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Course Code: CSE408 **Paper Code A**

Course Title: DESIGN AND ANALYSIS OF ALGORITHMS

Time Allowed: 3 hrs **Max. Marks: 60**

Read the following instructions carefully before attempting the question paper.

1. *Match the Paper Code shaded on the OMR Sheet with the Paper code mentioned on the question paper and ensure that both are the same.*
2. *This question paper contains 60 questions of 1 mark each. 0.25 marks will be deducted for each wrong answer.*
3. *All questions are compulsory.*
4. *Do not write or mark anything on the question paper except your registration no. on the designated space.*
5. *Submit the question paper and the rough sheet(s) along with the OMR sheet to the invigilator before leaving the examination hall.*

Q.1 Consider a undirected graph G with vertices { A, B, C, D, E}. In graph G, every edge has distinct weight. Edge CD is edge with minimum weight and edge AB is edge with maximum weight. Then, which of the following is false?

A. Every minimum spanning tree of G must contain CD
B. If AB is in a minimum spanning tree, then its removal must disconnect G
C. No minimum spanning tree contains AB
D. G has a unique minimum spanning tree

Q.2 Name the type of data structure among the following that could be used to implement queues? L2CO1

A. Linked List type of data structure
B. Arrays type of data structure
C. Stack type of data structure
D. All of the above

L1CO1

Q.3 What is the maximum number of possible non zero values in an adjacency matrix of a simple graph with n vertices?

A. (n*(n-1))/2 B. (n*(n+1))/2 C. n*(n-1) D. n*(n+1) L2CO1

Q.4 Which of the following is not true about comparison-based sorting algorithms?

A. The minimum possible time complexity of a comparison-based sorting algorithm is O(n(log(n)) for a random input array
B. Any comparison based sorting algorithm can be made stable by using position as a criteria when two elements are compared
C. Counting Sort is not a comparison based sorting algorithm
D. Heap Sort is not a comparison based sorting algorithm L1CO1

Q.5 Which of the given options provides the increasing order of asymptotic complexity of functions f1, f2, f3, and f4?

$f1(n) = 2^n$
$f2(n) = n^{(3/2)}$
$f1(n) = n*\log(n)$
$f1(n) = n^{\log(n)}$

A. f3, f2, f4, f1
B. f3, f2, f1, f4
C. f2, f3, f1, f4
D. f2, f3, f4, f1

L2CO1

Q.6 Which of the following is the fastest algorithm in string matching field?

A. Boyer-Moore's algorithm
B. String matching algorithm
C. Quick search algorithm
D. Linear search algorithm

L4CO2

Q.7 What is the basic formula applied in Rabin Karp Algorithm to get the computation time as Theta(m)?

A Halving rule B. Horner's rule
C. Summation lemma D. Cancellation lemma

L3CO2

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Q.8 What is the worst time complexity of KMP algorithm (m=length of text, n=length of pattern)?
A. O(n) B. O(m*n) C. O(logn) D. O(m) L2CO2

Q.9 What is the basic principle in Rabin Karp algorithm?
A. Hashing B. Sorting
C. Augmenting D. Dynamic Programming

Q.10_____ is a method of constructing a smallest polygon out of n given points. L1CO2
A. Closest pair problem B. Convex hull problem C. Path compression. D. Union-by-rank

Q.11Which of the following statement is not related to convex hull algorithm? L2CO2
A. Finding points with minimum and maximum coordinates
B. Dividing the subset of points by a line
C. Eliminating points within a formed triangle
D. Finding the shortest distance between two pointsL2CO3

Q.12The worst case occurs in quick sort when
A. Pivot is the median of the array
B. Pivot is the smallest element in the array
C. Pivot is the middle element
D. None of the above

Q.13For getting best time complexity in the worst case scenario, which type of sorting algorithms are used? L1CO3
A. Bubble sort algorithm
B. Selection sort algorithm
C. Quick sort algorithm
D. Merge sort algorithm

