## 1. State the resolution principle.

- For any two clauses C1 and C2, if there is a literal L1 in C1 and a complementary literal L2 in C2, then delete L1 and L2 from C1 and C2, respectively and construct the disjunction of the remaining clauses.

## 2. Define what is meant by resolution deduction.

- Given a set S of clauses, a resolution deduction of C from S is a finite sequence C1, C2, ..., CK clauses such that each Ci is either a clause in S of the resolvent of previous clauses in the sequence, and C = Cx.

3.Show by means of resolution, line by line, that the formula U is a logical consequence of the three formulas (  $P \rightarrow S$  ) and (  $S \rightarrow U$  ) and P. (Please don't forget that you must first convert to clausal form).

```
a) Convert to clause form
     1. ~ P v S
     2. ~ S v U
     3. P
b) Add the negation of the goal
     S augmented = { ( \sim P \vee S ), ( \sim S \vee U ), P, \sim U }
c) Refute
     1) ~ P v S
                                [in S]
     2) ~ S v U
                                [in S]
     3) P
                                [in S]
     4) ~U
                                [negation of goal]
     5) ~P v U
                                [resolution of i. & ii.]
     6) U
                                [resolution of iii. & v.]
     7)
                                [resolution of iv. & vi.]
```

4. Draw the resolution tree corresponding to the resolution deduction that you performed in the previous problem.



5. Show by means of the inconsistency truth table approach that the formula U is a logical consequence of the three formulas (  $P \rightarrow S$  ) and (  $S \rightarrow U$ ) and P.

Р	S	U	$P{\rightarrow} S \land S \rightarrow U \land P \rightarrow U$
Т	Т	Т	Т
Т	Т	F	Т
Т	F	Т	Т
Т	F	F	Т
F	Т	Т	Т
F	Т	F	Т
F	F	Т	Т
F	F	F	Т

## 6. Define Horn Clause.

- A Horn clause is a disjunction of literals.

7. Can the formula ( P ^ Q ^ R )  $\rightarrow$  S be converted to a Horn Clause?

- Yes, by the switcheroo principle.

8. Write down a clause which is not a Horn clause. - (P  $\rightarrow$  Q) ^ R

9. Write down a Horn clause involving P, Q, R, S, and T. -  $(P \land O \land R) \lor (S \land T)$ 

10.Argue that the following Prolog statement is a Horn clause: a :- b, c, d.

- The Prolog statement contains commas, which are equivalent to the logical conjunctions(and symbol), and `:-' which is equivalent to a logical implication. The symbols can be combined and rearranged into a logical string of disjunctives, and can therefore be deemed a Horn clause.

## 11. TRUE or FALSE: Prolog is essentially a Horn clause problem solver.

- TRUE

12. TRUE or FALSE: Prolog performs a computation by (1) converting its rule to Horn clauses, (2) negating a given goal, and (3) endeavoring to derive the empty clause by means of resolution. If variables are involved, they must be instantiated in order to obtain complementary literals.

- TRUE

```
13. Consider the following Prolog program:
    p :- q, t.
    p :- r, s.
    q :- r.
    r.
    t.
    s.
a) Convert to Horn clause form (Simply write down each statement
as a Horn clause).
    ~Q v ~T v P
    ~R v ~S v P
    ~R v ~S v P
    ~R v ~Q
    R
    T
    S
```

b) Draw a resolution deduction tree which derives the empty clause.

c) Draw a different resolution deduction tree which derives the empty clause.

```
14. Consider the following Prolog program:
% Animal KB
% Think of these rules as what is known about animals.
id(polarbear) :- description(large,white).
id(dove) :- description(small, white).
id(cow) :- description(large, brown).
id(chipmunk) :- description(small, brown).
id(cardinal) :- description(small, red).
description (Size, Color) :- size(Size),color(Color).
% Think of these facts as what we were in the wild.
size (small).
color(brown).
```

```
Draw a resolution deduction tree, instantiating variables as
needed, to respond to the
Prolog query: id(X) (Don't forget that the idea is to negate the
query, add it to the set of
clauses (the Prolog program in clausal form), and refuse
(instantiating variables
appropriately)!).
```

