Advanced Data Structures & Algorithm (IT)

T.E - V Sem - IT

NM

Advanced Data Structures & Analysis of Algorithms

University of Mumbai

Examination 2020 under cluster 7 (Lead College: SCSJCE)

Program: Information Technology

Curriculum Scheme: Rev2016

Examination: TE Semester V

10

Course Code: ITDLO5011 and Course Name: Advanced Data Structures & Analysis of Algorithms

Time: 2 hour

Max. Marks: 80

Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1. 2	Which one of the following is Substitution method
Option A:	Forward
Option B:	Linked list
Option C:	Master's
Option D:	Stack
2. 3	Recursion is a method in which the solution of a problem depends on _____
Option A:	Smaller instances of the same problem
Option B:	Larger instances of the same problem
Option C:	Larger instances of different problems
Option D:	Smaller instances of different problems
3. 4	Which of the following is NOT recurrence method
Option A:	Substitution Method
Option B:	Master's Theorem
Option C:	Array
Option D:	Tree Method
4. 5	What is probabilistic analysis for hire assistant example?
Option A:	T(n)=O(n/2)
Option B:	T(n)=O(n)
Option C:	T(n)=O(logn)
Option D:	T(n)=O(1)
5. 6	A _____ is a special Tree-based data structure in which the tree is a complete binary tree.
Option A:	Graph
Option B:	Heap
Option C:	List
Option D:	Stack
6. 7	Which is not an application of Topological Sorting
Option A:	Ordered Statistics
Option B:	Finding prerequisite of a task
Option C:	Finding Deadlock in an Operating System
Option D:	Finding Cycle in a graph

~~7.~~8	In which of the following graph Topological Sort can be implemented?
Option A:	Directed Acyclic Graphs
Option B:	Undirected Cyclic Graphs
Option C:	Directed Cyclic Graphs
Option D:	Undirected Acyclic Graphs
~~8.~~9	In most of the cases, topological sort starts from a node which has
Option A:	Maximum Degree
Option B:	Minimum Degree
Option C:	Any degree
Option D:	Zero Degree
~~9.~~10	Matrix A is of order 3*4 and Matrix B is of order 4*5. How many elements will be there in a matrix A*B multiplied recursively.
Option A:	12
Option B:	15
Option C:	16
Option D:	20
~~10.~~11	What is the worst case time complexity of merge sort?
Option A:	O(n log n)
Option B:	O(n^2)
Option C:	O(n^2 log n)
Option D:	O(n log n2)
~~11.~~12	Given an array arr = {45, 77, 89, 90, 94, 99,100} and key = 100; What are the mid values (corresponding array elements) generated in the first and second iterations?
Option A:	90 and 99
Option B:	90 and 100
Option C:	89 and 94
Option D:	94 and 99
~~12.~~13	Kruskal's algorithm is used to find
Option A:	Single Source Shortest Path
Option B:	Graph Traversal
Option C:	Minimum Spanning Tree
Option D:	All pair shortest Path
~~13.~~14	Which of the following is not greedy problem?
Option A:	Container loading
Option B:	Fractional Knapsack
Option C:	Flow Shop Scheduling
Option D:	Job Sequencing with deadlines
~~14.~~15	What is the optimal storage on tapes value when n=3, (l1, l2, l3) = (5, 10, 3)?
Option A:	29
Option B:	31
Option C:	34
Option D:	43

~~15.~~16	Which is not correct solution method of Flow shop scheduling problem?
Option A:	Branch and Bound
Option B:	Dynamic Programming
Option C:	Greedy algorithm
Option D:	Heuristic algorithm
~~16.~~17	Which of the following are the characteristics of dynamic programming approach?
Option A:	Overlapping sub problems
Option B:	Greedy approach
Option C:	Optimal substructure
Option D:	Both optimal substructure and overlapping sub problems
~~17.~~18	When a problem can be solved by combining optimal solutions to non-overlapping problems, the strategy is called
Option A:	Recursion
Option B:	Divide and Conquer
Option C:	Memorization
Option D:	Greedy
~~18.~~19	What is the time complexity of the above dynamic programming implementation of the longest common subsequence problem where length of one string is "m" and the length of the other string is "n"?
Option A:	O(n)
Option B:	O(m)
Option C:	O(m+n)
Option D:	O(mn)
~~19.~~20	What is the worst case running time of Rabin Karp Algorithm?
Option A:	Theta(n)
Option B:	Theta(n-m)
Option C:	Theta((n-m+1)*m)
Option D:	Theta(n* logm)
~~20.~~21	Which of the following is a substring of "engineering"
Option A:	engg
Option B:	gineer
Option C:	ning
Option D:	eiee

