perplexity

answer each of those questions, style should be perfect for CS exam:

Topic: 04 Knowledge, Reasoning, Planning

1. **What is logic? What are the advantages of first-order logic over propositional logic?**
   [2020, 2016]
2. **What is the difference between propositional logic and predicate logic? Mention the basic components of propositional logic.**
   [2020, 2018, 2015, 2013]
3. **What is fuzzy logic? List the properties of a fuzzy set.**
   [2014, 2012]
4. **Explain the fuzzy set operation with an example.**
   [2018]
5. **What is knowledge? How can we represent knowledge? Discuss the frame-based approach.**
   [2020, 2018, 2015]
   Or
   What is knowledge representation in AI?
   [2021]
6. **Explain knowledge representation using fuzzy logic.**
   [2016]
7. **Discuss various approaches and issues in knowledge representation.**
   [2017, 2012]
8. **Discuss different types of knowledge.**
   [2013]
9. **Distinguish between "knowledge and intelligence."**
   [2020, 2017, 2015, 2013, 2011]
10. **Describe the rules of inference.**
    [2021]
    Or
    What is an inference rule?
    [2018, 2017, 2013]
    Or
    Describe the rule of inference with examples.
    [2019, 2016]
11. **Discuss the inference rule of any two in propositional logic.**
    [2017, 2013]

Or
Discuss the Modus Ponens and Modus Tollens.
[2018]

12. **What do you mean by soundness and completeness of inference rules?**
[2016]
13. **What is a wff? What are the properties of wffs?**
[2017, 2015, 2012]
14. **Define wff and clause. Write down the steps of converting wffs into clauses.**
[2019, 2016]
15. **What is the purpose of the unification algorithm? What is a horn clause?**
[2019, 2016]
16. **Represent the following sentence in wff and convert the wff to clause form:**
"All Romans who know Marcus either hate Caesar or think that anyone who hates anyone is crazy."
[2019, 2016]
17. **Represent the following facts using propositional logic:**
i) It is raining
ii) It is sunny
iii) It is windy
iv) If it is raining, then it is not sunny
[2020, 2018, 2016]

18. (a) Translate the following sentence into first-order logic:

i) All dogs are mammals.

ii) Fido is a dog.

iii) Fido is a mammal.

iv) All mammals produce milk.

[2017, 2015, 2011]

(b) Use the Modus Ponens deduction rules to deduce sentence (iii) from (i) and (ii).

[2011]

(c) Write the answers from part (a) in conjunctive normal form.

[2011]

(d) Translate the following sentence into CNF:

"There exists a dog which does not produce milk."

[2011]

19. Translate the following sentences into formulas in predicate logic:

i) All elephants are grey.

ii) Sue eats everything Bill eats.

iii) Nobody likes to be poor.

iv) Everyone is loyal to someone.

v) Caesar was a ruler.

[2013]

20. Translate the following sentences into first-order logic:

i) Some flowers are red.

ii) Frogs are green.

iii) Some intelligent students study CSE.

iv) There is a person who loves everyone in the world.

[2016]

21. Represent the following sentence in FOPL:

i) All freighters are ships.

ii) The father of the child is a male parent.

iii) Some intelligent students study CSE.

iv) Man is mortal.

[2018]

22. Represent the following sentence in FOPL:

i) All CSE students are meritorious.

ii) Bithi obtained an A+ in neural networks.

iii) The car painted white belongs to me.

iv) CSE413 is an AI course.

[2014]

23. Represent the following sentence in FOPL:

i) The car painted white belongs to me.

ii) Man is mortal.

iii) Horses are faster than crows.

iv) Everybody likes an honest man.

[2012]

24. Determine whether each of the following sentences is:

ii) Contradictory

iii) Valid

[2018]

![[media /image.png]]
25. Translate the following statement into FOPI

i. All employee earning taka to 2, 40,000 or more per year pay Texs

ii. Some employers are sick today

iii. No employee earns more than the president

26. What do you mean by quantifier? What are the functionalities of different kinds of quantifiers? [2020]

1. **What is logic? What are the advantages of first-order logic over propositional logic?**
   Logic is a formal system that uses symbols and rules to represent and manipulate statements about the world, allowing for reasoning and inference. It provides a framework for determining the truth values of propositions based on their structure and relationships. First-order logic (FOL) extends propositional logic by introducing quantifiers and predicates, enabling it to express more complex statements about objects and their relationships. The advantages of FOL over propositional logic include:
   - **Expressiveness**: FOL can represent statements involving quantification (e.g., "for all" or "there exists"), which propositional logic cannot.
   - **Structure**: FOL allows for the representation of relationships between objects, making it suitable for more complex domains.
   - **Inferences**: FOL supports richer inference mechanisms, enabling more sophisticated reasoning compared to the limited capabilities of propositional logic.
2. **What is the difference between propositional logic and predicate logic? Mention the basic components of propositional logic.**

