ICS 6B F23 Take Home Exam 2

Due: October 13, 2023 at 11:59PM

Name: ______________________________

UCI NetID : | | | | | | | | |

(alpha-numeric; NOT your student ID)

- **Read** the instructions of each question carefully.
- **Please write your answers on the answer sheet instead and only submit the answer sheet.** We changed the format to save paper and give more space for work. Place your answers in the boxed regions. Writing outside of the boxes will not be considered as part of your answers.
- **Show all of your work. For problems without work to show then you should provide a brief 1 to 2 sentence description of what you did.**
- An answer where thought process is unclear will be given a grade of Not Yet
- Your submission should follow the template exactly. Any insertion, removal, or reordering of pages from the original template may result in readers not grading certain problems. In such an event you will receive "Not Yet" and no feedback on the problems in question.
- This exam will cover the Outcomes from the Q Learning Objective
- Please keep in mind of the academic honesty guidelines. This take-home exam is to be **completed individually, with no outside help**. You may use any resources from our class (ZyBooks and resources from Canvas), but you may not use any other online resources.
- You may choose to print the exam or use a digital editor for completing the exam. It is required that you use this PDF to complete your work. If you have no access to a printer or digital tools to fulfill the exam, feel free to reach out to the staffs regarding your concern.
- If you have any questions, please post a private Ed or attend available Office Hours. Note that we are not allowed to provide specific help to answering the exam questions.
- Good luck!

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Problem 1.1 (Q.1)

Consider the predicates over the domain of positive integers:

$$P(x) : x \text{ is an even number}$$
$$Q(x) : x \text{ is a multiple of } 3$$
$$R(x) : x \text{ is a prime number}$$

Determine the truth values of the following quantified statements:

a) $\forall x((P(x) \land R(x)) \to \neg Q(x))$

b) $\exists x(\neg P(x) \land \neg Q(x) \land \neg R(x))$

Problem 1.2 (Q.1)

Consider the predicates over the domain $D = \{-2, -1, 0, 1, 2\}$:

$$P(x, y) : x^2 + y^2 \leq 4$$

$$Q(x, y) : x + y > 0$$

$$R(x, y) : xy = 0$$

For each of the following statements, determine whether it is true, false, or undetermined:

a) $\forall x \, \forall y \, (P(x, y) \lor Q(x, y))$

b) $\exists x \, (P(x, y) \land Q(x, y) \land R(x, y))$

c) $\exists x \, \forall y \, (P(x, y) \land R(x, y))$

Problem 1.3 (Q.1)

Two predicates $P(x, y)$ and $Q(x, y)$ are defined below and all the variables x, y, z have the same domain $\{a, b\}$.

x	y	$P(x,y)$
a	a	True
a	b	False
b	a	False
b	b	True

y	z	$Q(y,z)$
a	a	False
a	b	True
b	a	False
b	b	False

Determine the truth values for the following nested quantified statements:

a) $\forall x \exists y \forall z \, (P(x, y) \to Q(y, z))$

b) $\exists x \exists y \forall z \, (P(x, y) \land Q(y, z))$

c) $\forall x \forall y \forall z \, (P(x, y) \lor \neg Q(y, z))$

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Problem 2 (Q.2)

Suppose there is a Science Club at the school, and the domain for the following predicates is the club members.

1. $P(x, y)$: x knows that y won a science competition.
2. $Q(x)$: x received a special recognition certificate.
3. $R(x)$: x is a seasoned club member.

Translate the following English sentences into quantified logical expressions (suppose Jim is a club member):

a) Every member of the Science Club knows that Jim won a science competition, but none of them received a special recognition certificate.

b) There is at least one member of the Science Club who is not a seasoned club member, but everyone in the Science Club knows that Jim won a science competition.

c) There are exactly 2 members of the Science Club such that if they received a special recognition certificate, then they are a seasoned club member.

Problem 3 (Q.3)

Rewrite each of these statements so that negations appear only within predicates (that is, so that no negation is outside a quantifier or an expression involving logical connectives).

a) $\neg\forall x\exists y\,(P(x, y) \wedge Q(y) \rightarrow \exists z\, R(x, y, z))$

b) $\neg\exists x\forall y((P(x) \leftrightarrow Q(y)) \vee R(x, y))$