Show the steps for *factorial three*. You can use delta reduction for multiplication. (d) Given tuples of the form *(project topic, faculty name)* write suitable lambda calculus expression to extract project topic.	3+7+ 3+2= 15

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Group D (Total Marks: 10) [CO4]
Answer any ONE question.

9.	(a) Discuss the concept of purity reflection in functional programming. (b) Compare between call by need and call by name. (c)Define functional interface. Is `java.io.Closeable` a functional interface?	4+3+3=10
10.	(a) Discuss the applicability of normal order and applicative order reduction to modern programming languages. (b) Discuss the concept of call by need.	6+4=10

Group E (Total Marks: 10) [CO5 and CO6]
Answer any ONE question.

11.	(a) Define higher order function. (b)Discuss the concept of data abstraction.	4+6= 10
12.	(a) What are the main drawbacks of imperative programming? (b) Discuss the role of double dispatch in object oriented programming. (c) Discuss the concept of unit abstraction.	3+5+2=10