

Homework #2

(50 points)

Due Date: September 15th, 2023, 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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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.
 - $\neg a \oplus b$
 - $c \rightarrow b$
 - $c \rightarrow (b \wedge a)$
- (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 offered the job but you didn’t write a thank-you note.
 - You were offered the job only if you both impressed the interviewer and wrote a thank-you note.
 - You impressed the interviewer when you wrote a thank-you note.
 - You wrote a thank-you note if and only if you were offered the job.
- (4 points) Rewrite each of the following not-very-conversational English sentences as equivalent conversational English sentences that are in the “if – then” form.
 - Only if he walked to school are his feet sore.
 - The sun having risen is sufficient for you to wear a hat.

(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” phrasing.

(a) My air conditioner runs constantly when the temperature is over 110.

(b) The weeds grow well only if we recently had rain.

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) $\bar{t} \oplus t$

(b) $p \vee (\neg p \wedge q) \vee (\neg p \wedge \neg q \wedge r) \vee (\neg p \wedge \neg q \wedge \neg r \wedge s)$

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) $(o \oplus p) \wedge \neg(p \rightarrow o)$

(b) $s \rightarrow (t \leftrightarrow \neg u)$

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.

$$\overline{p \rightarrow r} \wedge (p \rightarrow r)$$

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) $(000 \vee 101) \oplus 111$

(b) $\overline{01110} \wedge (10110 \vee 11101)$

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) dust devils in Arizona

(b) bushes that do not have fruit

(c) electric cars made by Kia or Ford