

B.E. COMPUTER SCIENCE & ENGINEERING 3rd YEAR 1st SEMESTER EXAM- 2025**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 (i) “collect” and “collecting”; (ii) external and internal iteration. (b) Given a list of student objects called BCSEIII, divide them into 3 subgroups based on their attendance (‘regular’, ‘moderately regular’, ‘irregular’). Then print the average marks scored by the students of each group. (c) Given a text file, find any character that is repeated.	5+5+ 5=15
2.	<i>Artist class denotes</i> an individual or group who creates music having the following fields. • <i>name</i>: The name of the artist (individual or group name) • <i>members</i>: A set of other artists who comprise this group - this field might be empty • <i>origin</i>: The primary location of origin of the group (e.g., “Kolkata”). (a) Find the bands with <i>least</i> members using lambda expressions and/or streams API. (b) Print the artists’ names city-wise. This should be done parallelly. (c) Form a list of numbers that represents pairwise summations of numbers taking each number from two lists of numbers. Each number should appear exactly once in the list. (d) Partition the list of natural numbers into prime and non-prime numbers using Java Streams.	4+3+ 4+4= 15
3.	(a) 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.). (b) 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] (c) Discuss mutable accumulator pattern and its effect on parallelization w.r.t Java Streams. (d) Which of these lambda expressions are valid Function<Double,Double> implementations? Explain. (i) $x \rightarrow x$; (ii) $(x, y) \rightarrow x + y + 1$;	5+5+ 3+2= 15

[Turn over

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

4.	(a) Write code in Prolog to implement (i) splitting a list into two parts, (ii) print first 10 natural numbers, (iii) inserting an element at the first position of a list, (iv) generating a list by replicating a number n, x times. (b) Build the search tree for (ii) and (iv) stated above. (c) Write a program in Prolog that prints the reverse of a list. Write an example query and output.	(3x4) +5+3 = 20
5.	(a) Given the following Prolog clauses: <pre> ancestor(X, X):-!. ancestor(X,Y) :- parent(X, Z),ancestor(Z, Y). parent(bob, amy). </pre> Show the search tree to be generated for the query <code>ancestor(X, amy)</code> . Discuss the role of cut here. (b) Write a code in Prolog to find the length of a given list. Show the working for an example input. (c) Write a procedural code for insertion sort. Write a Prolog program for insertion sort. Differentiate the two approaches. Show the initial computation steps of the Prolog program for the list [3,2,1].	5+5+ 10= 20

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

6.	(a) <pre>i=1; sum=0; while(i<n) { sum+=i; i++; } Average=sum/n;</pre> Represent above construct in lambda calculus. You can assume that <i>Church numerals</i> , <i>Booleans</i> , <i>if-then-else</i> predicates are in place. <i>Justify your answer.</i> (b) Show the deduction steps for any number, $n > 3$ (c) Apply Normal order reduction to the following lambda expression. $((((\lambda f. (\lambda g. (\lambda x. ((fx) (gx)))) (\lambda m. (\lambda n. (nm)))) (\lambda n. z))) p)$	10+ 3+2 =15
7.	(a) Design a message filter in Lambda calculus that will take two inputs-(i) message from your friend and (ii) semester time flag. If it is not semester time, you get all the messages of your friend otherwise no messages will be viewed. Rather the message filter will always display "Believe in your brain, you can". Derive any predicates, combinators and data types that you need. (b) Explain by showing the deductions of any one use-case. (c) 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 and constructs that you need. No need to define <i>boolean</i> and <i>Church numerals</i> .	8+3 +4= 15

8.	(a) Derive Lambda calculus expression for factorial of a Church numeral. You can assume that <i>Church numerals</i>, <i>Booleans</i>, <i>if-then-else</i> predicates are in place. (b) Show the steps for <i>factorial four</i>. You can use delta reduction for multiplication. (c) In a student-teacher meeting, students are asked to sit along even numbered rows and teachers are asked to sit along the odd numbered rows. So, if a student comes, his/her row number will be even else it is odd. Write this row checker in Lambda calculus. Explain with an example value.	7+3 +5= 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) Analyze how memoisation is implemented in logic programming and in functional programming. (c) Define functional interface. Is <code>java.io.Closeable</code> a functional interface?	4+4+2= 10
10.	(a) Discuss the applicability of normal order reduction to modern programming languages. (b) What is the need for introducing typed lambda calculus over untyped lambda calculus?	5+5=10

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

11.	(a) Discuss the role of regularity and its aspects in programming language design. (b) Compare between object oriented and functional programming styles w.r.t unplanned extensions (extensibility) of a code.	6+4= 10
12.	A Planet Explorer routinely travels across the planets in the Solar System to discover life form. However, the method of exploring is different on each planet, due to the difference in atmosphere and surface composition. Write suitable class(s) and/or interface(s) to represent the scenario. Analyze how single/double dispatch polymorphism is supported by your code.	10