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B.Tech. DEGREE EXAMINATION, MAY 2017
Third / Fourth Semester

15CS204J – ALGORITHM DESIGN AND ANALYSIS
(For the candidates admitted during the academic year 2015 – 2016 onwards)

Note:
(i) **Part - A** should be answered in OMR sheet within first 45 minutes and OMR sheet should be handed over to hall invigilator at the end of 45th minute.
(ii) **Part - B** and **Part - C** should be answered in answer booklet.

Time: Three Hours Max. Marks: 100

PART – A (20 × 1 = 20 Marks)
Answer **ALL** Questions

1. The asymptotic notation for the polynomial $T(n) = n^4 + 3n^3 + 2n + 1$ is
   (A) $0(n^3)$ (B) $\Omega(n^3)$
   (C) $0(n^2)$ (D) $\Omega(n^5)$

2. What is the recurrent equation for the sequence 3,9,27,81,.....
   (A) $t_n = 3^i$ (B) $t_n = t_{n-1}{}^3$
   (C) $t_n = t_{n-1} + 3$ (D) $t_n = 3t_{n-1}$

3. The worst case complexity of an algorithm gives us _____ on the algorithm
   (A) An upper bound (B) A lower bound
   (C) A tight bound (D) A middle bound

4. Performance analysis of an algorithm can be referred as
   (A) Profiling (B) Program proving
   (C) Priori estimate (D) Posteriori testing

5. The time complexity of strassen's matrix multiplication is
   (A) $T = \theta(N^{\log 2})$ (B) $T = \theta(7^{\log 2})$
   (C) $T = \theta(7^{\log n})$ (D) $T = \theta(N^{\log 7})$

6. Divide and conquer algorithms are not very effective if
   (A) Divisions are unbalanced (B) The size of problem is big
   (C) The depth of the recursion is high (D) The process of combining the results of subproblem is complex

7. Find the Euclidean distance between the points (4,3) and (7,5)
   (A) $\sqrt{3}$ (B) $\sqrt{5}$
   (C) $\sqrt{13}$ (D) $\sqrt{19}$

8. A polygon is defined to be convex if for any two points p_1 and p_2 inside the polygon, the directed line segment from p_1 and p_2 is
   (A) Fully contained in the polygon (B) Partially contained in the polygon
   (C) Fully outside the polygon (D) Partially outside the polygon

9. Suppose the letters a,b,c,d,e,f have probabilities, $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{64}$ respectively. Which of the following is the Huffman code for the letters a,b,c,d,e,f?
(A) 01, 10, 11, 001, 1110
(B) 0, 10, 110, 1110, 11110, 11111
(C) 110, 100, 010, 000, 001, 111
(D) 11, 10, 011, 010, 0001, 0010

10. Which of the following standard algorithms is not a greedy algorithm?
(A) Dijkstra's shortest path algorithm
(B) Prim's algorithm
(C) Huffman coding algorithm
(D) Bellmen ford shortest path algorithm

11. We use dynamic programming approach because
(A) The solution has optimal substructure
(B) It provides optimal solution
(C) The given problem can be reduced to the 3-sat problem
(D) It is faster than greedy

12. The time complexity of travelling sales person using dynamic programming is
(A) $\theta(n!)$
(B) $\theta(n^2 2^n)$
(C) $\theta(n^{2n})$
(D) $\theta(2^{n-1})$

13. A graph is said to be _____ iff it can be drawn in a plane in such a way that no two edges cross each other
(A) Clique
(B) Complete
(C) Planar
(D) Isomorphic

14. A cycle that starts from a vertex visits all other vertices only once, and returns back to the starting vertex
(A) Chordless cycle
(B) Peripheral cycle
(C) Hamilton cycle
(D) Girth

15. How many solutions are possible for a 4-queen problem?
(A) 4
(B) 4!
(C) 4^4
(D) 2

16. A node in a state space tree that is under consideration and is in the process of being generated is called
(A) Live node
(B) Dead node
(C) E node
(D) Answer node

17. A search technique where we keep expanding nodes with least accumulated cost so far is called
(A) Hill climbing
(B) Branch and bound
(C) Backtracking
(D) Depth first search

18. Which term refers to all state space search methods in which all the children of the e-node are generated before any other live node can become the e-node
(A) Dynamic programming
(B) Branch and bound
(C) Backtracking
(D) Lower bound theory

19. Assuming P! = NP, which of the following is true?
(A) NP hard = NP
(B) NP complete = P
(C) $np = \phi$
(D) NP complete U P = ϕ

20. Let X be a problem that belongs to the class NP. Then which one of the following is true?
(A) If X is NP-hard, then it is NP-complete (B) If X can be solved deterministically in polynomial time, then P = NP
(C) There is no polynomial time algorithm for X (D) X may be undecidable

PART – B (5 × 4 = 20 Marks)
Answer **ANY FIVE** Questions

21. Prove the equations using mathematical induction $\sum_{i=1}^{n} i^3 = \left[\frac{n(n+1)}{2}\right]^2$.

22. Solve the following recurrence equation using substitution method $t_n = nt_{n-1}$ with initial condition $t_0 = 1$.

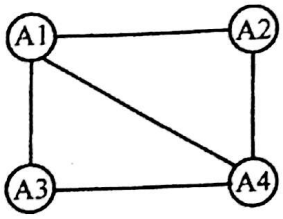
23. Write the general algorithm for divide and conquer method.

