Thapar Institute of Engineering & Technology, Patiala
Department of Electrical and Instrumentation Engineering
END SEMESTER EXAMINATION

B. E. (**Third Year -EIC**): Semester-II (2023-24)	Course Code: **UCS411**
	Course Name: **Artificial Intelligence**
Time: **3** Hours, Marks: **45**	Name of Faculty: **Prof. Mukesh Singh**

Note: a) Attempt any <u>nine</u> questions.   b) All questions carry equal marks
c) Assume any missing data.   d) Use of non-programable calculator is allowed

1. Translate the following sentences in first-order logic.
    a) Star Trek, Star Wars and The Matrix are science fiction movies.   **CO1   L2**
    b) Every AI student loves Star Trek or Star Wars.
    c) Some AI students do not love Star Trek.
    d) All AI students who love Star Trek also love The Matrix.
    e) Every AI student loves some science fiction movie.
    f) No science fiction movie is loved by all AI students.
    g) There is an AI student who loves all science fiction movies.

2. Consider a planning problem where an agent needs to navigate through a grid world to reach its goal state. The grid world is represented as a 5x5 matrix, where each cell can either be empty (0) or blocked (1). The agent can move up, down, left, or right, but cannot move into blocked cells. The agent starts at cell (1, 1) and needs to reach the goal state at cell (5, 5). The following matrix represents the grid world: **CO3   L3**

0	0	0	0	0
0	1	0	1	0
0	0	0	1	0
(	1	0	0	0
0	0	0	1	0

Calculate the minimum number of movements required for the agent to reach the goal state if it follows a breadth-first search algorithm.

3. Consider a dataset containing information about the heights and weights of individuals. You are tasked with predicting the gender (male or female) of a new individual based on their height and weight using the K Nearest Neighbours (KNN) algorithm. The dataset is as follows: **CO2   L3**

Height (cm)	Weight (kg)	Gender
160	55	Female
165	60	Female
170	68	Male
175	75	Male
180	80	Male

A new individual with a height of 172 cm and a weight of 70 kg needs to be classified. Use the KNN algorithm with K=3 to predict the gender of this individual.

4. Suppose you are given a dataset containing the scores of two exams (Exam A and Exam B) for a group of students. You want to analyse the relationship between the scores of these two exams using the Pearson correlation coefficient. Calculate the Pearson correlation coefficient between the scores of Exam A and Exam B for these students. The dataset is as follows: **CO1   L4**

Student	Exam A	Exam B	Student	Exam A	Exam B
1	80	85	6	65	75
2	75	90	7	88	92
3	85	88	8	72	80
4	90	82	9	78	85
5	70	78	10	85	88

5. You are tasked with creating a semantic network to represent the relationships between various concepts in a specific domain. The domain chosen for this task is "Education System". Identify key concepts within the education system domain and their interconnections. These concepts may include "student," "teacher," "classroom," "subject," "school," "university," "curriculum," and "degree". Finally construct a semantic network representing these concepts, incorporating attributes and relationships to reflect the connections between them. Consider relationships such as "teaches," "attends," "belongs to," and "comprises". **CO1   L1**

6. You are provided with a dataset containing information about weather conditions and whether customers played tennis. The dataset includes features such as **Outlook, Temperature, Humidity, and Wind**. Your task is to build a decision tree using the Information Gain criterion to predict whether customers will play tennis based on these features. Here's a subset of the dataset:

Outlook	Temperature	Humidity	Wind	Play Tennis	Outlook	Temperature	Humidity	Wind	Play Tennis
Sunny	Hot	High	Weak	No	Sunny	Mild	High	Weak	No
Sunny	Hot	High	Strong	No	Sunny	Cool	Normal	Weak	Yes
Overcast	Hot	High	Weak	Yes	Rain	Mild	Normal	Weak	Yes
Rain	Mild	High	Weak	Yes	Sunny	Mild	Normal	Strong	Yes
Rain	Cool	Normal	Weak	Yes	Overcast	Mild	High	Strong	Yes
Rain	Cool	Normal	Strong	No	Overcast	Hot	Normal	Weak	Yes
Overcast	Cool	Normal	Strong	Yes	Rain	Mild	High	Strong	No

Using this dataset, draw a decision tree using the Information Gain criterion to predict whether customers will play tennis. **CO5   L3**

7. A desk lamp produced by The Luminar Company was found to be defective (D). There are three factories (A, B, C) where such desk lamps are manufactured. A Quality Control Manager (QCM) is responsible for investigating the source of defects. This is what the QCM knows about the company's desk lamp production and the possible source of defects:

Factory	% of total production	Probability of defective lamps
A	0.35=P(A)	0.015=P(D|A)
B	0.35=P(B)	0.010=P(D|B)
C	0.30=P(C)	0.020=P(D|C)

The QCM would like to answer the following question:
If a randomly selected lamp is defective, what is the probability that the lamp was manufactured in factory C, when P(D), the probability that a lamp manufactured by the Luminar Company is defective is 0.01475.

CO1   L1

8. (a) Define Nash Equilibrium in the context of game theory. Explain how it is reached and its significance in understanding strategic interactions. Discuss the conditions necessary for a strategy profile to be considered a Nash Equilibrium. Illustrate the concept of Nash Equilibrium using a simple game (e.g., Prisoner's Dilemma). Provide a payoff matrix and explain how to identify Nash Equilibrium in this game.

   (b) Define Prolog and explain its role as a logic programming language. Describe the basic structure of a Prolog program, including facts, rules, and queries. **CO4   L1**

9. Consider a genetic algorithm (GA) applied to optimize a function $f(x)= x^2 - 4x +4$ subject to the constraints $x \geq 0$. Implement the GA to find the global minimum of $f(x)$ within the range $0 \leq x \leq 5$. Make 2 complete iterations involving crossover, selection and mutations. Show all the results in tabular format. Assume any single point crossover and mutation rate as 0.02. (For population generation use this sequence where 0 means less than 0.5 and 1 means greater then 0.5 (00011101010101011 0011110001100110000110101). Take initial population size of 4. **CO3   L2**

10. Imagine a scenario where a robot is tasked with rearranging three blocks on a table to achieve a specific configuration. The blocks are labelled A, B, and C, and they are initially placed as follows:

Block A is on the table	Block B is on top of block A	Block C is on top of block B

The robot has the following actions it can perform: Pickup(block); Putdown(block); Stack(block1, block2) and Unstack(block1, block2).
The goal is to rearrange the blocks on the table to achieve the following configuration:

Block C is on the table	Block B is on top of block C	Block A is on top of block B

(a) Construct a goal stack representing the high-level plan to achieve the desired configuration, breaking it down into subgoals and actions.
(b) Provide a sequence of actions that the robot needs to execute to accomplish the goal. Include the subgoals and intermediate steps involved in achieving each action.

CO1   L3