National University of Computer & Emerging Sciences, Karachi

Fall-2019 Department of Computer Science

Mid Term-2

5th November 2019, 11:00 AM – 12:00 PM

Course Code: CS302	**Course Name:** Design and Analysis of Algorithm
Instructor Name / Names: Dr. Muhammad Atif Tahir, Waqas Sheikh, Zeshan Khan	
Student Roll No:	**Section:**

Instructions:

- Return the question paper.
- Read each question completely before answering it. There are **4 questions** on **2 pages.**
- In case of any ambiguity, you may make assumption. But your assumption should not contradict any statement in the question paper.

Time: 60 minutes. **Max Marks: 12.5**

Question # 1 **[2+2=4 marks]**

A) Which of the following sorting algorithms are stable: insertion sort, merge sort, heapsort, and quicksort? Give a simple scheme that makes any sorting algorithm stable. How much additional time and space does your scheme entail?

B) Explain why the worst-case running time for bucket sort is $O(n^2)$. What simple change to the algorithm preserves its linear average-case running time and makes its worst-case running time $O(n \log n)$.

Question # 2 **[3 marks]**

As stated, in dynamic programming we first solve the sub problems and then choose which of them to use in an optimal solution to the problem. Professor Capulet claims that we do not always need to solve all the sub problems in order to find an optimal solution. She suggests that we can find an optimal solution to the matrix chain multiplication problem by always choosing the matrix A_k at which to split the sub product $A_i A_{i+1} \dots A_j$ (by selecting k to minimize the quantity pi-1pkpj) before solving the subproblems. Proof that for dimensions $p_0; p_1; p_2; p_3; p_4 = 1000; 100; 20; 10; 1000$ is an instance of the matrix-chain multiplication problem for which this greedy approach yields a suboptimal solution.

Question # 3 **[3 marks]**

Given a rope of length n meters, the provided algorithm cuts the rope in different parts of integer lengths in a way that maximizes product of lengths of all parts. Execute the following algorithm to compute the optimal way of cutting the rope of length **12** meters.

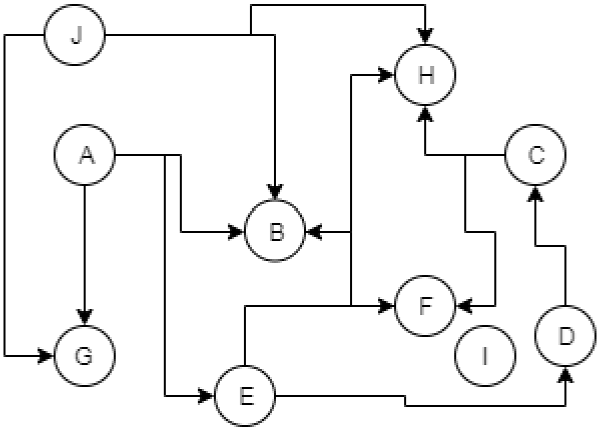
$$\text{maxP}[n] = \begin{cases} 0 & if \quad n = 0 \\ 1 & if \quad n = 1 \\ \max\limits_{1 \le i \le n} (n, i * (n - i), i * maxP[n - i]) & if \quad n > 1 \end{cases}$$

Question # 4 **[0.5+0.5+1.5=2.5 marks]**

A) Explain how one can check a graph's acyclicity by using breadth-first search.

B) Does either of the two traversals—DFS or BFS—always find a cycle faster than the other? If you answer yes, indicate which of them is better and explain why it is the case; if you answer no, give two examples supporting your answer.

C) Apply the topological sort to check if the provided graph (**Fig#1**) is a DAG (Directed Acyclic Graph) or not.



Fig#1

BEST OF LUCK