Propositional logic, also known as sentential logic, deals with propositions that can be true or false but does not involve quantifiers or variables. In contrast, predicate logic (or first-order logic) includes predicates, variables, and quantifiers, allowing for statements about objects and their properties.
Basic components of propositional logic include:

- **Propositions**: Statements that have a definite truth value (e.g., "It is raining").
- **Logical Connectives**: Operators used to form compound propositions (e.g., AND ($\wedge$), OR ($\vee$), NOT ($\neg$), IMPLIES ($\rightarrow$)).
- **Truth Values**: Each proposition can be assigned a truth value of either true (T) or false (F).

3. **What is fuzzy logic? List the properties of a fuzzy set.**
Fuzzy logic is an extension of classical logic that deals with reasoning that is approximate rather than fixed and exact. It allows for the representation of concepts that cannot be expressed with binary true/false values by introducing degrees of truth.
Properties of a fuzzy set include:
    - **Membership Function**: Defines how each element in the set is mapped to a membership value between 0 and 1.
    - **Support**: The set of elements that have a non-zero membership value.
    - **Normality**: A fuzzy set is normal if there exists at least one element with a membership value of 1.
    - **Convexity**: A fuzzy set is convex if, for any two elements in the set, all elements in between also belong to the set.
4. **Explain the fuzzy set operation with an example.**
Fuzzy set operations allow for combining fuzzy sets in various ways, similar to classical set operations but adapted to handle degrees of membership.
For example, consider two fuzzy sets:
    - Set A (Temperature): {Cold: 0.8, Warm: 0.5, Hot: 0.2}
    - Set B (Comfort): {Comfortable: 0.7, Uncomfortable: 0.4}

    The intersection operation (AND) can be defined as:
$$\mu_{A\cap B}(x) = \min(\mu_A(x), \mu_B(x))$$
If we calculate the intersection for "Warm" from Set A and "Comfortable" from Set B:
$$\mu_{A\cap B}(Warm) = \min(0.5, 0.7) = 0.5$$
Thus, "Warm" is considered moderately comfortable with a membership degree of 0.5 in the intersection.
5. **What is knowledge? How can we represent knowledge? Discuss the frame-based approach.**
Knowledge refers to information that has been processed and understood by an individual or system, encompassing facts, concepts, skills, and experiences.
Knowledge can be represented in various forms including:
    - **Propositional Logic**: Using logical statements.
    - **Predicate Logic**: Using predicates and quantifiers.

- **Semantic Networks**: Graph structures representing relationships between concepts.

The frame-based approach organizes knowledge into structured units called frames, which consist of slots (attributes) and fillers (values). Each frame represents an entity or concept along with its properties and relationships.

6. **Explain knowledge representation using fuzzy logic.**
Knowledge representation using fuzzy logic involves modeling uncertain or imprecise information through fuzzy sets and rules. In this context:

   - **Fuzzy Sets** represent concepts with degrees of membership rather than binary classifications.
   - **Fuzzy Rules** are used to infer conclusions based on fuzzy inputs. For instance:
     If "Temperature is Hot" then "Comfort Level is Low".

   This representation allows systems to handle ambiguity effectively, making it suitable for applications like control systems where precise values are often unavailable.

7. **Discuss various approaches and issues in knowledge representation.**
Various approaches to knowledge representation include:

   - **Logical Representation**: Using formal languages like propositional and predicate logic.
   - **Frame Representation**: Utilizing frames to capture hierarchical relationships among concepts.
   - **Semantic Networks**: Graphical representations showing how concepts are related.

   Issues in knowledge representation involve:

   - **Expressiveness vs. Efficiency**: Balancing the ability to represent complex knowledge while maintaining computational efficiency.
   - **Handling Uncertainty**: Developing methods to represent and reason about incomplete or uncertain information.
   - **Scalability**: Ensuring that representation methods can scale with increasing amounts of data.

8. **Discuss different types of knowledge.**
Different types of knowledge include:

   - **Declarative Knowledge**: Knowledge about facts or information (e.g., "Paris is the capital of France").
   - **Procedural Knowledge**: Knowledge about how to perform tasks or procedures (e.g., knowing how to ride a bicycle).
   - **Conditional Knowledge**: Knowledge that specifies conditions under which certain facts hold true (e.g., "If it rains, then the ground gets wet").

9. **Distinguish between "knowledge and intelligence."**
Knowledge refers to the accumulation of facts, information, and skills acquired through experience or education; it represents what one knows about a subject. Intelligence, on the other hand, refers to the ability to apply that knowledge effectively in problem-solving situations; it encompasses reasoning, learning from experience, understanding complex ideas, and adapting to new situations.