Q2. (20 Marks Each)	**Solve any Two Questions out of Three** **10 marks each**
A	Explain Probabilistic Analysis &Randomized Algorithm with the help of example.
B	Sort the following numbers using Heap Sort.[25,67,56,32,12,96,82,44].Show the contents of the array after every iteration. Also Derive time complexity for the same.
C	Explain Strassen's matrix multiplication rules. Solve the following example with the help of Strassen's matrix multiplication. $A=\begin{bmatrix} 3 & 4 \\ 5 & 6 \end{bmatrix}$ $B=\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$

Q3. (20 Marks Each)	**Solve any Two Questions out of Three** **10 marks each**
A	Explain Minimum Spanning Tree. Find Minimum spanning tree of the following graph using prims and kruskals algorithm.
B	Explain 0/1 knapsack problem using dynamic programming approach.
C	Explain Rabin Karp Algorithm with a suitable example.

Paper / Subject Code: 32405 / Elective - I Advance Data Structures & Analysis of Algorithms

E/IT/SEM V/Choice Base/Advance Data Structures & Analysis of Algorithm

(3 Hours) [Total Marks: 80]

10

N.B.: (1) Question No.1 is compulsory.

(2) Attempt any three out of remaining questions.

(3) Assume Suitable data if necessary.

(4) Figures to the right indicate full marks.

Q1 a. Differentiate between Greedy method and Dynamic Programming. 5

b. Write an algorithm for finding minimum and maximum number from a given set 5

c. Explain coin changing problem 5

d. Explain Flow Shop Scheduling Technique 5

Q2a. Define AVL tree. Construct an AVL tree for the following data. 10

63, 9, 19, 27, 18, 108, 99, 81

b. Write an algorithm for implementing Quick sort. Also, comment on its complexity. 10

Q3a. What is longest common subsequence problem? Find LCS for the following string: 10

String X: ABCDGH

String Y: AEDFHR

b. Explain Rabin Karp Algorithm in detail. 10

Q4a. Which are the different methods of solving recurrences? Explain with suitable examples. 10

b. Explain Travelling Salesman Problem with an example. 10

Q5a. Explain Huffman Algorithm. Construct a Huffman Tree and find Huffman code for the message: KARNATAKA. 10

b. Explain Knapsack Problem with an example. 10

Q6 Write Short notes on (any four) 20

a. Genetic Algorithm
b. Red and Black Tree
c. Merge Sort
d. Knuth Morris Pratt Algorithm
e. Optimal Binary Search Tree (OBST)

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T.E(IT) ADSA. - V Sem.

Advanced Data Structure and Analysis.

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0212_IT_Sem-V_R19_ADSA_Inst. Name

1) The Question Paper will have MCQs (for 20 marks) and Subjective/Descriptive Questions (for 60 marks).

2) MCQ correct options and subjective question answers to be written on A4 size papers. Scan all pages of answer papers of Q.1 to Q.4 and create single file in pdf format to upload in the link given.

* Required

1. Enter your Name *

2. Enter your Seat Number *

0212_IT_Sem-V_R19_ADSA_Inst. Name

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2) MCQ correct options and subjective question answers to be written on A4 size papers. Scan all pages of answer papers of Q.1 to Q.4 and create single file in pdf format to upload in the link given.

Q.1) 1 to 5

Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	The asymptotic notation used to determine Average case running time of an algorithm is:
Option A:	Big Oh
Option B:	Big Omega
Option C:	Big Theta
Option D:	Small Theta
2.	Time Complexity for Merge Sort algorithm using Divide and Conquer is
Option A:	O (n)
Option B:	Θ (n Log n)
Option C:	O (log n)
Option D:	O (n^2)
3.	If a problem can be broken into subproblems which are reused several times, the problem possesses property.
Option A:	Overlapping subproblems
Option B:	Optimal substructure
Option C:	Memorization
Option D:	Greedy
4.	Identify the data structure used for multilevel indexing :
Option A:	B Tree
Option B:	B+ -tree
Option C:	AVL Tree
Option D:	Red-black Tree
5.	Identify the correct technique used for solving fractional Knapsack problem.
Option A:	Greedy Technique
Option B:	Divide and conquer
Option C:	Dynamic programming
Option D:	Cannot be solved

Q.1) 6 to 8

6.	Which of the following statement is True for TSP.
Option A:	In TSP, we know that Hamiltonian Tour exists
Option B:	In TSP, many Hamiltonian tours exist
Option C:	In TSP, we find a minimum weight Hamiltonian Cycle.
Option D:	In TSP, we find a maximum weight Hamiltonian Cycle.
7.	To merge two files containing m and n records respectively using Greedy Optimal Merge Pattern, the number of comparisons needed to merge them is :
Option A:	m - n
Option B:	m + n
Option C:	m * n
Option D:	m / n
8.	Best case number of comparisons to for a Naïve string matching algorithm is :
Option A:	O(m*(n-m+1))
Option B:	O(m*n)
Option C:	O(n)
Option D:	O(1)

