United International **University** (**UIU**)

Dept. of Computer Science and Engineering (CSE)

Mid-Term Exam Year: **2025** Semester: **Spring**

Course Code: **CSE 3811** Title: **Artificial Intelligence**

Marks: **30** Time: **1 Hour 30 minutes**

Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules.

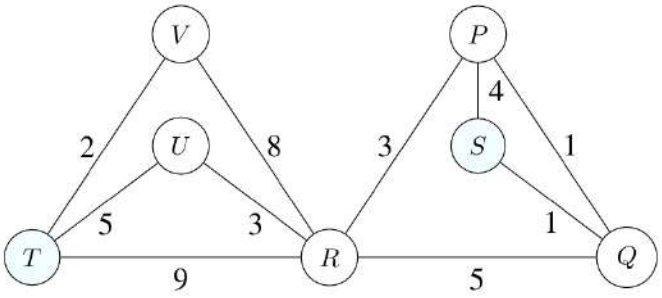
Answer all the questions. All questions are of values indicated on the right-hand margin.

1. Okabe Rintarou has a time machine that allows him to jump forward or backward in time by any number of years in a single jump. He is currently in the year **2025** and wants to reach the year **2000** using **at most 4 time jumps**. Each jump can move him to any year in the past or future.
   For example, the sequence 2025 → 2001 → 1997 → 2000 reaches the goal in 3 jumps.
   Now provide a problem formulation for this scenario. Can the time machine itself be considered an AI agent? Justify your answer in short. **[3]**

2. **a)** Consider that you have an encryption software that takes a string and converts it to an encrypted string. You used this software to encrypt your password and store it in a file, but somehow you forgot the password. You know that the password contains only the letters X, Y, and Z. The only way to recover the password is to provide a guess to the software, which will give you the encrypted string and then compare it with the string stored in the file. You are trying to recover your password using search.
   You formulate the search problem in this manner:
   State: Each possible string consisting of the letters X, Y, Z
   Start state: An empty string
   Successor Function: Appends one letter (X, Y, or Z) to the string
   Path Cost: You suspect that some letters are more likely to occur than others. To encode this in your search, you set cost(X) = 1, cost(Y) = 2, cost(Z) = 3.
   Goal Test: Verify a candidate password using the decrypt software.

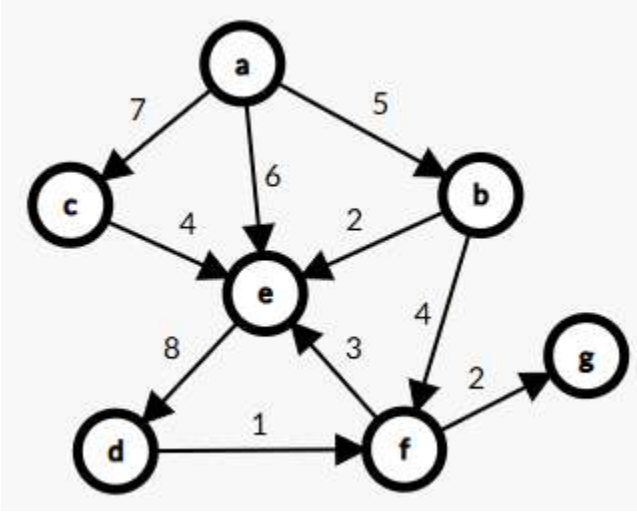
   Your search algorithm will keep generating different passwords and send them to the encryption software for checking until you find the first match. **Assume that all ties are broken alphabetically.**
   Assume that your search algorithm predicts up to 10 character strings. There are 6 correct passwords: XXXZZZ, XYYZZ, YXYXY, YZXYXZY, ZYXZ, and ZYXZY. Matching with any one of them will do. **With a brief explanation, select the one** that will be returned by: **[3x2=6]**
   i. DFS
   ii. BFS
   iii. UCS

b)



In this graph, S is the start state and T is the goal state. Run UCS on this graph and show the path returned and its cost. In case of ties, break them alphabetically. **[2]**

3. Consider the graph given below:



Here, **a** is the start node and **g** is the goal node. The Heuristic values of the nodes are as follows:

n	**a**	**b**	**c**	**d**	**e**	**f**	**g**
h(n)	**10**	**8**	**20**	**2**	**14**	**3**	**0**

