Due: Thursday Jan. 22, 2015.

Question 1 (10%)
Write down the parenthesized version of each of the following expressions.

(1.a) \( P \lor \neg Q \land R \to P \lor R \to \neg Q \)

(1.b) \( A \to B \lor \neg C \land D \land E \to F \)

Question 2 (25%)
For each of the expressions below, state whether it is a wff or not.

(2.c) \( A \to B \lor \neg C \land D \land E \to F \)

(2.d) \( \neg \neg P \land Q \)

(2.e) \( (A \to B) \lor \neg (C \land D \land E) \to F \land (G \to \neg H) \)

(2.f) \( (A \to B \lor \neg C) \land (D \land E) \to F \)

(2.g) \( A \to (B \lor \neg (C \land D) \land E) \to F \)

Question 3 (40%)
Draw the syntax tree for each of the following expressions.

(3.h) \( (P \lor \neg Q) \land (\neg P \lor Q) \)

(3.i) \( (P \land \neg Q) \lor (\neg P \land Q) \)

(3.j) \( P \lor (Q \land R \to P) \lor (R \to \neg Q) \)

(3.k) \( (A \to B) \lor \neg (C \land D) \land (E \to F) \)

Question 4 (25%)
Write down how the expression \( (A \to B) \lor \neg (C \land D) \land (E \to F) \) can be obtained using the definition of wffs (use the example below):

**Example:** The expression \( (A \land \neg B) \lor (C \to D) \) can be obtained as follows:

1. \( A \) is a wff (propositional variable)
2. \( B \) is a wff (propositional variable)
3. \( \neg B \) is a wff (obtained by applying \( \neg \) to 2)
4. \( A \land \neg B \) is a wff (obtained by applying \( \land \) to 1 and 3)
5. \( (A \land \neg B) \) is a wff (obtained by applying parentheses to 4)
6. \( C \) is a wff (propositional variable)
7. \( D \) is a wff (propositional variable)
8. \( C \to D \) is a wff (obtained by applying \( \to \) to 6 and 7)
9. \( (C \to D) \) is a wff (obtained by applying parentheses to 8)
10. \( (A \land \neg B) \lor (C \to D) \) is a wff (obtained by applying \( \lor \) to 5 and 9)