Q.14 Consider the following program: L2CO3

```
int main()
{
  int x, y, m, n;
  scanf ("%d %d", &x, &y);
  /* x > 0 and y > 0 */
  m = x; n = y;
  while (m != n)
  {
    if(m>n)
      m = m - n;
    else
      n = n - m;
  }
  printf("%d", n);
}
```

What is the output of the aforementioned program?
A. x + y using repeated subtraction
B. x mod y using repeated subtraction
C. The greatest common divisor of x and y
D. The least common multiple of x and yL1CO3

Q.15 Consider the following array: [23, 32, 45, 69, 72, 73, 89, 97]. Which algorithm out of the following options uses the least number of comparisons (among the array elements) to sort the above array in ascending order?
A. Selection sort
B. Mergesort
C. Insertion sort
D. Quicksort using the last element as pivot

L2CO3

Q.16 In heap sort, after deleting the last minimum element, the array will contain elements in
A. Increasing sorting order B. Decreasing sorting order
C. Tree in-order D. Tree pre-order

L1CO4

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Q.17 What can be the value of m in the division method (p=prime number)?
A. Any prime number
B. Any even number
C. $2^p - 1$
D. 2^p
L1CO4

Q.18 Consider the following three functions.
$f1 = 10^n$
$f2 = n\log n$
$f3 = n^{\sqrt{n}}$
Which one of the following options arranges the given functions in the increasing order of asymptotic growth rate?
A. f3<f2<f1
B. f2<f1<f3
C. f1<f2<f3
D. f2<f3<f1

Q.19 Which of the following is/are property/properties of a dynamic programming problem? L1CO4
A. Optimal substructure
B. Overlapping sub-problems
C. Greedy approach
D. Both optimal substructure and overlapping sub-problems

Q.20 Which of the following standard algorithms is not Dynamic Programming based? L1CO4
A. Bellman–Ford Algorithm for single source shortest path
B. Floyd-Warshall Algorithm for all pairs shortest paths
C. 0-1 Knapsack problem
D. Prim's Minimum Spanning Tree

Q.21 We use dynamic programming approach when L1CO4
A. We need an optimal solution
B. The solution has optimal substructure
C. The given problem can be reduced to
C. 3-SAT problem.
D. It's faster than Greedy

L1CO4

Q.22 Consider two strings A = "qpqrr" and B = "pqprqrp". Let x be the length of the longest common subsequence (not necessarily contiguous) between A and B and let y be the number of such longest common sub-sequences between A and B. Then x + 10y = ____.
A. 33
B. 23
C. 43
D. 34
L1CO4

Q. 23 Let A1, A2, A3, and A4 be four matrices of dimensions 10 x 5, 5 x 20, 20 x 10, and 10 x 5, respectively. The minimum number of scalar multiplications required to find the product A1A2A3A4 using the basic matrix multiplication method is
A. 1500
B. 2000
C. 500
D. 100

L1CO4

Q.24 Consider the weights and values of items listed below. Note that there is only one unit of each item.

Item number	Weight in kg	Value in Rs.
1	10	60
2	7	28
3	4	20
4	2	24

he task is to pick a subset of these items such that their total weight is no more than 11 kg and their total value is aximized. Moreover, no item may be split. The total value of items picked by an optimal algorithm is denoted by . A greedy algorithm sorts the items by their value-to-weight ratios in descending order and packs them greedily, rting from the first item in the ordered list. The total value of items picked by the greedy algorithm is denoted by . The value of $V_O - V_g$ is _____.
16
B. 8
C. 44
D. 60
L1CO4

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Q.25 Consider the following two sequences:
X = <B, C, D, C, A, B, C>, and
Y = <C, A, D, B, C, B>
The length of longest common subsequence of X and Y is
A. 5 B. 3 C. 4 D. 2 L1CO4

Q.26 The following paradigm can be used to find the solution of the problem in minimum time: Given a set of non-negative integer, and a value K, determine if there is a subset of the given set with sum equal to K:
A. Divide and Conquer C. Dynamic Programming
C. Greedy Algorithm D. Branch and Bound L1CO4