Q.1) 9 to 10

9.	Predict an optimal schedule using Job sequencing with deadlines that gives maximum profit.

Jobs	J1	J2	J3	J4	J5	J6
Deadlines	4	2	3	3	3	3
Profits	60	50	26	42	20	84

Option A:	1—2—6--3.
Option B:	4—2—6--1.
Option C:	3—2—6--4.
Option D:	4—5—6--2.
10.	State which of the following options is True:
Option A:	P is set of problems that can not be solved by a deterministic Turing machine in Polynomial time.
Option B:	NP is set of decision problems that can be solved by a Non-deterministic Turing Machine in Polynomial time.
Option C:	NP is subset of P
Option D:	P, NP, NP-Hard and NP-Complete are not related

Q.2

Q2	Solve any Four out of Six 5 marks each
A	Define the Asymptotic notations with suitable diagrams.
B	Explain different methods used for solving recurrences.
C	Analyze Time complexity of Binary Search using Divide and Conquer. Also write the algorithm for the same.
D	Describe Genetic algorithms and its importance.
E	Explain approximate algorithms with a suitable example.
F	Describe NP-Hard and NP-Complete

Q.3

Q3	Solve any Two Questions out of Three 10 marks each
A	Apply All Pair Shortest Path algorithm to solve following problem.
B	Illustrate the process of finding LCS to find the Longest Common Subsequence for the following set of strings: ABCDGH AEDFHR
C	Solve the following Knapsack problem using Greedy method. W = 45

Item (Oi)	A	B	C	D
Value (Pi)	50	140	60	60
Size (wi)	5	20	10	12

Q.4

Q4	Solve any Two Questions out of Three 10 marks each
A	Explain B Tree and Illustrate the insertion operation in a B tree of degree 3 by inserting following data values. 16,70,30,10,18,22,24,5,75,9,7,2,12.
B	Explain Matrix Chain Multiplication problem.
C	Demonstrate the use of adjacency matrix method to find the topological sorting order for following graph.

3. Upload your answer papers *

Files submitted:

4. Have you uploaded required pdf file of answers? *

Mark only one oval.

- Yes

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Analysis Of Algorithm (CS)

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S.E - IV Sem - Comp.
Analysis of Algorithms -

University of Mumbai
Examination June 2021

Examinations Commencing from 1st June 2021
Program: **Computer Engineering**
Curriculum Scheme: Rev2019
Examination: SE Semester IV
Course Code: CSC402 and Course Name: Analysis of Algorithm

Time: 2 hour

Max. Marks: 80

Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
3 ~~1.~~	Which of the following is not $O(n^2)$?
Option A:	$(5^{10}) * n + 990$
Option B:	$N^{1.45}$
Option C:	$n^3 / (\sqrt{n})$
Option D:	$(3^{50}) * n$
4 ~~2.~~	If A is asymptotically less efficient than B, it means?
Option A:	B will be a better choice for all inputs
Option B:	B will be a better choice for all inputs except possibly small inputs
Option C:	B will be a better choice for all inputs except possibly large inputs
Option D:	B will be a better choice for small inputs
5 ~~3.~~	In Quicksort algorithm, there is a procedure for finding a pivot element that splits the array into two sub-arrays, each of which contains at least Two-fifth of the elements. Let T(n) be the number of comparisons required to sort n elements. Then
Option A:	$T(n) <= 2T(n/5) + n$
Option B:	$T(n) <= T(2n/5) + T(3n/5) + n$
Option C:	$T(n) <= 2T(4n/5) + n$
Option D:	$T(n) <= 2T(n/2) + n$
6 ~~4.~~	What is the result of following recurrences $T(n)=aT(n/b)+n^c$?
Option A:	$T(n) = O(n^{\log_b a})$
Option B:	$T(n) = O(n^c \log n)$
Option C:	$T(n) = O(f(n))$
Option D:	$T(n) = O(n^2)$
7 ~~5.~~	The class of decision problems that can be solved by non-deterministic polynomial algorithms are called as.
Option A:	NP
Option B:	P
Option C:	Hard
Option D:	Complete
8 ~~6.~~	If you are sorting in ascending order with insertion sort, average case running time it will take is?
Option A:	O(N)

