Mahavir Education Trust's
Shah & Anchor Kutchhi Engineering College
An Autonomous Institute Affiliated to University of Mumbai
UG Program in Artificial Intelligence & Data Science

Name:	Vipul Rajesh Parmar
Roll No:	40
Academic Year:	2024-25

Semester V

Third Year

Artificial Intelligence & Data Science

Artificial Intelligence Laboratory

(ADLR0503)

Mahavir Education Trust's

Shah & Anchor Kutchhi Engineering College

An Autonomous Institute Affiliated to University of Mumbai

UG Program in Artificial Intelligence & Data Science

Institute

Vision: To become a globally recognized institution offering quality education and enhancing professional standards	**Mission:** To impart high-quality technical education to the students by providing an excellent academic environment, well-equipped laboratories and training through the motivated teachers.

Department

Vision: To be globally recognized for contributing professional and ethical engineer in the field of Artificial intelligence & Data Science with commitment to industry readiness and potential for research.	**Mission:** • To provide problem solving and analytical skill-based education to students that will enhance their expertise in the field of AI & DS through industry collaboration & research. • To develop skilled & ethical professional who are capable of providing AI & DS based solutions to societal challenges. • To equip students for gaining mastery in the art of mathematical, computational and modelling methodologies & contribute towards innovation in the field of AI & DS.
Program Educational Objectives (PEO)	**Program Specific Outcomes (PSOs)**
1. To train the students in formulating, analyzing, designing and deploying real world problems with a strong foundation in Mathematics, scientific and engineering fundamentals to meet the ever-increasing demand from the AI and DS sector. 2. To build technical skills, soft skills and competencies to collaboratively work in multi-disciplinary projects and diverse professional activities. 3. To equip graduates to contribute ethically to the needs of society. 4. To inculcate students with the ability to engage in independent and life-long learning in the context of technological changes.	By the end of the educational experience our students will be able to: 1. To analyse and apply mathematical, computational and modelling methodologies related to Al and DS. 2. Implement Al and DS techniques such as data analytics, machine learning, search algorithms, neural networks and design novel algorithms to solve practical problems. 3. Apply the acquired technical skills in the multi-disciplinary areas of Al and DS such as health care, education, agriculture, intelligent transport, environment, smart systems, etc.

UG Program in Artificial Intelligence & Data Science

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping of PSOs to POs:

PSO Number	PO Number
PSO1	PO1, PO2, PO3
PSO2	PO4, PO5, PO6, PO7, PO8, PO9, PO4, PO11, PO12
POS3	PO4, PO5, PO6, PO7, PO8, PO9, PO4, PO11, PO12

Sd/-
Program Coordinator
Artificial Intelligence &Data Science Program

Mahavir Education Trust's

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UG Program in Artificial Intelligence & Data Science

A Laboratory Journal for

Artificial Intelligence Lab

(CSC)

Semester V

Bachelor of Technology

(B. Tech.)

in

Artificial Intelligence & Data Science Department

Final Year with Effect from AY 2024 -2025

Prepared By:	Audited By:	Approved By:
Mr. Milind Khairnar (Assistant Professor)	(Language Expert)	**Dr. Bhavesh Patel** (Principal)
Mr. Milind Khairnar (Assistant Professor)	(Subject Expert)	**Dr. Pravin Shinde** (Head of Department)

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UG Program in Artificial Intelligence & Data Science

Program: Second Year B.Tech.	Semester: V	L	P	C
Artificial Intelligence	Course Code: ADCR0503	3	0	3
Artificial Intelligence Lab	Lab Code: ADLR0503	0	2	1
		3	2	4

Course Objectives:	
1	To gain perspective of AI foundations &study different agent architectures and properties of the environment.
2	To understand the basic principles of AI towards problem solving, inference, perception, knowledge representation, and learning.
3	To investigate probabilistic reasoning under uncertain and incomplete information.
4	To explore the current scope, potential, limitations, and implications of intelligent systems

Course Outcomes:	
After successful completion of this course, the students should be able to	
CO 1:	Identify the characteristics of the environment and differentiate between various agent architectures.
CO 2:	Apply the most suitable search strategy and represent a natural language description of statements in logic and apply the inference rules to design problem solving agents.
CO 3:	Apply a probabilistic model for reasoning under uncertainty
CO 4:	Describe the various building blocks of an expert system for a given real word problem.

