Homework 1: Propositional Logic

Due date: Wednesday January 11th at 10 PM
If you work with others (and you should!), remember to follow the collaboration policy outlined in the syllabus.
In general, you are graded on both the clarity and accuracy of your work. Your solution should be clear enough that someone in the class who had not seen the problem before would understand it.
We sometimes describe approximately how long our explanations are. These are intended to help you understand approximately how much detail we are expecting. You are allowed to have longer explanations, but explanations significantly longer than necessary may receive deductions.

Be sure to read the grading guidelines on the assignments page for more information on what we're looking for.

1. Syllabus [4 points]

Read the syllabus and/or watch "Lecture 0" on panopto. If you have any questions about the syllabus, ask us on Ed!

On your homework submission write "I have watched lecture 0 and/or read the syllabus, and agree to follow the collaboration policies." for full credit.

2. Translation [16 points]

Translate the English statements into symbolic logic. You will need to define the propositions you use. Make sure the propositions you introduce are atomic (not the combination of smaller propositions) and as basic as possible.

(a) Parking is allowed on Saturday and Sunday.

You must translate this sentence as an implication. *Hint: remember propositions need to unambiguously assert something. You'll need a subject and verb in all the propositions here. Similarly, recall that we intend to make the atomic propositions* ***as basic as possible*** *– if there's an "and," "or," or "not" in your proposition, it probably isn't atomic!*

(b) You can become the Queen of England only if you are born a royal or participate in a popular uprising.

(c) Define a set of *at most three* atomic propositions. Then, use them to translate all of these sentences about study locations into logical notation. *Do not simplify the statements.* [8 points]

(i) I go to the library because I want to study.

(ii) To go to the library, I need to bring my Husky Card.

(iii) If I don't want to study, then I will not go to the library, but will still bring my Husky Card.

3. Trickier translation [5 points]

The following sentence is idiomatic in English...but not very clear logically. Convert the statement into propositional logic, then write an English sentence that has the same meaning, but is clearer logically.

(a) Unless you carry cash with you, if you don't have your Husky Card, you can't ride the bus or the light-rail.

4. Inequivalence [12 points]

For each part, find a truth assignment (i.e. an assignment of `True` or `False` to $p, q,$ and r) to show the pair of statements are not equivalent. Explain why your assignments work (our explanations are 1-2 sentences).

(a) $(p \wedge q) \vee r$ vs. $p \wedge (q \vee r)$

(b) $(r \rightarrow q) \rightarrow p$ vs. $r \rightarrow (q \rightarrow p)$

(c) $(p \vee q) \rightarrow r$ vs. $\neg p \vee \neg q \vee \neg r$

5. Compound Proposition [7 points]

Find a compound proposition involving the variables $p, q,$ and r that is true precisely when either

- **at least** two of $p, q,$ and r are true,
- or p is true and r is false

The "either...or..." above is an exclusive or; for example, we would want the statement to evaluate to false if p, q are true and r is false since we want either at least 2 of the variables to be true or p to be true and r to be false, and that causes both parts to be true.

In addition to writing an expression, explain why your answer works (1-2 sentences).
For this problem, you may only use the logical connectives: $\neg$, $\vee$, $\wedge$, $\rightarrow$
Hint: There are a few different ways to approach this question, but the easiest is probably to think of all the settings which will meet the conditions and make a statement that properly combines the elements of your list.

6. Highly Illogical [12 points]

You want to take a trip downtown to see a show. Your friend has also expressed interest in a trip, but they have strong opinions about the method of travel. Your friend, a former CSE 311 TA, is ruthlessly and perfectly logical – they take each statement at its logical meaning; they do not believe you will lie, but they do not accept unstated intentions.

You want your friend to take a bus to the show (which, from your research is the only option), your friend loves the idea of going to the show, but hates the bus[1]. Your friend would rather take the bus and have guarantee of seeing the show than do neither, but will not get on a bus without knowing that you'll make it to the show and that it's the only way to get there.

(a) You tell your friend "If you get on the bus, then you can come to the show." Your friend says, "It is not yet logical to board the bus." Why is your friend still unwilling to board? (1-2 sentences)

(b) You try again: "Let's start over; forget the first promise." "If you don't get on the bus, then you cannot come to the show."
Your friend looks at you and says "It is not yet logical to get on the bus." Why will they not comply? (1-2 sentences)

(c) Give a logical sentence (or sentences) which will compel your friend to get on the bus. You cannot just **assert** that they will come (e.g. you cannot just say "You will board the bus") you must give promise(s) to make it the only logical choice for them to join you.

Argue that your friend will finally step on board. (2-4 sentences)

[1] They love the lightrail, but it doesn't run late enough at night, so the bus is your only option.

7. Feedback [1 point]

Please keep track of how much time you spend on this homework and answer the following questions. This can help us calibrate future assignments and future iterations of the course, and can help you identify which areas are most challenging for you.

- How many hours did you spend working on this assignment (excluding any extra credit questions, if applicable)? Report your estimate to the nearest hour.
- Which problem did you spend the most time on?
- Any other feedback for us?