This assignment is due at the beginning of the first section on the due date. Unless all problems carry equal weight, the point value of each problem is shown in [ ]. To receive full credit all your answers should be carefully justified. Each solution must be written independently by yourself - no collaboration is allowed.

For this homework only, there will be no penalty for not using \LaTeX. You may choose to legibly hand-write and scan the solutions or use another text editor if you wish. However, we strongly advise you to learn \LaTeX for this homework as it will be required for all other homeworks.

Note that Question 3 is intended more as a brainteaser to get you into the problem solving mindset of CIS 160, and does not directly relate to material in lecture. Such questions generally only appear in the first few homeworks – after that, homework questions will relate more closely with the material seen in lecture and recitations.

1. [12 pts] Let \( p \), \( q \), and \( r \) be the following propositions.

\( p \): It’s a full moon tonight.

\( q \): My dogs are barking.

\( r \): My dogs are hungry.

Express the following propositions using \( p \), \( q \), \( r \) and logical operators.

For this question specifically, a line or two explaining your answer may help, but don’t worry too much about providing justification.

(a) My dogs are barking and they are hungry.

(b) If it is not a full moon tonight or my dogs are not barking, then my dogs are not hungry.

(c) It is necessary for my dogs to be barking for it to be a full moon tonight. It is also necessary for my dogs to be barking for them to be hungry.

(d) My dogs are hungry if and only if it is a full moon tonight.

(e) My dogs are not hungry and it is a full moon tonight.

(f) It being a full moon is sufficient for my dogs to be barking and hungry.

2. [10 pts] Decide if the following proposition forms are a tautology using a truth table. Make sure you clearly state your final answer and show all intermediate logical expressions – for example,
in showing the truth table for \((p \lor q) \land p\), you should show \(p \lor q\) as a separate column on its own.

(a) \([ (p \lor \neg q) \lor (p \land \neg q) ] \land (p \implies \neg q) \]

(b) \([ (p \land \neg p) \lor \neg q ] \implies (p \lor \neg p) \]

3. [8 pts] AJ, Nikhil, and Marshall are CIS 160 TAs and therefore are able to instantly and infallibly make logical conclusions. They are going to a country music concert and need to pick out their cowboy hats. They each blindly pick and put on one hat from a chest originally containing 2 tan and 3 black hats. With their hats on, each of them can see the hats the other 2 are wearing, but they can’t see their own. Instead of just taking off their hats and looking at them, they decide to try to logically deduce which color hat they each are wearing. AJ begins thinking, but after a while concludes out loud, “I don’t know what color hat I am wearing.” After hearing this, Nikhil thinks momentarily, and then decides as well, “I don’t know what color hat I am wearing.” At this point, is Marshall able to know what color hat he is wearing? Justify your answer rigorously.