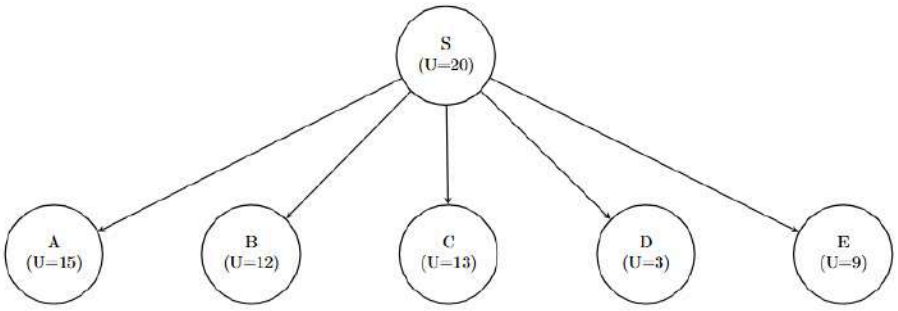
i. Check if the heuristic values are **admissible** or not. If not, then update the values so that admissibility is maintained. **[3]**
ii. If the graph is inconsistent, update the values of the nodes(not edges). **[2]**
iii. Suppose you have four heuristic functions h1, h2, h3, and h4. h1, h2, and h3 are admissible, but h4 is inadmissible. Consider the following heuristics and answer the questions:

- $h5(n)=h1^2+h2+h3$
- h6(n)=max(h1,h2,h3,h4)
- h7(n)=min(h1,h2,h4)
- h8(n)=(h1+h2+h3+h4)

- h9(n) = max(min(h1,h3),h4)

Which of the heuristic functions will be inadmissible and why? Can you suggest a new heuristic(combination of h1,h2,h3,h4) that will be better than all of the above-mentioned heuristics? **[2]**

4.



Starlink is a satellite internet constellation that wants to operate in *Bangladesh*. But it is unsure of the path that it should approach starting from a location **S**. *Elon Musk* has now asked to utilize the **Simulated Annealing** algorithm on the problem where higher Utility(**U**) is better i.e. a **maximization problem**.
The Temperature(**T**) at any time-step(**t**) is given by:

$$T = 100 - t \times 0.2$$

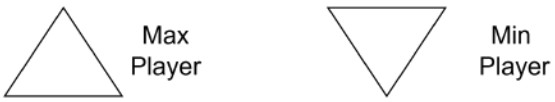
The Random Generator generates any number(**N**) between 0 to 1 by following the function:

$$N = \left|\sin\left(90 - 4.0 \times t\right)\right|$$

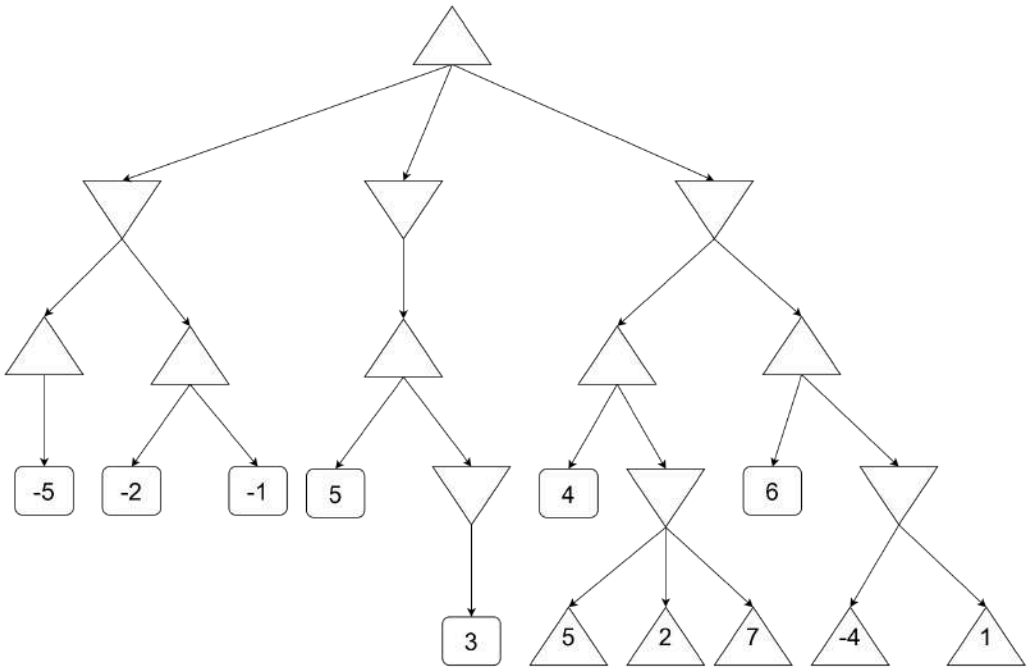
Here sine is in degrees and **t** is the time-step.
At **t=0**, **C** is randomly selected among the neighbors. **A** is selected at **t=1**. Similarly, at next consecutive timesteps, **E ,B** and **D** will be selected randomly.

a. For time-step **t=0 to t=4**, show with calculations if the corresponding randomly selected neighbor for each time-step will be picked or not. **[5]**
b. For time-step **t=5**, pick a neighbor of your choice and show with calculation if it will be picked or not. **[2]**

5. Consider the following game tree where:



Now apply the MinMax algorithm with alpha-beta pruning to show which nodes will be pruned. Show utility values for each node. **[5]**


-5
-2
-1
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1