

CSI 30, Homework 3 on Sections 1.3, 1.4

Due by Mon, Sept 28.

Write all your working out and answers on your own notepaper. Please use lots of space and as many pages as you want, so I can include corrections or comments. You do not need to write the questions, but it is very important that you explain your answers and show clearly any work you had to do. Each question is worth 3 points.

Section 1.3 Propositional equivalences

- (1) Is $\neg(p \rightarrow p)$ a tautology, a contradiction or a contingency. Explain your answer.
- (2) Use De Morgan's laws to find the negation of this statement:

I will wash the dishes and take out the trash.

- (3) Use a truth table to prove that $\neg(p \oplus q) \equiv p \leftrightarrow q$
- (4) Use laws of logic (and not a truth table) to prove that

$$p \vee \neg(p \wedge q)$$

is a tautology (always true). Justify each of your steps.

Section 1.4 Predicates and quantifiers

- (5) The propositional function $P(x)$ says " $x = x^2$ ". Decide the truth values of:
- (a) $P(-1)$
 - (b) $P(0)$
 - (c) $P(1)$
 - (d) $P(5)$
- (The answer to each part is true or false.)
- (6) Let $R(x)$ be the statement "the word x contains the letter a ". Give the truth values of these:
- (a) $R(\text{orange})$
 - (b) $R(\text{lemon})$
 - (c) $R(\text{true})$
 - (d) $R(\text{false})$

- (7) Suppose $Q(x)$ says “ x can speak Swedish”. Let the domain be all people living in New York City.
- (a) Explain in words what $\forall x Q(x)$ means.
 - (b) Is $\forall x Q(x)$ true?
 - (c) Explain in words what $\exists x Q(x)$ means.
 - (d) Is $\exists x Q(x)$ true?
- (8) As before, let $P(x)$ say “ $x = x^2$ ”. Let the domain be the set of integers. Decide the truth values of these, explaining your answer:
- (a) $\forall x P(x)$
 - (b) $\exists x P(x)$
 - (c) $\exists! x P(x)$
 - (d) $\exists x \neg P(x)$
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Many of you are using AI to help with homework questions. You can paste them in and get step by step answers most of the time. If you are using AI, the smart way is:

- Study the relevant class notes and section in the textbook first.
- Try the homework questions yourself.
- Use AI help if you’re having trouble.
- Make sure you understand the answers you’re handing in - there will be similar questions on exams.

If you’re still stuck on a question:

- Ask me about it after class.
 - Come to my office hours: Mon 12:00 - 1:00, Wed 12:00 - 1:00 in CP 317.
 - Go to the Math Tutorial Lab in-person in CP 303 or online.
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Note – If I don’t have time to grade every question then I will just grade two random ones. Then your score will be awarded as follows

- First graded question: 25%
- Second graded question: 25%
- You provided answers to all questions: 25%
- Homework was done neatly and submitted on time: 25%