SOLUTION NOTES

Database Theory 2003 Paper 9 Question 9 (AD)

1.
```
cousin(x,x).
cousin(x,y) <- cousin(w,z), parent(w,x), parent(z,y).
```

2.
```
dcousin(x,y) <- relative(x,y), -cousin(x,y).

relative(x,x).
relative(x,y) <- parent(w,x), relative(w,y).
relative(x,y) <- parent(w,y), relative(x,w).
```

3. Any query definable in Datalog without negation must be monotone. To show that the second query is not definable in Datalog it suffices to show that it is not monotone. For example, take the following database:

parent	
A	B
A	C
C	D

   The pair (B,D) is in the query as defined. However, if we add the entries (E,B) and (E,D) to the relation `parent`, then the pair (B,D) is no longer in the query.

4. The query `cousin` is defined using a single recursive rule, with four variables in the body. This, therefore takes $O(n^4)$ steps to evaluate. `relative` has at most three variables in the recursive rules and therefore takes $O(n^3)$ steps. `dcousin` has two variables in its rule body, and an $O(n^4)$ query inside a negation. It therefore requires $O(n^6)$ steps.