24. Multiply the following two matrices using strassen's multiplication method

$$A = \begin{bmatrix} 1 & 3 \\ 4 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

25. Find an optimal solution to the knapsack instance $n = 7$, $m = 15$,
$(p_1, p_2, \ldots\ldots p_7) = (10,5,15,7,6,18,3)$ and $(w_1, w_2, \ldots\ldots w_7) = (2,3,5,7,1,4,1)$.

26. Colour the following graph using graph colouring algorithm. What is the minimum number of colour required?



27. Distinguish between randomized and deterministic algorithms.

PART – C (5 × 12 = 60 Marks)
Answer **ALL** Questions

28. a. Define master theorem and its cases. Apply master theorem to solve the following equations
(i) $T(n) = 3T(n/4) + n\log n$
(ii) $T(n) = 9T(n/3) + n$
(iii) $T(n) = T(2n/3) + 1$

(OR)

b.i. Devise an algorithm for generating 'n' terms of Fibonacci series.

ii. Calculate the computing time of the above algorithm using frequency count method and analyze the time complexity using Big-oh notation.

iii. Write the recurrence equation for Fibonacci series and solve the equation using substitution method.

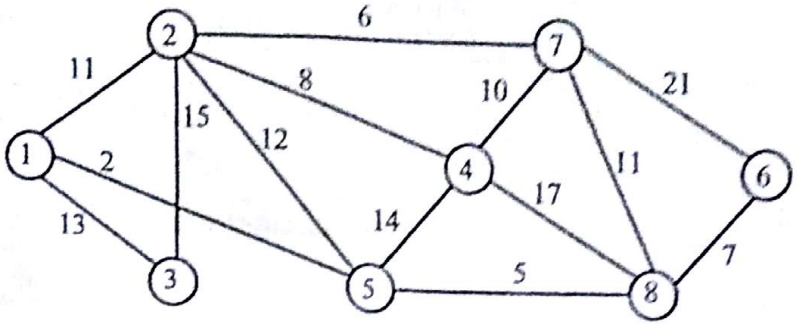
29. a.i. Devise an algorithm for quicksort using divide and conquer method. Also sort the following sequence of characters in non-decreasing order using quicksort. "EXPONENTIAL". (7 Marks)

ii. Analyze the best, average and worst case complexity of quick sort algorithm. (5 Marks)

(OR)

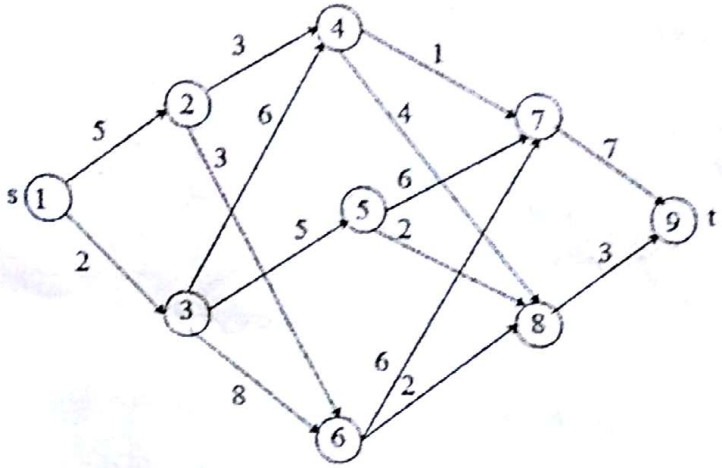
b. Given a set of points in the plane. Write an algorithm to find the smallest convex polygon that contains all the points of it. Also analyse the time complexity of your algorithm.

30. a. Compute a minimum cost spanning tree for the graph of the following figure using
(i) Kruskals algorithm
(ii) Prim's algorithm



(OR)

b. Find a minimum cost path from 's' to ' t' in the multistage graph of the following figures. Do this using
(i) Forward approach and
(ii) Backward approach



31. a. Write a backtracking algorithm for the sum of subsets problem using the state space tree corresponding to the variable tuple size formulation.

(OR)

b. Develop an algorithm to find all the Hamilton cycles of a graph. The graph is stored as an adjacency matrix G[1:n] [1:n] and all cycles begin at node 1.

32. a. Consider the travelling salesperson problem instance defined by the cost matrix

$$\begin{bmatrix} \alpha & 2 & 3 & 4 \\ 1 & \alpha & 4 & 3 \\ 2 & 3 & \alpha & 4 \\ 4 & 3 & 2 & \alpha \end{bmatrix}$$

Solve using branch and bound technique and generate the state space tree.

(OR)

b. Write a randomized algorithm for 'Hiring problem' and analyse the time complexity.

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