MASTER OF COMPUTER SCIENCE AND ENGINEERING EXAMINATION, 2024

(1st Semester)

ADVANCED ALGORITHMS

Time: Three Hours Full Marks 100

Answer Question No. 1 and any four from the rest.

1. Answer the following questions: 20

(i) What is the significance of asymptotic analysis of time complexity of an algorithm? [5]

(ii) What are decision problems? What are their relationships with optimization problems? Explain with examples. [5]

(iii) What is amortized analysis? Using accounting method, show that the total amortized cost of performing n increment operations on a binary counter is O(n). [5]

(iv) What are Randomized algorithms? Briefly discuss how randomized algorithms are developed for APPROX-MEDIAN problem.

2. (a) If decision problem A can be polynomially reduced to decision problem B, then explain the following statement.
"if decision algorithm for B is polynomial, so does A, i.e. A is no harder than B (or B is no easier than A) and if A is NPC, so does B. i.e. if A is hard, so does B".
(b) How do you prove that a problem is in NP? How do you prove that a problem is in NPC?
(b) Prove that CNF-SAT is in NP. Next prove that CNF-SAT is NP-hard.

6+4+10=20

3. (a) Why do we need approximation algorithms? What is approximation ratio for a maximization problem? Define PTAS and FPTAS.
(b) State the vertex cover problem. Write a greedy approximation algorithm for vertex cover problem. Explain its functioning with an example.
(c) Show that the approximation algorithm is a polynomial time 2-approximation algorithm.

(2+2+3)+(2+3+3)+5=20

4. A baker makes two types of cakes, fruitcake and chocolate cake. Each fruitcake can be sold for a profit of Rs. 100 and each chocolate cake for a profit of Rs.200. The baker can afford to spend up to 8 hours per day working and takes two hours to make a fruitcake and 1.5 hours to make a chocolate cake. Customer demand requires that he makes at least four times as many chocolate cakes as fruitcakes. Fruitcakes take up twice as much storage space as chocolate cakes and there is room for at most 5 fruitcakes in the cake shop every day.
(a) Formulate a linear programming problem to find how many of each product to produce per week to maximise the profit.
(b) Express the problem in its standard form. Find the dual of the problem.
(c) Show the feasible region graphically and find the maximum profit from the graph.

7+4+9=20

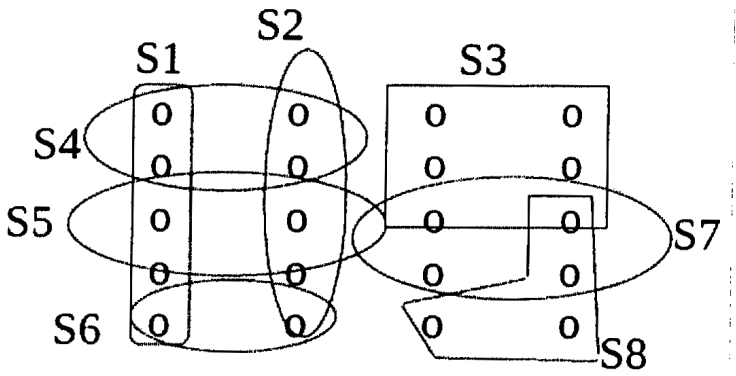
5. (a) Draw the KMP flowchart with fail indexes for the pattern "APAALPAA".
(b) Given the string "ALAPAAAPAALPAA", use the above flowchart and KMPScan algorithm to trace the pattern "APAALPAA". Show every step while tracing the pattern.
(c) Using Boyer-Moore first heuristic, find how many comparisons are required to locate the pattern "TEST" in the following text: "THIS IS A TEST TEXT".
(d) List the values in the charjump array for Boyer-Moore algorithm for the pattern "discuss".

6+5+5+4=20

6. (a) Describe the PRAM and BSP models of parallel computation.
(b) What is spawing? Write a parallel graph coloring algorithm based on PRAM model. Comment on its running time.
(c) Define Speedup and Work. What is a work optimal algorithm?

6+(2+6+2)+4=20

7. (a) Write a greedy algorithm for set covering problem. What is its approximation ratio?
(b) Consider the following family of subsets of a set S. What is the minimum set cover for S? What is the set cover that is returned by the greedy algorithm? Discuss how the greedy algorithm works for the following family of subsets.



(d) Discuss the Trim function for the approximate algorithm of subset sum problem. Using the subroutine show how the lists of integers are reduced in case of the following input: {1,4,5,7,8,13}. Consider all the iterations. Consider the value of δ for the Trim function is 0.1.

5+7+8=20