

# CS 2050 Fall 2023 Homework 1

Due: September 1 @ 11:59 PM

Released: August 25

This assignment is due at **11:59 PM EDT** on **Friday, September 1, 2023**. Submissions submitted at least 24 hours prior to the due date will receive 2.5 points of extra credit. On-time submissions receive no penalty. You may turn it in one day late for a 10-point penalty or two days late for a 25-point penalty. Assignments more than two days late will NOT be accepted. We will prioritize on-time submissions when grading before an exam. You should submit a typeset or *neatly* written PDF on Gradescope. The grading

TA should not have to struggle to read what you've written; if your handwriting is hard to decipher, you will be required to typeset your future assignments. Illegible solutions will be given 0 credit. A 5-point penalty will occur if pages are incorrectly assigned to questions when submitting. You may collaborate

with other students, but any written work should be your own. Write the names of the students you work with on the top of your assignment. Always justify your work, even if the problem doesn't specify it. It

can help the TA's to give you partial credit. Author(s): Ronnie Howard

1. (2 points each) Rewrite each of the following in the form "if ..., then Idots". (You may adjust verb tense as you wish to make the sentences sound natural.)

(a) Rowing a boat is necessary for being a Viking.

If you are a Viking, you row a boat.

(b) You sharpen your axe unless you are not a Viking.

If you are a viking, you sharten your axe.

(c) You are a Saxon provided that you are from England.

If you are from England, you are a Saxon

2. (2 points each) Evaluate each of the following propositions as True or False.

(a) If humans are birds, then humans are birds.

True.

(b) If  $2 \leq 3$ , then  $2 > -1$ .

True.

(c) If  $4^2 = 33$ , then  $7 - 5 = 100$ .

True.

(d) If 8 is even, then 10 is odd.

False.

3. (2 points each) Let  $s$  be the proposition "You are a pirate," let  $d$  be the proposition "You are on a pirate ship," and let  $n$  be the proposition "It is storming." Express the following as English sentences. (You may adjust tense as you like.)

(a)  $(d \vee n) \rightarrow s$

If you are on a pirate ship or it is storming, then you are a pirate.

(b)  $\neg d \rightarrow (n \rightarrow s)$

If you are not on a pirate ship, then if it is storming, you are a pirate.

(c)  $(n \vee d) \leftrightarrow s$

It is storming or you are on a pirate ship if and only if you are a pirate.

4. (3 points each) Let  $l$  be the proposition "You walk the plank," let  $a$  be the proposition "You upset the captain," and let  $h$  be the proposition "You raised the sail." Represent each of the following statements using only  $l$ ,  $a$ ,  $h$ , and logical operators. Then, negate the statements you identify pushing all negations in as far as possible. Then, translate it back to English.

- (a) You upset the captain only when you walk the plank.

$a \rightarrow l$	given
$\neg(\neg a \vee l)$	negation
$a \wedge \neg l$	De Morgans Law
You upset the captain and you did not walk the plank	

- (b) You do not walk the plank unless you did not raise the sail.

$\neg\neg h \rightarrow \neg l$	(given)
$h \rightarrow \neg l$	(double negation)
$\neg(h \rightarrow \neg l)$	(negation)
$\neg(\neg h \vee \neg l)$	(conditional disjunction law)
$h \wedge l$	(de morgans law)
You raised the sail and you walk the plank.	

5. (6 points) Give the converse, contrapositive, and inverse of the statement "I get a treasure chest whenever I find the X on the map." (You can change tense as needed.)

$t = \text{I get a treasure chest}$	
$x = \text{I find x on the map}$	
$x \rightarrow t$	(given)

Contrapositive:  $\neg t \rightarrow \neg x$

Contrapositive: If I do not get a treasure chest, I do not find X on the map.

Converse:  $t \rightarrow x$

Converse: If I get a treasure chest, I find X on the map.

Inverse:  $\neg x \rightarrow \neg t$

Inverse: If I do not find X on the map, I do not get a treasure chest

6. (8 points each) Construct truth tables for the following propositions. Include all intermediate columns, in an appropriate order, for full credit.

(a)  $\neg p \rightarrow (\neg q \vee \neg p)$

$p$	$q$	$\neg p$	$\neg q$	$\neg q \vee \neg p$	$\neg p \rightarrow (\neg q \vee \neg p)$
$T$	$T$	$F$	$F$	$F$	$T$
$T$	$F$	$F$	$T$	$T$	$T$
$F$	$T$	$T$	$F$	$T$	$T$
$F$	$F$	$T$	$T$	$T$	$T$

(b)  $(\neg p \vee q) \rightarrow r$

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

7. (8 points each) Simplify each of the following to  $p$ ,  $q$ ,  $\neg p$ ,  $\neg q$ ,  $T$ , or  $F$  using logical equivalences. State the equivalence used at each step. Do not skip steps. You can only use one equivalence or definition per step (even if the same one can be applied multiple times). Do not forget about the double negation law.

(a)  $\neg q \rightarrow (p \vee \neg q)$

$$\begin{array}{ll}
 \neg q \rightarrow (p \vee \neg q) & \text{(given)} \\
 q \vee (p \vee \neg q) & \text{(conditional disjunction law)} \\
 p \vee (q \vee \neg q) & \text{(associative and commutative law)} \\
 p \vee T & \text{(negation law)} \\
 T & \text{(domination law)}
 \end{array}$$

(b)  $(\neg p \rightarrow q) \wedge (q \rightarrow p)$

$$\begin{array}{ll}
 (\neg p \rightarrow q) \wedge (q \rightarrow p) & \text{(given)} \\
 (p \vee q) \wedge (\neg q \vee p) & \text{(conditional disjunction law)} \\
 p \vee (q \wedge \neg q) & \text{(some law idk)} \\
 p \vee F & \\
 p &
 \end{array}$$

8. (10 points each) Prove that  $(\neg p \wedge \neg q) \rightarrow \neg q \equiv (\neg p \wedge q) \rightarrow q$  in both of the following ways.

- (a) truth table (do not skip intermediate columns)
  - (b) logical equivalences (do not skip steps or combine steps)
9. (8 points) Vikings always tell the truth and Saxons always lie. Given the following information, use a truth table to determine what type each person is or if their status cannot be determined. Be sure to provide a conclusion based on your work. Person A says: "I am a Viking and B is a Saxon."  
Person B says: "C is a Saxon if A is a Viking."  
Person C says: "I am a Saxon or A is a Saxon only if B is a Viking."