Pre-requisite courses: Pre-requisite courses: C/JAVA Programming/Data Structure Course Assessment Methods

Course Assessment Methods:

DIRECT
1. Continuous Internal Assessment (Theory component) 2. Assignments/Tutorials/Power-point-presentation/Group-discussion/Quiz/seminar/Case studies/Design Thinking/Innovation/Creativity (Blog writing/Vlogging, etc) 3. Pre/Post - Experiment Test/Viva; Experimental Write-Up for each Experiment, Day to Day Experiments /Assignments/Tutorials/Power-point-presentation/Group-discussion/Quiz/seminar/Case studies/Design Thinking/Innovation/Creativity (Blog writing/Vlogging, etc) (Lab Component) 4. End Semester Examination (Theory component)
INDIRECT
1. Course-end survey 2. Activity based survey (if any)

DETAILED SYLLABUS:

Module 1: Intelligent Agents	**07 Hours**

1.1 Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally.

1.2 History of AI, Applications of AI, The present state of AI, Ethics in AI.

1.3 Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents.

1.4 Types of Agents: Simple Reflex, Model Based, Goal Based, Utility Based Agents.Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent.

Module 2: Solving Problems by Searching	**12 Hours**

2.1 Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems.

2.2 Solving Problems by Searching, Performance evaluation of search strategies, Time Complexity, Space Complexity, Completeness, Optimality.

2.3 Uninformed Search: Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search.

2.4 Informed Search: Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search: Hill Climbing Search, Simulated Annealing Search, Optimization: Genetic Algorithm.

2.5 Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-Beta Pruning.

Module 3: Knowledge and Reasoning	**10 Hours**

3.1 Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems.

3.2 Propositional Logic (PL): Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed-formula, Introduction to logic programming (PROLOG).

3.3 Predicate Logic: FOPL, Syntax, Semantics, Quantification, Inference rules in FOPL

3.4 Forward Chaining, Backward Chaining and Resolution in FOPL.

Module 4: Reasoning Under Uncertainty, Planning and Learning	**10 Hours**

4.1 Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution.

4.2 Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks.

4.3 The planning problem, Partial order planning, total order planning.

4.4 Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi -Supervised Learning, Reinforcement Learning, Ensemble Learning.

4.5 Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems.

LAB COMPONENT CONTENTS:

A. Suggested Topic/List of Experiments (Minimum 8 Experiments)

1. Provide the PEAS description and TASK Environment for a given AI problem.
2. Identify suitable Agent Architecture for the problem
3. Write simple programs using PROLOG as an AI programming Language
4. Implement any one of the Uninformed search techniques
5. Implement any one of the Informed search techniques E.g. A-Star algorithm for 8 puzzle problem
6. Implement adversarial search using min-max algorithm.
7. Implement any one of the Local Search techniques. E.g. Hill Climbing, Simulated Annealing, Genetic algorithm
8. Prove the goal sentence from the following set of statements in FOPL by applying forward, backward and resolution inference algorithms.
9. Create a Bayesian Network for the given Problem Statement and draw inferences from it. (You can use any Belief and Decision Networks Tool for modeling Bayesian Networks)
10. Implement a Planning Agent
11. Design a prototype of an expert system
12. Case study of any existing successful AI system

One beyond curriculum experiment may be conducted (To be decided by the Subject Teacher)

Practical: 2 hrs/week **Total Hours :26 Hrs**

Textbooks:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition"Pearson Education.
2. Elaine Rich and Kevin Knight —Artificial Intelligencel Third Edition, Tata McGraw- Hill EducationPvt. Ltd., 2008.
3. George F Luger —Artificial Intelligencel Low Price Edition, Pearson Education., Fourth edition.

Reference Books:

1. Ivan Bratko —PROLOG Programming for Artificial Intelligencel, Pearson Education, Third Edition.
2. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3. Saroj Kaushik —Artificial Intelligencel, Cengage Learning.
4. Davis E. Goldberg, —Genetic Algorithms: Search, Optimization and Machine Learningl, AddisonWesley, N.Y., 1989.
5. Patrick Henry Winston, —Artificial Intelligencel, Addison-Wesley, Third Edition.
6. N. P. Padhy, —Artificial Intelligence and Intelligent Systemsl, Oxford University Press.

