National University of Computer & Emerging Sciences, Karachi
Fall-2023 Department of Computer Science
Final Exam
26th December 2023, 09:00 AM – 09:30 AM
Part (A)

Course Code: CS2009	**Course Name:** Design and Analysis of Algorithm
Instructor Name / Names: Dr. Muhammad Atif Tahir, Dr. Fahad Sherwani, Dr. Farrukh Salim, Dr. Nasir Uddin, Mr. Faisal Ahmed, Mr. Sandesh Kumar, Ms. Anaum Hamid, Mr. Syed Faisal Ali, and Mr. Minhal Raza	
Student Roll No:	**Section:**

Instructions:

- Must be submitted within 30 minutes. No extra sheets allowed. Must solve in given space
- You can start Part B but not before returning Part A to invigilator.

Time: 30 minutes **Max Marks: 10**

Question # 1 [CLO: 2] **[5 marks]**

Sol: Strict marking but different valid algorithm can be proposed by the students

Problem	Give name of Algorithm e.g. insertion sort etc [0.25 marks each]	Worst Time Complexity [0.125 marks]	Space Complexity [0.125 marks]
to design networks with the least cost. It can be used to find the least expensive network connections that can connect all the nodes in the network.	Kruskal / Prims Algorithm	O(V LOG E)	O(E),
selecting sites for satellite stations in order to maximize the global traffic with respect to a budget constraint.	Knapsack Algorithm	2^n or m*w	O(N)
to avoid vehicle collisions in cars and airplanes.	Convex Hull	Nlogn	(n log n)
Arbitrage detection in financial markets, where negative weights represent profitable trading opportunities.	Bellmen Ford	V^3	O(V)
to design a scheduler that to schedule a set of tasks. A number of the tasks need to wait for some other tasks to complete prior to running themselves.	Use Topological Sort	O(V LOG E)	O(|V|).
Picking the optimal location for a cell tower so that it covers the maximum number of customers	Use Set Cover	O(2^n)	O(n)
Consider a social network, where the graph's vertices represent people, and the graph's edges represent mutual acquaintance.	Clique Problem	O(2^n)	O(n^2 + n)

scheduling of a machine to drill holes in a circuit board or other object. In this case the holes to be drilled are the cities, and the cost of travel is the time it takes to move the drill head from one hole to the next.	Travelling Sales Men Problem	O(N^2LogN) "Or" O(N^22^N)	O(N).
sorts data with integer keys by grouping the keys by individual digits that share the same significant position and value (place value)	Radix Sort	O(dn+kd)	n+k
sorts data by selecting a 'pivot' element from the array and partitioning the other elements into two sub-arrays, according to whether they are less than or greater than the pivot	Quick Sort	O(nlogn)	O(1)

Question # 2 [CLO: 2] **[5 marks]**

(a) [3 Points] For each of the following questions, indicate whether it is T (True) or F (False) and justify using some examples e.g. assuming a function?

I. For all positive $f(n), g(n)$ and h(n), if $f(n) = O(h(n))$ and $f(n) = \Omega(g(n))$, then $g(n) + h(n) = O(f(n))$.

II. Let f (n) and g(n) be asymptotically nonnegative functions, then min (f (n), g(n)) = Θ (f (n) + g(n)).

III. if $f(n) = O(g(n))$ and $f(n) = \Omega(g(n))$, then we have $(f(n))^3 = (g(n))^3$

Sol: Correct Answer with explanation: 1 mark; Only Correct Answer without explanation: 0.5 marks; Wrong Answer with some explanation and attempt: 0.25 marks; Wrong Answer: 0 marks

(a) Let $f(n) = n^2$, then h(n) can be n^3 and g(n) can be n, and thus $n + n^3 = O(n^2)$; thus False

(b) Let $f(n) = n$, $g(n) = n^2$, $\min(n, n^2) = \Theta(n + n^2) \Rightarrow n = \Theta(n^2)$; thus False

(c) f(n) and g(n) can be of same order, but these are different functions, thus False

(b) [2 Points] Compute the time complexity of the following. Show all steps clearly

```
for i=1...n do
   j=n
   while i<j do
      if j mod 2 = 0 then j=j-1
      else j=i
```

Sol: While loop will each time run at most two iterations. This makes the algorithm O(n)
Marking Scheme: Correct Answer with reasoning 2 marks; Correct Answer with no / wrong reason: 1 mark; Incorrect Answer: 0 mark