10. **Describe the rules of inference.**
    Rules of inference are logical rules that dictate the valid steps one can take in deriving conclusions from premises within a logical system. They serve as foundational principles for deductive reasoning.
    Common rules include:

    - **Modus Ponens**: If $$

P

$$implies$$

Q

$$(i.e.,$$

P \rightarrow Q

$$)and$$

P

$$istrue, then$$

Q$$ must also be true.

```
- **Modus Tollens**: If $$
```

P

$$implies$$

Q

$$and$$

Q

$$isfalse($$

\neg Q

$$), then$$

P

$$mustalsobefalse($$

\neg P$$).

11. **Discuss the inference rule of any two in propositional logic.**
    Two fundamental inference rules in propositional logic are:

    - **Modus Ponens:**If we have $$

P \rightarrow Q

$$(if$$

P

$$, then$$

Q

$$)and$$

P

$$,wecanconclude$$

Q$$.

```
Example:
Given "If it rains ($$
```

P

$$), thenthegroundwillbewet($$

Q

$$). Itisraining($$

P

$$). Therefore, thegroundiswet($$

Q$$)."

```
- **Modus Tollens**:
  If we have $$
```

P \rightarrow Q

$$and$$

\neg Q

$$,wecanconclude$$

\neg P$$.

```
Example:
Given "If it rains ($$
```

P

$$), thenthegroundwillbewet($$

Q

$$). Thegroundisnotwet($$

\neg Q

$$). Therefore, itisnotraining($$

\neg P$$)."

12. **What do you mean by soundness and completeness of inference rules?**
    Soundness refers to a property of an inference system where any statement derived using its rules is logically valid; that is, if a conclusion can be inferred from premises using these rules, then it must be true in every model where those premises are true.

Completeness means that if a statement is logically valid (true in every model), then there exists a derivation using the inference rules; every valid conclusion can be reached through some sequence of applications of those rules.

13. **What is a wff? What are the properties of wffs?**
    A well-formed formula (wff) is a syntactically correct expression constructed from symbols according to specific rules in formal languages such as propositional or predicate logic.
    Properties of wffs include:
    - They must adhere strictly to grammatical rules defined by the logical system.
    - They can represent propositions that have truth values.
    - Wffs can contain logical connectives like AND ($\land$), OR ($\lor$), NOT ($\neg$), etc., as well as quantifiers in predicate logic.
14. **Define wff and clause. Write down the steps of converting wffs into clauses.**
    A well-formed formula (wff) is an expression built from symbols according to specific syntactic rules in formal languages.
    A clause is a disjunction of literals; it can be viewed as an OR statement among one or more literals (which may be negated).
    Steps for converting wffs into clauses:
    1. Convert wff into prenex normal form (move all quantifiers to the front).
    2. Convert into conjunctive normal form (CNF), ensuring it's expressed as a conjunction of disjunctions.
    3. Remove universal quantifiers by replacing them with free variables.
    4. Each disjunctive part becomes an individual clause.
15. **What is the purpose of the unification algorithm? What is a horn clause?**
    The unification algorithm's purpose is to determine whether two logical expressions can be made identical by appropriately substituting variables with terms; this process facilitates reasoning mechanisms such as resolution theorem proving.
    A Horn clause is a special type of clause that contains at most one positive literal; it can be expressed in disjunctive form as follows:
    $$A_1 \land A_2 \land ... \land A_n \rightarrow B$$
    where $$

A_1, A_2,...A_n

$$arenegativeliteralsand$$

B$$ is a positive literal.

16. **Represent the following sentence in wff and convert the wff to clause form:**
    "All Romans who know Marcus either hate Caesar or think that anyone who hates anyone is crazy."
    WFF Representation:
    $$\forall x((Roman(x) \land Knows(x, Marcus)) \rightarrow (Hates(x, Caesar) \lor Thinks(x, \forall y(Hat$$
    Clause Form Conversion Steps:
    1. Prenex Normal Form:
       Move quantifiers outwards.

2. Convert into CNF:
   Apply distribution laws until only conjunctions/disjunctions remain.

Resulting Clauses:
1st Clause: $$

Roman(x) \land Knows(x, Marcus)$$

```
2nd Clause: $$
```

Hates(x,Caesar)$$

```
3rd Clause: $$
```

Think(x,\forall y(Hates(x,y)))$$

17. **Represent the following facts using propositional logic:**
    i) It is raining
    ii) It is sunny
    iii) It is windy
    iv) If it is raining, then it is not sunny
    Propositional Representation:
    Let R = "It is raining", S = "It is sunny", W = "It is windy".
    i) R
    ii) S
    iii) W
    iv) $$

