1. (20) Problem 8.6 in RN. Do only parts: a, c, f-k.

2. (10)

(a) (Problem 8.7 in RN) Represent the sentence “All Germans speak the same languages” in Predicate calculus. Use Speaks(x,l) to mean, person x speaks language l.

(b) Suppose your vocabulary has only one binary relational symbol, “CANFOOL(p,t)” which means that “you can fool person p at time t”, and no function and constant symbols. Write a first-order expression which represents the following statement:

You can fool some people all of the time, and all of the people some of the time, but you cannot fool all of the people all of the time.

3. (15) (Problem 16.1 from Nilsson) Say whether or not the following pairs of expressions are unifiable, and show the most general unifier for each unifiable pair:

(a) P(x, B, B) and P(A, y, z)
(b) P(g(f(v)), g(u)) and P(x, x)
(c) P(x, f(x)) and P(y, y)
(d) P(y, y, B) and P(z, x, z)
(e) 2 + 3 = x and x = 3 + 3

4. (15) (Problem 16.3 from Nilsson) Convert the following to clause form:

(a) (\exists x)[P(x)] \lor (\exists x)[Q(x)] \supset (\exists x)[P(x) \lor Q(x)]
(b) (\forall x)[P(x)] \supset (\forall y)[(\forall z)[Q(x, y)] \supset \neg(\forall z)[R(y, x)]]
(c) (\forall x)[P(x)] \supset (\exists x)[(\forall z)[Q(x, z)] \lor (\forall z)[R(x, y, z)]]
(d) (\forall x)[P(x)] \supset Q(x, y] \supset ((\exists y)[P(y)] \land (\exists z)[Q(y, z)])

5. (20) (Problem 16.4 from Nilsson) We are given the following paragraph:

Tony, Mike, and John belong to the Alpine Club. Every member of the Alpine Club is either a skier or a mountain climber or both. No mountain climber likes rain, and all skiers like snow. Mike dislikes whatever Tony likes and likes whatever Tony dislikes. Tony likes rain and snow.

Represent this information by predicate-calculus sentences in such a way that you can represent the question “Who is a member of the Alpine Club who is a mountain climber but not a skier?” as a predicate-calculus expression. Use resolution refutation with answer extraction to answer it.
8. (20) (Problem 16.10 from Nilsson) Use resolution refutation on a set of clauses to prove that there is a green object if we are given:

- If pushable objects are blue, then nonpushable ones are green.
- All objects are either blue or green but not both.
- If there is a nonpushable object, then all pushable ones are blue.
- Object 01 is pushable.
- Object 02 is not pushable.

(a) Convert these statements to expressions in first-order predicate calculus.
(b) Convert the preceding predicate-calculus expressions to clause form.
(c) Combine the preceding clause form expressions with the clause form of the negation of the statement to be proved, and then show the steps used in obtaining a resolution refutation.