**Birla Institute of Technology & Science, Pilani**
**Work Integrated Learning Programmes Division**
**First / 2023-2024**

**Comprehensive Test**
**(EC-3 Makeup)**

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| Course No. | : | AIMLCZG557 |
| Course Title | : | Artificial and Computational Intelligence |
| Nature of Exam | : | Open Book |
| Weightage | : | 40% |
| Duration | : | |
| Date of Exam | : | 21-4-2024 (AN) |

No. of Pages = 4
No. of Questions = 5

Note to Students:
1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.

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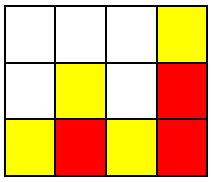
| Q1 | Consider the Connect Three game on a 3x4 board. Player1 has 12 yellow checkers, and Player2 has 12 red checkers. In Connect Three, the objective is to align three of your checkers in a row either horizontally, vertically, or diagonally before your opponent does. On your turn, place one of your checkers into an open slot at the top of the board. The checkers falls to the lowest unoccupied space in that column, occupying it. Assume that player with Yellow colored checkers moves first and answer the following questions: **[3+3+2 = 8 Marks]**<br>**Initial State:**<br>  <br>a) Construct the game tree (with neat diagram) from the given current state (0th level) as Start Node up to exactly 2 levels only (1st & 2nd Level - ie., one round for each of the player.) | 8 Marks |

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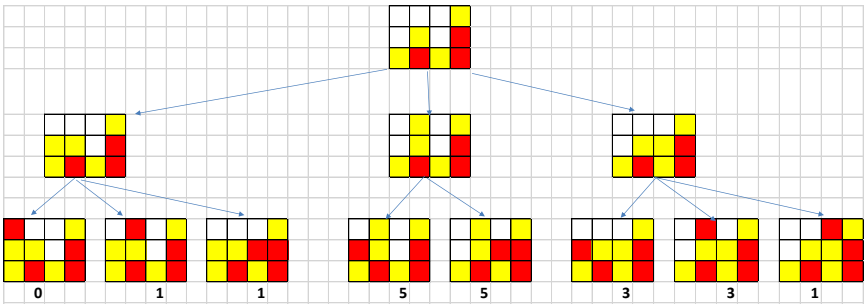
| | b) Calculate the utility of the leaves of the tree with below static evaluation function.<br>***Board value = MAX player chance of Win – 2 * (MIN player chance of Win)***<br>***Player Chance of Win = No. of. Matches possible is this player alone is allowed to fill all the empty cells with its checkers.***<br>c) Apply the MIN MAX algorithm on the game tree constructed in part a) using static evaluation values calculated in the part b) and highlight the best path chosen by players in the game given.<br><br>**Marking Scheme:**<br>**a) Correct Game tree construction upto level 1: 1 Marks**<br>**Correct Game tree construction upto level 2: 2 Marks**<br>**b) Computation of Max Player Winning Chance for all leaf nodes: 1.5 Marks**<br>**Computation of Min Player Winning Chance for all leaf nodes: 1.5 Marks**<br>**Final Board value calculation: 2 Marks**<br>**c) Step by step process of MIN MAX algorithm: 1.5 Marks**<br>**Representation of Best path: 0.5 Marks**<br><br>  <br> | |
| Q2 | In a city aiming for sustainable industrial growth, the government has set specific regulations to govern emissions from factories. Factory Y, which specializes in chemical production, has been reported for emitting pollutants into the atmosphere. The emitted pollutants contained harmful chemicals, potentially exceeding the permissible limits set by environmental regulations. ***[2+4+2 =8 Marks]***<br><br>a) Convert the above into predicate logic. Clearly define your own predicate designs<br>b) Prove by forward chaining that, "factory Y violates the environmental regulations" using the result of part a. Show the step by step inferences using neat diagram with direction. | 8 Marks |

c) Explain briefly the unsuitability of propositional logic representation for given above example with any two valid justifications.

**Marking Scheme:**

**a) Note: multiple predicate functions are available. (2 Marks)**

Predicate Logic

Emit (f, p): Factory f releases pollutant p into the atmosphere.

Contains (p, c): Pollutant p encompasses harmful chemical c.

Legal Limit (p, l): The maximum allowable concentration for pollutant p is l

Harmful (p): Pollutant p poses a threat to health and the ecosystem

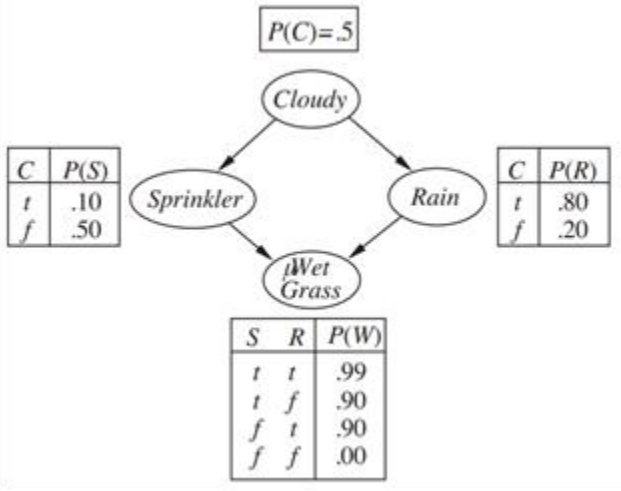
Violation (f): Factory f breaches environmental emission regulations.

