National University of Computer and Emerging Sciences, Lahore Campus

	Course Name:	Artificial Intelligence	Course Code:	AI2002
	Program:	BS Computer Science	Semester:	Sp 2025
	Section	BSC-6H	Total Marks:	50
	Due Date:	28th Feb, 2025	Weightage:	3.33
	Exam Type:	Assignment 1	Page(s):	2

Instructions:

- Do the work by yourself, this is an individual assignment.
- Plagiarism cases will be dealt with strictly.
- Late submissions will not be acceptable.
- Q1 is to be handwritten. Submit pdf of Q1 handwritten solution

Question #1: [20]

A farmer needs to cross a river with a fox, a chicken, and a bag of grain. He has a small boat that can only carry himself and one item at a time. However, he faces the following **constraints:**

- If left alone together, the fox will eat the chicken.
- If left alone together, the chicken will eat the grain.
- The farmer can take only one item with him per trip.

The goal is to get all three items across the river before the time runs out, considering the time constraints for each movement. Following are **allowed moves:**

- The farmer can row the boat alone.
- The farmer can take one item (Fox, Chicken, or Grain) across the river.
- The farmer can return alone.
- The farmer can return with one item if necessary.

Tasks:

1. **Define the problem formally**, identifying the:
    - **Initial state**
    - **Goal state**
2. **Pathfinding Algorithms:**
    - Use **A* Search Algorithm and Breadth-First Search (BFS)** to find a solution.
    - Clearly explain how each algorithm explores the state space.
3. **Construct the State Space:**
    - Represent all possible states in a **state space graph** with actions as edges.

4. **Heuristic Function for A*:**
    - The heuristic function **h(n)** is defined as the **Manhattan Distance** between the current state and the goal state.
    - Since the goal is to get all three items (fox, chicken, grain) across the river, the heuristic function is: **h(n) = number of items(including the farmer) that are still on the starting side**
    - This ensures that states closer to the goal have a lower heuristic value.
5. **Cost Function for A*:**
    - The actual cost **g(n)** represents the number of moves taken to reach a particular state from the initial state.
    - Each valid move (taking one item across or bringing an item back) has a uniform cost of **1**.
    - The total cost function for A* is given by: **f(n)=g(n)+h(n)**
6. **Comparison of A* and BFS:**
    - Compare the **number of nodes expanded** by each algorithm.
    - Compare the **solution path length** in both cases.
    - Show the **solution path found** by each algorithm.
    - Discuss which algorithm performed better and why.

Question #2: [30]

Implement the following uninformed state space search strategies for the Vacuum Cleaner problem in python language. Compare these strategies on the basis of the maximum number of states generated and solutions found.

You must display the solution path from initial state to goal state with all moves performed along with board updates.

1. Breadth First Search
2. Depth First Search
3. Iterative Deepening Search Problem:

Vacuum Cleaner

1. States: Dirt, Robot status w.r.t. room numbers
2. Successor function (Actions): Move Left, Clean, Move Right
3. Goal test: No dirt in both rooms
4. Path cost: 1 per move