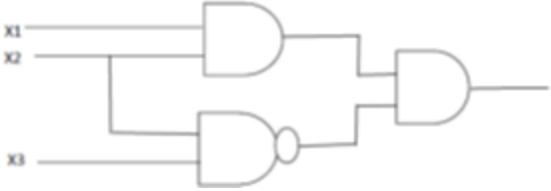CS 366: ADVANCED ALGORITHM DESIGN
Assignment 2:
Submission due date: 15/10/2025

- Assignment scores/markings depend on neatness and clarity.

- Write your answers with enough detail about your approach and concepts used, so that the grader will be able to understand it easily.

- The marking would be out of 100

- You are allowed to use only those concepts which are covered in the lecture class till date.

- Plagiarized assignments will be given a zero mark.

Sl. No.	Question
1.	a. Define the class NPH (NP-Hard). How does it differ from NPC? b. Provide examples of NP-Hard problems that are not necessarily in NP. Explain why they are classified as NP-Hard. c. Discuss the relationship between NP-Hard problems and computational hardness. How are they relevant in practical computing scenarios?
2.	a. Define the class NPC (NP Complete). What are the defining properties of an NP Complete problem? b. Provide examples of well-known NP Complete problems and explain why they are considered as such. c. Explain the concept of polynomial time reduction. How is it used to prove a problem is NP Complete?
3.	Given a decision vertex cover problem instances $G(V,E,k)$, where $V=<1,2,3,4,5,6,7>$ and $E=<(1,2),(1,3),(2,3),(1,4),(2,5),(3,6),(4,6),(4,5),(5,7),(6,7)>$, $k=3$. Find the decision set cover problem instances (i.e., V, subsets of V and k). And give a possible solution.
4.	Draw a graph $G(V,E)$ from the given information where V is the set of all vertices, $E=<(v1,v2),(v1,v9),(v2,v3),(v2,v8),(v3,v5),(v4,v5),(v5,v6),(v6,v7),(v7,v8),(v7,v9)>$ set of all edges. a. Can a Vertex Cover of size 3 possible for the given graph? Justify your answer. b. Can a Vertex Cover of size 4 possible for the given graph? Justify your answer. c. Why can't an undirected Complete Graph with 8 vertices have a vertex cover of size 3?
5.	Given a Boolean circuit as follows

	Convert the following circuit to CNF (Reduction of Circuit Satisfiability Problem to CNF SAT)

6.	A new telecom company is trying to establish its offices in a large city. The company wants to open offices at various (traffic) junctions of the road to cover maximum percentage of consumers. The local govt. authority has put a restriction that the company cannot open offices at adjacent junctions and has to leave at least two junctions gap between two offices. Now, our goal is to find the maximum number of offices that can be opened by the company in the given city.
	    a. Define the decision version of the problem
	    b. Show that, the given problem is a NP Complete problem. (Hint: Show the reduction of a NP complete problem to the given problem and justify the hardness).

7.	Reduce a 3 SAT formula to an independent set problem. (Explain with an example).