Option B:	O(N log N)
Option C:	O(log N)
Option D:	$O(N^2)$
9 ~~7.~~	Worst case time complexity of merge sort is
Option A:	O(n log n)
Option B:	$O(n^2)$
Option C:	$O(n^2 \log n)$
Option D:	$O(n \log n^2)$
10 ~~8.~~	Apply Quick sort on a given sequence 6 10 13 5 8 3 2 11. What is the sequence after first phase, pivot is first element?
Option A:	5 3 2 6 10 8 13 11
Option B:	5 2 3 6 8 13 10 11
Option C:	6 5 13 10 8 3 2 11
Option D:	6 5 3 2 8 13 10 11
11 ~~9.~~	Consider the graph M with 3 vertices. Its adjacency matrix is shown below. Which of the following is true? 0 2 2 / 2 0 2 / 2 2 0
Option A:	Graph M has no minimum spanning tree
Option B:	Graph M has a unique minimum spanning trees of cost 4
Option C:	Graph M has 3 distinct minimum spanning trees, each of cost 4
Option D:	Graph M has 3 spanning trees of different costs
12 ~~10.~~	Given items as {value, weight} pairs {{60,10}, {20,10}, {40,5}}. The capacity of knapsack=20. Find the maximum value output assuming items to be divisible.
Option A:	110
Option B:	80
Option C:	100
Option D:	40
13 ~~11.~~	A graph with negative weight cycle is having _____ no. of shortest paths
Option A:	One
Option B:	Two
Option C:	Zero
Option D:	Infinite
14 ~~12.~~	Floyd Warshall Algorithm falls into _____
Option A:	Greedy technique
Option B:	Dynamic Programming
Option C:	Linear Programming
Option D:	Backtracking
15 ~~13.~~	In assembly line scheduling problem, _____ lookup tables are required.
Option A:	0
Option B:	1
Option C:	2
Option D:	3

16 ~~14.~~	A travelling salesman problem with 55 cities has_____no. of feasible tours. Correctness of no. of edges in any feasible tours
Option A:	37 arcs
Option B:	54 arcs
Option C:	55 arcs
Option D:	990 arcs
17 ~~15.~~	_____is not a branch and bound strategy to generate branches
Option A:	LIFO branch and bound
Option B:	FIFO branch and bound
Option C:	Lowest cost branch and bound
Option D:	Highest cost branch and bound
18 ~~16.~~	Of the following given options, which one of the following is a correct option that provides an optimal solution for 4-queens problem?
Option A:	(3,1,4,2)
Option B:	(2,3,1,4)
Option C:	(4,3,2,1)
Option D:	(4,2,3,1)
19 ~~17.~~	Chromatic number of a graph is _____no of colors required to color the vertices in graph.
Option A:	Maximum
Option B:	Same
Option C:	Minimum
Option D:	More than Number of vertices
20 ~~18.~~	In Rabin and Karp Algorithm, preprocessing can be done in
Option A:	$\theta(m^2)$
Option B:	θ (mlogn)
Option C:	θ (m)
Option D:	O(n)
21 ~~19.~~	What happens when the modulo value(q) is taken large?
Option A:	Complexity increases
Option B:	Spurious hits occur frequently
Option C:	Cost of extra checking is low
Option D:	Matching time increases
22 ~~20.~~	Given a pattern of length- 5 window, find the spurious hit in the given text string. Pattern: 7 3 9 9 2 Modulus: 13 Index: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Text: 2 3 5 9 0 2 3 1 4 1 5 2 6 7 3 9 9 2 1 3 9

Option A:	6-10
Option B:	12-16 10-14
Option C:	3-7
Option D:	13-17

Q2	**Solve any Four out of Six** **5 marks each**
A	Explain Master theorem with example
B	Define P, NP, NP-Hard and NP-Complete Complexity Classes.
C	Discuss Complexity of Quicksort Algorithm in all cases.
D	Rewrite Binary Search Algorithm and Explain its complexity
E	Find LCS for strings X= "ABSDG" and Y= "GBSTR"
F	Write short note on Rabin Karp Algorithm

Q3.	**Solve any Two Questions out of Three** **10 marks each**
A	Apply Dijkstra algorithm on following graph. Show all intermediate steps.
B	Explain 15 Puzzle problem with Branch and Bound method
C	Find a minimum cost path from A to L in the following multistage graph

Computer 20/05/22

S.E (COMP) Sem IV 'C' Scheme AOA QPCode: 93328

University of Mumbai

Examinations Summer 2022

Time: 2 hour 30 minutes Analysis of Algorithm Max. Marks: 80

Q1. (20 Marks)	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	_____ is the class of decision problems that can be solved by non-deterministic polynomial algorithms.
Option A:	NP
Option B:	P
Option C:	Hard
Option D:	Complete
2.	Following data structure is used to implement LIFO Branch and Bound Strategy
Option A:	Priority Queue
Option B:	array
Option C:	stack
Option D:	Linked list
3.	For the given elements 6 4 11 17 2 24 14 using quick sort, what is the sequence after first phase, assuming the pivot as the first element?
Option A:	2 4 6 17 11 24 14
Option B:	2 4 6 11 17 14 24
Option C:	4 2 6 17 11 24 14
Option D:	2 4 6 11 17 24 14
4.	Which of the following is correct for branch and bound technique? i. It is BFS generation of problem states ii. It is DFS generation of problem states iii. It is D-search.
Option A:	Only i
Option B:	Only ii
Option C:	Only ii and iii
Option D:	Only i, and iii
5.	Consider the given graph.