**b)** Proper steps as discussed in class (4 Marks)

**c)** Explanation with justification: 1 Mark

Example : 1 Mark

| Q3 | ***Consider the below Bayesian Network and answer the following questions:***<br>***[4+2+ 4 = 10 Marks]*** | 10 Marks |
|---|---|---|



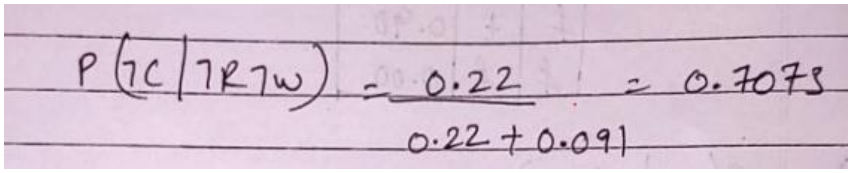

a) What is the chance that the day was not cloudy given the evidence that did not rain and the grass was not wet?

b) What is the likelihood that on a specific day, the sprinkler was not used while it rained?

c) Apply approximate inference for the part b) query. Use prior sampling and only 5 samples generated using the below random numbers.
"0.7, 0.3, 0.5, 0.9, 0.45, 0.8, 0.12, 0.6, 0.4, 0.75, 0.25, 0.5, 0.36, 0.3, 0.8, 0.1, 0.6, 0.4, 0.7, 0.2

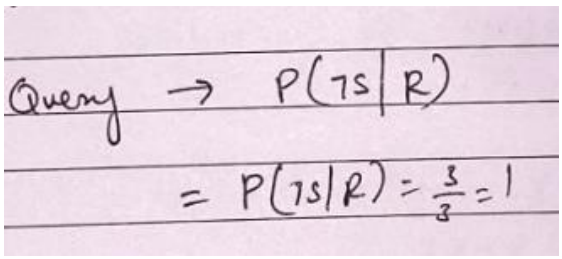
**Marking Scheme:**

**a) Proper query extraction - 1M, chain rule implementation and proper mathematical approach (Hidden variable identification) - 2M.**
**final result - 1M.**




**b) Correct query extraction - 1M, Final result - 1M.**

**c) Correct query - 1M, Sample table - 2M, Final result - 1M.**



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| Q4 | In a streaming service app, users can choose between three subscription plans: Basic, Standard, and Premium. Users' preferences for these plans are as follows:<br>Basic plan, offering standard quality streaming, is preferred by 65% of users for their everyday viewing. Standard plan, providing HD streaming and multi-device access, is chosen by 25% of users for family viewing and slightly enhanced quality. Premium plan, known for its Ultra HD quality, support for multiple devices, and exclusive content, is selected by 10% of users who are enthusiasts or want the best viewing experience. After subscribing to the service, users' preferences for their next subscription are influenced by their initial choice: Among users who initially chose the Basic plan, 55% decide to stick with the Basic plan for their next subscription, while 40% upgrade to the Standard plan for better quality. Users who initially opt for the Standard plan are inclined to continue with the Standard plan for their future subscriptions, with 70% remaining loyal. However, 20% of them decide to upgrade to the Premium plan for the best experience, while 10% downgrade to the Basic plan for cost-saving. For users who initially select the Premium plan, 85% continue with the Premium plan for their subsequent subscriptions due to their preference for the high-quality experience. However, 10% occasionally choose the Standard plan for a balance between quality and cost. [3+5 = 8 Marks]<br><br>a. Construct the Markov Model by extracting the transition and emission probability matrices from above pattern. Depict them with neat diagrams in addition to tabular representation. Assume equal likelihood for initial state.<br>b. For the below observations in the two sequences of user's requirements, what is the most likely sequence of subscription plans preferred by the user? Strictly follow the approach as discussed in class only.<br>***Observed Sequence: Everyday Viewing, Family Viewing.***<br>**Marking Scheme:**<br>**a) Transition matrix -1 Mark, Emission matrix-1 Mark, Markov Diagram-1 Mark** | 8 Marks |

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| | Transition Matrix : 1Mark<br><br>Basic \| Standard \| Premium \|<br>0.55 \| 0.1 \| 0.05 \| Basic<br>0.4 \| 0.7 \| 0.1 \| Standard<br>0.05 \| 0.2 \| 0.85 \| Premium<br><br>Emission Matrix : 1Mark<br><br>Basic \| Standard \| Premium \|<br>0.65 \| 0.375 \| 0.45 \| Everyday Viewing<br>0.175 \| 0.25 \| 0.45 \| Family Viewing<br>0.175 \| 0.375 \| 0.1 \| Best viewing<br><br>**Note : Mutlible answers are accpetable For emission Probabilty. Here we considered equally likelywood values.**<br><br>**b) Identification of Initial probability values: 0.33,0.33,0.33 (1Mark)**<br>**Computation for first observed sequence with normalization: (1.5 Mark)**<br>**Computation for second observed sequence: (1.5 Mark)**<br>**Best unobserved sequence based on maximum value : (1 Mark)** | |
| Q5 | Answer the following questions: ***[ 3+3 = 6 Marks ]***<br>a) Describe the importance of mutation in genetic algorithms, providing a plagiarism-free numerical example and justified explanation.<br>b) Explain the evaluation components of the Uniform cost Search (UCS) algorithm using an example.<br>**Marking Scheme:**<br>a) Mutation adds randomness to the search, helping the algorithm explore different solutions while also sticking to the ones that seem good. Mutation is a fundamental operator in genetic algorithms that enables them to effectively navigate complex search spaces, maintain diversity, and converge towards optimal or near-optimal solutions. [ 2 Marks]<br>Numerical Example [1 Mark]<br>b) Explanation [ 2 Marks]<br>Time complexity, Space complexity, Optimality, Completeness.<br>Numerical Example [1 Mark] | 6 Marks |