CS1800
Fall 2025
Homework 1
Assigned: September 16, 2025
Deadline: September 23, 2025 at 9pm eastern
Late Deadline: September 25, 2025 at 9pm eastern

Submission Format

CS1800 Homeworks must be handwritten, on physical paper or a tablet. **Typed submissions will not be accepted.**

Submit a PDF or images to Gradescope. If you submit images, make sure they are JPEG, JPG, or PNG. (Don't submit iPhone HEIC images!) Each problem starts on a new page. Problem 1 is on a different page than Problem 2. Problems 1A and 1B can be on the same page.

Collaboration and Academic Integrity

We encourage you to work with classmates on these problems; list all collaborators on the first page of your submission. You may also consult outside sources, including generative AI; list all outside sources you referenced and how you used them on the first page of your submission.

However, **you must write all your solutions yourself, in your own words**. Do not submit anything you can't explain. Copying solutions from another person or an outside source is a violation of our academic integrity policy.

Deadline and Late Submissions

You can submit any/all homeworks up to 48 hours late with no penalty. However, **once the late deadline has passed, no submissions will be accepted**. This policy exists so you take extra time when you're especially busy, not feeling well, tending to your family, etc.; we won't make any exceptions to this policy.

Second-Chance Homework: You will have an opportunity at the end of the semester to submit one homework (HWs 1-6 only) for a new grade. If you miss both the deadline *and* the late deadline on a homework, use the Second-Chance to submit it.

For full credit

- select which pages go with which questions on Gradescope, and
- show ALL your work including intermediate steps.

Your Name

Your Collaborators (Classmates)

Outside References and How You Used Them

Problem #1 - Logical Equivalence *(4+4+4 = 12 points)*

For each pair of logical expressions below, determine whether they are logically equivalent.

- **If yes...** Apply the laws of logical equivalence to prove that they are the same. Take one step at a time and label each step with one law.
- **If no...** give values for p and q that would yield a counterexample. Simplify both expressions to demonstrate that they are not the same.

For full credit, both *yes* and *no* answers should be clear, precise, and walk through your solution one small step at a time.

1A $\neg(p \wedge (p \vee \neg q))$
$p \wedge q$

Are the two expressions logically equivalent? _____

Demonstrate equivalence with a proof, or inequivalence with a thorough counterexample.

1B $\neg(p \wedge (p \vee \neg q))$
$\neg p$

Are the two expressions logically equivalent? _____

Demonstrate equivalence with a proof, or inequivalence with a thorough counterexample.

1C $p \vee (p \wedge q) \vee (\neg p \wedge q)$
$p \vee q$

Are the two expressions logically equivalent? _____

Demonstrate equivalence with a proof, or inequivalence with a thorough counterexample.

Problem #2 - English & Logic *(2+2+3+4 = 13 points)*

Consider the statements S, R, U, and V below, about Laney's dog, Grizz.

S = Grizz is asleep
R = Grizz is hungry
U = Grizz plays fetch with Prof. Patterson
V = Grizz wants attention

2A Translate into logic statements, using only the symbols ¬, ∧, ∨, and/or ⇒ :
Grizz never plays fetch with Prof. Patterson when he is hungry.

2B Translate into logical statements, using only the symbols ¬, ∧, ∨, and/or ⇒ :
If Grizz is hungry, then he wants attention, but if he is not hungry, then if he's awake he wants attention.

2C Express the following logic statement in English:
$(R \vee U) \Rightarrow V$

2D Negate the following logic statement, fully distributing the negation and labelling each step with a law of Logical Equivalence.

$(R \vee \neg(R \wedge U)) \vee (U \wedge S)$

Problem #3 - Truth Tables *(3+4+4 = 11 points)*

3A Use a truth table to prove the Logical Distributive law: $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$. For full credit, your truth table must have one column for each logical operation applied, with the concluding columns clearly labelled.

3B Consider the statement: *You can access the website only if you have paid the subscription fee.*

Let P = you can access the website, and Q = you have paid the subscription fee

Write out a complete truth table that includes the implications $P \Rightarrow Q$ and $Q \Rightarrow P$. State the implication that best respects the English statement and why.

3C Consider the statement: *You can't log in unless you enter your password.*

Let P = you can log in, and Q = you enter your password

Write out a complete truth table that includes $\neg P \Rightarrow \neg Q$ and $\neg Q \Rightarrow \neg P$. State the implication that best respects the English statement and why.

Problem #4 - Predicates *(3+3+2+5 = 13 points)*

4A Negate the predicate $\forall x(\ x^2 > 2)$, fully distributing the negation such that there is no $\neg$ at all in your final expression.

4B Let our domain be the positive integers, and let $P(x)$ be the statement "x is even". Express the statement "the product of an even number and an odd number is even" in predicate logic.

4C Let our domain be all people and all dogs. Let $D(x)$ mean "x is a dog", and $L(x, y)$ be the statement "x loves y."

Translate this predicate into natural English:

$$\exists x \forall y \ D(x) \ \wedge (\neg D(y) \Rightarrow \ L(y, x))$$

4D Negate the logic statement from part C, fully distributing the negation. Express the final result in logic and English (but don't worry I'm sure it's not true in real life!!). Show all your work and take small steps.

Problem #5 - Implications *(2+2+5 = 9 points)*

5A For the statements below, answer: (1) does the conclusion logically follow from the premise? (2) Is the conclusion the converse, inverse, or contrapositive of the premise?

- **Premise**: If it's Wednesday, then we wear pink.
- We are wearing pink.
- **Conclusion**: Therefore, it is Wednesday.

(1) does the conclusion logically follow from the premise?

(2) Is the conclusion the converse, inverse, or contrapositive of the premise?

5B

- **Premise**: If it's Wednesday, then we wear pink.
- It is not Wednesday.
- **Conclusion**: Therefore, we are not wearing pink.

(1) does the conclusion logically follow from the premise?

(2) Is the conclusion the converse, inverse, or contrapositive of the premise?

5C Let our domain be the positive integers. Prove the following statement by contrapositive: If $n = ab$ then $a \leq n$ or $b \leq n$.

Begin by clearly stating what the contrapositive is.