

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)**

**CLASS: BCA
BRANCH: BCA**

**SEMESTER: V
SESSION: MO/2025**

SUBJECT: CN301 FUNDAMENTALS OF COMPUTER ALGORITHMS

TIME: 3 Hours

FULL MARKS: 50

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
 2. Attempt all questions.
 3. The missing data, if any, may be assumed suitably.
 4. Before attempting the question paper, be sure that you have got the correct question paper.
 5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
-

- Q.1(a) Define Big O notation formally. Give an example of a function $f(n)$ which is $O(n)$ but not $\theta(n)$. [5] CO 4 BL 1, 2, 3

Arrange the following functions in order of their growth rates:

$$f(n) = n^2 + n(\log n)^3 + 100, \quad g(n) = n^2 \log n + n, \quad h(n) = n + e^n \text{ and } p(n) = n^3 + 4n$$

- Q.1(b) Taking binary-search as an example, explain the significance of the best and the worst-case time complexity of an algorithm. What is the space complexity of binary-search algorithm? [5] CO 4 2
- Q.2(a) Write the recurrence relation for the time $T(n)$ required by Merge-sort algorithm for sorting n elements. Solve the recurrence relation for $T(n)$ to find the time complexity of Merge-sort algorithm. Then, use Master's theorem to validate your answer. [5] CO 4 2, 3
- Q.2(b) Explain Quick-sort algorithm with example. Mention its best, worst and average case time complexities. [5] CO 1 2

- Q.3(a) A message of length 10000 characters consists of only six different characters a, b, c, d, e and f. The following table shows the respective frequencies of occurrence of these characters in the message: [5] CO 1 & 3 3, 4

Characters	a	b	c	d	e	F
Frequencies (in hundreds)	30	15	13	7	23	12

Find Huffman codes for these six characters to encode the message and then find the length of the encoded message in bits.

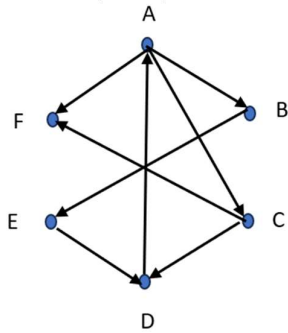
Mention which design paradigm is used here.

- Q.3(b) Write Prim's algorithm for finding minimum spanning tree of a connected weighted graph. Explain this algorithm with the help of a small example. What is the time complexity of this algorithm? [5] CO 1 & 3 2
- Q.4(a) What is dynamic programming? How does it improve upon recursion? What are the main properties of a problem that make it suitable for dynamic programming? --- Explain with suitable examples. [5] CO 3 4
- Q.4(b) Solve the following instance of 0/1 Knapsack problem using dynamic programming technique. [5] CO 1 & 3 2, 3

No. of objects: 4; Sack capacity: 5; W: <2, 1, 3, 1>; P: <10, 10, 6, 8>

Mention the time complexity of this algorithm. Do you think this is a polynomial time algorithm? Justify your answer.

- Q.5(a) Name one way of storing a general graph in computer memory. Explain with the following graph. Mention its space complexity. [5] CO 2,3
2



Execute Depth First Search (DFS) algorithm on the given Graph, starting from the vertex A. Show the DFS-tree/forest generated by your execution. Classify each non-tree edge as forward edge, back edge or cross edge.

- Q.5(b) Define NP-Complete and NP-Hard problems. [5] CO 2, 4
5
- Using a Venn diagram show the relationship between P, NP, NP-Complete, and NP-Hard classes. In that Venn diagram plot *n-Queen* problem and *Sum-of-Subset* problem.

Give example: (i) An NP-complete problem, (ii) An NP-Hard problem which is not NP-Complete.

:::::19/11/2025:::::M