PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

BSc DEGREE EXAMINATION MAY 2025
(Sixth Semester)

Branch – **COMPUTER SCIENCE**

DESIGN AND ANALYSIS OF ALGORITHMS

Time: Three Hours Maximum: 50 Marks

SECTION-A (5 Marks)
Answer **ALL** questions
ALL questions carry **EQUAL** marks (5 x 1 = 5)

1. Consider the following recurrence relation for an algorithm's time complexity: $T(n)=3T(n/4)+n^2$. Determine the asymptotic behavior of T(n)
(i) O(nlogn) (ii) $O(n^2)$
(iii) $O(n^3)$ (iv) $O(n^2 logn)$

2. A king has n coins, but one of them is fake and has a different weight. He has a balance scale that can compare the weights of two groups of coins. Using a brute force approach, how many weighings are required in the worst case to find the fake coin?
(i) O(n) (ii) O(log n)
(iii) O(n log n) (iv) O(1)

3 Given a set of n positive integers and a target sum S, the Sum of Subsets problem aims to find:
(i) All subsets whose sum is exactly S
(ii) The largest subset with a sum less than or equal to S
(iii) The smallest subset whose sum exceeds S
(iv) The total number of subsets whose sum is greater than S

4. Which of the following statements is true about the Branch and Bound technique?
(i) It guarantees an optimal solution for all optimization problems
(ii) It is primarily used for solving NP-hard problems efficiently
(iii) It explores all possible solutions without pruning any branches
(iv) It is faster than all other algorithms for combinatorial problems

5. Which of the following is true about NP-Hard problems?
(i) Every NP-Hard problem is also in NP
(ii) NP-Hard problems can be solved in polynomial time
(iii) If an NP-Hard problem can be solved in polynomial time, then P = NP
(iv) All NP-Hard problems are decidable

SECTION - B (15 Marks)
Answer **ALL** Questions
ALL Questions Carry **EQUAL** Marks (5 x 3 = 15)

6 a. Show that the solution to the recurrence $T(n)=T(n-1)+n$ is $O(n^2)$ using substitution method.

OR

b. Consider the following algorithm:

```
void mystery(int n) {
int count = 0;
for (int i = n; i > 0; i /= 2) {
for (int j = 1; j <= i; j++) {
count++;
  }
 }
cout << count;
 }
```

Without executing the code, determine its time complexity and justify your answer.

Cont...

7 a A drone delivery company wants to minimize flight time by identifying the two closest delivery locations from a list of n locations on a 2D map.

1. What is the naive approach to solve this problem, and what is its time complexity?
2 Why does this approach become inefficient as the number of locations increases?
3 Suggest a more efficient strategy to solve this problem.

OR

b A wildlife conservation team is tracking a group of endangered animals using GPS coordinates. To protect their habitat, they want to build a fence that encloses the entire group using the shortest possible boundary.

1. What type of boundary should be used to enclose the group efficiently?
2. What is a simple but inefficient way to determine this boundary?
3. Can you suggest a faster method to find the optimal boundary?

8. a. A university is conducting online exams for multiple subjects. The university wants to assign exam slots such that:

1. No two exams scheduled at the same time have students enrolled in both.
2. The number of time slots used is minimized.

Given the following subject conflict table, design an efficient Backtracking algorithm to determine the minimum number of time slots needed.
Subject Conflict Table:

- S1 clashes with S2, S3
- S2 clashes with S3, S4
- S3 clashes with S1, S2, S5
- S4 clashes with S2
- S5 clashes with S3

OR

b Question: Surveillance Drone Deployment in a City
A city wants to deploy 4 surveillance drones in a 4×4 grid to monitor an area efficiently. The rules for placement are:
No two drones should be able to detect each other based on their range of surveillance. The placement must ensure maximum coverage without any two drones affecting each other's signals. Find a valid arrangement where all 4 drones are deployed safely.

9 a Differentiate branch and bound and dynamic programming using Knapsack Problem.

OR

b Summarise the Travelling Sales person Problem.

10 a What is meant by approximation algorithms.

OR

b Give some example of NP hard problems.

SECTION -C (30 Marks)

Answer **ALL** questions
ALL questions carry **EQUAL** Marks (5 x 6 = 30)

11 a An algorithm has the following loop structure:

```
for (int i = 1; i <= n; i *= 2) {
  for (int j = 1; j <= i; j++) {
    // Constant time operation
  }
}
```

Estimate the time complexity of this algorithm and explain your reasoning.

OR

b Analyse the pseudocode step-by-step for best and worst-case scenarios. Express its bound using standard asymptotic notation.

Algorithm Sort(A,n)

1. ***for i = 2 to n***
2. ***key = A[i]***
3. ***j = i − 1***
4. ***while j > 0 and A[j] > key***
5. ***A[j + 1] = A[j]***
6. ***j = j − 1***
7. ***A[j + 1] = key***

12 a A graphics rendering engine needs to process high-resolution images by applying complex transformations. A standard algorithm performs $O(n^3)$ operations, making it slow for large images.
A researcher proposes an improved divide-and-conquer approach that reduces the number of computations in each step while still producing accurate results.

1. What kind of optimizations can reduce the computational cost?
2. Formulate a recurrence relation for an approach that breaks the problem into 7 subproblems instead of 8.
3. Solve for the time complexity and explain why this approach is faster for large inputs.

OR

b A company needs to assign four employees (A, B, C, D) to four different projects (P1, P2, P3, P4) based on their efficiency scores (lower is better). The efficiency cost matrix is given below:

	P1	P2	P3	P4
A	9	2	7	8
B	6	4	3	7
C	5	8	1	8
D	7	6	9	4

The company wants to minimize total inefficiency by assigning each employee to exactly one project.

1. Formulate the problem as a cost minimization problem.
2. Solve it optimally using a suitable method.
3. What is the minimum total inefficiency?

13 a. A network engineer is responsible for maintaining n data centers connected by fiber-optic cables. The engineer must visit each data center exactly once to perform maintenance checks and then return to the starting location.
The cost of traveling between two data centers depends on the network congestion and distance. Given the following latency cost matrix, determine the minimum cost route that the engineer should take to complete the maintenance efficiently.
Network Latency Cost Matrix:

	D1	D2	D3	D4
D1	0	12	25	30
D2	12	0	15	20
D3	25	15	0	18
D4	30	20	18	0

Find the optimal sequence of data center visits that results in the lowest total latency(Consider Starting at D1).

OR

b Explain Knapsack problem with example.

14 a Elucidate the fast fourier transform.

OR

b Discuss FIFO Branch and bound.

15 a Give and enumerate cook's theorem.

OR

b With example, explain code generation problem.

Z-Z-Z

END