R \rightarrow ¬S$$

18(a). Translate into first-order logic:

i) All dogs are mammals.

$$

\forall x(Dog(x) \rightarrow Mammal(x))

$$

ii) Fido is a dog.

$$

Dog(Fido)

$$

iii) Fido is a mammal.

$$

Mammal(Fido)

$$

iv) All mammals produce milk.

$$

\forall x(Mammal(x) \rightarrow ProducesMilk(x))

$$

18(b). Use Modus Ponens deduction rules:

From i):

$$

Dog(Fido)

$$and ii):$$

Dog(Fido) \rightarrow Mammal(Fido)

$$Conclusion:$$

Mammal(Fido)

$$

18(c). Conjunctive Normal Form:

1st Clause: $$

Dog(Fido)$$

2nd Clause: $$

¬Dog(Fido)\lor Mammal(Fido)$$

3rd Clause: $$

¬Mammal(Fido)\lor ProducesMilk(Fido)$$

18(d). Translate into CNF:

"There exists a dog which does not produce milk."

$$

∃x(Dog(x) ∧ ¬ProducesMilk(x))

$$

19 Translate into formulas in predicate logic:

i) All elephants are grey.

$$
\forall x(\text{Elephant}(x) \rightarrow \text{Grey}(x))
$$

ii) Sue eats everything Bill eats.

$$
\forall y(\text{Eats}(\text{Bill},y) \rightarrow \text{Eats}(\text{Sue},y))
$$

iii) Nobody likes being poor.

$$
\neg \exists x(\text{Likes}(x,\text{Poor}))
$$

iv) Everyone is loyal to someone.

$$
\forall x(\exists y(\text{Loyal}(x,y)))
$$

v) Caesar was a ruler.

$$
\text{Ruler}(\text{Caesar})
$$

20 Translate into first-order logic:

i) Some flowers are red.

$$
\exists x(\text{Flower}(x) \land \text{Red}(x))
$$

ii) Frogs are green.

$$
\forall x(Frog(x) \rightarrow Green(x))
$$

iii) Some intelligent students study CSE.

$$
\exists x(IntelligentStudent(x) \land StudiesCSE(x))
$$

iv) There exists a person who loves everyone in the world.

$$
\exists x(Person(x) \land \forall y(Loves(x,y)))
$$

21 Represent in FOPL:

i) All freighters are ships.

$$
\forall x(Freighter(x) \rightarrow Ship(x))
$$

ii) The father of the child is a male parent.

$$
Father(Child(y)) = MaleParent(y)
$$

iii) Some intelligent students study CSE.

$$
\exists x(IntelligentStudent(x) \land StudiesCSE(x))
$$

iv) Man is mortal.

$$
\forall x(Man(x) \rightarrow Mortal(x))

$$

22 Represent in FOPL:

i) All CSE students are meritorious.

$$

∀x(CSEStudent(x) → Meritorious(x))

$$

ii) Bithi obtained an A+ in neural networks.

$$

Obtained(Bithi,A+ , NeuralNetworks)

$$

iii) The car painted white belongs to me.

$$

Car(White,x) ∧ BelongsTo(x , Me)

$$

iv) CSE413 is an AI course

$$

AI(CSE413)

$$

23 Represent in FOPL:

i) The car painted white belongs to me

$$

Car(White,x) ∧ BelongsTo(x , Me)

$$ii) Man is mortal$$

∀x(Man(x) → Mortal(x))

$$iii) Horses are faster than crows$$

∀x(Horse(x) → FasterThan(Horse , Crow))

$$iv) Everybody likes an honest man$$

∀x(HonestMan(x) → LikesEverybody(x))

$$

24 Determine whether each sentence:

- ii) Contradictory
- iii) Valid

25 Translate into FOPI

i) All employees earning taka 240000 or more per year pay taxes

$$

∀x(Employee(x) ∧ EarnsMoreThan240000(Taka)) → PaysTaxes(x)

$ii)Someemployersaresicktoday$

∃x(Employer(x) ∧ SickToday(x))

$iii)Noemployeeearnsmorethanthepresident$

¬∃x(Employee(x) ∧ EarnsMoreThan(President))

$$

26 What do you mean by quantifier? What are functionalities?

Quantifiers are symbols used in predicate logic to indicate quantity within statements about objects within certain domains.

There are two primary types:

- Universal Quantifier ($$

\forall
$) : Indicatesthatastatementappliestoallelementswithinadomain(e.g.,$

∀x(Predicate(x))

$means''forall$

x$$").

- Existential Quantifier ($$

\exists
$) : Indicatesthatthereexistsatleastoneelementwithinadomainsatisfyingcertaincon$

∃y(Predicate(y))

$means''thereexistssome$

y$$").

These functionalities enable precise expression about groups or individual elements within logical formulations.

⁂