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	 What is the weight of the minimum spanning tree using the Kruskal's algorithm?
Option A:	24
Option B:	23
Option C:	15
Option D:	19
6.	Bellman Ford algorithm is used to find out single source shortest path for negative edge weights. Bellman Ford algorithm uses which of the following strategy?
Option A:	Greedy method
Option B:	Dynamic Programming
Option C:	Backtracking
Option D:	Divide and Conquer
7.	The optimal solution for 4-queen problem is
Option A:	(2,3,1,4)
Option B:	(1,3,2,4)
Option C:	(3,1,2,4)
Option D:	(2,4,1,3)

8.	Consider the following code snippet:
	Bounding function(k,i) {
	for(j=1 to k-1)
	{ if ((x[j]==i) or (Abs(x[j]-i) ==abs(j-k))) return false;
	} return true }
	The above code represents the bounding function for which of the following algorithm?

Option A:	Subset sum problem using backtracking
Option B:	n-queens using backtracking
Option C:	Graph coloring using backtracking
Option D:	Subset sum using branch and bound
9.	What do you mean by chromatic number?
Option A:	The minimum number of colors needed to color all the vertices optimally in a Graph

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SE(COMP) Sem IV 'C' Scheme AOA QPCode: 93328

	Coloring problem
Option B:	The maximum number of colors needed to color all the vertices optimally in a Graph Coloring problem
Option C:	The number of colors using which the edges of graph have been colored in a Graph Coloring Problem
Option D:	The individual colors with which we color the vertices of a Graph in a Graph Coloring Problem
10.	Which string matching algorithm uses a Prefix Table?
Option A:	Naïve String Matching Algorithm
Option B:	Boyer Moore String Matching Algorithm
Option C:	Knuth Morris Pratt Algorithm
Option D:	Rabin Karp Algorithm

Q2. **(20 Marks)**	**Solve any Four out of Six** **05 marks each**
A	Write and Explain binary search algorithm.
B	Write a short note on job sequencing with deadline
C	Determine the LCS of the following sequences: X: {A, B, C, B, D, A, B} Y: {B, D, C, A, B, A}
D	Solve the sum of subsets problem for the following: n=4, m=15, w={3,5,6,7}
E	Give the algorithm for the N-Queen's problem and give any two solutions to the 8-Queen's problem
F	Explain and apply Naïve string matching on following strings String1: COMPANION String2: PANI

Q3. **(20 Marks)**	**Solve any Two Questions out of Three** **10 marks each**
A	Write algorithm for greedy knapsack and Obtain the solution to following knapsack problem where n=7,m=15 (p1,p2.....p7) = (10,5,15,7,6,18,3), (w1,w2,.....,w7) = (2,3, 5,7,1,4,1).
B	Explain Dijkstra's Single source shortest path algorithm. Explain how it is different from Bellman Ford algorithm. Explain 15-puzzle problem using LC search technique.
C	Rewrite and Compare Rabin Karp and Knuth Morris Pratt Algorithms Give the pseudo code for the KMP String Matching Algorithm.

Q4. **(20 Marks)**	**Solve any Two Questions out of Three** **10 marks each**
A	Write algorithm for quick sort and sort the following elements [40,11,4,72,17,2,49]
B	Write multistage graph algorithm and solve following example.

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SE(COMP) Sem IV 'C' Scheme AOA QPCode: 9332

C	Write algorithm for 0/1 knapsack problem using dynamic programming .Also solve the following example. N=4, M=21 (p1,p2,p3,p4)=(2,5,8,1),(w1,w2,w3,w4)=(10,15,6,9)

Advanced Algorithm (CS)

T.E - V Sem - Comp
Advanced Algorithms

University of Mumbai

Examination 2020 under cluster 4 (Lead College: PCE New Panvel)

Examinations Commencing from 7th January 2021 to 20th January 2021

Program: Computer Engineering

Curriculum Scheme: Rev2016

Examination: TE Semester V

Course Code: CSDLO5013 and Course Name: Advanced Algorithm

Time: 2 hour

Max. Marks: 80

Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.01	In dynamic table, the amortized cost of the single operation is at the most -------
Option A:	2
Option B:	1
Option C:	3
Option D:	4
2.03	In Hiring Problem, how many times a new office assistant will be hired if the input is considered in the order of rank of candidates where the order is <4, 5, 2, 6, 3, 7, 8, 9, 10, 1>
Option A:	5
Option B:	6
Option C:	8
Option D:	7
3.04	A binomial tree B_k has ---
Option A:	K^2 nodes and the height of the tree is 2k
Option B:	(k+2) nodes and the height of the tree is (lg k)
Option C:	K nodes and the height of the tree is (k +2)
Option D:	2^k nodes and the height of the tree is k
4.05	Let the capacity of the edge from vertex u to vertex v is 30 and flow from vertex u to vertex v is -10 (minus 10). The residual capacity C_f is ---------
Option A:	20
Option B:	30
Option C:	40
Option D:	50
5.06	In bipartite graph G = (V E), vertex set can be partitioned into V = P U Q where ---------- and all edges in E go between P and Q.