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Course Code	Lab Name	Credits
ADLR0503	Artificial Intelligence Lab	1

Continuous Internal Assessment Practical (CIAP): CIAP will be assessed for 50 marks on the following rubrics and scaled down to 10 marks	
1	5 marks – Evaluation of write-up on day-to-day experiment in the laboratory (in terms of aim, components/procedure, expected outcome)
2	The Course In charge will choose any two of the below mentioned components, with each component having weightage of 20 marks each Assignments/Tutorials/Power point Presentation /Group discussion/Quiz/seminar/Case studies/Design Thinking/Innovation/Creativity/Project/App development
3	Attendance will be having weightage of 5 marks
End Semester Examination (ESEP)	
1	Based on the above contents and entire syllabus of ADLR0503 The End Semester Examination Practical shall be conducted for 100 marks for a duration of three hours and scaled down to 15 marks

Evaluation Method	Passing Requirement
Continuous Internal Assessment (CIAP)+End Semester Examination (ESEP)	Obtained Marks ≥40 % of maximum marks

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Course Outcomes (CO)

CO No.	**CO Statement** (At the end of the course, students will be able to …)	BL
1	Identify the characteristics of the environment and differentiate between various agent architectures	2
2	Apply the most suitable search strategy and represent a natural language description of statements in logic and apply the inference rules to design problem solving agents.	3
3	Apply a probabilistic model for reasoning under uncertainty.	3
4	Describe the various building blocks of an expert system for a given real word problem.	4

List of Experiments

Sr. No.	Title	CO	PO	PSO
1	Provide the PEAS description and TASK Environment for a given AI problem.	1	1,2,3,5,12	1,2
2	Write simple programs using PROLOG as an AI programming Language.	2	1,2,3,5,12	1,2
3	Develop a program in python for Depth First Search Iterative Deepening.	2	1,2,3,5,12	1,2
4	Implement the A* searching technique for finding the optimal path to the goal node if it exists.	2	1,2,3,5,12	1,2
5	Design and implement a chatbot that can engage in simple conversations using NLP techniques.	3	1,2,3,5,12	1,2,3
6	Implement adversarial search using min-max algorithm.	2	1,2,3,5,12	1,2
7	Implement Genetic algorithm using python for finding the optimal solution.	3	1,2,3,5,12	1,2
8	Prove the goal sentence from the following set of statements in FOPL by applying forward, backward and resolution inference algorithms.	4	1,2,3,5,6,12	1,2
9	Case study of any existing successful AI system.	4	1,2,3,5,6,7,8,9,10, 11,12	1,2,3

Name and Signature:

Date:

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Shah & Anchor Kutchhi Engineering College

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UG Program in Artificial Intelligence & Data Science

Subject: ARTIFICIAL INTELLIGENCE

INDEX

Sr. No.	Title of Experiment/Assignment/Tutorial	Date of Performance	Date of Submission	Page No.	Marks	Initials of Teacher with Remarks
1	Provide the PEAS description and TASK Environment for a given AI problem.	19/07/24	26/07/24	12		
2	Write simple programs using PROLOG as an AI programming Language.	26/07/24	02/08/24	17		
3	Develop a program in python for Depth First Search Iterative Deepening.	02/08/24	09/08/24	20		
4	Implement the A* searching technique for finding the optimal path to the goal node if it exists.	09/08/24	16/08/24	24		
5	Design and implement a chatbot that can engage in simple conversations using NLP techniques.	16/08/24	23/08/24	27		
6	Implement adversarial search using min-max algorithm.	30/08/24	06/09/24	32		
7	Implement Genetic algorithm using python for finding the optimal solution.	06/09/24	27/09/24	36		
8	Prove the goal sentence from the following set of Statements in FOPL by applying forward, backward and resolution inference algorithms.	04/10/24	11/10/24	40		
9	Case study of any existing successful AI system.	04/10/24	11/10/24	45		

	Marks
Evaluation of write-up on day-to-day experiment in the laboratory (in terms of aim, components/procedure, expected outcome)	**/05**
Assessment Method 1	**/20**
Assessment Method 2	**/20**
Attendance	**/05**

This is to certify that Shri.Vipul Rajesh Parmar.....

Batch.....B.....Roll No....40.....Semester……5……

has completed the

specified CIAP in the subject of …Artificial intelligence and data science……..…….in a satisfactory manner in the college during the academic year of …2024….. to …2025……

Subject In-charge

Instructions for Students

1. For effective implementation and attainment of practical outcomes, in the beginning of each exercise, students need to read through the complete write-up.
2. Students ought to refer to reference books, lab manuals, etc.
3. Students should not hesitate to ask about any difficulties which they face while performing practical.
4. Algorithms & Flow graphs to be handwritten for programming subjects.