Q.27 What happens when a top-down approach of dynamic programming is applied to any problem?
A. It increases both, the time complexity and the space complexity.
B. It increases the space complexity and decreases the time complexity.
C. It increases the time complexity and decreases the space complexity.
D. It decreases both, the time complexity and the space complexity. L1CO4

Q.28 You are given a knapsack that can carry a maximum weight of 60. There are 4 items with weights {20, 30, 40, 70} and values {70, 80, 90, 200}. What is the maximum value of the items you can carry using the knapsack?
A. 160 B. 200 C. 170 D. 90 L1CO4

Q.29 In dynamic programming, the technique of storing the previously calculated values is called_____.
A. Saving value property B. Storing value property C. Memorization D. Mapping L1CO4

Memoization

Q.30What is the time complexity of the divide and conquer algorithm used to find the maximum sub-array sum?
A. O(n) B. O(logn) C. O(nlogn) D. O(n^2) L1CO4

Q.31 For which values of m and n does the complete bipartite graph km, n have a Hamilton circuit?
A. $m \neq n$, m, $n \geq 2$ B. $m \neq n$, m, $n \geq 3$ C. $m = n$, m, $n \geq 2$ D. $m = 2$, m, $n \geq 3$ L3CO5

Q.32 Let G be an undirected complete graph on n vertices, where $n > 2$. Then, the number of different Hamiltonian cycles in G is equal to
A. n! B. (n-1)! C. 1 D. (n-1)!/2 L3CO5

Q.33 Consider the following statements:
I: If A = {x: x is an even natural number} and B = {y: y is a natural number}, A subset B.
II: Number of subsets for the given set A = {5, 6, 7, 8) is 15.
III: Number of proper subsets for the given set A = {5, 6, 7, 8) is 15.
Which of the following statement(s) is/are correct?
A. I and II
B. II and III
C. I and III
D. None of the above L2CO5

Q.34 The problem of finding a subset of positive integers whose sum is equal to a given positive integer is called as?
A. n- queen problem
B. Subset sum problem
C. Knapsack problem
D. Hamiltonian circuit problem L3CO5

Q.35Of the following given options, which one of the following does not provides an optimal solution for 8-queens problem?
A. (5, 3, 8, 4, 7, 1, 6, 2) B. (1, 6, 3, 8, 3, 2, 4, 7)
C. (4, 1, 5, 8, 6, 3, 7, 2) D. (6, 2, 7, 1, 4, 8, 5, 3) L1CO5

Q.36 In general, backtracking can be used to solve
A. Numerical problems B. Exhaustive search
C. Combinatorial problems D. Graph colouring problems L2CO5

Q.37 In n-queen problem, how many values of n does not provide an optimal solution?
A. 1 B. 2 C. 3 D. 4 L3CO5

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Q.38 Backtracking algorithm is implemented by constructing a tree of choices known as _____. L2CO5
A. State-space tree B. State-chart tree C. Node tree D. Backtracking tree

Q.39 A node is said to be _____ if it has a possibility of reaching a complete solution. L3CO5
A. Non-promising B. Promising C. Succeeding D. Preceding

Q.40 In what manner is a state-space tree for a backtracking algorithm constructed? L1CO5
A. Depth-first search B. Breadth-first search
C. Twice around the tree D. Nearest neighbour first

Q.41 Consider a knapsack of capacity 80 kg, with the list of items and their profits as shown below:

Items	Weights	Profits
1	30	120
2	60	60
3	20	60
4	50	100

What is the maximum obtainable profit if the items can be fractional? L3CO5
A. 220 B. 240 C. 200 D. 210

Q.42 0/1 Knapsack is solved via _____ while fractional knapsack is solved via _____. L2CO5
A. dynamic programming, backtracking B. backtracking, dynamic programming
C. branch and bound, dynamic programming D. dynamic programming, greedy method

Q.43 The Nearest Neighbour Method consist of following steps:
A. Form the circuit by joining the starting vertex with the last vertex added by an edge.
B. A path of one edge is formed by selecting an arbitrary vertex and finding the vertex nearest to it.
C. A vertex that has been added to the path is denoted by v. Select the closest vertex to v from the list of vertices that are not part of the path, then add the edge connecting this vertex to the path. In this step, repeat the process until the path includes all the vertices of graph G.
Select the correct order in which process should take place.
A. A > B > C B. B > A > C C. B > C > A D. C > A > B