Option A:	P is subset of Q
Option B:	Q is subset of P
Option C:	$P \cap Q = \Phi$
Option D:	$P \cap Q \neq \Phi$
6. 07	The sweeping algorithm which takes n line segments as input and considers endpoints in sorted order have runtime complexity of ---------- to determine any pair of line segments intersects.
Option A:	O(n)
Option B:	O(n lg n)
Option C:	$O(n^2)$
Option D:	O(lg n)
7. 08	Let $A \leq p$ B. Which of the following statement is true?
Option A:	problems A and B are polynomial time equivalent
Option B:	problem B is polynomial time reducible to problem A
Option C:	problem A is polynomial time reducible to problem B.
Option D:	problem A cannot be reducible to Bin polynomial-time.
8. 09	In Aggregate analysis for sequence of n operations worst case time is T(n). In the worst case the amortized cost per operation is given by ----------
Option A:	n /T(n)
Option B:	T(n)/n
Option C:	T(n) * T(n)
Option D:	n * n
9. 10	In Red-Black tree, RB-DELTE_FIXUP procedure takes time ------- and performs at the most ----------rotations.
Option A:	O(n) and 2 rotations
Option B:	O(n) and 4 rotations
Option C:	O(lg n) and 3 rotations
Option D:	O(n lg n) and 1 rotations
10. 11	In relabel-to-front algorithm let f is preflow. The edge from vertex u to vertex v is admissible if and only if ----------
Option A:	Residual capacity of edge u to v is greater than zero and height of vertex u is

	larger than vertex v.
Option B:	Residual capacity of edge v to vertex u is greater than zero and height of vertex u is less than vertex v.
Option C:	Residual capacity of edge u to v and height of vertex u and vertex v is equal.
Option D:	Residual capacity and height both conditions need not be fulfilled.
~~11.~~ 12	Those problems that can be solved in polynomial time known as ---------- problems.
Option A:	Decision
Option B:	Intractable
Option C:	Tractable
Option D:	Complete
~~12.~~ 13	The convex hull of a set Q of points, denoted by CH(Q). If $\|Q\| \geq 3$ then at termination of Graham scan algorithm bottom to top content of stack is ---------
Option A:	Exactly the vertices of CH(Q) in counterclockwise order
Option B:	Exactly the vertices of CH(Q) in clockwise order
Option C:	All the vertices in CH(Q)
Option D:	All the vertices having same polar angle.
~~13.~~ 14	The time complexity of the recurrence T(n) = 3T (n/3)+ n/2 by using master theorem is -----
Option A:	$\theta(n^2)$
Option B:	$\theta(n \log n)$
Option C:	$\theta(\log n)$
Option D:	$\theta(n)$
~~14.~~ 15	Let Red-Black has n number of internal nodes. Then this tree has height at most --------
Option A:	lg(n +1)
Option B:	n
Option C:	$2 \lg(n^2)$
Option D:	2 lg(n+1)
~~15.~~ 16	Which of the following statement is correct in case of hiring problem?
Option A:	Interviewing has higher cost than hiring.
Option B:	Interviewing and hiring both have equal cost.

Option C:	Interviewing has lower cost whereas hiring is expensive
Option D:	hiring has lower cost than Interviewing
~~16.~~ 17	In Push-relabel algorithm the basic operation PUSH(u, v) that pushes flow from vertex u to vertex v applies if ----------
Option A:	u is an overflowing vertex, $C_f(u, v)>0$ and vertex u height = vertex v height + 1.
Option B:	v is an overflowing vertex, $C_f(v, u)>0$ and vertex v height = vertex u height + 1.
Option C:	u is an underflowing vertex, $C_f(u, v)>0$ and vertex u height = vertex v height + 1.
Option D:	v is an underflowing vertex, $C_f(v, u)>0$ and vertex v height = vertex u height + 1.
~~17.~~ 18	Let M and N are the two vectors. If the cross product M X N = 0 then --------
Option A:	M and N are said to be colinear
Option B:	M is clockwise from N with respect to the origin (0,0)
Option C:	M is counterclockwise from N with respect to the origin (0,0)
Option D:	M and N are not related to each other.
~~18.~~ 19	Suppose two problems A and B not known to be in NP. Let problem C be an NP-Complete problem. Problem A is polynomial-time reducible to C and problem C is polynomial-time reducible to problem B. Which one of the following statements is true?
Option A:	Problem A is NP-hard
Option B:	Problem A is NP-Complete
Option C:	Problem B is NP-hard
Option D:	Problem B is NP-Complete
~~19.~~ 20	In the union of two binomial heaps H1 and H2, the root list of H1 and H2 is merged into a single linked list which is sorted by ----------
Option A:	Increasing order of the key value of the root nodes.
Option B:	Decreasing order of the key value of the root nodes.
Option C:	Decreasing order of the degree of the root nodes.
Option D:	Increasing order of the degree of the root nodes
~~20.~~ 21	Deletion of a node in Red-Black tree takes ---------- time
Option A:	O(lg n)
Option B:	O(n)
Option C:	O(lg n) ← correct O(n log n)
Option D:	O(lg (lg n))

