This exam is open book, open note. You may use the computer only to refer to the online copy of the textbook or my lecture notes.
You have 2 hours to complete the exam.

1. Use a truth table to determine if the following argument is valid:

\[
\begin{array}{c|c}
1 & A \rightarrow B \\
2 & C \rightarrow \neg A \\
3 & C \vee \neg B \\
\end{array}
\]

Explain your reasoning.

2. Write an informal proof (in words, not in the Fitch format) of the following statement:

If \(3n + 2\) is odd, then \(n\) is odd.

(Hint: prove the contrapositive.)

3. (a) Give an example of a sentence that is logically necessary but not a tautology, or say that no such sentence exists.

(b) Give an example of a sentence that is tT-possible but not logically possible, or say that no such sentence exists.

4. Translate the following into logic:

If drunken driving laws are strictly enforced, traffic deaths decline. Drunken driving laws will not be strictly enforced. It follows that traffic deaths will not decline.

Is this a valid argument? Explain your reasoning.

5. Consider the following argument:

\[
\begin{array}{c|c}
1 & a = b \land \text{Cube}(b) \\
2 & \neg \neg \text{Cube}(a) \\
\end{array}
\]

(a) Is the conclusion a tautological consequence of the premises? A first-order consequence of the premise? An analytical consequence of the premise?
(b) Write a Fitch-style formal proof for the above argument. Number the lines of your proof and justify each line as you would in the Fitch program. You do not need to use an Con rules (Taut Con, FO Con, or Ana Con) to write this proof, and you should not use any of them here. However, if you get stuck and do use a Con rule, use the weakest one that suffices.

6. Write an informal proof or disproof (in words, not in the Fitch format) of the following statement:

If \( n \) is not a multiple of 3 then \( n^2 + n - 2 \) is a multiple of 3.

7. Consider the following argument:

Vice President Cheney has argued that officials in the executive branch should be allowed to keep their conversations with constituents private for the reason that this privacy encourages free and open consultation, which is necessary for government to function well. We should pay no attention to this argument, since Cheny is obviously a corrupt official who is just trying to hide evidence of improper influence.

(a) Translate this argument into FOL.
(b) Is this argument valid?
(c) If it is valid, do you think it is sound?

Make sure you explain your reasoning.

8. Consider the Fitch-style "proof below. It’s a "proof" instead of a proof because there are mistakes in it. Circle all the mistakes that the Fitch program would complain about and indicate how to fix them.

\[
\begin{array}{c|c}
1 & a = b \land \text{tet}(c) \\
2 & \neg \text{Dodec}(d) \lor \text{Tet}(c) \\
3 & \text{SameShape}(a, c) \\
4 & \neg \text{Dodec}(d) \\
5 & \neg \text{Dodec}(d) \quad \neg \text{Intro: 4} \\
6 & \neg \text{Tet}(c) \\
7 & \text{Tet}(c) \quad \land \text{Intro: 1} \\
8 & \bot \quad \bot \text{Intro: 6} \\
9 & \neg \text{Dodec}(d) \quad \lor \text{Elim: 2, 4-5, 6-8} \\
10 & a = b \quad \land \text{Elim: 1} \\
11 & \text{SameShape}(b, c) \quad = \text{Elim: 10} \\
12 & \text{Tet}(c) \quad \land \text{Elim: 1} \\
13 & \text{Tet}(b) \quad \text{Taut Con: 11, 12} \\
14 & \neg \text{Dodec}(d) \land \text{Tet}(b) \quad \land \text{Elim: 9.13}
\end{array}
\]
9. (a) What does it mean for an argument to be valid?
   (b) What does it mean for an argument to be sound?
   (c) What does it mean for the conclusion to logically follow from the premises?

10. Translate the following English statements into FOL, introducing names, predicates, and function symbols as needed. Make your translation as faithful to the original text as you can. Explain the meaning of each predicate and function symbol unless it is completely obvious.

   (a) Joanne doesn’t like Paul, and she doesn’t like his ugly face, either.
   (b) If Bertram’s mom finds his cigarettes, her head will explode.
   (c) Bobby Sue enjoys neither caviar nor the music of Stravinsky.

11. (a) How do you demonstrate that an argument is invalid?
    (b) How do you demonstrate that an argument is unsound?

12. Using Table 1.2, page 30, translate the following into colloquial English.

   (a) \( \forall t \neg Gave(claire, folly, max, t) \)
   (b) \( \forall x(Pet(x) \rightarrow Hungry(x, 2 : 00)) \)
   (c) \( \forall y(Person(y) \rightarrow \neg Owned(y, pris, 2 : 00)) \)
   (d) \( \neg \exists x(Angry(x, 2 : 00) \land Student(x) \land Fed(x, carl, 2 : 00)) \)
   (e) \( \forall x((Pet(x) \land Owned(max, x, 2 : 00)) \rightarrow Gave(max, x, claire, 2 : 00)) \)

13. Translate the following into FOL introducing names, predicates, and function symbols as needed. As usual, explain your predicates and function symbols, and any shortcomings of your translations. If you assume a particular domain of discourse, mention that as well.

   (a) Only the brave know how to forgive.
   (b) No man is an island.
   (c) I care for nobody, not I, If no one cares for me.
   (d) Every nation has the government it deserves.
   (e) There are no certainties, save logic.
   (f) Misery (that is, a miserable person) loves company.
   (g) All that glitters is not gold.
   (h) There was a jolly miller once, Lived on the River Dee.
   (i) If you praise everybody, you praise nobody.
   (j) Something is rotten in the state of Denmark.

14. Replace the following with equivalent sentences using only \( \neg \) and \( \lor \):

   (a) \( Tet(a) \land Small(a) \)
   (b) \( Tet(a) \rightarrow Small(a) \)
   (c) \( Tet(a) \leftrightarrow Small(a) \)
   (d) \( (Cube(b) \land Cube(c)) \rightarrow (Small(b) \leftrightarrow Small(c)) \)
Midterm Makeup problems. Note that the above was fairly comprehensive so I’m only adding a few addition classes of problems: truth tables, simplification, validity. If you do well on the final, it will count for more than your midterm (if in fact you improved!)

1. Determine if the following is a valid argument. If it is, write an informal proof. If not construct a counterexample.

   1. Max or Claire is at home but either Scruffy or Carl is unhappy
   2. Either Max is not home or Carl is happy
   3. Either Claire is not home or Scurffy is unhappy.
   4. Scruffy is unhappy.

2. Simplify the following:

   (a) \((\neg A \lor B) \lor (B \lor C)\)
   (b) \((A \land B) \lor C \lor (B \land A) \lor A\)

3. Write a truth table for:

   1. \(\text{Taller(claire, max)} \lor \text{Taller(max, claire)}\)
   2. \(\text{Taller(claire, max)}\)
   3. \(\neg \text{Taller(max, claire)}\)