Nirma University

Institute of Technology

Semester End Examination (IR/RPR), December - 2019

M. Tech. in Computer Science and Engineering, Semester-I /
M. Tech. in Computer Science and Engineering (INS), Semester-I /
M. Tech. in Computer Science and Engineering (Data Science), Semester-I

3CS1109 Complexity Theory and Algorithms

Max. Marks: 100 Time: 3 HOURS

Roll No. | | Supervisor's initial with date | |

Instructions:
1. **Attempt all questions.**
2. **Figures to right indicate full marks.**
3. **Draw neat sketches wherever necessary.**
4. **Assume suitable data wherever necessary and specify clearly.**
5. **Use section wise separate answerbooks.**

SECTION I

Q 1 **Answer the following** **[17]**

CO1, L1, L2 — A. Formally define various complexity classes viz. P, NP, NP-COMPLETE and NP-HARD and discuss importance of these classes in context of algorithmic complexity theory. [8]

B. Solve following recurrences **(any one)** [5]

1. $t(n)=5t(n-1)-6t(n-2)$, if $n>=2$, $t(n)=n$, if $n=0$ or $n=1$
2. $t(n)=nt^2(n/2)$, if $n>=2$, $t(n)=1/3$, if $n=1$

C. Solve following recurrences either by using Master's Theorem or by using Extended Master's theorem appropriately **(any one)**. (Answer should be asymptotically tight bound.) [4]

1. $t(n)= 2t(n/4)+ \sqrt{n}$
2. $t(n) = 9t(n/3)+ n^2/\log^2 n$

Q 2 **Answer the following** **[17]**

CO3, L6 — A. Develop an algorithm (with time complexity $\Theta(\sqrt{n})$) to find all divisors of a number n. [9]

B. Develop a recursive algorithm for Bubble Sort (*iterations not to be used at all*) and trace it on suitable example with 6 numbers. [8]

Q 3 **Answer the following** **[16]**

CO2, L3 — A. Using Limit rules prove that [8]

$$2n^2 + 3n \log_3 n + 5n = O(n^3)$$

B. For an efficient implementation of Kruskal's Algorithm (for minimum spanning tree), which is the most suitable data structure to detect cycle. Justify your answer with a suitable example and give proper complexity analysis. [8]

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SECTION II

Q 4 **Answer the following** **[16]**

CO3, CO1, L4

A. Write Merge Sort algorithm and analyse its complexity for all the possible scenarios. [8]

B. Develop an algorithm to solve 0/1 Knapsack Problem using Greedy Strategy. Trace your algorithm on following data for *knapsack capacity= 5*, to maximise the value in knapsack: [8]

Item	Weight	Value
1	2	3
2	3	4
3	4	5
4	5	6

Q 5 **Answer the following** **[17]**

CO3 L3

A. Solve the following problem on the given data using Dynamic Programming approach (complete trace expected) **(any one)**. [8]

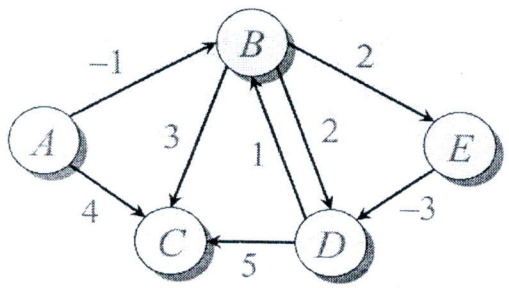
1. To find longest common subsequence in given two strings A and B

   A = abcdabcab
   B = aadbabdadabc

2. To find a largest sum sub-matrix in a given two dimensional matrix M.

$$M = \begin{vmatrix} 5 & -2 & 9 & 6 \\ -2 & 4 & -3 & 2 \\ 6 & 9 & 3 & -5 \\ -8 & -2 & 1 & -6 \end{vmatrix}$$

B. Give trace of Bellman–Ford Algorithm to find shortest path from node A to all other nodes for the following graph. Find negative cycle(s), if any. [9]



Q 6 **Answer the following** **[17]**

CO3, CO2, L5

A. Write an algorithm for Breadth First Traversal (BFT) in a graph with a trace on a suitable example. Justify that "*Branch and Bound technique of development of algorithms is based on BFT*". [9]

B. Use Hungarian Algorithm and solve the following example where four jobs (*J1, J2, J3,* and *J4*) need to be executed by four workers (*W1, W2, W3,* and *W4*), one job per worker. The matrix below shows the cost of assigning a certain worker to a certain job. The objective is to minimize the total cost of the assignment. (Complete trace expected). [8]

	J1	*J2*	*J3*	*J4*
W1	82	83	69	92
W2	77	37	49	92
W3	11	69	5	86
W4	8	9	98	23

OR

B. Use Backtracking Technique and write an algorithm to solve 8-queen puzzle problem, also evaluate its time complexity. [8]

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