Q2 (20 Marks)	**Solve any Four out of Six (5 marks each)**
A	Show the red-black tree that result after successively inserting the keys 11, 10, 9, 4, 6, 1 into an initially empty red-black tree.
B	Explain how accounting method of amortized analysis is used to analyze the increment operation on a binary counter that starts at zero.
C	Use master method to find run time complexity of the following recurrence. $T(n) = 6T(n/3) + n^2 \log n$
D	Prove that vertex-cover problem is NP-complete
E	Consider the initial flow network as shown below. Find maximum flow from source vertex s to sink t using Relabel-to-front Algorithm. Consider initial vertex V_1 for discharge operation.
F	Explain analysis of hiring problem using indicator random variable.

Q3. (20 Marks)	**Solve any Two Questions out of Three (10 marks each)**
A	Write steps to extract the node with minimum key from binomial heap. Extract the node with minimum key from following binomial heap. Show each step clearly.
B	Use recursion tree method to find time complexity of the following recurrence. $T(n) = T(n/4) + T(n/2) + cn^2$
C	What is maximum flow in the given network from source s to sink t by Ford Fulkerson algorithm? Show all the flow networks, residual networks and augmented paths.

TE/COMP/SEM V/Choice Base/Advance Algorithm

5

(3 Hours) [Total Marks: 80]

N.B. (1) Question No. 1 is compulsory
(2) Attempt any three out of the remaining five questions
(3) Assumptions made should be clearly stated

1. (a) Differentiate between P, NP, NP Complete and NP-Hard classes of Complexity. 05
(b) Define Red-Black tree. 05
(c) Write short note on bipartite matching. 05
(d) Explain recurrences with example. 05

2. (a) Define Maximum flow and Minimum-Cut. Apply Ford Fulkerson algorithm on following. 10

(b) What is convex hull? Explain Jarvis March in detail. 10

3. (a) Prove that Vertex Cover is NP-Complete. 10
(b) Explain Master theorem, and apply on the following examples. 10

i) $T(n)= 2T(n/2)+ n$

ii) $T(n)= 4T(n/2)+ n^2$

4. (a) Explain steps to prove any problem as NP Complete problem. 10
(b) Define Binomial Heap, Explain its operations with example. 10

5. (a) Explain DELETE operation in Red-Black Tree. Discuss its time complexity. 10
(b) Prove that TSP is NP-Complete. 10

6. Write a short note on following (any 4) 20
(a) Amortized Analysis
(b) Randomized Algorithm
(c) Relabel to Front algorithm
(d) Line segment properties
(e) NP-Completeness

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T-E- V Sem - Comp.

Advanced Algorithms.

University of Mumbai

Examination 2020 under cluster 4 (Lead College: PCE, New Panvel)

Program: **Computer Engineering**

Curriculum Scheme: Rev2016

Examination: Third YearSemester V

Course Code: CSDLO5013and Course Name: Advanced Algorithms

Time: 1 hourMax. Marks: 50

For the students:- All the Questions are compulsory and carry equal marks .

Q1.3	What is A if A= { f (n) : there exist positive constants c1, c2, and n0 such that 0 <= c1(n)<= f (n)<= c2g(n) for all n >= n0 }
Option A:	Ω(g(n))
Option B:	Θ(g(n))
Option C:	log(n)
Option D:	O(n)
Q2.4	If the recurrence relation is T(n) = 3T(n/4) + n log(n), then the solution to the recurrence is
Option A:	T(n) = O(log n)
Option B:	T(n) = O(n)
Option C:	T(n) = O(n log n)
Option D:	T(n) = O(n^2)
Q3. 5	Which of the following are the types of amortized analysis?
Option A:	Potential, Accounting, Integration
Option B:	Aggregate , Potential, Integration
Option C:	Aggregate , Accounting, Integration
Option D:	Potential, Accounting, Aggregate
Q4. 6	In dynamic tables the load factor α(T) of a nonempty table T is given by which of the following statements.
Option A:	α(T) = (Number of items stored in the table) / (size of the table)
Option B:	α(T) = Number of items stored in the table
Option C:	α(T) = (size of the table) / (Number of items stored in the table)
Option D:	α(T) = size of the table
Q5. 7	The time complexity of convex hull is :
Option A:	O (n)
Option B:	O (log n)
Option C:	O(n log n)
Option D:	O(n^2)
Q6.8	Package wrapping (or gift wrapping) technique to compute the convex hull of a set of points is used in :
Option A:	Jarvis's march
Option B:	Graham's scan

