1. Write the negation, contrapositive, converse and inverse of the following statements.

   (a) For any integer $x$, if $x$ is even, then $x^2$ is even.
   (b) You will be late to class if you oversleep.
   (c) If Dr. Chambers’ daughter is sick this week, then she either brings her to lecture or gets a babysitter.

2. Rewrite the following propositions as unambiguous English sentences, given the following prepositions.

   • $A(x)$ means ”$x$ likes West Wing”.
   • $B(x)$ means ”$x$ likes Buffy”.
   • $C(x)$ means ”$x$ has good taste”.
   • $D(x)$ means ”$x$ watches TV”.

   For example the statements $\forall x[D(x) \rightarrow A(x)]$ could be translated to ”Everyone who watches TV likes West Wing.”

   (a) $\forall x[A(x) \lor B(x) \rightarrow D(x)]$
   (b) $\exists x[A(x) \land B(x)]$
   (c) $\forall x[B(x) \rightarrow C(x)]$
   (d) $\exists x[A(x) \lor B(x) \land C(x) \land D(x)]$

3. Express the negations of the following statements so that all negation symbols appear immediately preceding the predicates (and not outside any quantifiers or groups of predicates).

   (a) $\forall x \exists y P(x, y) \lor \forall x \exists y Q(x, y)$
   (b) $\exists x \exists y (Q(x, y) \rightarrow Q(y, x))$
   (c) $\forall y \exists x \exists z (T(x, y, z) \lor Q(x, y)) \land \exists x \forall y \neg P(x, y)$

4. Classify the following formulas into logically equivalent groups. (Hint: Try using truth tables!)
(a) $p$
(b) $p \lor \neg p$
(c) $p \land \neg p$
(d) $(p \land q) \rightarrow p$
(e) $(p \lor q) \rightarrow p$
(f) $((p \lor q) \land \neg q) \rightarrow (p \land q)$
(g) $(p \lor \neg p) \rightarrow (p \land \neg p)$
(h) $(((p \lor q) \lor \neg q) \lor (r \land p)) \land (p \lor \neg q)$

5. While walking across campus, you come across 3 people have an argument. The first, Alice, tells you, “Bob or Carol is lying.” The second, Bob, tells you, “Carol is lying”. The third, Carol, tells you, ”Alice and I are both telling the truth”. Who, if anyone, is telling you the truth?

6. **Extra Credit:** Next, you come across two different people on your walk. Donald says, “I am lying if Erik is.” Erik says, “If I am lying, then Donald is lying.” Can you tell who if anyone is telling the truth?