CIS 160 — Mathematical Foundations of Computer Science
Homework Assignment 1T

Assigned: August 31, 2021 **Due:** 8:30 AM ET, September 2, 2021

This homework is due electronically on Gradescope at 8:30 AM ET, September 2, 2021. To receive full credit all your answers should be carefully justified. **Additionally, make sure to fill out the Gradescope Policy Quiz!**

Please make note of the following:

A. LaTeX: Normally, we require all solutions to be typeset in LaTeX. We have provided a LaTeX primer video on Canvas and have provided a template, should you choose to use LaTeX. However, LaTeX is not strictly required **for this first assignment only.**

B. Standard Deductions:
- 5 points will be deducted from your homework if you do not select pages when submitting to Gradescope.

C. Solutions: Please make sure to keep your solutions clear and precise. While no points will be deducted for overly verbose solutions, clarity and brevity are important skills that can be developed through CIS 160. *Solutions must be given in closed form (as defined on Piazza).*

D. Collaboration: You may not collaborate with anyone via any means.

E. Citations: All solutions must be written in your own words. If you would like to use part of a solution from a problem presented in lecture, recitation, or past homework solutions you may do so with attribution; i.e., provided you add a comment in which you make clear you copied it from these sources.

F. Outside Resources: Any usage of resources outside of the course materials on the course website or Canvas is strictly prohibited. Violations may seriously affect your grade in the course.

G. Late Policy: We will allow you to drop two homework assignments assigned on a Tuesday and two homework assignments due on a Thursday (i.e. two 'T' homeworks and two 'H' homeworks). Because of this, we will not accept late homework under any circumstances. If you will be missing school for an extended period of time due to severe illness, please notify the professor.

1. [12 pts] WHAT YOU KNOW ABOUT ROLLIN' DOWN IN THE YEAST

David the Duck was swimming like an astronaut in the ocean searching for some bread to nibble on. He found an old fisherman who offered him a plethora of bread if he could answer a few questions. Let p, q, and r be the following propositions:

p: It is sunny outside.

q: The ducks swim quickly.

r: Ducks love to eat bread.

Express the following propositions using p, q, r and logical operators to help David get the bread.

For this problem specifically, we'll only be grading your final answer, so no work is necessary.

(a) The ducks swim quickly and it is sunny outside.

(b) If it is not sunny outside or the ducks swim quickly, then ducks don't love to eat bread.

(c) It is necessary for the ducks to swim quickly for it to be sunny outside. It is also necessary for the ducks to swim quickly for the ducks to not love to eat bread.

(d) Ducks love to eat bread if and only if it is sunny outside.

(e) Ducks don't love to eat bread and it is sunny outside.

(f) It being sunny outside is sufficient for the ducks to swim quickly and the ducks to not love to eat bread.

2. [10 pts] Pls don't change the table headers in your solution <3

Decide if the following proposition forms are tautologies using a truth table. Make sure your truth table shows **all** intermediate logical expressions. We've provided the template for you below. **Make sure you fill out the entire table, even if you do not need the entire table to determine whether the given expression is a tautology.** You should also clearly state your final answer to the question.

(a) $[(p \vee q) \vee (p \wedge \neg q)] \wedge (p \implies \neg q)$

(b) $[(\neg p \wedge q) \implies (p \vee \neg q)] \implies (p \vee \neg p)$

Note that a formatted table is provided below. If you do not choose to use LaTeX for this question, please copy the format directly from below to ensure you receive credit.

(a)

p	q	$\neg q$	$(p \vee q)$	$(p \wedge \neg q)$	$[(p \vee q) \vee (p \wedge \neg q)]$	$(p \implies \neg q)$	$[(p \vee q) \vee (p \wedge \neg q)] \wedge (p \implies \neg q)$
T	T						
T	F						
F	T						
F	F						

(b)

p	q	$\neg p$	$\neg q$	$(\neg p \wedge q)$	$(p \vee \neg q)$	$[(\neg p \wedge q) \implies (p \vee \neg q)]$	$(p \vee \neg p)$	$[(\neg p \wedge q) \implies (p \vee \neg q)] \implies (p \vee \neg p)$
T	T							
T	F							
F	T							
F	F							

3. [8 pts] "What the quack is on my forehead?"

This past weekend was move-in week at the bio pond. Ducks Ananya, Andrew, and Anusha all moved in, but it didn't take long for conflicts to arise. They wanted half of the pond for the three of them and the other half of the pond for all the other ducks. Pond RA Winnie didn't think this was fair, but decided to give these ducks a chance at what they wanted.

Winnie has a sheet of 5 stickers, 3 red and 2 blue. She puts a sticker on each of Ananya, Andrew, and Anusha's foreheads, then hides the sticker sheet. The 3 ducks can't see their own sticker, but they can see the stickers of the other two. Winnie says if at least one of them can logically deduce the color of their own sticker, then they can have half of the pond as they wanted. After some thought, Ananya quacks, "I don't know the color of my sticker." Hearing this, Andrew thinks momentarily and also quacks, "I don't know the color of my sticker either." At this point, does Anusha know the color of her sticker? Please justify your answer.