Option C:	Incremental method
Option D:	Divide –and-conquer method
Q7.9	If the cross products between vector p1and vector p2 (p1 X p2) is positive, then:
Option A:	vector p1 is counterclockwise from vector p2 with respect to the origin (0,0).
Option B:	vector p1 is clockwise from vector p2 with respect to the origin (0,0).
Option C:	the boundary condition arises.
Option D:	it can be concluded that cross products is wrong.
Q8.10	Which of the following statements about red-black tree is false?
Option A:	It is a binary tree.
Option B:	The root is black.
Option C:	Every leaf (NIL) is black.
Option D:	The root is red.
Q9.11	What is the maximum height of a red-black tree with n internal nodes?
Option A:	2 log (n+1)
Option B:	n^2
Option C:	(n (n+1))/2)
Option D:	log(n)
Q10.12	Which of the following is a properties specific to the red-black tree?
Option A:	The root is red.
Option B:	If a node is red, then both its children nodes are black.
Option C:	Every leaf (NIL) is red.
Option D:	The root node can hold any number of child nodes.
Q11.13	Which of the following is irrelevant to the Ford-Fulkerson method for solving the maximum-flow problem?
Option A:	Residual networks
Option B:	Augmenting paths
Option C:	Minimum cuts
Option D:	Minimum joints
Q12.14	Select the complexity of SEARCH operation in Red Black Tree.
Option A:	O(n2log n)
Option B:	O(n)
Option C:	O(n log n)
Option D:	O(log n)
Q13.15	The maximum flow problem involves:
Option A:	finding a flow between source and sink that is maximum
Option B:	finding a flow between source and sink that is minimum
Option C:	finding the shortest path between source and sink
Option D:	computing a minimum spanning tree
Q14.16	An augmenting path is a:

Option A:	simple cyclic path between source and sink which pass through only positive weighted edges.
Option B:	simple acyclic path between source and sink which pass through only positive weighted edges.
Option C:	simple cyclic path between source and sink which pass through only negative weighted edges.
Option D:	simple acyclic path between source and sink which pass through only negative weighted edges.
Q15. 17	How many conditions have to be met if an NP- complete problem is reducible?
Option A:	1
Option B:	2
Option C:	3
Option D:	4
Q16. 18	A CNF-satisfiability problem belongs to which class.
Option A:	NP class
Option B:	P class
Option C:	NP complete
Option D:	NP hard
Q17. 19	What is the total cost of hiring an assistant in worst case situation if Ci is the interviewing cost and Ch is the hiring cost?
Option A:	O (n Ci + n Ch)
Option B:	O (n^2)
Option C:	O (n Ci * n Ch)|
Option D:	O (n Ch)
Q18. 20	Indicator random variables provide a convenient method for ___ .
Option A:	converting between probabilities and expectations.
Option B:	converting between probabilities and randomness.
Option C:	converting between randomness and expectations.
Option D:	converting between worst case and average case.
Q19. 21	A binomial tree of order k has
Option A:	2^k nodes, and height k.
Option B:	2^{k+1} nodes, and height log (k).
Option C:	2^k nodes, and height log (k).
Option D:	k nodes, and height log (k).
Q20. 22	A binomial heap with 13 nodes will consist of
Option A:	three binomial trees of orders 8, 3, and 2.
Option B:	three binomial trees of orders 3, 2, and 0.
Option C:	three binomial trees of orders 6, 5, and 2.
Option D:	three binomial trees of orders 5, 5, and 2.
Q21. 23	A vertex cover of a graph is a set of vertices that includes
Option A:	at least one endpoint of every edge of the graph.

Option B:	all vertices of the graph.
Option C:	all edges of the graph.
Option D:	number of vertices more than edges
Q22.24	The traveling-salesman problem is
Option A:	P type
Option B:	NP-complete type
Option C:	NP type
Option D:	NP hard type
Q23.25	Which of the following statements is true about Push-relable algorithm?
Option A:	It examines the entire residual network to find an augmenting path.
Option B:	It examines only a part of the residual network to find an augmenting path.
Option C:	It works on one vertex at a time.
Option D:	It works on all vertices at a time.
Q24.26	Extra bit in red black tree is for:
Option A:	Address
Option B:	Height
Option C:	Index
Option D:	Color
Q25.27	What is probabilistic analysis?
Option A:	It is linear analysis.
Option B:	Probability is used in input.
Option C:	Probability is used in output.
Option D:	Use of probability in analyzing randomized algorithms.