1. Exercise 1

Translate the following statements into Propositional Logic, breaking them down into atomic statements and factoring out the PL connectives as much as possible.

a. Either the turkey run away, or the guests are vegetarian and Sophia doesn’t want to offend them.
   \( (r \lor (v \land \neg o)) \land \neg (r \land (v \land \neg o)) \)
   \( r = \) the turkey run away \( v = \) the guests are vegetarian \( o = \) Sophia wants to offend the guests

b. It is not the case that we will cancel Thanksgiving if John doesn’t bring the cranberry sauce.
   \( \neg (\neg b \rightarrow c) \)
   Another possible reading, though less likely given the paraphrase: \( (\neg b \rightarrow \neg c) \)

c. Fumi is making the beans and Noa is making the apple pie, or vice-versa.
   \( (f \land n) \lor (f' \land n') \)
   \( f = \) Fumi is making the beans \( n = \) Noa is making the pie \( f' = \) Fumi is making the pie \( n' = \) Noa is making the beans

(d) If the turkey screams when you pinch it, then it is not done yet.
   \( (p \lor s) \lor (p \land s) \)
   \( s = \) the turkey screams \( p = \) you pinch it \( d = \) the turkey is done

\( (p \land s) \rightarrow \neg d \)

\( e. \) Martin will baste the turkey only if the skin is dry.
   \( b = \) Martin will baste the turkey \( d = \) the skin is dry
   \( b \rightarrow d \)

\( f. \) If neither Alan finds the Pink Rose nor Maribel bakes the custard, there will be no desserts.
   \( f = \) Alan finds the Pink Rose \( b = \) Maribel bakes the custard
   \( d = \) there will be desserts
   \( \neg f \land \neg b \rightarrow \neg d \)

\( g. \) For the stuffing to be good, it is a necessary condition that it contains chestnuts.
   \( g = \) the stuffing is good \( c = \) the stuffing contains chestnuts
   \( g \rightarrow c \)

\( h. \) Maribel won’t be upset if either John or Alan is late, but she will be upset if both are late.
   \( u = \) Maribel is upset \( j = \) John is late \( a = \) Alan is late
\[
[ (j \lor a) \land \neg (j \land a) ] \rightarrow \neg u \] \land [ (j \land a) \rightarrow u ]
\]

i. Unless the gravy or the cranberry sauce is homemade, the turkey won’t taste good.

g = the gravy is homemade \quad c = the cranberry sauce is homemade

t = the turkey takes good

t \rightarrow (g \lor c), assuming:

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<th>p</th>
<th>q</th>
<th>unless p, q</th>
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(g \lor c) \leftrightarrow t, assuming:

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j. If the turkey doesn’t fit in the oven or it is still frozen, call 1-800-8TURKEY.

f = the turkey fits in the oven \quad z = the turkey is still frozen

c = (you) call 1-800-8TURKEY

(\neg f \lor z) \rightarrow c

2. Exercise 2

The connective Y can be defined according to the truth table below. Show that all the other connectives (\rightarrow, \land, \lor, \rightarrow, \leftrightarrow) can be defined in terms of Y exclusively.

(1)

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\neg \phi = \phi Y \phi

\phi \lor \psi = (\phi Y \psi) Y (\phi Y \psi)

\phi \land \psi = (\phi Y \phi) Y (\psi Y \psi)

\phi \rightarrow \psi = ((\phi Y \phi) Y \psi) Y ((\phi Y \phi) Y \psi), among other possibilities.

\phi \leftrightarrow \psi = [ [((\phi Y \phi) Y \psi) Y ((\phi Y \phi) Y \psi)] Y [((\phi Y \phi) Y \psi) Y (((\phi Y \phi) Y \psi))] Y [((\phi Y (\psi Y \psi)) Y (\phi Y (\psi Y \psi))] Y [((\phi Y (\psi Y \psi)) Y (\phi Y (\psi Y \psi))] ], among other possibilities.
3. Exercise 3

Translate the following sentences into Predicate Logic, breaking them down into predicates as much as possible. (If you need to use the predicate “be equal to itself”, just use the symbol ‘=’.) If a sentence is ambiguous, give as many formulae as needed.

a. A student talked to a professor.
\[ \exists x \exists y \ [ S(x) \land P(y) \land T(x,y)] \]

b. Every student that talked to a professor was nice.
\[ \forall x \ [ ( S(x) \land \exists y (P(y) \land T(x,y))) \implies N(x) ] \]

c. Nobody saw anybody.
\[ \neg \exists x \exists y \ [ S(x,y) ] \]

d. Miriam danced with a guy that everybody likes.
\[ \exists x \ [ G(x) \land \forall y[L(y,x)] \land D(m,x) ] \]
\[ \iff \exists x \forall y \ [ G(x) \land L(y,x) \land D(m,x) ] \]

e. Everybody likes a guy that Miriam danced with.
\[ \exists x \ [ G(x) \land \forall y[L(y,x)] \land D(m,x) ] \quad (“a certain guy that Miriam danced with”) \]
\[ \forall y \exists x \ [ G(x) \land L(y,x) \land D(m,x) ] \]

f. No good guy1 betrays a friend of his1.
\[ \neg \exists x \exists y \ [ \text{GOOD}(x) \land \text{GUY}(x) \land \text{FRIEND-OF}(y,x) \land \text{B}(x,y) ] \]

g. Sue erased all the files in the computer.
\[ \forall x \ [ \text{F}(x) \implies \text{E}(s,x) ], \text{ or } \forall x \ [ (\text{F}(x) \land \text{IN}(x,c)) \implies \text{E}(s,x) ], \text{ where } c \text{ is the name of the particular computer we are talking about.} \]

h. Sue likes somebody John danced with.
\[ \exists x \ [ \text{L}(s,x) \land D(j,x) ] \]

i. Kate sent only Pat to Sue.
\[ \forall x \ [ S(k,x,s) \iff x=p ] \]

j. Kate sent Pat only to Sue.
\[ \forall x \ [ S(k,p,x) \iff x=s ] \]