United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Mid Exam: Summer 2024
Course Code: CSE 3811, Course Title: Artificial Intelligence
Total Marks: **30** Duration: **1 hour 45 minutes**

Answer all the six questions. Marks are indicated in the right side of each question.
[Any examinee found adopting unfair means will be expelled from the trimester/program as per UIU disciplinary rules]

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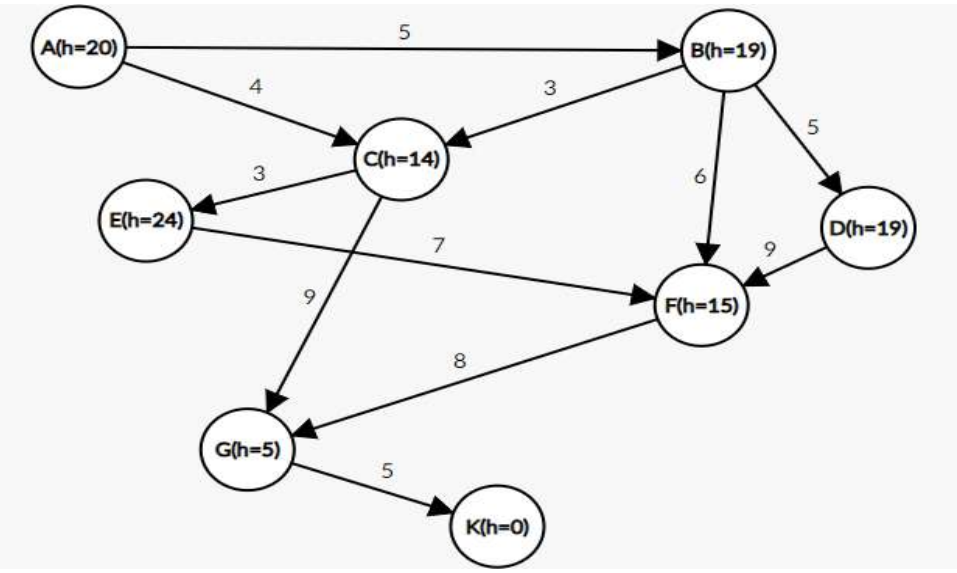
1. Imagine you are tasked with designing an autonomous gardening robot named "**Gardenia**". This robot is intended to maintain a home garden by performing tasks such as watering plants, removing weeds, monitoring plant health, and optimizing plant growth. The robot should function both during the day and at night, and it should be able to adapt to different types of plants and weather conditions.

a. Write the **PEAS** description for the "Gardenia" robot. **[2]**

b. Suppose, some of the trees have been infected with insects. The robot, firstly, has to find out the plants affected by the worms and then apply pesticides on them. **Formulate** this as a search problem using the problem formulation steps. **[2]**

2. Consider the following state-space graph below:



"**A**" is the **start** node and "**K**" is the **goal** node. Each node is represented with its name and heuristic value

a. Check whether the heuristic used in the graph is admissible or not. If inadmissible, **change the heuristic values** of the nodes **to make them both admissible and consistent**. **Show the calculations** and **mention the updated heuristic values**. **[3]**

b. Given, two heuristics h_1 and h_2 are admissible.

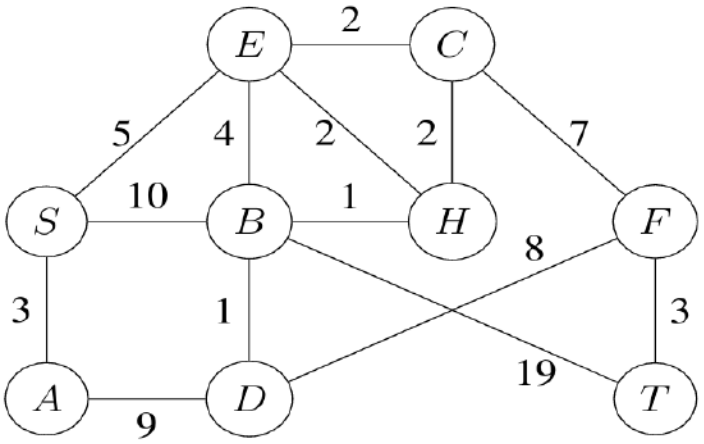
i. $h_3 = \sqrt{(h_1^2 + h_2^2)}$

ii. $h_4 = h_1^2 + h_2$

iii. $h_5 = h_1 + 2*h_2$

Which of these three will be **inadmissible**? Give proper reasoning and explain with equations. **[2]**

3. Consider the following graph:



Assume that "**S**" is the **start** state and "**T**" is the **goal** state. We will apply different search algorithms to find a path from S to T. When expanding the successors of a state, we will **break ties in alphabetic order**. For each of the following questions, **you must draw the search tree**.