Q.44 How does the practical travelling salesman problem differ from the classical travelling salesman problem? L3CO5
A. In the practical travelling salesman problem each vertex can only be visited once
B. In the practical travelling salesman problem each vertex can be visited more than once
C. In the practical travelling salesman problem each edge can only be visited once
D. In the practical travelling salesman problem each edge can be visited more than once

Q.45 Consider the following statements: L2CO5
1. The null set is a subset of every set.
2. Every set is a subset of itself.
3. If a set has 10 elements, then its power set will have 1024 elements.
Which of the above statements are correct?
A. 1 and 2 B. 2 and 3 C. 1 and 3 D. 1, 2, 3

Q.46 Problems that cannot be solved by any algorithm are called? L3CO5
A. Tractable problems B. Intractable problems C. Undecidable problems D. Decidable problems

Q.47 Hamiltonian path problem is _____. L1CO6
A. NP problem B. N class problem C. P class problem D. NP complete problem

Q.48 Standard planning algorithms assume environment to be _____. L1CO6
A. Both deterministic and fully observable B. Neither deterministic nor fully observable
C. Deterministic but not fully observable D. Not deterministic but fully observable

Q.49 Let S be an NP-complete problem and Q and R be two other problems not known to be in NP. Q is polynomial time reducible to S and S is polynomial-time reducible to R. Which one of the following statements is true? L1CO6
A. R is NP-complete B. R is NP-hard
C. Q is NP-complete D. Q is NP-hard

Q.50 The problem 3-SAT and 2-SAT are: Regds: _____

A. Both in P
B. Both NP-complete
C. NP-complete and in P respectively
D. Undecidable and NP-complete respectively

Q.51 Ram and Shyam have been asked to show that a certain problem Π is NP-complete. Ram does a polynomial time reduction from the 3-SAT problem to Π, and Shyam shows a polynomial time reduction from Π to 3-SAT. Which of the following can be inferred from these reductions?
A. Π is NP-hard but not NP-complete
B. Π is in NP, but is not NP-complete
C. Π is NP-complete
D. Π is neither NP-hard, nor in NP

Q.52 A problem in NP is NP-complete if:
A. It can be reduced to the 3-SAT problem in polynomial time
B. The 3-SAT problem can be reduced to it in polynomial time
C. It can be reduced to any other problem in NP in polynomial time
D. Some problem in NP can be reduced to it in polynomial time

Q.53 Given the following statements:
S1: Every context-sensitive language L is recursive
S2: There exists a recursive language that is not context-sensitive
Which statements are true?
A. Only S1 is correct
B. Only S2 is correct
C. Both S1 and S2 are incorrect
D. Both S1 and S2 are correct

Q.54 The Euler's circuit problem can be solved in:
A. O(n)
B. O(nlogn)
C. O(log n)
D. O(n²)

Q.55 Halting problem is an example of
A. Decidable problem
B. Undecidable problem
C. Complete problem
D. Tractable problem

Q.56 The choice of polynomial class has led to the development of an extensive theory called
A. Computational complexity
B. Time complexity
C. Problem complexity
D. Decision complexity

Q.57 How many stages of procedure does a non-deterministic algorithm consist of?
A. 1
B. 2
C. 3
D. 4

Q.58 To which of the following class does a CNF-satisfiability problem belong?
A. NP class
B. P class
C. NP complete
D. NP hard

Q.59 How do we categorize a problem as NP?
A. By showing its running time to be non-polynomial
B. By showing its running time to be exponential
C. By showing its running time to be non-deterministically polynomial
D. None of the above

Q.60 What does P ≠ NP imply?
A. There is no way to check if a given problem is solvable in polynomial time.
B. The time complexity of a polynomial time solution is not equal to non-polynomial time solution.
C. The answer from a solution cannot be verified in polynomial time.
D. The time taken to solve a problem is smaller than the time taken to verify the solution.

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