BRAC UNIVERSITY
Department of Computer Science and Engineering

Examination: Semester Midterm | Semester: Summer 2022
Duration: 1 Hour 10 Minutes | Full Marks: 40

CSE 422: Artificial Intelligence

Answer 4 from 5 of the following questions.
Answer briefly and to the point.
Figures in the right margin indicate marks.

Name:	ID:	Section:

1. CO1

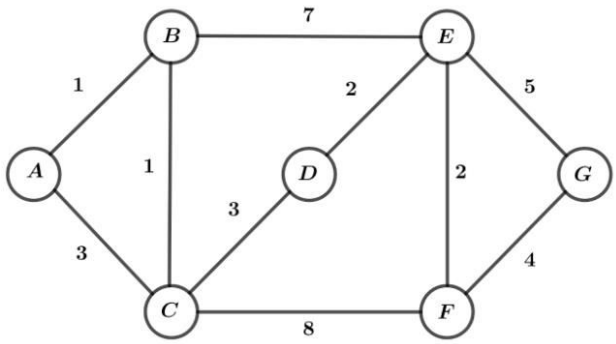
a. **Bullet-point** the differences between simple reflex agent and utility-based agent. 2

b. **Identify** the characteristics/properties of the environment of chess: 3
- Fully observable?
- Deterministic?
- Episodic?
- Static?
- Discrete?
- Single agent?

c. **Define** actuators and sensors with examples of robotic cashiers 3

d. **Find** the elements of an environment where a robot which rows a boat works in. 2

2. CO2



Consider the undirected state space graph above. A is the start state and G is the goal state. The cost of each edge is given in the graph.

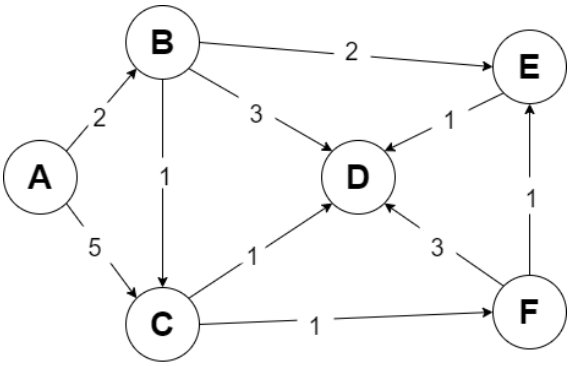
a. **Answer** which of the following paths are achievable using BFS, DFS and UCS. Consider only graph search while answering (not tree search). 8
1) A-B-E-G
2) A-C-F-G
3) A-B-C-D-E-G
4) A-C-B-E-F-G

b. Suppose all the edge costs are doubled in the original graph. For example, cost of A-B becomes 2, cost of B-E becomes 14 and so on. Will the path returned by UCS (graph search) remain the same? Briefly **explain**. 2

3. CO2 a. **Illustrate** the diagrams of Hill Climbing Search pitfalls. 4

b. **Analyze** the solutions of Hill Climbing Pitfalls briefly and mention which of those will guarantee a solution and why. 6

4. CO2 a. **Analyze** a good heuristic function for finding the shortest path between two locations in a city. 1



Possible Heuristic Functions				
Node	Heuristic 1	Heuristic 2	Heuristic 3	Heuristic 4
A	2	4	5	2
B	2	2	3	1
C	1	3	2	1
D	0	0	0	0
E	0	5	6	1
F	1	8	10	1

Use the following directed graph and table of possible heuristic functions for Questions b to e. Here, assume your start node is A and goal node is D.

b. Among these four possible heuristic functions, which are admissible? Which of these are consistent? **Analyze**. 4

c. **Find** the minimum possible value of the node B's heuristic function, h(B), such that the heuristic is admissible. 1

d **Find** the maximum possible value of the node C's heuristic function, h(C), such that the heuristic is admissible? 1

e. **Find** the node after which node E be expanded, if we use Heuristic 1 as the heuristic function? Resolve all ties in reverse-alphabetic order (if you have E and F in the fringe with the same f () value, expand/relax F first). 1

f. If we assume the heuristic function is Heuristic 1 for all nodes apart from node F, **find** the maximum possible value of the node F's heuristic function, h(F), such that the heuristic is admissible but not consistent. 2

5. CO3 Today is July 18. The CSE422 midterm exam is just seven days away. Unfortunately, you have been procrastinating this entire semester and you still have a lab assignment (L) and a written assignment (W) left. You also have not yet come up with an idea for the project (P). Each of these things takes one day to do. In addition, you still need two days to study for the midterm (S1 and S2).

You decide to formulate the problem of managing all your tasks as a Constraint

Satisfaction Problem. The details are as follows.

- Variables: L, W, P, S1, S2
- Domains: Each variable has the domain {1, 2, 3, 4, 5, 6, 7} where the numbers denote days of the week. For example, setting W = 2 means that you are deciding to do the written assignment on day 2.

You also have the following constraints.

(1) No two different tasks can be done on the same day.

(2) All the assignment and project-related tasks (L, W, P) must be completed before you start studying for the midterm (S1).

(3) The lab assignment (L) and the project idea submission (P) are both due in 4 days. So, they have to be completed in days 1, 2, 3, or 4.

(4) The first day of studying (S1) must come before the second day of studying (S2). Also, you like to take rests. So, no two study days in a row.

(5) The written assignment (W) cannot be done on an odd-numbered day.

Now answer the following questions:

a. You first decide to enforce the unary constraints (also called enforcing node consistency). **List** the values that remain in the domain of each variable. You should treat constraint (3) as a pair of unary constraints. 2

b. Continuing from (a), you now decide to enforce arc consistency for each arc. It turns out all of the arcs except S1 → L, S1 → W, S1 → P, S1 → S2 and S2 → S1 are already consistent. Enforce consistency of the arc S1 → S2 and **list** the values that remain in the domains of the variables S1 and S2. 2

c. Continuing from (b), **determine** the arcs that used to be consistent but need to be checked again after enforcing the consistency of the arc S1 → S2. 3

d. **Show** that at least one of the arcs you listed in (c) is not consistent anymore. 3