

Homework #2

(50 points)

Due Date: September 20th, 2024, at the beginning of class

Directions

- This is an INDIVIDUAL assignment; do your own work! Submitting answers created by computers or by other people is NOT doing your own work.**
 - Start early!** Getting help is much easier n days before the due date/time than it will be n hours before. Help is available from the class staff via piiazza.com and our office hours.
 - Write complete answers to each of the following questions, in accordance with the given directions. Create your solutions as a PDF document such that each answer is clearly separated from neighboring answers, to help the TAs easily read them. Show your work, when appropriate, for possible partial credit.
 - When your PDF is ready to be turned in, do so on gradescope.com. Be sure to assign pages to problems after you upload your PDF. Need help? See “Submitting an Assignment” on <https://help.gradescope.com/>.
 - Solutions submitted more than five minutes late will cost you a late day. Submissions more than 24 hours late are worth no points.**
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Topic: Propositional Logic

- (6 points) Consider the propositions a : “Your knee is healthy”, b : “You ran the half-marathon”, and c : “You beat your best time”. Rewrite each of the following logical expressions as equivalent conversational English sentences.
 - $c \oplus \neg a$
 - $a \wedge b \wedge \neg c$
 - $b \rightarrow a$
- (8 points) Consider the propositions i : “You impressed the interviewer”, w : “You wrote a thank-you note”, and o : “You are offered the job”. Rewrite each of the following English sentences in the form of an equivalent logical expression, using those propositions and appropriate logical operators.
 - You were not offered the job or you wrote a thank-you note.
 - You wrote a thank-you note only if you impressed the interviewer and were offered the job.
 - You impressed the interviewer unless you were not offered the job.
 - You impressed the interviewer if and only if you wrote a thank-you note.
- (4 points) Rewrite each of the following not-very-conversational English sentences as equivalent conversational English sentences that are in the “if – then” form.
 - The water is boiling implies the flame is lit.
 - You not touching the wall follows from the paint still being wet.

(Continued on the back ...)

4. (6 points) For each of the following English conditional statements, write the inverse, converse, and contrapositive in conversational English, using the same phrasing as the given statement. For example, if the statement uses the form “something follows from that thing,” your answers are to use the same “follows from” wording. Be sure to label each of your three answers with the type of expression it is (inverse, converse, or contrapositive).

- (a) My nephew eats a lot of ketchup whenever he visits.
- (b) The movie has poor reviews only if I wait for it to be streamed.

5. (4 points) If you were to construct the complete truth table for each of these compound propositions, how many rows would the table contain?

- (a) $m \wedge (n \vee r) \wedge (r \oplus \neg v)$
- (b) $(a \wedge a) \vee (a \oplus a)$

6. (8 points) Construct complete truth tables for the given expressions. Remember to use only ‘T’ and ‘F’ truth values, to follow our required ordering of the table rows (as explained in class and in “Kneel Before Zodd”), and to build up to the final expression by including one column per sub-expression.

- (a) $(h \wedge \bar{i} \wedge j) \vee h$
- (b) $v \leftrightarrow (\neg w \wedge x)$

7. (4 points) Use a truth table to show that the following logical expression is a contradiction. Remember to use only ‘T’ and ‘F’ truth values, to follow our required ordering of the table rows (as explained in class and in “Kneel Before Zodd”), and to build up to the final expression by including one column per sub-expression.

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

8. (4 points) Using bit-wise logical operations, evaluate each of the following bit string expressions, producing a bit string result. These operators are the standard logical operators, not the versions used by Python and Java (e.g., \wedge is logical AND, not exclusive-OR).

- (a) $110 \wedge (\overline{101})$
- (b) $(00010 \vee 11001) \wedge (11000 \oplus 00100)$

9. (6 points) Google Search (www.google.com) supports some logical operators: The keywords AND and OR, and negation via prefixing a term with a hyphen (e.g., `-red` for ‘not red’). You can even form complex searches with parentheses. (Need more context? See Section 1.2.4 in Rosen.) Show how to construct a suitable Google search query for each of the following searches.

- (a) fish that live in salt water
- (b) types of clouds that do not produce rain
- (c) bird food for hummingbirds or orioles