BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP/2025)

CLASS: BTECH
BRANCH: CSE/AIML

SEMESTER : IV/ADD
SESSION : SP/2025

SUBJECT: CS241DESIGN AND ANALYSIS OF ALGORITHMS

TIME: 02 Hours

FULL MARKS: 25

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

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			CO	BL
Q.1(a)	Discuss a practical scenario where asymptotic notation is more useful than considering the actual run-time of an algorithm. Also prove that if $f(n) = 2n^3 + 3n^2 + 1$ and $g(n) = 2n^2 + 3$ then $f(n) = \Omega(g(n))$.	[2]	1	3

Q.1(b)	Consider a part of an algorithm below:
	`int count = 0;`
	`for (int i = n; i > 0; i /= 2) {`
	`  for (int j = 0; j < i; j++) {`
	`  count++;`
	`  }}`
	1. Find the time complexity of the above algorithm.
	2. Will there be any difference in the complexity if the outer loop is substituted by `for(int i=0; i<n; i*= 2)`
		[3]	1	4

Q.2(a)	Solve the following recurrences using the *Recursion Tree* method: T (n) = T (n / 3) + n/2	[2]	1	3
Q.2(b)	Using *Master's Theorem* solve the following recurrence relations: (1) T (n) = 2 T (n / 4) + $n^{0.5}$ (2) T (n) = 2 T ($\sqrt{n}$) + *log n*	[3]	1	3
Q.3(a)	Suggest an algorithm which dichotomizes any randomly distributed dataset around a pivot value (say *p*) such that after the partition is achieved, values lesser than p are placed left to it, and the values larger than p are placed right to it. Assuming the last element as the pivot, apply this algorithm to process the following data: 8, 2, 1, 5, 6, 1, 3, 7, 4, 9, 5.	[2]	2, 3	3
Q.3(b)	In a class, there are *m* boys and *n* girls. Their CGPAs are stored in two arrays B & G, one for the boys (B) in descending order, the other for the girls(G) in ascending order. Devise an efficient O (m +n) algorithm to find out the set (A) of duplicate CGPAs that are common between both the boys and girls in ascending order.	[3]	3	3
Q.4(a)	Finding the n^{th} order statistic in a given dataset (of size *n*) typically requires (n-1) comparisons. Going by this we can find both the 1^{st} and the n^{th} order statistics in (2n-2) comparisons. Suggest an algorithm which finds these order statistics in $kn + c$ comparisons, where *k* is a positive real constant and is less than 2, and *c* is an integer value.	[2]	4	6
Q.4(b)	Prof Sheshadri has discovered a divide-and-conquer matrix multiplication algorithm that is based on multiplying two 70-by-70 matrices using 143,640 multiplications. Find the asymptotic efficiency of this algorithm and compare it with that of Strassen's algorithm. Give your comment on the admissible number of additions and/or subtractions required.	[3]	5	3

PTO

Q.5(a)	A data compression system needs to encode the following characters with their given frequencies: {(A, 10), (B, 15), (C, 30), (D, 16), (E, 29)} 1. Determine the optimal prefix-free binary code for each character. 2. Critically analyse if the applied algorithm always produces an optimal encoding for lossless compression.	[2]	3	4
Q.5(b)	A courier company needs to maximize the profit of a delivery truck that can carry a maximum weight of 20 kg. The available parcels (Pi) have the following weights (Wi) and values (Vi) in Rs.: (Pi, Wi, Vi) = {(P1, 4, 40), (P2, 8, 60), (P3, 2, 20), (P4, 6, 50), P5, 10, 100)} Task: 1. Compute the maximum profit the company can obtain. Show all steps. 2. Critically evaluate whether the greedy strategy is guaranteed to produce the globally optimal solution.	[3]	3	4

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