Q1: Answer the following

(a) Short questions (1 mark each)

1. **Which AI type, currently non-existent, aims to perform any intellectual task a human can?**
   Answer: General AI (Strong AI)

2. **What is the process of converting a problem into a search problem called?**
   Answer: Problem formulation

3. **In predicate logic, which symbol is used for universal quantification?**
   Answer: ∀ (For all)

Q1:

(B)

1. What technique allows AI to deal with gray areas and uncertain outcomes?

Answer: c) Fuzzy Logic

2. Self-correction in AI means that algorithms continuously improve themselves for better accuracy: True/False

Answer: True

3. Which search strategy guarantees the shortest solution?

Answer: b) Breadth-First Search

4. A technique in AI that allows for reasoning with uncertainty and dealing with gray areas is called a head of absolute values: True/False

Answer: False

5. Which AI technique is most useful for solving real-world problems using prior experience?

Answer: b) Heuristic Search

6. What is the primary goal of Machine Learning?

Answer: b) To enable machines to learn from data and improve performance over time

7. In predicate logic, what does the existential quantifier (∃) mean?

Answer: b) At least one exists

Q2: Answer the following

(a) Two Questions of 2 Marks

1. **Define Narrow AI with an example.**
   Answer: Narrow AI, also known as Weak AI, is an AI system designed to perform a specific task. It cannot perform tasks outside its predefined scope.
   Example: Siri, Google Assistant, and ChatGPT are examples of Narrow AI.

2. **What is a heuristic function? Provide an example.**
   Answer: A heuristic function is a function that ranks alternatives based on available information to make search algorithms more efficient.
   Example: In A* algorithm, the heuristic function estimates the cost from a node to the goal.

(b) Two Questions of 3 Marks

1. **List and explain four key aspects of AI programming.**
   Answer:
   - **Machine Learning:** Enables AI systems to learn from data and improve performance.
   - **Natural Language Processing (NLP):** Helps AI understand and process human language.
   - **Computer Vision:** Enables AI to interpret and analyze visual information.
   - **Expert Systems:** AI-based systems that mimic human decision-making.

2. **Define the term predicate logic in AI. Write a brief detail with an example.**
   Answer: Predicate logic is a formal representation of knowledge that expresses relationships among objects. It uses quantifiers (∃, ∀) and logical operators.
   Example: "All humans are mortal" can be represented as:
   ∀x (Human(x) → Mortal(x))

(i) Compare Narrow AI and General AI, highlighting their capabilities and limitations.

Feature	Narrow AI	General AI
Definition	AI designed for a specific task	AI that can perform any intellectual task a human can
Capabilities	Works within a predefined scope	Adapts and learns new tasks independently
Examples	Siri, Alexa, ChatGPT	Hypothetical, still under research
Limitations	Cannot think beyond its programming	Theoretical, not yet developed

(ii) Explain the key features of Machine Learning that differentiate it from traditional programming.

1. **Learning from Data:** Unlike traditional programming, ML models learn from data instead of following hardcoded rules.
2. **Pattern Recognition:** ML algorithms detect patterns in data to make predictions.
3. **Adaptability:** ML models improve over time as they are exposed to more data.
4. **Automation:** Reduces the need for manual programming by automatically improving performance.
5. **Generalization:** ML models can apply learned knowledge to new, unseen data.

(iii) Discuss in detail how predicate logic is used for knowledge representation in AI.

1. **Formal Representation:** Predicate logic expresses knowledge in a structured form using quantifiers (∀, ∃).
2. **Expressing Relationships:** It helps define relationships between objects and properties.
3. **Inference Mechanisms:** AI uses logical rules to infer new facts from existing knowledge.
4. **Example:**
    - Fact: "Socrates is a man" → Man(Socrates)

- Rule: "All men are mortal" → ∀x (Man(x) → Mortal(x))
- Conclusion: Mortal(Socrates)

Q4: Answer the following

(a) Consider an AI-based expert system for a hospital that diagnoses diseases based on patient symptoms. Explain how predicate logic can be used for knowledge representation in this system. Provide examples to demonstrate its application. (5 Marks)

1. **Knowledge Representation:** Predicate logic is used to represent medical knowledge formally.
2. **Rules and Facts:**
   - Fact: "John has a fever" → Fever(John)
   - Rule: "If a person has a fever and cough, they may have flu"
     ∀x (Fever(x) ∧ Cough(x) → Flu(x))
3. **Inference:** If the system knows that John has a cough, it can conclude that John may have the flu.
4. **AI Application:** The expert system can use this knowledge to assist doctors in diagnosing diseases.

(b) Explain how an AI-based navigation system like Google Maps utilizes heuristic search techniques to determine the shortest route. Provide relevant examples. (Minimum 3 search techniques must explain with example) (5 Marks)

1. *A Algorithm:**
   - Uses a heuristic function (estimated distance to goal) to find the shortest route.
   - Example: Finding the shortest driving route from Location A to B.
2. **Dijkstra's Algorithm:**
   - Finds the shortest path from a source node to all destinations.
   - Example: Used when there are no heuristic estimates available.
3. **Greedy Best-First Search:**
   - Chooses the path that appears best at each step.

- Example: If multiple routes are available, it picks the one with the lowest estimated time first.

OR

(b) Heuristic search is faster but not always optimal. In what scenarios would you prefer using heuristic search over exhaustive search? Explain with examples. (5 Marks)

1. **Time Constraints:**
   - In real-time systems like Google Maps, heuristic search is preferred as exhaustive search takes too long.
2. **Large State Space:**
   - In chess, heuristic search (Minimax with Alpha-Beta Pruning) helps find a good move without evaluating all possibilities.
3. **Approximate Solutions:**
   - In recommendation systems (Netflix, Amazon), heuristic search provides good suggestions instead of searching all possibilities.