

[illegible]

Choose the most appropriate answer for each of the following questions.

1. A hospital system stores **DrugAllergy(Ahmed, Penicillin)** and the rule **DrugAllergy(x, Penicillin) $\rightarrow$ Avoid(x, Penicillin)**. The statement **Avoid(Ahmed, Penicillin)** is best described as:
 - A. Raw data
 - B. Implicit knowledge derived by reasoning**
 - C. A syntax error
 - D. A second-order predicate
2. Which statement is a **proposition**?
 - A. Close the warehouse door.
 - B. Is lane 3 congested?
 - C. The robot battery is below 20%.**
 - D. $x + 2 = 7$
3. Let **p** = 'the soil is dry' and **q** = 'the irrigation valve is open.' Which **expression** means 'the soil is dry and the irrigation valve is not open'?
 - A. $p \vee \neg q$
 - B. $p \wedge \neg q$**
 - C. $\neg p \wedge q$
 - D. $p \rightarrow q$
4. In the rule 'If a vehicle exceeds the speed limit, then the ITS system issues an alert,' **exceeding the speed limit** is:
 - A. Necessary for issuing an alert
 - B. Sufficient for issuing an alert**
 - C. Equivalent to issuing an alert
 - D. The converse of issuing an alert
5. A warehouse access rule says 'A worker enters the hazardous zone **if and only if** the worker has authorization.' Which expression represents it?
 - A. $p \rightarrow q$
 - B. $q \rightarrow p$
 - C. $p \leftrightarrow q$**
 - D. $p \oplus q$
6. A smart farm alarm is defined as **A = moisture_low $\vee$ temperature_high**. Which expression means '**the alarm condition is not present**'?
 - A. $\neg \text{moisture_low} \vee \neg \text{temperature_high}$
 - B. $\text{moisture_low} \wedge \text{temperature_high}$
 - C. $\neg \text{moisture_low} \rightarrow \text{temperature_high}$
 - D. $\neg \text{moisture_low} \wedge \neg \text{temperature_high}$**
7. Why is a truth table usually impractical for a large SAT problem?
 - A. Truth tables cannot represent negation
 - B. The number of rows grows as 2^n**
 - C. SAT problems have no Boolean variables
 - D. Truth tables work only for FOL
8. A system stores many correct facts but has no rules linking them and cannot derive anything new. Which course idea best diagnoses the limitation?
 - A. Facts alone equal intelligence
 - B. Representation without useful structure limits reasoning**
 - C. Every KB must be second-order
 - D. All reasoning should be hard-coded
9. Which of the following is a function (not a predicate)?
 - A. Pedestrian(x)
 - B. MarriedTo(x, y)
 - C. MustStop(x)
 - D. ceoOf(x)**
10. Let **p** = "the gripper is closed" and **q** = "the part is detected". **When is $p \wedge q$ true?**
 - A. When at least one of p, q is true
 - B. Only when both p and q are true**
 - C. When exactly one of p, q is true
 - D. Only when both p and q are false

A. Consider the following propositional logic formula:

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$$[(p \rightarrow q) \wedge \neg q] \rightarrow \neg p$$

i. Construct a complete truth table for the formula, including all intermediate columns

p	q	$p \rightarrow q$	$\neg q$	$(p \rightarrow q) \wedge \neg q$	$\neg p$	Final
T	T	T	F	F	F	T
T	F	F	T	F	F	T
F	T	T	F	F	T	T
F	F	T	T	T	T	T

ii. Based on your completed truth table, determine whether this formula is a tautology, a contradiction, or a contingency. Justify your answer clearly by referencing the truth values in the final column.

Based on the completed truth table, the formula is a tautology because the final column contains T for every possible combination of truth values of (p) and (q) . Therefore, the formula is always true.

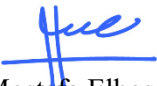
B. To **prevent collisions at an intersection**, the safety interlock requires that the North and East signals cannot be green simultaneously, nor can both be red when traffic is flowing — meaning exactly one signal is active ($N \oplus E$). An engineer proposes replacing the dedicated XOR gate with an equivalent network of standard AND, OR, and NOT gates ($(N \vee E) \wedge \neg(N \wedge E)$).

Prove or disprove the engineer's design by providing a comparative truth table evaluation.

(Points: 5)

N	E	$N \oplus E$	$N \vee E$	$N \wedge E$	$\neg(N \wedge E)$	$(N \vee E) \wedge \neg(N \wedge E)$
T	T	F	T	T	F	F
T	F	T	T	F	T	T
F	T	T	T	F	T	T
F	F	F	F	F	T	F

Best Wishes


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