- **a.** Run **BFS** on this graph and show the path returned. **[1]**
- **b.** Run **UCS** on this graph and show the path returned **along with its cost**. **[2]**
- **c.** Run **DLS** on this graph with: **[3]**
  - i. depth limit = 2
  - ii. depth limit = 7

4. Consider the following table for **Simulated Annealing** on a **maximization problem**:

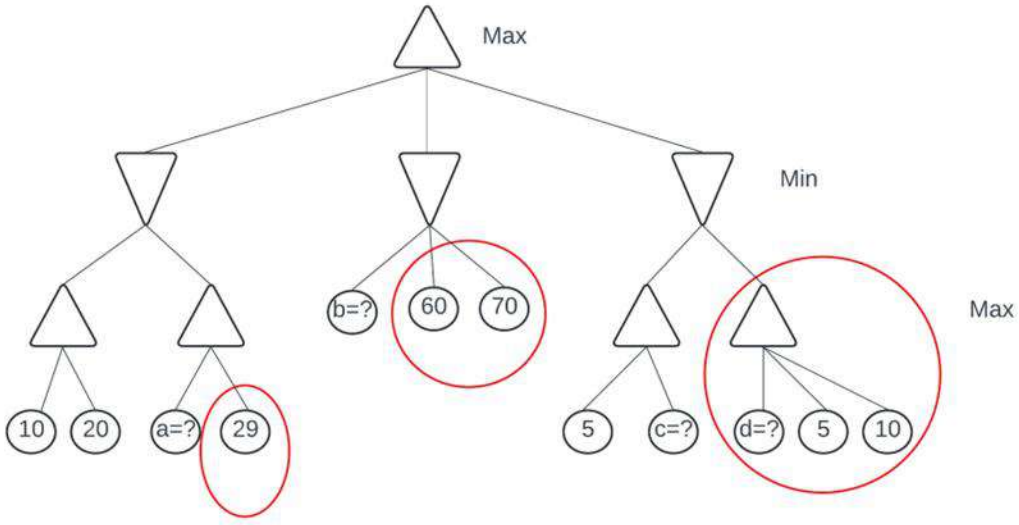
Neighbor Generation Sequence Number	E(Neighbor)	Value provided by Random Generator
1	4	0.55
2	9	0.95
3	5	0.5
4	12	0.1
5	6	0.35

The neighbors are generated sequentially according to their Sequence Number. If the **energy/utility value** of the current state, **E(current) = 10**, find **which neighbor** will be selected given the values of the Random Generator for each neighbor for the following temperature values. Show the calculation steps.

- **a.** For temperature, **T = 8** **[2]**
- **b.** For temperature, **T = 2** **[2]**
- **c.** For temperature, **T = ∞**(infinity) **[1]**

[*Hint: Probability for taking a **bad move** is* $e^{\Delta E/T}$, *here:* $\Delta E = E(neighbor) - E(current)$ *The Random Generator generates values between 0 and 1 inclusive.*]

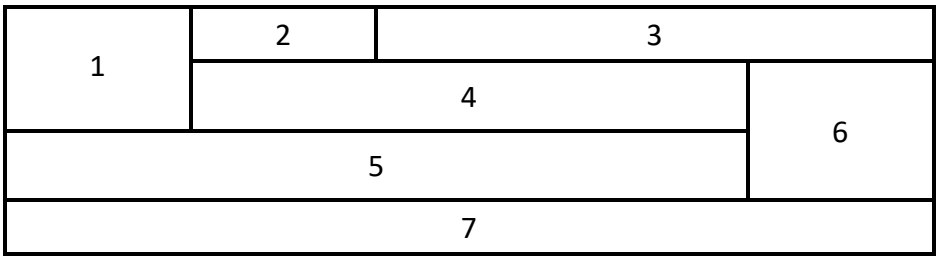
5. Consider the following tree:



a. Find the **range** of values of **a**, **b**, **c** and **d** so that the **circled branches are pruned** when the minimax algorithm with **alpha-beta pruning** is applied to this tree and show the values of **α**, **β**, and **utility value** at each of the internal nodes. **[4]**

b. Explain why those branches are pruned with your chosen values (explain for a single branch i.e. why your chosen value of "**a**" prunes the branch with utility value 29) **[1]**

6. Consider the following 7 tiles. You need to fill each tile with one of the **four** colors: Red, Green, Blue, White in such a way that all the 7 tiles are distinguishable after assigning the colors.



However, there are **some additional constraints**:

- Tile 1 must be colored with **Red**
- Tile 3 **cannot** be colored with **Green** or **Blue**
- Tile 7 **cannot** be colored with **Green**

Now formulate the problem as a Constraint Satisfaction Problem (CSP). You **must apply both MRV** and **LCV heuristics** while choosing and assigning a color to a tile. **Show the steps**. **[5]**
[Hint: Do not assign same color to adjacent tiles]