Guidelines for Faculties

1. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practical.
2. For difficult practical if required, teachers could provide the demonstration of the practical emphasizing of the skills which the students should achieve.
3. Teachers should give opportunities to students for hands-on work after the demonstration.
4. During the practical, ensure that each student gets a chance and takes active part in taking observation/readings and performing practical.

UG Program in Artificial Intelligence & Data Science

Experiment No. - 1					
Date of Performance:		**19/07/24**			
Date of Submission:		**26/07/24**			
Program Execution/ formation/correction/ ethical practices (07)	Documentation (02)	Timely Submission (03)	Viva Answer to sample questions (03)	Experiment Total (15)	Sign with Date

Experiment No. 1

1.1 Aim:

To provide the PEAS (Performance measure, Environment, Actuators, Sensors) description and TASK environment for a given AI problem.

1.2 Course Outcome (CO):

CO 1: Identify the characteristics of the environment and differentiate between various agent architectures.

1.3 Problem Statement:

Consider a vacuum-cleaner agent operating in a 2D grid environment. The task is to provide a detailed PEAS description for the agent in this environment and define its task environment, assuming that the grid is partially observable and contains dirt at random locations. It is shown in the diagram 1.1.

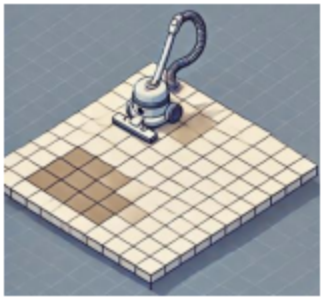

Figure 1.1

1.4 Related Theory:

In Artificial Intelligence (AI), agents are systems that perceive their environment and take actions to maximize their chances of success. The **PEAS** framework is a commonly used method to describe the components of an agent. PEAS stands for:

- **Performance Measure**: Defines the criteria for the agent's success. In the vacuum-cleaner problem, the performance measure could be the cleanliness of the grid or the number of cleaned tiles.
- **Environment**: The external world in which the agent operates. In this case, the environment is a 2D grid containing dirt in some tiles. The environment can be fully observable or partially observable, static or dynamic.
- **Actuators**: The mechanisms by which the agent interacts with its environment. For the vacuum cleaner, actuators could include the ability to move in four directions (up, down, left, right) and the ability to suck dirt.
- **Sensors**: These allow the agent to perceive the environment. The vacuum cleaner agent might have sensors that detect whether the current tile is dirty or clean and whether there are obstacles or walls.

Additionally, the **task environment** for an agent defines the broader context in which the agent operates, characterized by its:

- **Observability**: Whether the agent can fully or partially observe the environment.
- **Determinism**: Whether the results of actions are predictable.
- **Dynamics**: Whether the environment changes while the agent is making decisions.
- **Discrete vs. Continuous**: Whether the environment is composed of distinct states or continuous spaces.
- **Single vs. Multi-agent**: Whether the agent interacts with other agents in the environment.

1.5 Program Listing (if applicable) and Output:

Agent	Performance	Environment	Actuators	Sensors
Autonomous Car	Safety, time, efficient transportation	Roads, traffic, weather	Steering, brakes, accelerator, lights, indicators	Cameras, radar, GPS, ultrasonic sensors
Chess Playing-AI	Winning game	Chessboard, opponent	Move chess pieces	Board recognition, opponent moves
Healthcare Diagnosis	Accurate disease identification	Patient data, medical facilities	Prescription, treatment planning, tests	Medical records, diagnostic tests, patient data
Robot Arm Assembly	Precise and manipulation of objects	Assembly line, various objects to assemble	Grasping, lifting,placing objects	Cameras, tactile sensors, vision sensors
Subject Tutoring	Maximize scores, improvement in students	Classroom, chair, board staff, students	Smart displays, corrections	Eyes, ears, notebooks

1.6 Procedure

1. **Define the AI Problem**:
   - Choose an AI problem that involves an agent interacting with an environment. For example, the vacuum cleaner agent tasked with cleaning a 2D grid environment.
2. **Identify the Components for PEAS Framework**:
   - **Performance Measure**: Identify the success criteria for the agent (e.g., the percentage of clean tiles).
   - **Environment**: Define the environment in which the agent operates (e.g., a partially observable 2D grid with dirt on random tiles).
   - **Actuators**: List the actions the agent can perform (e.g., move up, down, left, right, and clean a tile).
   - **Sensors**: Specify the data the agent receives from the environment (e.g., detecting dirt on a tile, sensing obstacles or walls).
3. **Define the Task Environment**:

