Q1 (a) i) What is a knowledge based agent? Explain its role and importance.
ii) Explain different Inference Rules for First Order Predicated logic.

→ In artificial intelligence, a knowledge agent is autonomous entity, which observes through sensors and acts upon an environment using actuators and direct its activities towards achieving their goals It may also learn or use knowledge to achieve their goal.

Role and importance:

1) An agent should be able to represent states, actions, etc.
2) An agent should be able to incorporate new percepts.
3) An agent can update the internal representation of the world.
4) An agent can deduce the internal representation of the world.
5) An agent can deduce appropriate action.

Inference Rule for first Order Predicated logic are:

i) Universal Generalisation - Universal generalisation is a valid inference rule which states that if premise P(c) is true for any arbitrary element c, then we can have a conclusion as $\forall x\ P(x)$. It can be represented as $P(c) / \forall x\ P(x)$

ii) Universal Instantiation (UI) - The UI rule states that we can infer any sentence P(c) by substituting a ground term c from $\forall x\ P(x)$ for any object in the universe of discourse It can be represented as $\frac{\forall x\ P(x)}{P(c)}$

iii) Existential Instantiation - Existential Instantiation is also called or Existential Elimination, which is a valid inference rule in first-order logic. It can be applied only to replace the existential sentence.

iv) Existential Introduction → This rule states that if there is some element c in the universe of discourse which have a property P, then we can infer that there exists something in the universe which has property P.

Q1 (b) What is FOPL? Represent the following sentences using FOPL.

i) John has at least two friends.

ii) If two people are friends then they are not enemies.

→ The first Order Predicate Logic is a method of formal representation of Natural Language text. The prolog representation language for AI programming has its foundations in FOPL. If demonstrates how to translate NL to FOPL in the form of facts and rules, use of quantifiers and variables, syntax and semantics of FOPL, and conversion of predicate expression to clause forms. This is followed with unification of predicate expressions using instantiations and substitutions, compositions of substitutions, unification algorithm and its analysis.

i) $x : x(\text{John}) \rightarrow$ at least friends $(y \wedge z)$

ii) $x \wedge y$ (friends) $\rightarrow (\sim x) \wedge (\sim y)$ (enemies)

Q.1 (c) i) Write note on Wumpus world problem

→ 1) The Wumpus world is a simple world example to illustrate the worth of a knowledge - based agent and to represent knowledge representation. It was inspired by a video game Hunt the Wumpus by Gregory Yob in 1973.

2) The Wumpus world is a cave which has 4/4 rooms connected with passageways. So there are total 16 rooms which are connected with each other.

3) We have a knowledge - based agent who will go forward in this world. The cave has a room with a beast which is called Wumpus, who eats anyone who enters the room.

4) The Wumpus can be shoot by the agent, but the agent has a single arrow. In the Wumpus world, there are some Pits rooms which are bottomless, and if agent falls in Pits, then he will be stuck there forever.

5) The exciting thing with this cave is that in one room there is a possibility of finding a heap of gold.

6) So the agent goal is to find the gold and climb out the cave without fallen into Pits or eaten by Wumpus. The agent will get a reward if he comes out with gold, and he will get a penalty if eaten by Wumpus or fallen in the pit.

(ii) Write short note on Bayesian Network with example.

→ 1) A Bayesian network is a probabilistic graphical model which represents a set of variables and their conditional dependencies using a directed acyclic graph.

2) It is called a Bayes network, belief network, decision network or Bayesian model.

3) Bayesian networks are probabilistic, because these networks are built from a probability distribution, and also use probability theory for prediction and anomaly detection.

4) Real world applications are probabilistic in nature, and to represent the relationship between multiple events, we need a Bayesian network. It can also be used in various tasks including prediction, anomaly detection, diagnostics, automated insight, reasoning, time series prediction and decision making under uncertainly.

Q2 Explain planning in AI. Compare Partial Order Planning with Conditional Planning. Also, Explain the real time application of hierarchical planning.

→ 1) The task coming up with a sequence of actions that will achieve a goal is called planning.
2) Planning is typically viewed as a generic term of problem solving because it deals with search in an abstract level.
3) Planning is involved in plan generation
4) Planner is viewed as the producer or generator of the solution
5) Backward planning is typical for planning, the pre-requirements are almost same for variety of problems in planning.

Comparing Partial order planning with conditional Planning:

1) Partial order planning is an approach to automated planning that maintains a partial ordering between actions and only commits ordering between actions when the actions are partial
2) Where as, conditional planning deals with the planning by some appropriate conditions. The agent plan first and then execute the plan to test for the appropriate conditions
3) Conditional Planning works regardless of the outcome of an agent.
4) Conditiond planning take place in fully observable Environment where the current state of the agent in known environment is fully observable
5) The outcome of actions cannot be determined so the environment is said to be non-deterministic.

Examples of Hierarchical Planning are:

1) An example of hierarchy is the corporate ladder.
2) An example of hierarchy is the various levels of priests in catholic churches.
3) All files and folders on the hard disk are organised in a hierarchy.

Q3] Explain different components of Natural language processing? Also explain different level of knowledge used in language understanding?

→ Components of NLP:

There are two components of NLP:
Mapping the given input in the natural language into a useful representation. Different levels of analysis required: morphological analysis, syntatic analysis, semantic analysis discourse analysis.

1) Natural language generation: Producing output in the natural language from some internal representation.

2) NL understanding: NL understanding is much harder than NL generation. But still both of them are harder.

Different levels of NLP are:

1) Morphology: It is the analysis of individual words that consist of morphemes the smallest grammatical unit. This analysis becomes necessary in the determination of tense as well

2) Syntax: Syntax is concerned with the rules. It includes legal formulation of the sentence to check the structure

3) Semantic: During this phase, meaning check is carried out and way in which the meaning is conveyed as analyzed

4) Discourse integration: In communication or even in text formats, often the meaning of the current sentence is dependent on the one that is prior to it

5) Pragmatic: In this phase, analysis of the response from the user with reference to what actually the language meant to convey is handled

6) Prosody: It is an analysis phase that handles rhythm.

7) Phonology: This involves analysis of the different kinds of sound that are combined. It is concerned with speech recognition.