- Describe the task environment in terms of its properties:
  - **Fully/Partially Observable**: Does the agent have full information about the environment, or can it only sense a part of it?
  - **Deterministic/Stochastic**: Are the outcomes of the agent's actions always predictable, or is there some uncertainty?
  - **Static/Dynamic**: Does the environment change while the agent is deciding on actions?
  - **Discrete/Continuous**: Is the environment composed of a finite set of states, or can the agent be in any position within a range?
  - **Single-Agent/Multi-Agent**: Does the agent operate alone, or does it interact with other agents?

4. **Document the PEAS and Task Environment**:
   - Write a detailed description of the PEAS components and the task environment characteristics.

Performance Measure:

The performance of the vacuum-cleaner agent can be evaluated based on several criteria:

Cleanliness: The amount of dirt removed from the environment.

Efficiency: Measured by the distance traveled while cleaning and the time taken to complete the task.

Battery Life: The duration for which the agent can operate before needing a recharge.

Safety: Avoiding obstacles and ensuring no damage occurs to the environment or the agent itself.

Coverage: Ensuring that all areas of the grid are cleaned effectively.

Environment:

The environment consists of:

A 2D grid (e.g., 4x4 blocks) where each block can contain dirt at random locations.

Various surfaces such as carpets, tiles, or hardwood floors, which may affect cleaning efficiency.

Obstacles such as furniture, walls, or other objects that can hinder movement.

The grid is partially observable, meaning the agent cannot see all locations at once and must rely on sensors to detect dirt.

Actuators:

The actuators that allow the vacuum-cleaner agent to interact with its environment include:

Wheels: For movement across the grid.

Vacuum Extractor: To suck up dirt from surfaces.

Brushes: To agitate dirt and debris for easier removal.

Motors: To control movement and operation of brushes and suction mechanisms.

Sensors:

The sensors used by the vacuum-cleaner agent to perceive its environment include:

Dirt Detection Sensors: To identify whether a block is dirty or clean.

Infrared Sensors: To detect obstacles and avoid collisions.

Location Sensors: To determine the current position within the grid (if applicable).

Battery Level Sensors: To monitor energy levels and determine when to return for recharging.

Task Environment:

The task environment for this vacuum-cleaner agent is characterized by:

Partial Observability: The agent cannot see all parts of the grid simultaneously, necessitating a strategy for exploration and cleaning based on limited information.

Dynamic Elements: The state of cleanliness may change if dirt is introduced after cleaning has begun, requiring adaptability in its cleaning strategy.

Discrete States: The grid consists of distinct locations that can be either clean or dirty.

Single-Agent Scenario: Typically operates alone without other competing agents in this context.

5. **Discuss Variations**:
   - Consider what changes might occur in the agent's design or operation if the environment were fully observable or dynamic. Discuss how these changes would affect the PEAS framework.

Fully Observable Environment:
Performance Measure: Focus on efficiency and speed; metrics on time and energy consumption.
Environment: All dirt locations known; allows for systematic cleaning strategies.
Actuators: Simpler design; less complex navigation required.
Sensors: Fewer sensors needed; simpler detection mechanisms.
Dynamic Environment:
Performance Measure: Emphasis on adaptability and responsiveness to new dirt or obstacles.
Environment: Includes moving objects and changing dirt locations, requiring real-time adjustments.
Actuators: Enhanced maneuverability and faster response mechanisms needed.
Sensors: Advanced sensors for real-time updates and detection of changes.

1.7 **Conclusion:**

The design and operation of a vacuum-cleaner agent are significantly influenced by the characteristics of its environment. In a fully observable environment, the agent benefits from complete visibility, allowing for more efficient and straightforward cleaning strategies, with simpler sensors and actuators. Conversely, in a dynamic environment, the agent must adapt to real-time changes, necessitating advanced sensors and enhanced maneuverability to effectively respond to new challenges.

1.7 Questions:

1. Define the PEAS framework and explain each of its components.
2. What are the differences between a fully observable and a partially observable environment?
3. How does a deterministic environment differ from a stochastic environment in AI?
4. Provide an example of an agent with a dynamic environment. What challenges does it face compared to a static environment?
5. In the context of the vacuum cleaner agent, what would happen if the environment were continuous rather than discrete?